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"STRENGTHENING FOOD AND FEED SECURITY AND ENERGY SUSTAINABILITY TO ENHANCE COMPETITIVENESS"

UNIVERSITAS LAMPUNG

PERTETA

Agricultural & Biological Engineering

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OF ISAE INTERNATIONAL SEMINAR
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AUGUST 10-12, 2017

"Strengthening Food and Feed Security and Energy Sustainability to Enhance Competitiveness"

DEPARTEMENT OF AGRICULTURAL ENGINEERING
FACULTY OF AGRICULTURE
UNIVERSITY OF LAMPUNG

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OF ISAE INTERNATIONAL SEMINAR BANDAR LAMPUNG AUGUST 10-12, 2017

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PREFACE

Alhamdulillahirabbil'alamin, I would like to express how grateful we are to finished "Proceeding of ISAE International Seminar 2017, Bandar Lampung, August 10-12, 2017 with theme "Strengthening Food and Feed Security and Energy Sustainability to Enhance Competitiveness". We are here to communicate and gather dissemination of information and research results in the field of agriculture as part of planning the development of agriculture in the future towards food and biomass-based energy self-sufficiency. Through this proceeding, we shared the problem, ideas, knowledge and technology to arrange solutions that communicated and discussed at ISAE International Seminar, Bandar Lampung, August 10-12, 2017. This proceeding contains 118 papers that divided by 8 categories namely Agricutural Engineering, Agribussiness, Agricutural Technology, Agricutural Science, Energy, Food, Natural Resources, and Sistem and Agricultural Management from many universities and many institutes in Indonesia.

I would like to extend gratitude for all authors of the proceeding who communicated and shared their research results, editorial team who work together to executed this proceeding, Agricultural Engineering Departement of University of Lampung, Faculty of Agriculture of University of Lampung, University of Lampung, PERTETA and committee members. Salutations to Dr. Ir. Sam Herodian, M.S. as Profressional Staff of The Minister of Agriculture of Republic of Indonesia; Ir. Sutono, MM as Regional Secretary of Lampung Province; Prof. Dr. Ir. Hasriadi Mat Akin, M.P. as Rector University of Lampung; Prof Dr. Ir. Irwan Sukri Banuwa, M.Si. as Dean of Agricultural Faculty of University of Lampung; Prof. Mikio Umeda from Kyoto University, Japan; Prof. Dr. Ir. Irwandi Jaswir, M.Sc. from International Islamic University, Malaysia; Dr. S. D. Filip To, PHD. PE from Mississippi State University, USA; Dr. Rosanna Marie C. Amongo from University of the Philippines Los Baños, The Philippines; Prof. Dr. Ir. Lilik Sutiarso, M.Eng. from Universitas Gadjah Mada, Indonesia; and Prof. Raden Achmad Bustomi Rosadi, M.S. from University of Lampung.

Last, we hope that you will have a great memories about the experience in Bandar Lampung and the relationship that have managed at Seminar can become better in the future.

Best Regard,

Dr. Ir. Sandi Asmara, M.Si
Chairman of ISAE IS 2017

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A

AGRICULTURAL ENGINEERING

A.1

EVALUATION OF THE PERFORMANCE OF PNEUMATIC CONVEYING RECIRCULATED DRYER FOR DRYING OF FLOURS MATERIALS

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ABSTRACT

The development of Pneumatic Conveying Dryer (PCD) or flash dryer for drying out high water-containing flour materials can be implemented by continuously recycling the materials. The recirculation process may increase the residence time of the materials, and reduce the length of drying pipes (the dryer's height) on PCD machine. In this research, the PCD machine had been developed into Pneumatic Conveying Recirculated Dryer (PCRD) with LPG fuel. The objective of this research was to evaluate the performance of PCRD machine in order to determine effects of drying process variable variations on values of Effective Heat Efficiency (EHE), Heat Utilization Factor (HUF), and Coefficient of Performance (COP) using mathematical and statistical analysis. The mathematical analysis result from variation of drying process variable obtains HUF value of 70.383%, EHE at 78.819% and COP at 29.617%. The mathematical analysis result suggests that HUF value is greater than COP's. It shows that the use of heat in the dryer is considerably effective. The smaller the COP value, the better the dryer's performance. The results of statistical analysis with one-way anova test show that variable variations significantly affecting EHE are drying air temperature (T_{u3}), the length of the recirculation or drying pipes (L_p), the diameter of outlet pipe on recirculation cyclone (D_{Acrb}), and the blower's air velocity on recirculation cyclone (V_{ucrb}). Meanwhile, the variable variations significantly affecting HUF and COP are v_u, L_p, and D_{Acrb}. It demonstrates that PCRD machine has a good performance, making it suitable for use in the drying process of flour materials with high moisture content.

Keywords : COP, EHE, flour, HUF, performance, pneumatic conveying recirculated dryer.

I. INTRODUCTION

The development of Pneumatic Conveying Dryer (PCD) or flash dryer for drying out high-containing flour materials can be implemented by continuously recycling the materials. The recirculation process may increase the residence time of the materials, and reduce the length of drying pipes (the dryer's height) on PCD machine. The research on Pneumatic Conveying Dryer (PCD) machine has been conducted by [1], [2], [3], [4], [5], and [6]. However, these studies do not involve the continuous materials recirculating process, such as the pipe's length and recirculated cyclone-shaped manifold. In this research, PCD machine had been developed into Pneumatic Conveying Recirculated Dryer (PCRD) with LPG fuel. The analysis result conducted by [7] has obtained PCRD machine performance based on the average value of gas fuel (E_{bbg}) of 945.80 kJ, and electrical energy (E_m) of 1074.24 kJ, which is used for 427.78 seconds (7.13 minutes). The required fuel gas power is 23.047 kJ/s, with dryer'sheat flow rate (q_u) of 17.29 kJ/s. The analysis results show that the average values of Specific Energy Utilization (SEU) and heating efficiency obtained on the PCRD machine are 10730.29 kJ/kg and 76.73%.

The drying performance based on the values of HUF, COP, and EHE performed by [8] has evaluated the performance of trolley dryer for drying up rice, [9] evaluated the performance characteristics of solar cooker cum dryer, and [10] evaluated the performance of modified green house dryer. These results suggest that evaluation of PCRD machine's performance on HUF, COP, and EHE has never been done, making it a novelty in this research.

The objective of this research was to evaluate the performance of PCRD machine in order to determine effects of variation of drying process variables on values of Heat Utilization Factor (HUF), Effective Heat Efficiency (EHE), and Coefficient of Performance (COP).

II. MATERIALS AND METHODS

A. Materials and Equipments

The materials used in this research were wet sago starch obtained from Tulung, Klaten, Central Java. Sago starch mass used was 81 kg. The sago starch was produced from sago tree (*Metroxylon sagus rottb* or *Metroxylon rumphii Mart*) through the process of size reduction and extraction process. The sago starch generally has a moisture content of 45-50% wb. The main equipment used was the PCRD machine produced in this research. The schematic illustration of PCRD machine can be seen in Fig. 1. The PCRD machine comprised of seven main components (units), namely LPG-fueled heating stove, disintegrator (centrifugal blower with 3 phase electric motor drive, 380V, 2 hp), input feeder (geared cylinder with 1 phase electric motor drive, 220V, 1 hp), recirculated-shape drying pipe (vertical and horizontal), manifold (recirculation cyclone and materials separator, and centrifugal blower with 1 phase electric motor drive, 220V, 1 hp), materials output cyclone, and control panel. Meanwhile, others aids used were ESTICO manual hydraulic, Lutron TM 946 digital thermometer, Krisbow KW06-291 digital hygrometer meters, Krisbow airflow meter, Lutron Tacho meters, OHAUS three-digit digital scales, and Memmert electric oven. The various drying process variables on PCRD machine can be seen in Table 1. The varied variables were 9. Each variable was put into variation 3 times, with 3 repetitions.

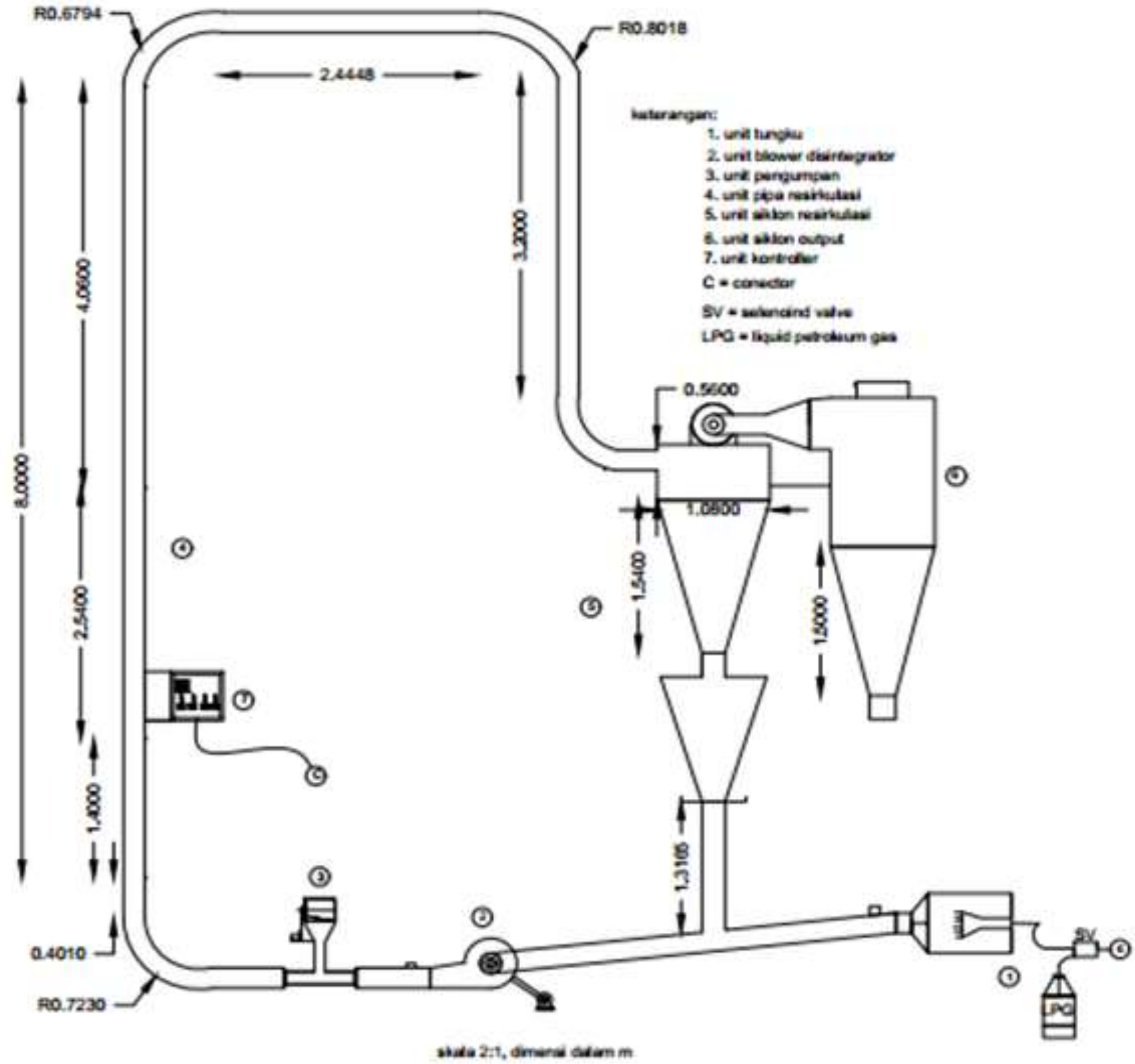

Fig. 1. A schematic drawing of PCRD machine

Table 1. Variable and Variation Value on PCRD Machine

Variation of Drying Process Variables	Symbol	Value of Variation	Units
Initial moisture content of materials	M_{ib}	21, 31, 41	%wb
Drying air velocity	v_u	15, 28, 31	m/s
Drying air temperature	T_{u3}	75, 100, 125	°C
Resirculation pipe length	L_p	9.38, 11.38, 13.38	m
Recirculation cyclone cylinder height	L_{scrb}	0.27, 0.54, 0.81	m
Outlet pipe diameter on recirculation cyclone	D_{Ascrb}	0.1016, 0.17, 0.22	m
Outlet pipe length on recirculation cyclone	L_{Acrb}	0.2, 0.37, 0.65	m
Blower's air velocity on recirculation cyclone	v_{ucrb}	10.75, 12.75, 15.75	m/s
Materials input capacity	Q_{ib}	0.00208, 0.00278, 0.00417	kg/s

B. Mathematical Analysis

The performance of dryer can be evaluated based on the values of Heat Utilization Factor (HUF), Coefficient of Performance (COP), and Effective Heat Efficiency (EHE). HUF is the decreasing temperature ratio due to air cooling during the drying, and temperature rise due to air heating ([8], [9], [10], [11], [12]).

$$HUF = \frac{T_{u3} - T_{op}}{T_{u3} - T_{ling}} x100\% \quad (1)$$

where T_{u3} is the dryer's air temperature (°C), T_{op} is the air temperature coming out of the dryer (°C), T_{ling} is ambient (environment) air temperature (°C).

Coefficient of Performance (COP) is the difference of air temperature coming out of the dryer (T_{op}) with ambient temperature (T_{ling}) divided by dryer's air temperature (Tu_3) and ambient temperature (T_{ling}). In the opinion of [11] and [12], the relationship between HUF and COP is HUF = 1- COP, or HUF+COP= 1. In this research, COP value is expressed by Equation 2 ([8], [11]).

$$COP = \frac{T_{op} - T_{ling}}{T_{u3} - T_{ling}} x100\% \quad (2)$$

where T_{op} is the air temperature coming out of the dryer (°C), T_{ling} is ambient (environment) air temperature (°C), and T_{u3} is the dryer's air temperature (ºC).

Effective Heat Efficiency (EHE) can be viewed as sensible heat in drying air, as an effective heat for drying [11]. In this research, EHE values are calculated based on Equation 3 ([8], [11]).

$$EHE = \frac{T_{u3} - T_{op}}{T_{u3} - T_{wib}} x100\% \quad (3)$$

where T_{u3} is the dryer's air temperature (°C), T_{op} is the air temperature coming out of the dryer (°C), and T_{wib} is the air temperature of wet bulb (°C).

C. Statistical Analysis

In order to determine effects of each variable's variation on HUF, COP, and EHE, statistical analysis was performed using one-way anova test and Duncan's advanced test. The assumption or hypothesis used is the initial hypothesis (H_o): there is no difference on the average result of variable's treatment on HUF, COP, and EHE. And the alternative hypothesis (H_a): there is a difference of average result of variable's treatment on HUF, COP, and EHE, with the level of significance (α) 0.05. Anova analysis was also used by [13] to evaluate the performance and use of impinging stream dryer energy.

III. RESULTS AND DISCUSSION

The mathematical and statistical analysis results using one-way anova testing on the effects of drying process variables on PCRD machine on the values of HUF, COP, and EHE will be presented in Fig. 2, 3, and 4. The HUF value obtained from the mathematical analysis using Equation 1 is 65-80%, with values of T_{op}, T_{u3}, T_{ling} of 50-58^{0}C, 75-100^{0}C, and 28-35^{0}C, respectively. The graph of effects of variation variables of PCRD machine on HUF can be seen in Fig. 2. Meanwhile, HUF value on several drying machines, such as trolley cum batch dryer is 52% (Alam and Sehgal, 2014), solar cooker cum dryer is 0.1-0.57 or 10-57% ([9]), and the green house dyer is 0.12-0.53 or 12-53% ([10]). In the opinion of [12], the HUF value is the ratio between the temperature drop due to air cooling caused by the use of heat in the dryer, and the temperature rise caused by air heating during the drying process. The HUF value is greater than the COP's because it is the value of heat use in the dryer.

The graph of effects of variation variables on the PCRD machine on COP can be seen in Fig. 3. The graph indicates that the COP value in the drying process using PCRD machine is between 20-25%. The value of COP is obtained from the mathematical analysis using Equation 2 with T_{op}, T_{ling} and T_{u3} of 50-58^{0}C, 75-100^{0}C, and 28-

35^{0}C, respectively. Meanwhile the COP value of several drying machines are: trolley-cum-batch dryer for drying up grain is 51.5% ([8]), solar cooker cum dryer is 0.43-0.8 or 43-80% ([9]), and the green house dryer is 0.55-0.87 or 55-87% ([10]). According to [11], the smaller the COP value, the better the performance of a drying machine.

It is because if the exit air temperature is equal to the ambient air temperature, the drying process is considered good – as the entire heat exhaled from the incoming temperature can be absorbed completely by the dryer, sothat its performance in utilizing heat will be good also. The sum of HUF and COP values equals to one.

The graph of effects of variation variables on PCRD machine on EHE can be seen in Fig. 4. The graph shows that the EHE value of the drying process on PCRD machine is between 70-90%. The EHE value is obtained from mathematical analysis using Equation 3 with values of T_{op}, T_{wib} and $T_{u3}$of 50-58^{0}C, 38.6^{0}C and 75-100^{0}C, respectively. The EHE value in trolley cum batch dryer is 40.4% ([8]). According to [11], EHE value considers the sensible heat in the dryer's air as the effective heat for drying.

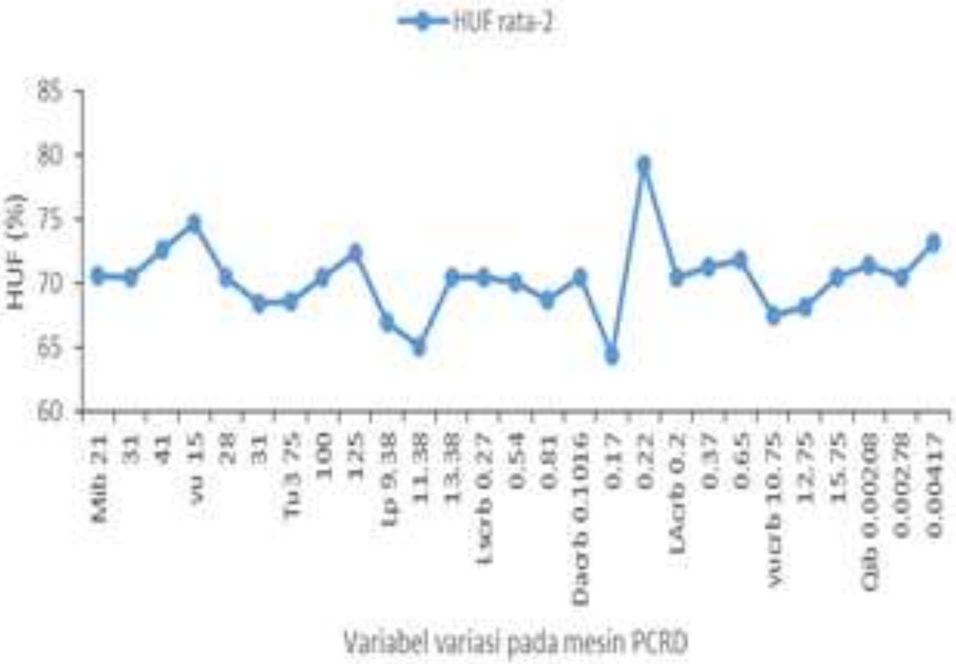

Fig. 2. Effect of drying process variable of PCRD machine on HUF

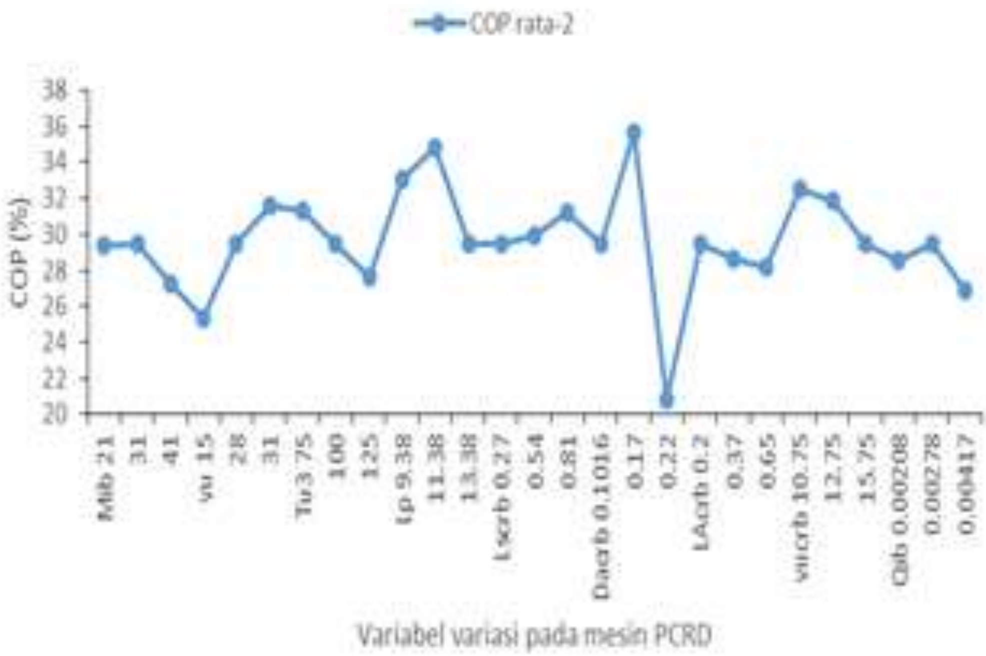

Fig. 3. Effect of drying process variable of PCRD machine on COP

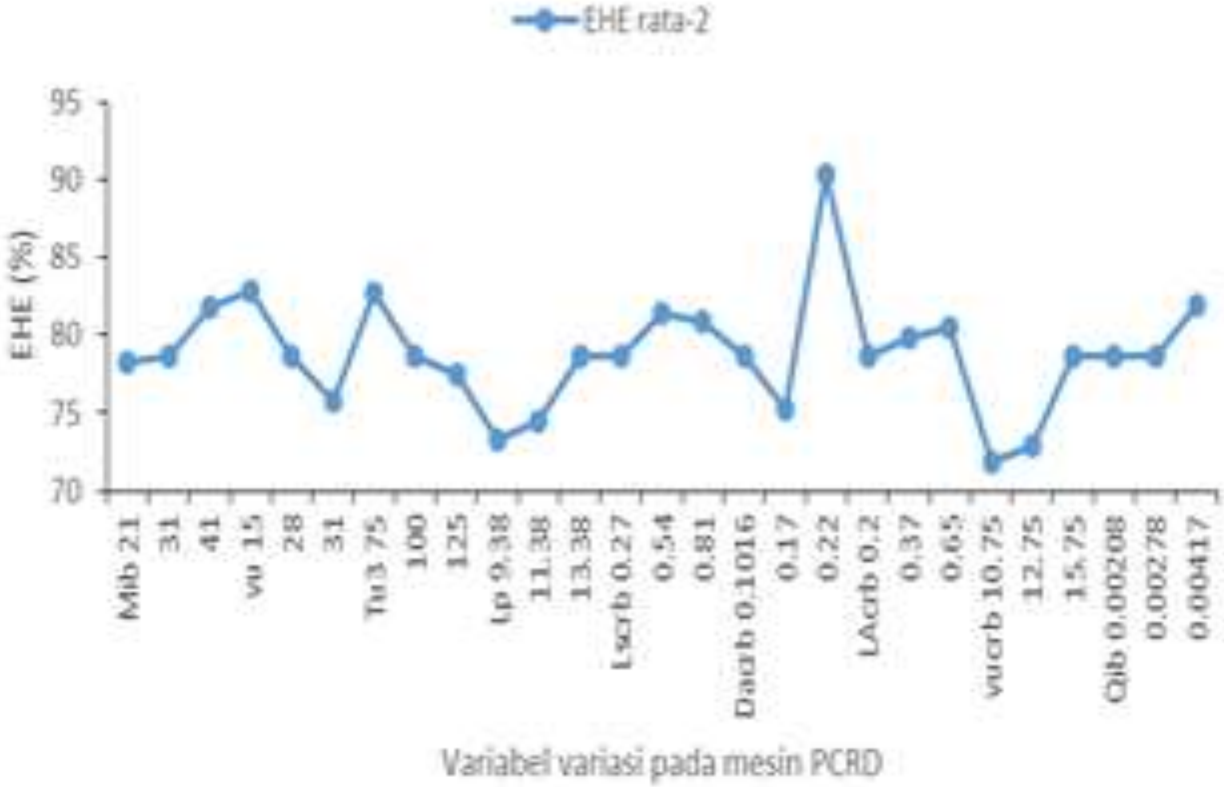

Fig. 4. Effect of drying process variable of PCRD machine on EHE

The significance level of each variation variable (M_{ib}, v_u, T_{u3}, L_p, L_{scrb}, D_{Acrb}, L_{Acrb}, v_{ucrb}, and Q_{ib}) of PCRD machine on HUF, COP, and EHE values based on statistical analysis using anova test and Duncan's advanced test can be seen in Table 2. Table 2 shows that the variables M_{ib}, L_{scrb}, L_{Acrb}, and Q_{ib} have no significant effect on HUF, COP, and EHE.

Table 2. Effects of Variation Variable on HUF, COP and EHE

Parameter of Performance on PCRD Machine	Drying Process Variable								
	M_{ib}	v_u	T_{u3}	L_p	L_{scrb}	D_{Acrb}	L_{Acrb}	v_{ucrb}	Q_{ib}
HUF	b	a	b	a	b	a	b	b	b
COP	b	a	b	a	b	a	b	b	b
EHE	b	b	a	a	b	a	b	a	b

Note: [a] significant, [b] not significant

A. Effects of Initial Moisture Content of Materials (M_{ib}) on HUF, COP, and EHE

The anova test result of M_{ib} effect on HUF shows that the probability value of significance is 0.388. As the value is 0.388>0.05, Ho is accepted and Ha is rejected, which means there is no significant difference in average treatment of M_{ib} variation (21, 31, and 41% wb) on HUF. Based on the Duncan test, further test results show that there is no different groups. The anova test result of M_{ib}effect on COP shows that the probability value of significance is 0.388. As the value is 0.388>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in average treatment of M_{ib}variation (21, 31, and 41% wb) to COP. Based on the Duncan test, further test results show that there is no different group. The anova test result of effects of M_{ib} on EHE shows that the probability value of significance is 0.222. As the value is 0.222>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in average treatment of M_{ib} variation (21, 31, and 41% wb) on EHE. Based on the Duncan test, further test results show that there is no different group.

B. Effect of drying air velocity (v_u) on HUF, COP, and EHE

The anova test result of v_u effect on HUF shows that the probability value of significance is 0.036. As the value is 0.036<0.05, Ho is rejected and Ha accepted. That is, there is a significant difference in average treatment of v_u variation (15, 28, and 31 m/s) on HUF. Based on the Duncan test, further test results show that there are two different groups, i.e. v_u 31 with 28 m/s, and v_u 28 with 15 m/s. The anova test result of effects of v_u on COP shows that the probability value of significance is 0,036. As the value is 0.036<0.05, Ho is rejected and Ha is accepted. That is, there is a significant difference in the average treatment of v_u variations (15, 28, and 31 m/s) on COP. Based on the Duncan test, further test results show that there are two different groups, i.e. v_u 15 with 28 m/s, and v_u 28 with 31 m/s. The anova test result of v_u effect on EHE shows that the probability value of significance is 0.081. As the value is 0.081> 0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in average treatment of v_u variations (15, 28, and 31 m/s) on EHE. Based on the Duncan test, further test results show that there are two different groups, i.e.v_u 31 with 28 m/s, and v_u 28 with 15 m/s.

C. Effects Drying Air Temperature (T_{u3}) on HUF, COP, and EHE

The anova test result of effects of T_{u3} on HUF shows that the probability value of significance is 0.064. As the value is 0.064>0.05, Ho accepted and Ha rejected. That is, there is no significant difference of average treatment of T_{u3} variations(75, 100, and 125^{0}C) on HUF. Based on the Duncan test, further test results show that there are two different groups, i.e. T_{u3} 75 with 100^{o}C, and T_{u3} 100 with 125^{o}C. The anova test result of T_{u3} effect on COP shows that the probability value of significance is 0,064. As the value is 0.064>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of Tu3 variations (75, 100, and 125^{o}C) on COP. Based on the Duncan test, further test results show that there are two different groups, i.e. T_{u3} 125 with 100^{o}C, and T_{u3} 100 with 75^{o}C. The anova test result of T_{u3} effect on EHE shows that the probability value of significance is 0,028. Asthe value is 0.028<0.05, Ho is rejected and Ha accepted. That is, there is a significant difference in the average treatment of T_{u3} variation (75, 100, and 125^{o}C) on EHE. Based on the Duncan test, further test results show that there are two different groups, namely T_{u3} 125 with 100^{0}C, and T_{u3} 100 with 75^{o}C.

D. Effects of Recirculation Pipeline Length (L_p) on HUF, COP, and EHE

The anova test result of L_p effect on HUF shows that the probability value of significance is 0,009. As the value is 0.009<0.05, Ho is rejected and Ha is accepted. That is, there is a significant difference in average treatment of L_p variation (9.38, 11.38, and 13.38 m) on HUF. Based on the Duncan test, further test results show that there are two different groups, i.e. L_p 11.38 with 9.38 m, and L_p 13.38 m. The anova test result of effects of L_p on COP shows that the probability value of significance is 0.009. As the value is 0.009 <0.05, Ho is rejected and Ha accepted. That is, there is a significant difference in average treatment of L_p variations (9.38, 11.38, and 13.38 m) on COP. Based on the Duncan test, further test results show that there are two different groups, i.e. L_p 13.38 m, and L_p 9.38 with 11.38 m. The anova test result of L_p effect on EHE shows that the probability value of significance is 0.036. As the value is 0.036<0.05, Ho is rejected and Ha accepted. That is, there is a significant difference in average treatment of L_p variations (9.38, 11.38, and 13.38 m) on EHE. Based on the Duncan test, further test results show that there are two different groups, i.e. L_p 9.38 with 11.38 m, and L_p 13.38 m.

E. Effects of Recirculation Cyclone Cylinder Height (L_{scrb}) on HUF, COP, and EHE

The anova test result of L_{scrb} effect on HUF shows that the probability value of significance is 0.386. As the value is 0.386>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in average treatment of L_{scrb}variations (0.27, 0.54, and 0.81 m) on HUF. Based on the Duncan test, further test results show that there is no different group. The anova test result of L_{scrb} effect on COP shows that the probability value of significance is 0.386. As the value is 0.386>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in average treatment of L_{scrb} variations (0.27, 0.54, and 0.81 m) on COP. Based on the Duncan test, further test results show that there is no different group. The anova test result of L_{scrb} effect on EHE shows that the probability value of significance is 0.333. As the value is 0.333>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of L_{scrb} variations (0.27, 0.54, and 0.81 m) on EHE. Based on the Duncan test, further test results show that there is no different group.

F. Effects of Outlet Pipe Diameter on Recirculation Cyclone (D_{Acrb}) on HUF, COP, and EHE

The anova testing result of D_{Acrb} effect on HUF shows that the probability value of significance is 0.000. As value is 0.000<0.05, Ho is rejected and Ha is accepted. That is, there is a significant difference on average treatment of D_{Acrb} variations (0.1016, 0.17, and 0.22 m) on HUF. Based on the Duncan test, further test results show that there are two different groups, namely D_{Acrb} 0.17, 0.1016, and 0.22 m. The anova testing result of D_{Acrb} effect on COP shows that the probability value of significance is 0.000. As the value is 0.000<0.05, Ho is rejected and Ha is accepted. That is, there is a significant difference in the average treatment of D_{Acrb}variation (0.1016, 0.17, and 0.22 m) on COP. Further test results show that based on the Duncan test, there are three different groups. Based on the Duncan test, further test results show that there are two different groups, namely D_{Acrb} 0.22, 0.1016, and 0.17 m. The anova testing result of D_{Acrb}effect on EHE shows that the probability value of significance is 0.000. As the value is 0.000 <0.05, Ho is rejected and Ha is accepted. That is, there is a significant difference in the average treatment of D_{Acrb} variations (0.1016, 0.17, and 0.22 m) on EHE. Based on the Duncan test, further test results show that there are two different groups, namely D_{Acrb} 0.17 with 0.1016 m, and D_{Acrb} 0.22 m.

G. Effects of Outlet Pipe Length on Recirculation Cyclone (L_{Acrb}) on HUF, COP, and EHE

The anova testing result of L_{Acrb} effect on HUF shows that the probability value of significance is 0.933. As the value is 0.933> 0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of L_{Acrb} variations (0.20, 0.37, and 0.65 m) on HUF. Based on the Duncan test, further test results show that there is no different group. The anova testing result of L_{Acrb} effects on COP shows that the probability value of significance is 0.933. As the value is 0.933>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of L_{Acrb} variations (0.2, 0.37, and 0.65 m) on COP. Based on the Duncan test, further test results show that there is no different group. The anova testing result of L_{Acrb} effect on EHE shows that the probability value of significance is 0.904. As the values is 0.904>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of L_{Acrb} variations (0.2, 0.37, and 0.65 m) on EHE. Based on the Duncan test, further test results show that there is no different group.

H. Effects of Blower's Air Velocity on Recirculation Cyclones (v_{ucrb}) on HUF, COP, and EHE

The anova testing result of v_{ucrb} effect on HUF shows that the probability value of significance is 0.239. As the value is 0.239>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of v_{ucrb} variations (10.75, 12.75, and 15.75 m/s) on HUF. Based on the Duncan test, further test results show that there is no different group. Anova testing results of v_{ucrb} effect on COP shows that the probability value of significance of 0.239. As the value is 0.239>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of v_{ucrb} variations (10.75,12.75, and 15.75 m/s) on COP. Based on the Duncan test, further test results show that there is no different group. The anova testing result of v_{ucrb} effect on EHE shows that the probability value of significance is 0.021. As the value of 0.021<0.05, Ho is rejected and Ha accepted. That is, there is a significant difference in the average treatment of v_{ucrb} variations (10.75, 12.75, and 15.75 m/s) on EHE. Based on the Duncan test, further test results show that there are two different groups, namely v_{ucrb} 10.75 with 12.75 m/s, and v_{ucrb} 15.75 m/s.

I. Effects of Materials Input Capacity (Q_{ib}) on HUF, COP, and EHE

The anova testing result of Q_{ib} effect on HUF shows that the probability value of significance is 0.573. As the value is 0.573>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in average treatment of Q_{ib} variations (0.00208, 0.00278, and 0.00417 kg/s) on HUF. Based on the Duncan test, further test results show that there is no different group. The anova testing result of Q_{ib} effect on COP shows that the probability value of significance is 0.573. As the value is 0.573>0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the mean treatment of Q_{ib} variation (0.00208, 0.00278, and 0.00417 kg/s) on COP. Based on the Duncan test, further test results show that there is no different group. The anova test result of Q_{ib} effect on EHE shows that the probability value of significance is 0.475. As the value is 0.475<0.05, Ho is accepted and Ha is rejected. That is, there is no significant difference in the average treatment of Q_{ib} variations (0.00208, 0.00278, and 0.00417 kg/s) on EHE. Based on the Duncan test, further test results show that there is no different group.

IV. CONCLUSION

The values of HUF, COP, and EHE obtained based on effects of variation variables on PCRD machine are 65-80%, 20-25%, and 70-90%. The variables that significantly affect HUF and COP are v_u, L_p, and D_{Acrb}. Meanwhile, the variables that significantly affect EHE are T_{u3}, L_p, and D_{Acrb}. It indicates that PCRD machine has proper performance for use in the drying process of flour materials.

NOMENCLATURE

D	diameter	m
L	length	m
M	moisture content	%wb
Q	capacity	kg/s
T	temperature	°C
v	velocity	m/s

Greek letters

α	the level of significance	-

Subscripts

b	materials	p	pipe
c	cyclone	r	recirculation
i	input	s	sylinder
o	output	u	air

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REFERENCES

[1] W. Namkung and M. Cho, “Pneumatic drying of iron ore particles in a vertical tube,” *Drying Technology* , vol. 22(4), pp. 877-891, 2005.

[2] N. Tippayawong, C. Tantakitti, and S. Thavornun, “Energy efficiency improvements in longan drying practice,” *Energy*, vol. 33, pp. 1137-1143, 2008.

[3] K.R. Ajao and I.K. Adegun, “Performance evaluation of a locally fabricated mini cassava flash dryer. *Journal of Agricultural Technology,”* vol. 5(2), pp. 281-289, 2009.

[4] D. Tolmac, Z. Blagojevic, S.Prvulovic, J. Tolmac, and L. Radovanovic, “Experimental study on drying kinetic and energetic characteristics of convection pneumatic dryer,” *Facta Universitatis*, vol. 8, pp. 89-90, 2010.

[5] J.N.W. Karyadi, Y.F. Primawati dan N. Bintoro, “Proses pengerigan singkong (Manihot esculenta crantz) parut dengan menggunakan pneumatic dryer,” in *Proc.* National Seminar PERTETA, Denpasar, July, 13-14, 2012.

[6] Suherman, A.C. Kumoro, dan T.D. Kusworo, “Experimental study on drying kinetic of cassava starch in a pneumatic drying system,” in *Proc. International Conference of Chemical and Material Engineering (ICCME)*, 2015.

[7] A. Jading, B. Nursigit, L. Sutiarso, and J.N.W. Karyadi, “Efficiency analysis of pneumatic conveying recirculated dryer for drying of flour materials,” in *manuscript National Seminar of Faculty of Agricultural UPN Veteran Yogyakarta*, Dec. 10, 2016.

[8] M. S. Alam and V.K. Sehgal, “Development and evaluation of trolley-cum-batch dryer for paddy,” *IJAET*, vol. 7, pp. 756-764, July 2014.

[9] F.G. Sayyad, N.R. Sardar, J.P. Rathod, U.A. Baria, B.K. Yaduvanshi, B.P. Solanki, and J.J. Chavda, “Design and development of solar cooker cum dryer,” *An International Research Journal of Environmental Science*, vol. 10, pp. 985-993. Nov. 2015.

[10] O. Prakash, A. Kumar, and V. Laguri, “Performance of modified greenhouse dryer with thermal energy storage,” *Energy Reports*, vol. 2, pp. 155-162. July 2016.

[11] Chakraverty and D.S. De, *Post Harvest Technology*, New Delhi: Oxford & IBH Publishing Co., 1981.

[12] M. Pradhapraj and V. Velmurugan, “Experimental investigation of solar air heater with charcoal porous medium,” *Asian Journal of Scientific Research*, vol. 7, pp. 56-65. 2014.

[13] Nimmol and S. Devahastin, “Evaluation of performance and energy consumption of an impinging stream dryer for paddy,” *Applied Thermal Engineering*, vol. 30, pp. 2204-2212. June 2010.

A.2

FIELD PERFORMANCE OF RICE COMBINE HARVESTER PROTOTYPE FOR TIDAL SWAMP LAND

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ABSTRACT

Currently, the conversion rate of paddy fields to non-farm area in Java reaches 100,000 ha per year. On the other hand, rice consumption of Indonesian people increases until 1-2% a year. If rice consumption of Indonesian people is 135 kg per capita per year, there is a need of 38.49 million tons of rice per year. The addition of this rice production amount can be increased by utilizing the potential of swamp land (sub optimal land) which is spread over Sumatra, Kalimantan, Sulawesi, and Papua. The potential for large swamps requires agricultural mechanization. Application of paddy combine harvester is one solution to overcome the lack of labuor on harvesting. Development of harvesting machinery for tidal swamp land should pay attention to the physical characteristic of the land conditions. BBP-Mektan has developed a location-specific mini spot combine for tidal swamp land with a ground pressure value of 0.13 kg/cm^2 in 2015-2016. Combine engine performance test used SNI test method No. 8185:2015 with the main performance test parameters including capacity, efficiency, speed of work, and slip. From the research result, it was found that the prototype of mini combine rice harvesting machine for tidal swamp land can operate well in Types B tidal swamp land. Prototype of mini combine paddy harvesting machine for tidal swamp land had a capacity of 7.37 h/ha or equivalent to 0.14 ha/h, average working speed of 1.76 km/h, average slip of 0.63%, and the average working efficiency of 65.83%.

Keywords : performance test, paddy combine harvester, swamp land.

I. INTRODUCTION

The Ministry of Agriculture noted that the current rate of conversion of paddy fields to non-sawah in Java reaches 100,000 ha per year. This depreciation rate is certainly not comparable with the addition of new paddy fields of about 37,000–45,000 hectares per year. On the other hand, the increase of Indonesian people's rice consumption reaches 1-2% per year. Assuming that rice consumption is 135 kg per capita per year, then 38.49 million tons of rice has to be provided annually. Technological innovation, production facilities, expansion of planting areas, and development new paddy fields are examples effort to increase national rice production.

The remaining land for agricultural development is sub-optimal land that requires high inputs with low accessibility, including dry land soils, dry climate dry lands, peat swamps, tidal swamp lands and degraded lands (Masganti, 2013; Sawiyo, et al., 2000).

The addition rice production can be enhanced by developing the potential of swamp land (sub optimal land) which spread over the islands of Sumatra, Kalimantan, Sulawesi, and Papua. According to Haryono (2013), the area of swamp land that has been utilized for agricultural land is approximately 2.270 million Ha (23.8%), the remaining 7.26 million ha (76.2%) has not been utilized. Some agricultural research have indicated that tides processing in tidal fields can increase yield (Noorsyamsi and Hidayat, 1973 and Anwarham, 1989).

Tidal land is a land whose water regime is affected by sea or river tides, whereas Lebak is a land regime that is affected by rainfall, either down in the local area or in the surrounding area and upstream of the river (Wayan, 2005).

The potential for large swamps requires the mechanization of agricultural machinery and equipment. Mechanization contribution is expected to suppress working times (Umar and Linda, 2010). Application of harvesting machines is one of solution to overcome the deficiency of labor harvesting. Some advantages of using a harvesting machine are: (a) increasing the capacity and efficiency of harvesting, (b) reducing fatigue, (c) decrease harvest costs, (d) reducing harvest losses, (e) improving crop quality. (Prabowo, 2011). Because the quality and quantity of yield will decrease when the harvest is late (Junsiri and Chinsuwan, 2009).

Development of agricultural machinery and equipment in addition to increasing the area can also increase productivity and resource efficiency, reduce yield loss and increase product value-added (Jumberi and Alihamsyah, 2005).

Combine harvester is a large-scale harvesting tool having capacity about 2 h/ha. The combine harvester suppresses losses by up to 2.0% (Umar, 2014).

Development of combine harvester for tidal swamp land should consider to the physical characteristic of the land. Low ground resistance due to the fragile soil texture due to continuous waterlogging can drown the engine while operating on it. In addition to low ground pressure, the engine sink can also be caused by ground damage by tread movement when turning (Book and Goering, 2000; Taghavifar and Mardani, 2013 in Mardison, 2015).

Harvest requires a work force of 30–50 man-days/ha whereas using a combine harvester machine only needs 1 driver and 2 assistants for combining grain pads and for collecting rice bag. Combine harvester machine has a capacity of about 4–6 h/ha and in one day the machine is able to complete harvesting about 2–3 ha in average (Anonymous, 2012; BBP Mektan, 2013). In addition, the harvest loss is less than 2%, lower as compared to about 3% of grain loss during traditional harvest, threshing and transportation (BPS, 2007). Production shrinkage from traditional harvest reaches 11%, whereas using combine harvester machine is only 2% maximum (Prayoga, 2011).

The Agricultural Research Agency (through BBP Mektan) in 2012 to 2014 through a series of re-engineering and modification process of existing combine engines has produced a prototype of rice harvesting machine called Indo Combine Harvester with an advantage of low ground pressure (0.13 kg/cm^2) and Mini Combine Harvester with ground pressure of 0.11 kg/cm^2. Both prototypes are very suitable to the condition of the rice fields in Indonesia. In the Year 2015 BBP Mektan has also produced a prototype of combine harvester rice for tidal swamp land. This machine has the same ground pressure value with the Indo Combine Harvester 0.13 kg/cm^2.

The prototype formed from the fabrication of combine harvester for tidal swamp land (activity of 2015) should be analyzed its performance at a specific location in selected tidal rice field Indonesia. Therefore, the harvesting machine test is very important. The purpose of this activity is to evaluate the performance of prototype of mini combine rice harvesting machine for tidal swamp land.

II. MATERIALS AND METHODS

Testing of mini combine rice harvesting machine for tidal swamp land was conducted in September 2016. Implementation of the test was conducted in the village of Sungai Batang, Sub-district of Martapura Barat, South Kalimantan Province.

Equipment used is tachometer, grain moisture tester, sound level meter, cone penetrometer, thresher ability gauge, fine scales, rough scales, measuring cylinders, gauge, slider, stopwatch.

The mini combine-type paddy machine tested has specifications as in Table 1 and Fig. 1.

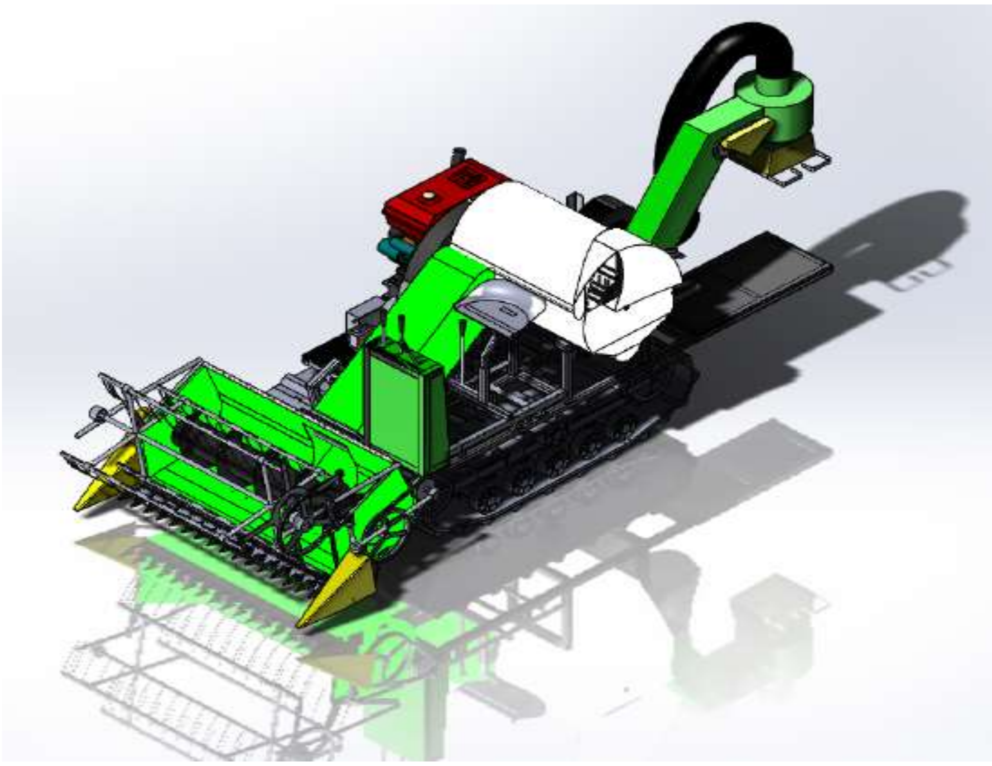

Fig. 1. Mini Combine Harvest Machine for Tidal Swamp Land

Table 1. Specification Mini Combine Rice Harvesting Machine for Tidal Swamp Land

Specification	Value	Unit
Prototype dimension		
Length	3,535	mm
Width	1,730	mm
Height	1,800	mm
Ground clearance	190	mm
Reel guide		
Diameter	590	mm
Width	1,200	mm
Cutter bar		
Length	75	mm
Width	75	mm
Height	3	mm
Theoretical work width	1,130	mm
Threshing unit		
Threshing drum dimension		
-Diameter	375	mm
-Length	800	mm
Type	Hexagonal	
Threshing blade dimension :		
-Diameter	8	mm
-Length	550	mm

Preparation testing of mini combine rice harvesting machine for tidal swamp land begins with the identification and characteriation of swamp land located in the province of South Kalimantan. This step is performed to determine the character of the swamp lands to be used as test grounds. Tidal swamp land is divided into four types of overflow (Widjaja Adhi et al., 1992; Noor, 2004), namely: Flood type A, Flood type B, Flood type C, and Flood type D. Each type of swamp land is limited by the extent of standing water. As the initial stage, identification will be done for farm road, accessibility, traffic ability, bearing capacity.

The mini combine harvesting machine test for tidal swamp land is carried out by adaptation method at Tidal swamp land Type B, this performance test is referred to SNI 8185:2015. The test parameters for performance test of mini combine rice harvesting machine for tidal swamp land are: working speed of harvest, effective field capacity, work efficiency, fuel consumption, and slip. In addition to the parameters of the performance of the machine, the condition of the plant is also measured with the parameter of plants, among others: spacing, plant density, plant height, plant length, the number of panicle, water content, puddle height, slope angle, and ratio of grain.

Evaluation and technical analysis of the performance of the combine machine prototype is performed after the adaptation test. Evaluation and analysis were performed to improve the performance of mini combine machine so that it can be operated on various topology of tidal swamp land.

Effective field capacity (ha/h)

$$\mathrm{EFC} = \mathrm{A/t} \tag{1}$$

where,
EFC = Effective field capacity (ha/h),
A = harvested area (ha)
t = harvesting time (h).

Working velocity

$$\mathrm{v} = {}^{\mathrm{S}}\!/_{\mathrm{t_1}} \tag{2}$$

where,
v = work velocity (m/s),
S = track distance (10 meter),
t_1= time to cover of distance 10 m (s).

Fuel Consumption

$$FC = \frac{FV}{t} \tag{3}$$

where
FC = fuel consumption (l/h),
FV = used fuel volume (l)
t = harvesting time (h)

Field Efficiency

$$\eta = \frac{EFC}{TFC} x100\% \tag{4}$$

$$TFC = 0.36\ w_t v_t \tag{5}$$

where
η = field efficiency (%),
EFC = Effective field capacity (ha/h),
TFC = theoretic field capacity (ha/h),
w_t = theoretic work width (m),
v_t = unloading velocity (m/s),
0.36 = unit correction factor.

III. RESULTS AND DISCUSSION

From the machine specifications it can be seen that the prototype of the mini combine rice harvesting machine for tidal swamp land has a ground pressure value of 0.13 kg/cm^2. With these values mathematically and simulated the prototype of this mini combine type of rice harvesting machine can be operated on swamp land that has a small soil sigh.

Identification and characteristics of the land is done in South Kalimantan location. South Kalimantan is a province whose territory is mostly swamp land in both tidal and lebak swamps, during the rainy season all the rice fields are inundated, on the tidal swamp land in Batang River, average water level 13.6 cm and the average foot sinkage depth of 10 cm so that the overall depth average of 23.6 cm, with the average depth of this tidal swamp land into type B.

In the development of tools and harvesting machines, the selection of designs should be tailored to the biophysical conditions of the land and the environment, among which are ground sanctions and high inundation during harvest. Both of these factors greatly affect the mobility of the harvesting machine used. From the measurement results using measuring instruments (Penetrometer) sanggah ground power in tidal swamp land of Sungai Batang Village, kec. Martapura Barat, South Kalimantan at 1.19 kg/cm^2.

The prototype of mini combine harvesters for tidal swamps has a ground pressure value of 0.13 kg/cm^2, with a ground value of 0.13 kg/cm^2 and a sanggah value of 1.19 kg/cm^2 mathematically prototype harvesting machine Mini combine type rice for tidal swamp land can operate on tidal swamp land at that location.

The performance test of mini combine rice harvesting machine for tidal swamp land is done on the tidal swampland rice field located in Batang River Village, Sub district of Martapura Barat, South Kalimantan, with maximum height of foot sink age and water is 300 mm, test site of tidal swamp land at that location is included in type B swamp land.

Land conditions during the test were wet and inundated with water levels between 10-18 cm, and a foot sink age depth of 10-20 cm, with ground sanction of 1.19 kg/cm^2 measured using a penetrometer. The condition of the plant during the test is the height of the crop 847 mm, the average grain water content of 21.52%, the weight of the average grain of 1.16 grams, with the average grain ratio of 35.3%, the complete data can be seen in Table 2.

From the field test results of the prototype of the mini combine rice harvesting machine for tidal swamp land is done in three average land area measuring 600 m^2, with RPM engine 2625 rpm. From the results of the field tests obtained the value of test parameters, among others: 1.13 m average cut width, average total working time of 26.51 minutes, the average working speed of 1.76 km/h, the average slip 0.63%, average working capacity of 7.37 h/ha or equivalent to 0.14 ha/h, average fuel consumption of 18 L/ha or 2.42 L/h, average efficiency of 65,83%, and average noise level 92,3 dB. The complete data can be seen in Table 3.

Table 2. Plant Condition on Test Land

No Ul.	Jarak tanam	Kerapatan tanam	Jumlah Malai/ rumpun	Tinggi tanaman *)	Panjang Tanaman **)	Tinggi Air	Sudut Kemiringan tanaman	Kadar Air Gabah	Bobot Gabah/ Malai	Gaya Lepas Gabah***)	Bobot Bahan padi	Berat Jerami		Bobot Gabah	Nisbah Gabah
	(cmxcm)	(rumpun/m2	(malai)	(cm)	(cm)	(cm)	)°	(%)	(g)	(g)	(g)	(g)	(%)	(g)	(%)
1	Broadcast	28	12	88	99	16	75	20.20	0.60	95	13.10	8.5	64.89	4.6	35.11
2		33	13	83	104	10	76	20.70	2.20	84	9.40	6.1	64.89	3.3	35.11
3		30	12	92	102	18	76	21.50	1.30	84	10.60	8.3	78.30	2.3	21.70
4		35	14	78	94.5	14	75	20.50	0.90	90	11.60	6.9	59.48	4.7	40.52
5		29	12	87	109	11	70	23.50	1.30	92	15.10	9.8	64.90	5.3	35.10
6		31	13	101	120	11	72	22.20	1.00	80	9.50	5.1	53.68	4.4	46.32
7		30	12	86	102	13	78	21.80	1.20	76	9.50	6.1	64.21	3.4	35.79
8		32	12	77	90	16	80	20.60	1.20	90	11.40	7.5	65.79	3.9	34.21
9		32	11	74	94	13	72	21.60	1.00	83	10.36	7.9	75.87	2.5	24.13
10		31	13	81	102	14	75	22.60	0.90	83	9.83	5.2	53.20	4.6	46.80
Rata-rata		31.1	12.4	84.7	101.65	13.6	74.9	21.52	1.16	85.7	11.04	7.1	64.7	3.9	35.3
Std			0.84	7.97	8.49	2.55	2.96	1.05	0.42	5.87	1.85	1.53	8.11	1.00	8.11
CV (%)			0.07	0.09	0.08	0.19	0.04	0.05	0.37	0.07	0.17	0.21	0.13	0.26	0.23

*) Tinggi batang jerami sampai malai merunduk
**) Panjang utuh dari pangkal sampai ujung
**) Gaya pelepasan butir 1 padi (1 skala = 1 gram)

Table 3. Average data and capacity analysis of rice harvesting machine mini combine type of tidal swamp land

No Ul.	Luasan Kerja	Lebar Hasil Pot.	Waktu kerja total	Kecepatan Kerja	Slip roda	Kapasitas Kerja		Konsumsi Bahan Bakar (solar)		Efisiensi	Bobot Gabah	
	(m^2)	(m)	(menit)	(Km/Jam)	(%)	(Ha/jam)	(Jam/ha)	(lt/jam)	(l/Ha)	(%)	(kg)	(kg/ha)
1	485.85	1.12	22.48	1.76	0.56	0.13	7.71	3.2	24.70	62.89	190.00	3,910.67
2	590.80	1.14	25.55	1.77	0.69	0.14	7.21	2.0	14.22	67.28	230.00	3,893.03
3	728.94	1.13	31.51	1.75	0.63	0.14	7.20	2.1	15.09	67.31	290.00	3,978.39
Rata-rata	**601.86**	**1.13**	**26.51**	**1.76**	**0.63**	**0.14**	**7.37**	**2.42**	**18.00**	**65.83**	**236.67**	**3,927.36**
Std	121.92	0.01	4.59	0.01	0.07	0.01	0.29	0.68	5.82	2.55	50.33	45.06
CV (%)	0.20	0.01	0.17	0.01	0.11	0.04	0.04	0.28	0.32	0.04	0.21	0.01

Tingkat kebisingan rata-rata : 92.3 dB
Kapasitas Kerja Teoritis : 0.21 Ha/jam 4.85 jam/ha

IV. CONCLUSION

1. The prototype of mini combine harvesting machine for tidal swamp land has a ground pressure of 0.13 kg/cm^2.
2. The prototype of the mini combine harvesting machine for tidal swamp land can operate well in the type B tidal swamp.
3. The prototype of mini combine rice harvesting machine for tidal swamp land has a capacity of 7.37 h/ha or equivalent to 0.14 ha/h, average working speed of 1.76 km/h, average slip of 0.63%, working efficiency of the machine is 65.83%.

REFERENCES

Anwarham, H. 1989. Bercocok Tanam Padi Pasang Surut dan Rawa. Pada Buku 2. Balai Penelitian Tanaman Pangan Banjarbaru. Pusat Penelitian dan Pengembangan Tanaman Pangan, Bogor.

Haryono. 2013. Lahan rawa Lumbung Pangan Masa Depan Indonesia. Badan Litbang Pertanian. Pasar Minggu. Jakarta.

Jumberi, A., Alihamsyah, T. 2005. Pengembangan Lahan Rawa Berbasis Inovasi Teknologi.Balitra.Prosiding Seminar Nasional. Inovasi Teknologi Pengelolaan Sumberdaya Lahan Rawa dan Pengendalian Pencemaran Lingkungan. Kalsel

Junsiri, C. and Winit Chinsuwan, 2009. Prediction equations for header losses of combine harvesters when harvesting Thai Hom Mali rice. Songklanakarin J. Sci. Technol. 31 (6), 613-620, Nov. - Dec. 2009.

Mardison, 2015. Pengembangan Prototipe Mesin panen Padi Tipe Mini Combine Kapasitas 14 jam/ha (uji kinerja), Laporan Akhir Kegiatan tahun 2015. BBP-Mektan. Serpong.

Masganti. 2013. Teknologi inovatif pengelolaan lahan sub-optimal gambut dan sulfat masam untuk peningkatan produksi tanaman pangan. Orasi Pengukuhan Profesor Riset Bidang Kesuburan Tanah dan Biologi Tanah. Badan Litbang Pertanian. 35 hal.

Noorsyamsyi dan O.O Hidayat, 1973. Pengaruh Pengolahan Tanah Terhadap Padi Pasang Surut dan Sawah Darat di Kalimantan. Lembaga Pusat Penelitian Pertanian. Bogor. 99 hlm.

Noor, M. 2004. Lahan Rawa. Sifat dan Pengolahan Tanah Bermasalah Sulfat Masam. PT. Raja Grafindo Persada Jakarta.

Prabowo, A. 2012. Pengembangan Desain Mesin Panen Padi Tipe Mini Combine Kapasitas 14 jam/ha untuk meningkatkan Efisiensi Kerja, Laporan Akhir Kegiatan tahun 2012. BBP-Mektan. Serpong

Prayoga, W. 2011. Combine harvester, bakal picu peningkatan beras. puskoptankarawang. blogspot.com/.../combine harvest.

Sawiyo, D. Subardja, dan D. Dajenudin. 2000. Potensi lahan rawa di daerah Kapuas Murung dan Kapuas Barat untuk pengembangan pertanian. Jurnal Penel. dan Pengembangan Pertanian 19(1): 9-16

Wayan, S. 2005, Potensi Dan Prospek Lahan Rawa Sebagai Sumber Produksi Pertanian, Analisis Kebijakan Pertanian. Volume 3 No. 2, Juni 2005 : 141-151

Umar, S, Linda I, 2010. Effisiensi Energi (Tenaga Kerja) dan Produksi pada Usah Tani Padi di Lahan Sulfat masam Potensial. Embryo vol 7. No 1.

Umar, S. 2014. Panen Padi dengan Mesin *Crown Combine Harvester* di lahan Rawa Pasang Surut Tipologi B. laporan Kunjungan Pelaksaan Panen di Kecamatan Anjir, Kabupaten Batola. 30 Juli 2014.

A.3

DESIGN AND MODELLING OF TEA PICKER MACHINE (*Camellia Sinensis* (L). Kuntze) TYPE RECIPROCATING SINGLE CUTTER WITH A BATTERY POWER SOURCE

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ABSTRACT

The research aimed at designing and modeling a tea picker machine with single reciprocating cutter. There are two design of tea picker that is tea picker with collection bag (model 1) and tea picker with collection box (model 2). The prediction model of work capacity, top tea qualified and top tea unqualified was developed with dimension analysis approach based on design and operation. Variables for model development are blade length (L), engine power (P), engine weight (W), container volume (υ), material density (ρ), rotation speed (μ), topography (S), picker speed (V) And shear modulus (E). Model validation for the work capacity of the picker (K), the top tea qualified (MS) and top tea unqualified (TS) results R^2 value of 0.97; 0.65 and 0.65 for model 1 and of 0.97; 0.74 and 0.74 for model 2. Work capacity test results of 146,69 kg / HKO, battery capacity of 2 hours, hanca petik of 0,11 man/Ha. Results of dimensional analysis showed that mathematical correlation between output capacity of the heating and the parameters that influence it, follow the equation:

$$K = 10^{0,416394} \left\{ (S^{-0,261879}, (\frac{L^{5/2} \text{ x } P^{1/2}}{\mu^{3/2} \text{ x } \rho^{1/2}})^{-0,891788}, (\frac{W \text{ x } \upsilon}{L \text{ x } P \text{ x } V})^{-0,835574}, (\frac{L^2 \text{ x } P \text{ x } W}{\rho \text{ x } E^2})^{-0,157720} \right\}$$

$$MS = 10^{-1,8566009} \left\{ (S^{-0,0946831}, (\frac{L^{5/2} \text{ x } P^{1/2}}{\mu^{3/2} \text{ x } \rho^{1/2}})^{-0,88132135}, (\frac{W \text{ x } \upsilon}{L \text{ x } P \text{ x } V})^{-0,9005988}, (\frac{L^2 \text{ x } P \text{ x } W}{\rho \text{ x } E^2})^{0,9873221} \right\}$$

$$TS = 10^{-1,856601} \left\{ (S^{-0,094583}, (\frac{L^{5/2} \text{ x } P^{1/2}}{\mu^{3/2} \text{ x } \rho^{1/2}})^{-0,881321}, (\frac{W \text{ x } \upsilon}{L \text{ x } P \text{ x } V})^{-0,900599}, (\frac{L^2 \text{ x } P \text{ x } W}{\rho \text{ x } E^2})^{0,9873221} \right\}$$

Keywords : tea picking machine, reciprocating single cutter, dimension analysis, ergonomic aspects

I. INTRODUCTION

Various innovative technological developments continue to be developed to overcome the problem of tea picker labor, one of the solutions is to increase the picker labor productivity that is by mechanical picking. (Herawati and Nurawan, 2009). Mechanical picking using picked machine is divided into 2 types, first, tea picking machine patrol power source and tea picking machine battery power source.

Tea picking machine with a battery power source has many advantages such as lightweight (ergonomic), easy to operate, friendly environmentally (no fuel), easy to repair and cheap operational cost. The current development of rechargeable batteries (rechargeble) is very rapid to have a high enough capacity to reach 34 Ampere hours on the size of 18650 batteries, can be combined in paraller, so that it can be increased capacity many times.

Reciprocating single cutter was developed by Cesare Maglioni (2009) on his thesis entitled analysis of reciprocating single cutter. Several studies have been done in the development of picking machine made by Dibakar Sen (2013) developed a prototype design that tea picking of small diesel engine / petrol. This picking machine was developed in tea plantations in India and applied to land with uneven topography.

The research was also developed by Sandeep et al (2010) who successfully developed a tea picking machine resembling a tea pickup scissor and applied to the plantation in India. Small and lightweight quotes can be performed by women workers with selective harvesting systems. Several other products have sprung up to develop batik-powered tea machines such as electric picking machines from China consisting of several models.

Required development of design of tea picking machine with battery power source with several criteria that can be operated on topography of hilly and bumpy, on various ability of picker especially woman labor and at tea varieties which in Indonesia which have many kinds. The design should also be tested technically, ergonomically and economically whether it is feasible to operate in tea plantations in Indonesia.

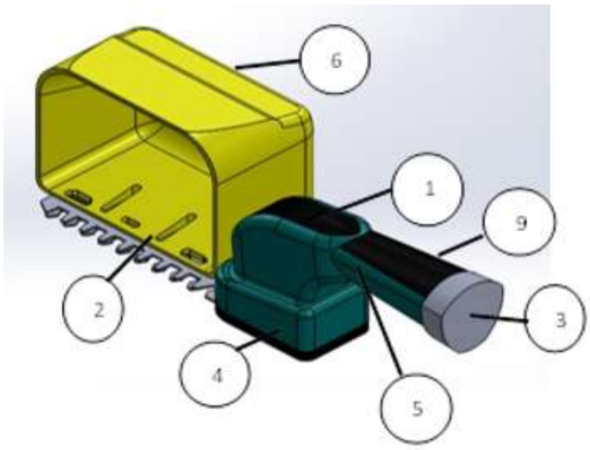
The research aimed at first, Conduct design of tea picking machine type reciprocating battery power source utilizing dimensional analysis to increase work capacity of pickers, tea shoot qualified and lower tea shoots unqualified. Second, Determining the mathematical equations of the working capacity of the pickers, tea shoots qualified and tea shoots unqualified for the parameters of the construction, the process and the result of which the passage affects, and Third, Applying a tea picking machine type reciprocating battery power source using selective picking with ergonomic approach to female labor.

II. MATERIALS AND METHODS

The research was conducted in December 2016-March 2017 at Agricultural Energy and Machinery Laboratory, Faculty of Agricultural Technology, Gadjah Mada University, Yogyakarta and Sambawa Tea Plantation, Megaraya and Private Garden in Tasikmalaya. The tools used for the manufacture of tea picking machine reciprocating type with a battery power source are: MLG Tools 7.2 Volt, Basket carrying, canvas (parachute), plate, battery, iron knife, waring, battery charger, hand tool, analysis tray, soldier, Baked glue etc. Tools used for machine testing: stopwatch, tachometer, texture analyzer brookfield, AVO meter, digital scales, meter and long run. Materials used are: iron plate, plastic box, galvanized pipe, Li-Ion MXJO batteries, tea shoots and garden area of 31.14 ha.

Picking system by tea picking machine using a system of plucking a straight alternation pattern which is done from the road in the form of a queue that is within 200 cm. Reachable fields that are affordable by the machine are about 100-120 cm. To support the pattern of plucking is made a queue of 40 cm. The picking width is 30cm with the standard 50 m - 100 m line length depending on the topography of the area and at each end it is made a shoot container path (waring stored) also for turning around which is approximately 120 cm wide. High passage cultivated 50-80 cm meters so easy in the process of picking (Abbas, 2013).

Concept design of tea picking machine reciprocating type with a battery power source (see Fig. 1) with a combination of the concept of tea picking machine patrol powered with grass shear power batteries. Namely picking is done by using a reciprocating single cutter system that consists of two blades that touch each other with a static knife and a moving blade (Maglioni, 2009). The motor is used using a dynamo DC motor 7.2 volts driven using a battery that has been modified by having 3 Ah. DC motor rotation is transferred using an eccentric gear to the cutting blade so as to form an alternating motion pattern. Cutter comes with a collection, which is a container shoot container that is adjusted with a knife, functioning to accommodate shoots before being inserted into the waring. Then do used dimensional analysis of the tea picking machine reciprocating single cutter type of battery power source and a collection box.



1. Machine Body
2. *Reciprocating Single Cutter*
3. Battery Pack
4. Excentric Cover
5. Swich on/off
6. Collection Box
7. Handle

Fig. 1. Concept of Tea Picking Machine Reciprocating Type With A Battery Power Source

Analysis of the work capacity and shoot quality of the pickers is done by determining the variables that are considered to be influential can be seen in table 1.

According to Phi - Buckhingham theory the number of groups of dimensionless numbers to look for is:

$$S_n = 8 - 3 = 5 \quad (1)$$

The number of π numbers sought is 5 ie π1, π2, π3, π4, π5.

$$\pi_1 = \frac{K \times P \times W \times \upsilon \times \mu^{3/2} \times V^{1/2}}{L^{1/2} \times \rho \times E^2} \quad (2)$$

varians of area topography (L)

$$\pi_2 = S \tag{3}$$

varians of motor rotation (μ)

$$\pi_3 = \frac{L^{5/2} x\ P^{1/2}}{\mu^{3/2} x\ \rho^{1/2}} \tag{4}$$

varians of speed of picker rate(V)

$$\pi_4 = \frac{W\ x\ \upsilon}{L\ x\ P\ x\ V} \tag{5}$$

variasi shear modulus (E)

$$\pi_5 = \frac{L^2\ x\ P\ x\ W}{\rho\ x\ E^2} \tag{6}$$

By entering the parameters π1, π2, π3, and π4 into the following equation:

$$\frac{K\ x\ P\ x\ W\ x\ \ \upsilon\ x\ \mu^{3/2}\ x\ V^{1/2}}{L^{1/2}\ x\ \rho\ x\ E^2} = f\left(S, \frac{L^{5/2} x\ P^{1/2}}{\mu^{3/2} x\ \rho^{1/2}}, \frac{W\ x\ \upsilon}{L\ x\ P\ x\ V}, \frac{L^2\ x\ P\ x\ W}{\rho\ x\ E^2}\right) \tag{7}$$

The function f is a constant C, so equation 7 becomes equation 8 :

$$\frac{K\ x\ P\ x\ W\ x\ \ \upsilon\ x\ \mu^{3/2}\ x\ V^{1/2}}{L^{1/2}\ x\ \rho\ x\ E^2} = C\left\{(S)^a, \left(\frac{L^{5/2} x\ P^{1/2}}{\mu^{3/2} x\ \rho^{1/2}}\right)^b, \left(\frac{W\ x\ \upsilon}{L\ x\ P\ x\ V}\right)^c, \left(\frac{L^2\ x\ P\ x\ W}{\rho\ x\ E^2}\right)^d\right\} \tag{8}$$

The capacity of the picker equation :

$$K = C\ \frac{P\ x\ W\ x\ \ \upsilon\ x\ \mu^{3/2}\ x\ V^{1/2}}{L^{1/2}\ x\ \rho\ x\ E^2}\left\{(S)^a, \left(\frac{L^{5/2} x\ P^{1/2}}{\mu^{3/2} x\ \rho^{1/2}}\right)^b, \left(\frac{W\ x\ \upsilon}{L\ x\ P\ x\ V}\right)^c, \left(\frac{L^2\ x\ P\ x\ W}{\rho\ x\ E^2}\right)^d\right\} \tag{9}$$

The qualified shoots (MS) equation :

$$MS = C\ \frac{P\ x\ W\ x\ \ \upsilon\ x\ \mu^{3/2}\ x\ V^{1/2}}{L^{1/2}\ x\ \rho\ x\ E^2}\left\{(S)^a, \left(\frac{L^{5/2} x\ P^{1/2}}{\mu^{3/2} x\ \rho^{1/2}}\right)^b, \left(\frac{W\ x\ \upsilon}{L\ x\ P\ x\ V}\right)^c, \left(\frac{L^2\ x\ P\ x\ W}{\rho\ x\ E^2}\right)^d\right\} \tag{10}$$

In the same way, The unqualified shoots (TS) equation :

$$TS = C\ \frac{P\ x\ W\ x\ \ \upsilon\ x\ \mu^{3/2}\ x\ V^{1/2}}{L^{1/2}\ x\ \rho\ x\ E^2}\left\{(S)^a, \left(\frac{L^{5/2} x\ P^{1/2}}{\mu^{3/2} x\ \rho^{1/2}}\right)^b, \left(\frac{W\ x\ \upsilon}{L\ x\ P\ x\ V}\right)^c, \left(\frac{L^2\ x\ P\ x\ W}{\rho\ x\ E^2}\right)^d\right\} \tag{11}$$

Table 1. The variables that affect the performance of the design of the tea picking machine reciprocating single cutter type of battery power source

No	Variables	Notations	Units	Dimensions
Construction				
1	Length of Blades Cutter	L	M	L
2	Power	P	Kg.m/s	$ML^2 T^{-3}$
3	Weight	W	Kg.m/s^2	MLT^{-2}
4	Volume of Collection	γ	m^3	L^3
Proccess				
5	Motor Rotation	μ	1/s	T^{-1}
6	Topography	S	%	-
7	Speed of Picker Rate	V	m/s	LT^{-1}
Materials				
8	Density of Passage	P	Kg/m^3	$M L^{-3}$
9	Shear Molulus	E	N/m^2	$ML^{-1}T^{-2}$
Dependent				
10	Picker Working Capacity	K	Kg/hour	MT^{-1}
11	Top Shoots Qualified	MS	%	
12	Top Shoots Unqualified	TS	%	

III. RESULTS AND DISCUSSION

Design of tea picking machine type reciprocating with a battery power source collection bag and collection box can be seen in Fig. 2.

Fig. 2. Tea Picking Machine Reciprocating Types With A Battery Power Source E-Tem M01 7,2 Volt 3000 mAh *Collection Box*

A. *Picker Working Capacity*

In the dimension analysis on the working capacity of machine the following equation is obtained:

$$K = 10^{0,416394}\left\{(S^{-0,261879}, \left(\frac{L^{5/2} x\, P^{1/2}}{\mu^{3/2} x\, \rho^{1/2}}\right)^{-0,891788}, \left(\frac{W\, x\, \upsilon}{L\, x\, P\, x\, V}\right)^{-0,835574}, \left(\frac{L^{2}\, x\, P\, x\, W}{\rho\, x\, E^{2}}\right)^{-0,157720}\right\} \quad (12)$$

The rotation of the motor or rotation per second (RPD) or by unit (1 / s) is the rotary electric motor of the quoted machine as a source of the tea leaf cutting process. According to Rofarsyam et al (2012) who examined the working capacity of soybean spinning machine (*Glycine max* L) rotary swivel system, that rotation has 75% Influence between rotation to work capacity. The picking speed is converted from rpm to rpd, from 900 rpm to 78,50 rpd, 1100 rpm to 95,94 rpd and 1250 rpm to 109,02 rpd.

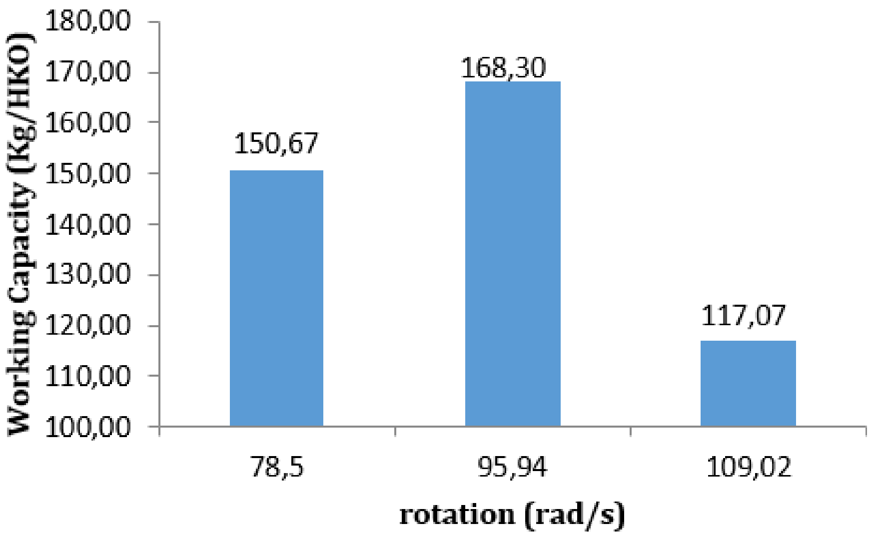


Fig. 3. Comparison of Working Capacity Picker based on variation of rotation on model collection box

Topography (%) is one of the constraints on the mechanical process of picking, the uneven topography of tea plantations in Indonesia causes the tea picking machine difficult to operate. Tea picking machine fuel power imported from Japan requires 2 people with 1 to 2 operators as a helper. This makes it difficult for tea picking machines to operate on hilly land, especially on slopes. Nevertheless, making the picking work path helps facilitate the process of picking tea, research on the inclination of brand Kawasaki NP-60 machine was tested by Nugraha (2003).

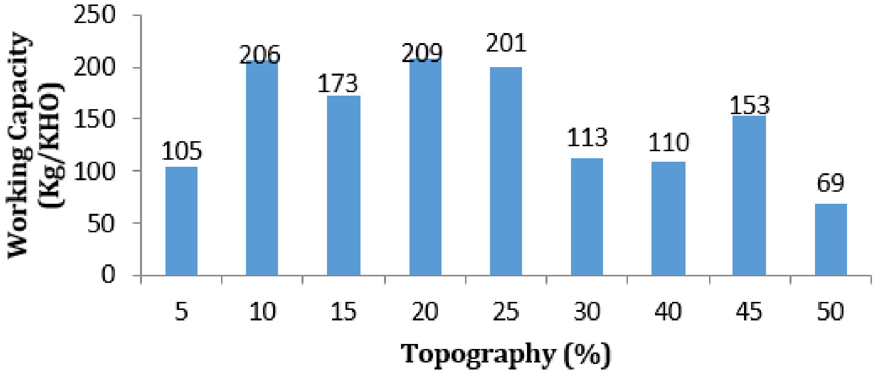


Fig. 4. Working Capacity Comparison based on topographic variation on model collection bag

The picking rate is the picking speed in picking, how much distance per unit time to carry out the picking. The use of tea picking machine influenced how fast the speed of an operator in the process of picking and seen the effect on the work capacity. According to research Nugraha (2003) the influence of picking speed is inversely proportional to the topography of plantation land, the more flat the land the faster picking speed, picking speed will decrease in the increasingly sloping land.

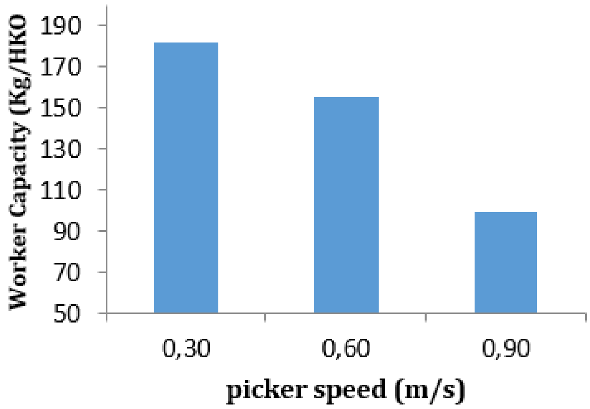


Fig. 5. Comparison of Working Capacity Picker based on variation of picker speed on model collection box

The shear modulus or cutting force symbolized by E, is the cracking power of the tea rod divided by the area of the tree trunk. The unit of shear modulus is (N / m2), the trunk diameter is 0.4 m2. Mechanical picking process by picking machine is influenced by several factors, such as tea material density (40 kg / m3), cutting knife area, engine power, engine weight and shear force itself. The bigger the diameter of the rod, the faster the motor power will affect the usage of the battery / fuel. Sampling is by differentiating into the type of tea snippet that is p + 1 / p + 2, p + 3 / b + 2 young,> b + 2young, stems and ceker.

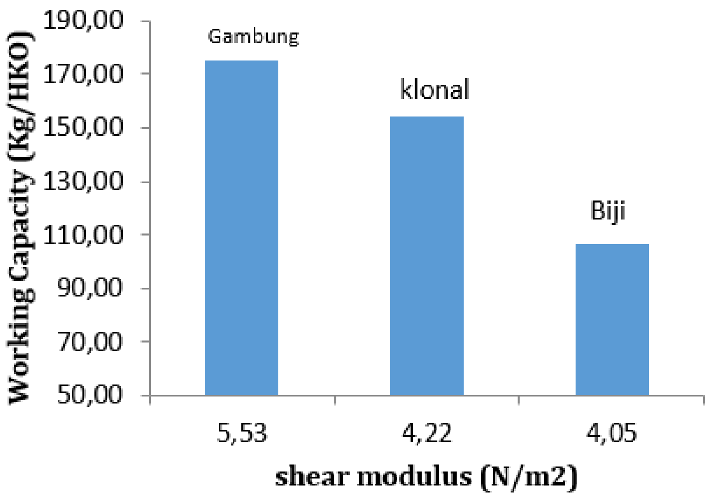


Fig. 6. Working Capacity Pickers based on tea varieties and shear forces on model collection box

B. Analysis of Shoot Quality

The quality of shoots is divided into qualified shoots (pms) and unqualified buds (ptms), indicated by (MS) and (TS), the percentage of top shoots will be inversely proportional to unqualified shoots.

1. Top Shoots Qualified

In the dimension analysis on the working capacity of machine the following equation is obtained:

$$\mathrm{MS} = 10^{-1{,}8566009}\left\{(S^{-0{,}0946831}, (\frac{L^{5/2} x\, P^{1/2}}{\mu^{3/2} x\, \rho^{1/2}})^{-0{,}88132135}, (\frac{W\, x\, \upsilon}{L\, x\, P\, x\, V})^{-0{,}9005988}, (\frac{L^2\, x\, P\, x\, W}{\rho\, x\, E^2})^{0{,}9873221}\right\} \quad (13)$$

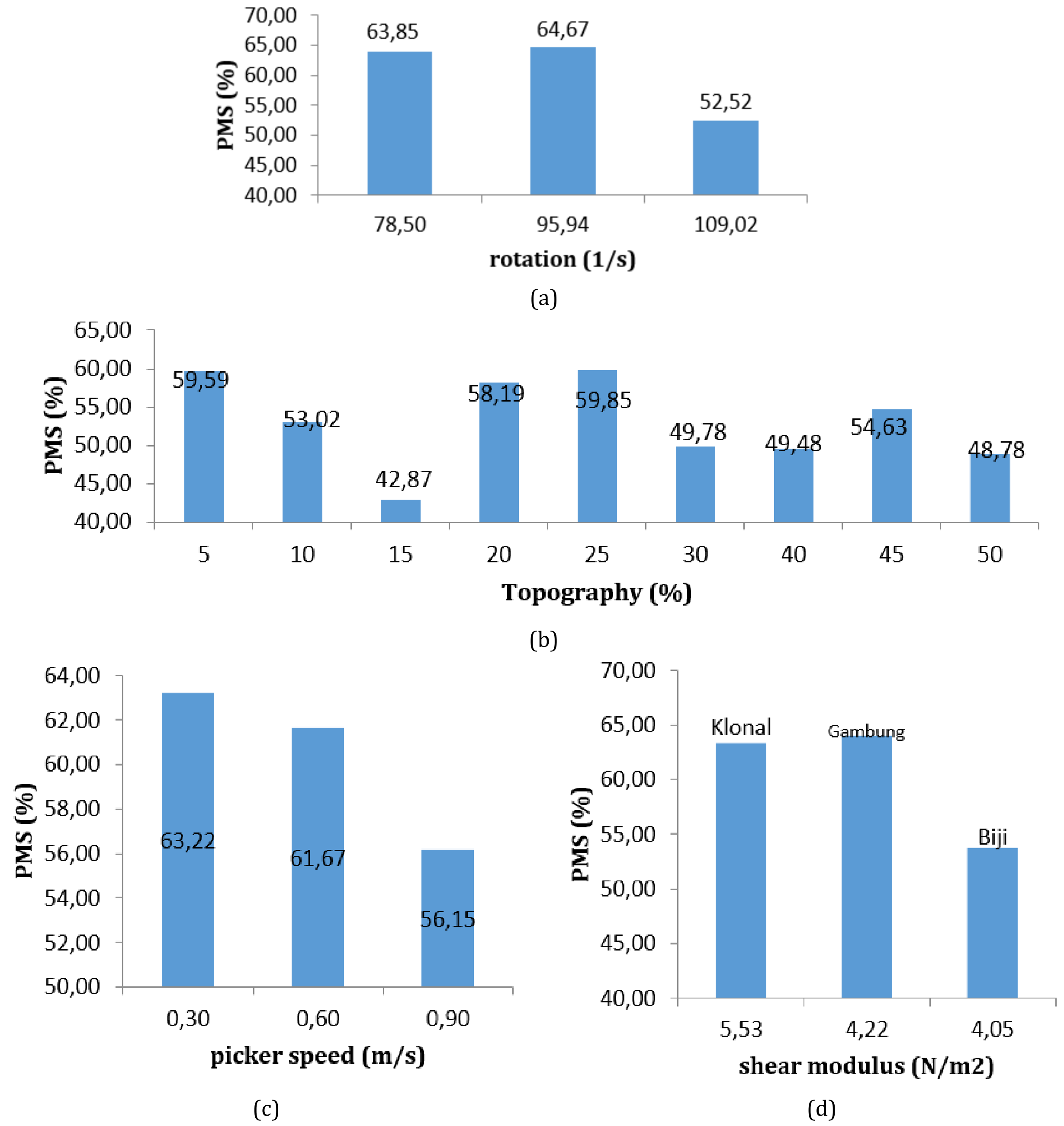


Fig. 7. Shoots qualify based on (a) rotation motor, (b) Topography, (c) picking speed, and (d) shear modules on machine model collection box

2. Top Shoots Unqualified

The dimension analysis on the working capacity of machine the following equation is obtained:

$$\mathrm{TS} = 10^{-1{,}59507}\left\{(S^{-0{,}19371}, (\frac{L^{5/2} x\, P^{1/2}}{\mu^{3/2} x\, \rho^{1/2}})^{1{,}16130}, (\frac{W\, x\, \upsilon}{L\, x\, P\, x\, V})^{-1{,}15365}, (\frac{L^2\, x\, P\, x\, W}{\rho\, x\, E^2})^{1{,}01083}\right\} \quad (14)$$

$$\mathrm{TS} : C\left\{(S^{a}, (\frac{L^{5/2} x\, P^{1/2}}{\mu^{3/2} x\, \rho^{1/2}})^{b}, (\frac{W\, x\, \upsilon}{L\, x\, P\, x\, V})^{c}, (\frac{L^2\, x\, P\, x\, W}{\rho\, x\, E^2})^{d}\right\} \quad (15)$$

$$\log(\mathrm{TS}) = \log \mathrm{C} + \mathrm{a} \log(S) + \mathrm{b} \log \frac{L^{5/2} \mathrm{x}\, P^{1/2}}{\mu^{3/2} \mathrm{x}\, \rho^{1/2}}) + \mathrm{c} \log\left(\frac{\mathrm{W\,x\,\upsilon}}{\mathrm{L\,x\,P\,x\,V}}\right) + \mathrm{d} \log\left(\frac{\mathrm{L}^2\,\mathrm{x\,P\,x\,W}}{\rho\,\mathrm{x\,E}^2}\right) \tag{16}$$

Graphical results and unqualified topical counts are inversely proportional to top shoots. The calculated/predicted (K-P) calculating work capacity, shoot compliant results/ predictions (MS-P) and shoots are not eligible for predicted results (TS-P) used to find the energy efficiency predictive output value. The relationship of energy efficiency observation (EP-O) Vs predictive energy efficiency (EP-P) can be read in Fig. 8.

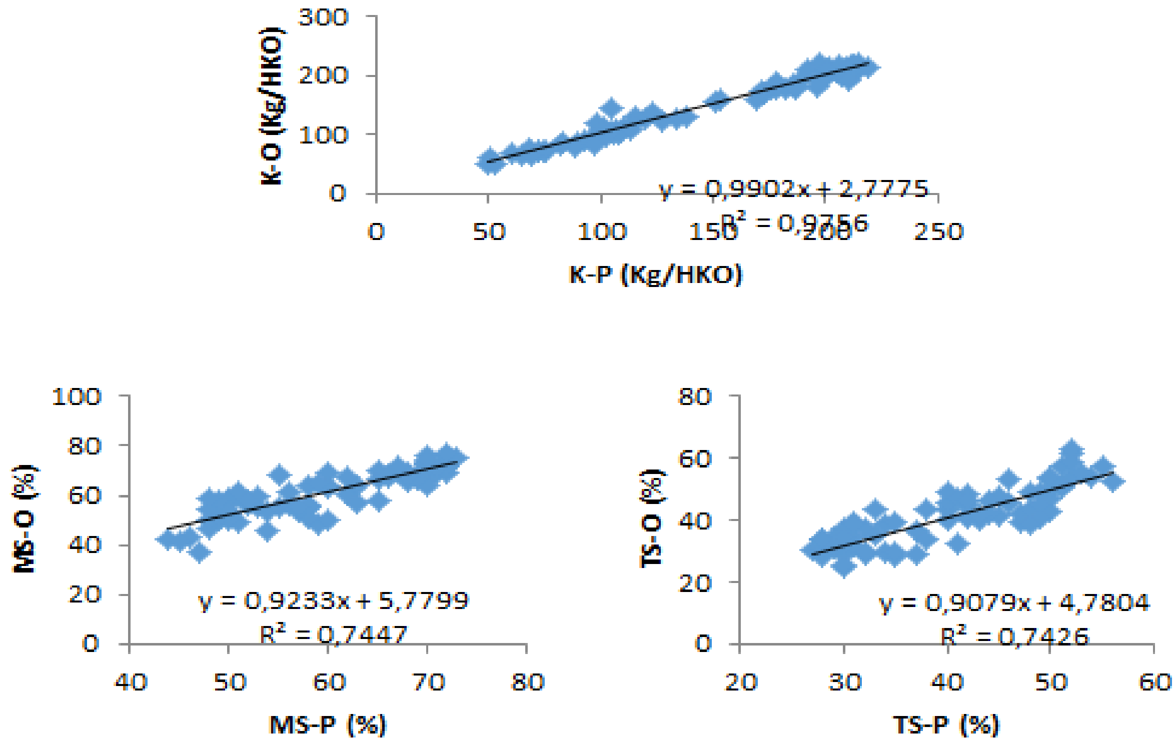


Fig. 8. Comparison of K-P against K-O, MS-P against MS-O, TS-P against TS-O Model Collection Box

From the picture above it is concluded that the average predictive working capacity of the picker is K-P = 163.55 (kg), while the average observer's work capacity is K-O = 165.83 (kg). The correlation between K-P and K-O yields a value of 0.98, thus the correlation between K-P and K-O has a strong relationship. The average working capacity of the average predictive picker is K-P = 143.34 (kg), while the average observer's working capacity is K-O = 146.69 (kg). The correlation between K-P and K-O yields a value of 0.98, thus the correlation between K-P and K-O has a strong relationship. The average shoot for the average prediction is MS-P = 62.85 (%), while shoots meet the average observation requirement is MS-O = 62.87 (%). The correlation between MS-P and MS-O yields a value of 0.81, thus the correlation between MS-P and MS-O has a strong relationship. The average shoot for the average predictive picker is MS-P = 60,34 (%), while shoots meet the mean observation requirement is MS-O = 61,49 (%). The correlation between MS-P and MS-O yields a value of 0.86, thus the correlation between MS-P and MS-O has a strong relationship. TS-P and TS-O values are the same as MS-P and MS-O values.

IV. CONCLUSION

The conclusion of this research are:

1. The design of tea picking machine reciprocating type battery power source that uses two models of Model 1 (Collection Bag) and model 1 (Collection Box) using dimensional analysis has been successfully created and can function continuously and more efficiently, ergonomically and economically in the process of mechanically picking tea.
2. With dimensional analysis approach, the parameters affecting the work capacity of the picker and the shoot quality are the length of the cutting blade (L), power (P), weight (W), Collection volume (υ), Motor rotation (μ), Topography (S) Speed of Picker Rate V), Material Density (ρ) Shear Modulus (E) to the picker working capacity (K), qualified shoots (MS) and shoots does not meet the requirements (TS)

$$K = 10^{0,894589}\left\{(S^{-0,298623}, (\frac{L^{5/2} x P^{1/2}}{\mu^{3/2} x \rho^{1/2}})^{-0,671517}, (\frac{W x \upsilon}{L x P x V})^{-0,640523}, (\frac{L^2 x P x W}{\rho x E^2})^{1,032865}\right\}$$

$$MS = 10^{-0,3164}\left\{(S^{-0,10899}, (\frac{L^{5/2} x P^{1/2}}{\mu^{3/2} x \rho^{1/2}})^{-0,90958}, (\frac{W x \upsilon}{L x P x V})^{-0,90878}, (\frac{L^2 x P x W}{\rho x E^2})^{0,989185}\right\}$$

$$TS = 10^{-1,59507}\left\{(S^{-0,19371}, (\frac{L^{5/2} x P^{1/2}}{\mu^{3/2} x \rho^{1/2}})^{1,16130}, (\frac{W x \upsilon}{L x P x V})^{-1,15365}, (\frac{L^2 x P x W}{\rho x E^2})^{1,01083}\right\}$$

3. The most important parameter relation on the working capacity of the picker is the rotation parameter (μ), because the increase of π3 value is followed by the increase of π1 value.
4. Tea picking machine can increase the need for labor of picker that is 10 per ha with hanca 0,11 ha so that labor of woman picker (operator) can operate tea picker machine reciprocating type power battery source.

REFERENCES

Abbas, Tadjudin. dkk., 2001. *Rancang Bangun Mesin Petik Teh Skala Kelompok Tani Rakyat*. Balai Besar Alat dan Mesin Pertanian. Tanggerang

Abbas, Tadjudin, 2013. *Unjuk Kerja Mesin Petik Tipe 120 Pada Pemetikan Tanaman Teh Assamica dengan jarak antara baris 120 cm.* Jurnal Peneltian Teh dan Kina Vol. 16 No.2, 2013:59-66, Bandung

Adinata, Carno. Moh. 2003. *Pengukuran Getaran, Kebisingan, dan Beban Kerja Pada Penggunaan Mesin Petik Teh Kawasaki Tipe NV-60 di Pusat Penelitian Teh dan Kina, Gambung, Jawa Barat.* Fakultas Teknologi Pertanian IPB. Bogor

Dirjen PPHP, 2015. *Perkembangan Ekspor Teh Indonesia*. Http://pphp.deptan.go.id Diakses 23 Desember 2015 pukul 15.15.

Dibakar, Sen. 2013. *Ab Initio Design and prototyping of a Tea Plucking Machine: A Case Study.* Center for Product Design and Manufacturing Indian Institute of Science. Bangalore, India

Herawati H dan Nurawan, 2009. *Pengkajian Penggunaan Gunting Petik pada Komuditas Teh di Kecamatan Cikalong Wetan, Kabupaten Bandung*. AGRITECH UGM; Yogyakarta.

Kurniawan, Anri 2015. *Modifikasi Alat Petik Teh Semi-Mekanis untuk Meningkatkan Ergonomika dan Produktivitas Pemetik Teh (Camellia Sinensis* (L) O. Kuntze*).* SKRIPSI. Institut Pertanian STIPER; Yogyakarta.

Maglioni, Cesare, 2009. *Analysis of Reciprocating Single Blade Cutter Bars.* TESIS. Agricultural Mechanization, Universita di Bologna. Bologna, Italy

Maina J, Kalili W. 2013. *Assessment of Mechanical Harvesting of Tea and Its Viability For Use in Kenya,* Biomechanical and Environmental Department Jomo Kenyatta University of Agriculture and Technology. Nairobi, Kenya

Nugraha, Deris. 2003. *Uji Reformasi Mesin Petik Teh Kawasaki Tipe NV60H Pada Lahan Miring*. SKRIPSI. Fakultas Teknologi Pertanian IPB. Bogor.

Sandeep., Gopinath dan Manas Rajan Mishra 2010. *Design and Development of a Conceptual Tea Leaf Harvesting Machine.* Jurnal School of Advance Bangalore; India.

Suhendra (2010). *Rancang Bangun dan Pengujian Alat Pengupas Lada (Piper nigrum, L) Tipe Silinder Putaran vertical.* Tesis Program Pasca Sarjana Universitas Gadjah Mada Yogyakarta.

A.4

A DRAFT FORCE CALCULATION FOR DITCHER IMPLEMENT ON SOYBEAN CULTIVATION UNDER SATURATED SOIL CULTURE

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ABSTRACT

The ditcher is the implement to produce a ditch or drainage channel. Saturated soil culture (SSC) is a cultivation technology maintaining water depth constantly to make soil layer in the saturated condition. Therefore, in the cultivation of soybean under SSC on tidal swamps urgently needs a ditch. The draft force and power requirements are among the most important engineering specifications of a ditcher. These requirements consider the soil parameters, ditcher parameters, and working speed parameter as the inputs. A quick method of predicting forces was adopted using the theoretical force prediction models of Godwin and O'Dogherty. The ditcher draft force and power calculator is created by entering the equation model into the Excel software so that it simplifies the calculation. Furthermore, the soil properties from tidal land consist of moisture content and bulk unit weight were measured for laboratory test. A sliding frictional plate and a sliding frictional plate with fins were used to determine the angle of soil internal resistance and cohesion, and soil-metal friction and adhesion. According to the results of this study, the calculator produced acceptable draft forces. Moreover, draft force and power requirements of a ditcher working under SSC on tidal swamps with the forward velocity of 0.7 ms^{-1} were 1.22 kN, and 0.85 kW. The equation can be used to calculate the draft force and power of the ditcher with rational precision.

Keywords : calculator, ditcher, draft force, saturated soil culture

I. INTRODUCTION

Soybean is one of the main food commodities in Indonesia. Reference [1] shows that soybean production in 2015 is 963 thousand tons of dry beans. Increased production was only 0.86% compared with the previous year. National soybean demand reaches 2.2 million tons per year [2]. The inability of production to meet domestic demand has led to soybean imports increasing every year. Over 20 years, the soybean harvest area also showed a significant decrease from 1.48 million ha (1995) to 614 thousand ha (2015) [3].

It is necessary to extend the soybean cultivation area by the utilization of marginal land such as tidal swamp land. Indonesia has 20.1-25.8 million ha of tidal swamp land [4]. The productivity of soybean plants in tidal swamp will exceed the average productivity of soybean in dryland if the cultivation use the saturated soil culture (SSC) technology [5]. SSC is a cultivation technology maintaining water depth constantly to make soil layer in the saturated condition (Fig. 1). The cultivation of soybean under SSC on tidal swamps urgently needs a ditch . Currently, hoe is the most common primary tool in order to conduct the ditching. Ditching by hoeing is one of the fundamental phases of soybean production under SSC. In addition, conditions in the field also show that the quality of the ditch (the width and depth of the ditch, the number and location of the ditch) is not in accordance with the recommendation [6].

Ditcher is one of the mechanization tools for ditching. For that reason, it is important to consider this implement from an engineering perspective. Furthermore, draft force and power requirements of a machine are important engineering specifications. Researchers have been trying to develop techniques for calculating the draft force and power of a tillage tools ([8], [9], [10], [11], [12]). As reported previously [13], Development and evaluation of a draft force calculator for moldboard plow using the laws of classical mechanics was conducted.

However, previous research has not concentrated on the ditcher yet. The experimental results on the soil physic properties on the tidal swamp land as well as on the draft force calculation of the ditcher are presented and discussed in this report. The objective in this paper is to determine the the draft force of the ditcher, engine power requirement and the tractive efficiency. The hypothesis of the geometry of lug wheel and its tractive performance to pull the ditcher also discussed.

Fig. 1. The ditch on the soybean cultivation under SSC [7]

II. MATERIALS AND METHODS

A. Prediction Models

To develop a draft force calculator for the ditcher, it is hypothesized that the stuctural form of ditcher consist a pair of moldboard those positions reflect each other with the mirrored angle of 180° (Fig. 2).

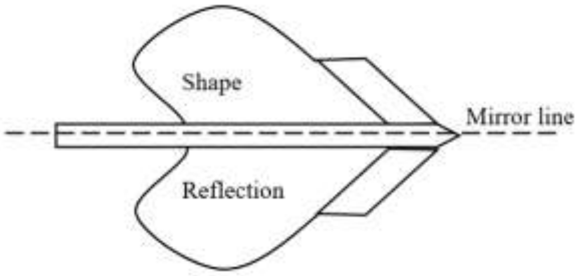

Fig. 2. Ditcher formation: moldboard and its reflection along the mirror line

The method of predicting forces was adopted using the integrated soil tillage force prediction models of Godwin and O'Dogherty for moldboard plow [14]. The model equations has resulted in some modifications to the original model equations of [15]. The total horizontal force acting upon a moldboard plow body result from: cutting force, soil turning force and drag effect [15]. The Fig. 3 shows the sub-components and the underlying principles used for their estimation.

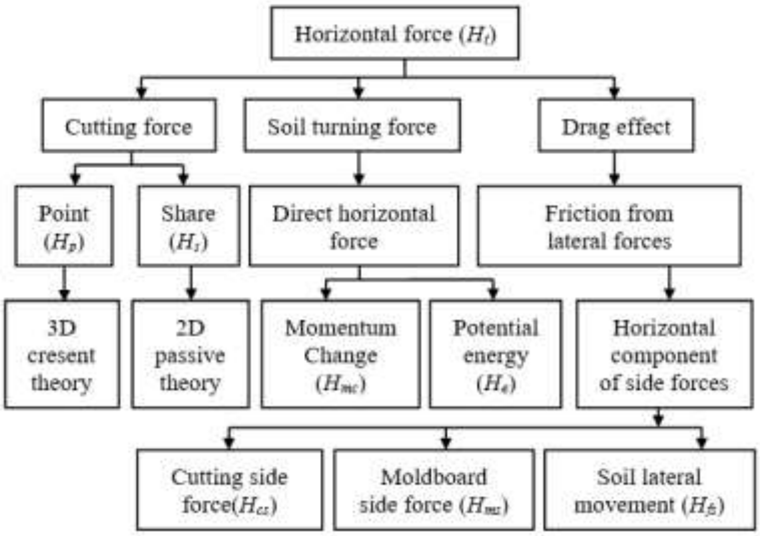

Fig. 3. Sub-components of horizontal forces acting upon a moldboard plow body result

Considering the draft force components acting on a moldboard plow in Fig. 4, they can be determined by the following equations.

$$H_t = H_p + H_s + H_{mc} + H_e + H_{cs} + H_{ms} + H_{fs} \tag{1}$$

$$H_p = \begin{bmatrix} \left(\gamma d_p{}^2 N_\gamma + c d_p N_c\right) \\ \left\{w_p + 0.55 d_p\left(m-(m-1)/3\right)\right\} \\ +\left(\gamma v^2 N_a d_p / g\right)\left(w_p + 0.33 d_p\right) \end{bmatrix} \sin\left(\alpha p + \delta\right) \tag{2}$$

$$H_s = \begin{pmatrix} \gamma d_s{}^2 N_\gamma + c d_s N_c \\ +\gamma v^2 N_a d_s / g \end{pmatrix} w_s \sin\left(\alpha_s + \delta\right) \sin\beta \tag{3}$$

$$H_{mc} = \begin{bmatrix} \left(\gamma / g\right)\left(w_p d_p + w_s d_s\right) v^2 \\ \left\{1 - \left(1 - \sin\theta \tan\delta\right)\cos\theta\right\} \end{bmatrix} \tag{4}$$

$$H_e = 2\gamma\left(w_p d_p + w_s d_s\right) d_s \tag{5}$$

$$H_{cs} = \begin{bmatrix} \left(\gamma d_s{}^2 N_\gamma + c d_s N_c + \gamma v^2 N_a d_s / g\right) w_s \\ \sin\left(\alpha_s + \delta\right)\cos\beta \tan\delta \end{bmatrix} \tag{6}$$

$$H_{ms} = \begin{bmatrix} \left(\gamma / g\right)\left(w_p d_p + w_s d_s\right) v^2 \\ \sin\theta\left(1 - \sin\theta \tan\delta\right)\tan\delta \end{bmatrix} \tag{7}$$

$$H_{fs} = 0.95\gamma\left(w_p d_p + w_s d_s\right)\tan\delta \tan\delta_s \tag{8}$$

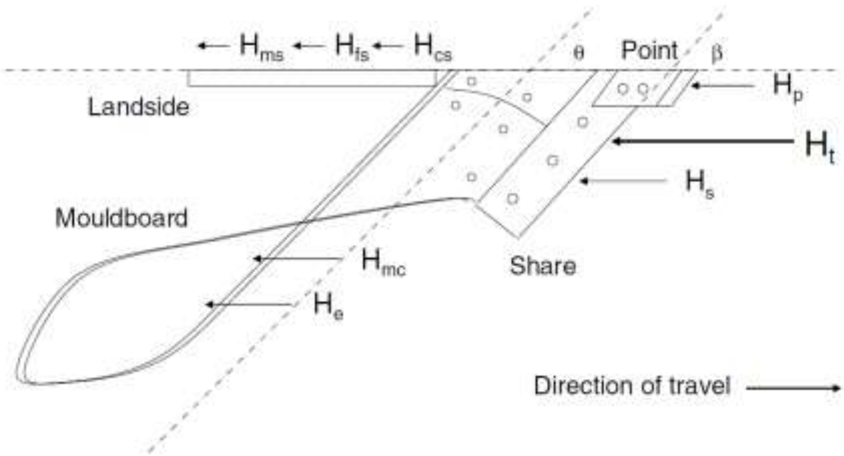

Fig. 4. The draft force components acting on a moldboard plow [15]

The dimensionless factors N_γ, N_c and N_a are dependent on the rake angle (α) and the soil friction angle (ϕ) and were calculated by reference [16] and published in graphical form for a range of values of α and ϕ for the soil-interface friction angle (δ) for δ = 0 and δ = ϕ. The values of the N factors are determined by logarithmic interpolation for intermediate values of δ between 0 and ϕ.

The total draft force on the ditcher (H_d) will be duplicated from one moldboard. Noting that there is no other interaction factor in the force analysis, it can be determined by the following equation.

$$H_d = 2H_t \tag{9}$$

The specific draft force of the ditcher can be determined by the following equation.

$$S_{Hd} = \frac{0.1 H_d}{dw} \tag{10}$$

The drawbar power requirement of the ditcher can be determined by the following equation.

$$P_d = H_d v \tag{11}$$

Moreover, if the power transmission efficiency ([17], [18] is 75% so the minimum net engine power requirement of the ditcher can be determined by the following equation.

$$N_e = 1.813 P_d \tag{12}$$

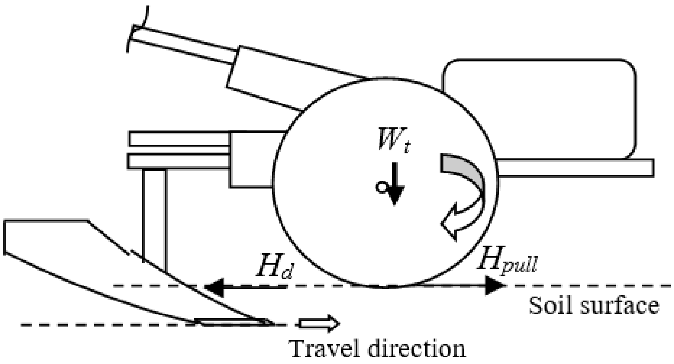

Fig. 5. Working forces on the lug wheels

When the ditcher is pulled trough the soil, the power of two-wheel tractor must overcome draft forces created by soil resistance in order to move forward (Fig. 5), then:

$$H_d < H_{pull} \tag{13}$$

$$H_{pull} = W_t \eta_t \tag{14}$$

As reported in [19], the maksimum tractive efficiency of the lug wheel is about 60%.

The main purpose of lug wheel is to support the weight of the two-wheel tractor while mowing with minimum amount of resistance over the soil surface. To do this, the lug wheel must rearrange the soil particles so as to give the soil enough shear strength to support the weight as well as generate forward motion. Shear strength is a measure of the force needed to deform the soil and is expressed as kNm^{-2} (Fig. 6). Soil derives its shear strength from a combination of internal friction and cohesion. The traction is obtained by means of increasing the contact area between lug wheel and soil . The characteristic of the soil reaction forces on the lug was studied at lug inclination angles, lug slippage and lug sinkage [20].

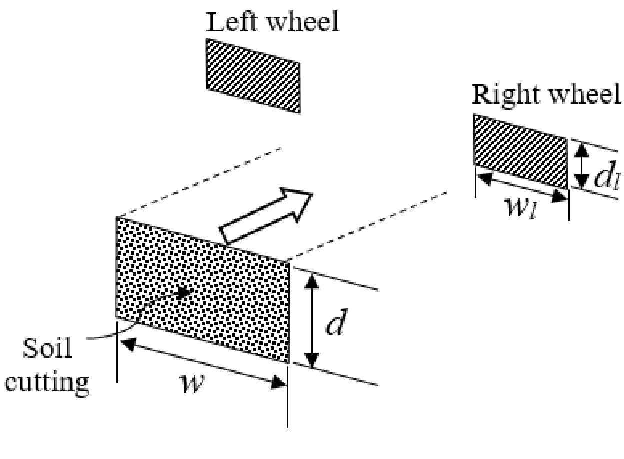

Fig. 6. Lug wheel-soil contact area and ditcher-soil cutting area

In practical terms this means traction on agricultural soils is most likely to be obtain by increasing the contact area between the lug wheel and soil, it can be determined by the following equation.

$$wd = 2w_l d_l \tag{15}$$

B. Soil Condition

The soil data were collected on a tidal swamp field in Jabung Timur, Jambi, Indonesia, on August 20, 2016. Rice (*Oryza sativa* L.) and soybean [*Glycene max* (L.) Merr.] are the major crops, and rice-soybean rotation are the main cropping systems. The texture of soil (0-25 cm) is silty clay soil, it was performed using Soil Texture Calculator program on NRCS-USDA website. The soil properties were listed in Table 1.

Table 1. Properties of the Soil

Particle Size Distribution (%)			Consistency Limits (%)		
Clay	Silt	Sand	Liquid Limit	Plastic Limit	Plasticity Index
48	47	5	67.22	35.14	32.08

The 0-25 cm soil profile was divided into five layers; 0-5, 5-10, 10-15, 15-20, and 20-25 cm. The soil samples to determine soil moisture content and soil bulk unit weight were collected with intact soil sampler. The cone index was measured with a standard cone penetrometer and the soil parameters of cohesion, angle of soil-soil friction, adhesion and soil-metal friction angle were measured with direct shear test apparatus. The soil conditions are listed in Table 2.

Table 2. Soil Conditions

Soil Moisture Content (% d.b.)	Bulk Unit Weight (kNm^{-3})	Cone Index (kPa)	Cohesion (kPa)	Angle of Soil-soil Friction (°)	Adhesion (kPa)	Angle of Soil-metal Friction (°)
66.7	1.4	129	23.9	37.2	7.3	12.9

C. Ditcher Geometry

The ditcher geometry will be based on the design concept already stated in the conceptualized design section (Table 3).

Table 3. Ditcher Geometry

Point Depth (m)	Share Depth (m)	Point Width (m)	Share Width (m)	Share Edge Angle (°)	Moldboard Mean Angle (°)
0.0178	0.2	0.0075	0.1425	35	30

III. RESULTS AND DISCUSSION

Consider the method as presented in [13], to simplify the required calculations, the derived equations were entered in the Excel software, and the finalized spreadsheet was utilized as the ditcher draft force and power calculator (Fig. 7). The working condition considered fixed were the forward velocity of 0.7 ms^{-1}, working depth of 0.2 m, and working width of 0.3 m. The draft force and power requirement of the ditcher were 1.22 kN and 0.85 kW respectively. The power source was determined 8.5 HP two-wheel tractor with lug wheel. Its weight is about 300 kg. From the net engine requirement of 1.55 HP, with the forward velocity of 0.7 ms^{-1}, the pull force requirement was 1.63 kN., then:

$$1.22 \text{ kN} < 1.63 \text{ kN} \tag{16}$$

The tractive efficiency of the lug wheel should be about 55%. Consider the experiment as presented in [21], the traction efficiency of 55.5% could be obtained by the normal lug (280 mm) with 40° lug spacing with 25% slip wheel.

Reference [22] stated if the draft force in paddy field about 100 kgf, then at a forward speed of 0.7 ms^{-1}, the engine power which can be converted to a draft power is less than 12%. Accordingly, the net engine requirement for the ditcher would be 1.02 HP. It appears that the 8.5 HP two-wheel tractor will be able to meet the net engine requirement. however it is highly dependent on the tractive performance of lug wheels. If the ditcher-soil cutting area is 0.06 m^2, the sum of contact area between the lug wheels and soil at least equal to it. The tractive performance could be achieved by using the movable lug wheel [19] and the opposing circumferential lug wheel [21].

INPUT				
Notation			Value	Units
Soil Parameters	bulk unit weight	γ	13.43	kN/m³
	angle of soil–metal friction	δ	12.90	°
	cohesion	c	23.91	kN/m²
	soil–soil angle of friction	δ_s	37.18	°
	adhesion	c_a	7.33	kN/m²
Ditcher Geometic Parameters	point depth	d_p	0.0178	m
	share depth	d_s	0.20	m
	point width	w_p	0.0075	m
	share width	w_s	0.1425	m
	rake angle	α	30	°
	angle of share edge to direction of motion	β	35	°
	mean angle of moldboard to direction of motion	θ	30	°
N factor - graphical	bulk density factor	N_γ	1.10	-
	cohesion-adhesion factor	N_c	0.51	-
$\delta=$	inertia factor	N_a	2.20	-
0	rupture distance ratio	m	2.05	
N factor - graphical	bulk density factor	N_γ	1.45	-
	cohesion-adhesion factor	N_c	1.55	-
$\delta=$	inertia factor	N_a	2.70	-
37.18	rupture distance ratio	m	3.20	
N factor - intermediate	bulk density factor	N_γ	1.22	-
	cohesion-adhesion factor	N_c	0.87	-
$\delta=$	inertia factor	N_a	2.37	-
12.90	rupture distance ratio	m	2.45	
Operating Condition	working speed	v	0.70	m/s
	acceleration of gravity	g	9.81	m/s²

OUTPUT			
Notation		Value	Units
point draft force	H_p	0.01	kN
share draft force	H_s	0.29	kN
moldboard soil momentum change and friction components of draft force	H_{mc}	0.00	kN
moldboard soil potential energy components of draft force	H_a	0.15	kN
draft due to friction from lateral force at share	H_{cs}	0.09	kN
draft due to friction from lateral force at moldboard	H_{ms}	0.00	kN
draft due to friction from lateral forces at moldboard due to soil lateral movement	H_{fs}	0.06	kN
total draft force	H_t	0.61	kN
total draft force on the ditcher	H_d	1.22	kN
power requirment of the ditcher	P_d	0.85	kW
specific draft of the ditcher	SH_d	2.14	N/cm²
efficiency engine to drawbar power	η	75%	
net engine power requirment	Ne	1.55	HP

Fig. 7 The draft force and power calculator of the ditcher

IV. CONCLUSION

Considering the results of this study, the use of the draft force and power calculator of the ditcher is recommended for a practical purpose. However, it is necessary to put side by side to the other prediction models.

NOMENCLATURE

γ	bulk unit weight	kNm^{-3}
c	cohesion	Pa
δ	angle of soil–metal friction	°
N_γ, N_c, N_a	dimensionless numbers	
d_p	point depth	m
d_s	share depth	m
w_p	point width	m
w_s	share width	m
β	angle of share edge to direction of motion	°
θ	mean angle of moldboard to direction of motion	°
δ_s	soil–soil angle of friction	°
H_p, H_s	point and share draft forces	kN
H_{mc}	moldboard soil momentum change and friction components of draft force	kN
H_e	moldboard soil potential energy components of draft force	kN
H_{cs}, H_{ms}	draft due to friction from lateral forces at share and moldboard	kN
H_{fs}	draft due to friction from lateral forces at moldboard due to soil lateral movement	kN
H_t	total draft force	kN
H_d	total draft force on the ditcher	kN
S_{Hd}	specific draft force of the ditcher	Ncm^{-2}
H_d	total draft force on the ditcher	kN
d	working depth of the ditcher	m
w	working width of the ditcher	m
P_d	drawbar power requirement	kW
v	working speed	ms^{-1}
N_e	minimum net engine power requirement	HP
H_{pull}	pull force requirement	kN
W_t	vertical load supporting by the wheels	kN
η_t	tractive efficiency	%
d_l	working depth of a lug wheel	m
w_l	working width of a lug wheel	m

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REFERENCES

[1] Badan Pusat Statistik, "Produksi Kedelai Menurut Provinsi (ton), 1993-2015," 2017. [Online]. Available: https://www.bps.go.id/linkTableDinamis/view/id/871. [Accessed: 06-Jun-2017].

[2] D. Harnowo and A. Wijanarko, "Teknologi Untuk Peningkatan Produktivitas Kedelai," in *Agribisnis Kedelai : Antara Swasembada dan Kesejahteraan Petani, Prosiding Seminar Nasional Dies Natalis XVI Program Studi Magister Manajemen Agribisnis Jurusan Sosial Ekonomi Pertanian, Fakultas Pertanian Universitas Gadjah Mada; 2015 Mei 7*, 2015, pp. 12–16.

[3] Badan Pusat Statistik, "Luas Panen Kedelai Menurut Provinsi (ha), 1993-2015," 2017. [Online]. Available: https://www.bps.go.id/linkTableDinamis/view/id/870. [Accessed: 06-Jun-2017].

[4] H. Subagyo, "Lahan Rawa Pasang Surut," in *Karakteristik dan Pengelolaan Lahan Rawa*, D. A. Suriadikarta, U. Kurnia, Mamat, W. Hartatik, and D. Setyorini, Eds. Bogor (ID): Balai Penelitian dan Pengembangan Pertanian, 2006, pp. 23–98.

[5] M. Ghulamahdi, M. Melati, and D. Sagala, "Production of Soybean Varieties under Saturated Soil Culture on Tidal Swamps," *J. Agron. Indones.*, vol. 37, no. 3, pp. 226–232, 2009.

[6] T. Adisarwanto, "Strategi peningkatan produksi kedelai sebagai upaya untuk memenuhi kebutuhan di dalam negeri dan impor," *Pengemb. Inov. Pertan.*, vol. 3, no. 4, pp. 319–331, 2010.

[7] M. Ghulamahdi, S. A. Aziz, and A. K. Makarim, "Penerapan Teknologi Budidaya Jenuh Air Pada Tanaman Padi Dan Kedelai Untuk Meningkatkan Indeks Penanaman Di Lahan Pasang Surut," in *Mendukung Kedaulatan Pangan dan Energi yang Berkelanjutan. Simposium dan Seminar Bersama PERAGI-PERHORTI-PERIPI-HIGI*, 2010, pp. 978–979.

[8] J. Glancey, "Prediction of agricultural implement draft using an instrumented analog tillage tool," *Soil Tillage Res.*, vol. 37, no. 1, pp. 47–65, 1996.

[9] J. M. A. Desbiolles, R. J. Godwin, J. Kilgour, and B. S. Blackmore, "A novel approach to the prediction of tillage tool draught using a standard tine," *J . agric . Engng Res .*, vol. 66, no. 1997, pp. 295–309, 1997.
[10] R. K. Sahu and H. Raheman, "Draught prediction of agricultural implements using reference tillage tools in sandy clay loam soil," *Biosyst. Eng.*, vol. 94, no. 2, pp. 275–284, 2006.
[11] A. F. Kheiralla, A. Yahya, M. Zohadie, and W. Ishak, "Modelling of power and energy requirements for tillage implements operating in Serdang sandy clay loam, Malaysia," *Soil Tillage Res.*, vol. 78, no. 1, pp. 21–34, 2004.
[12] J. Arvidsson, T. Keller, and K. Gustafsson, "Specific draught for mouldboard plough, chisel plough and disc harrow at different water contents," in *Soil and Tillage Research*, 2004, vol. 79, no. 2 SPEC.ISS., pp. 221–231.
[13] I. Ahmadi, "Development and evaluation of a draft force calculator for moldboard plow using the laws of classical mechanics," *Soil Tillage Res.*, vol. 161, pp. 129–134, 2016.
[14] R. J. Godwin and M. J. O'Dogherty, "Integrated soil tillage force prediction models," *J. Terramechanics*, vol. 44, no. 1, pp. 3–14, 2007.
[15] C. Saunders, R. J. Godwin, and M. J. O'Dogherty, "Prediction of soil forces acting on mouldboard Ploughs," in *Fourth international conference on soil dynamics, Adelaide, Australia*, 2000.
[16] D. R. P. Hettiaratchi, B. D. Withney, and A. R. Reece, "The Calculation of passive pressure in two-dimensional soil failure," *J. Agric. Engng Res.*, vol. 11, no. 2, pp. 89–107, 1966.
[17] J. Sakai, R. G. Sitompul, E. N. Sembiring, R. P. A. Setiawan, I. N. Suastawa, and T. Mandang, *Traktor 2-Roda*. Bogor (ID): IPB Press., 1998.
[18] ASAE, *EP496.2 Agricultural Machinery Management*. Minnesota, USA: ASAE Publication, 2000.
[19] W. Hermawan, M. Yamazaki, and A. Oida, "Design and traction performance of the movable lug wheel," *J. Terramechanics*, vol. 35, pp. 159–177, 1998.
[20] W. Hermawan, A. Oida, and M. Yamazaki, "The characteristics of soil reaction forces on a single movable lug," *J. Terramechanics*, vol. 34, no. 1, pp. 23–35, Jan. 1997.
[21] C. Watyotha and V. M. Salokhe, "Tractive performance of cage wheels with opposing circumferential lugs," *J. Agric. Engng Res.*, vol. 79, no. 4, pp. 389–398, 2001.
[22] P. A. S. Radite, W. Hermawan, and A. Soembagijo, "Desain dan pengujian roda besi lahan kering untuk traktor 2-roda," in *Prosiding Seminar Nasional Teknik Pertanian, 18-19 November 2008*, 2008.

A.5

DESIGN AND PERFORMANCE EVALUATION OF PRIME MOVER FOR OIL PALM FERTILIZER APPLICATOR

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ABSTRACT

Fertilizer application is one of the most important activity for oil palm plantation, especially in the early stage of vegetative growth. However, the main problem of fertilizer application for young oil palm before its production stage is the canopy of leaf still very low where the applicator machine cannot enter the field without breaking the leaf midrib. To overcome this problem a special purpose prime mover was design to operate fertilizer applicator for young oil palm. This prime mover was equipped with leaf lifter mechanism to allow prime mover enter the oil palm field without breaking the leaf or leaf midrib. Field performance of the prime mover was tested in the oil palm plantation where the age of oil palm about 4 years old. Performance test was conducted with engine speed at 2000 rpm. and forward speed in second gear transmission. It was revealed that forward speed and leaf lifter speed was 0.53 m/s and 0.54 m/s respectively. There were no forwarding and slashing movement of the leaf midrib, means that the forward speed is as synchronous as the leaf lifting speed. In general, the prime mover can easily enter the field without breaking the leaf midrib and it was revealed that the leaf lifting mechanism could lift upward 91.38% of leaf midrib, however it was found that the percentage of damaged midrib was 8.62%. The percentage of the damaged leaf was 3.53%, which was caused by the stuck of leaves inside the lines of lifter transmission system.

Keywords : prime mover; fertilizer applicator; oil palm; leaf midrib.

I. INTRODUCTION

Oil palm is the most important industrial plant in Indonesia where more than 50% of world palm oil production is produced in more than 14 million ha of Indonesia oil palm plantation [1]. On farm activity in oil palm plantation includes land clearing and block preparation, planting, crop maintenance, harvesting and transportation. Crop maintenance from planting until the plant starts producing fruit is the most critical activity in oil palm plantation. Among crop maintenance activity, fertilizer application for young oil palm is very important because during vegetative growth period the nutrient sufficiency will affect the plant health and fruit production [2],[3].

Fertilizer application of young oil palm is mostly done manually by spreading granular fertilizer around oil palm tree. So far, there is no machine is used for fertilizer application of young oil palm tree due to the difficulty of machine to enter among plant row. The high of leaf canopy of young oil palm tree is still very low, therefore they are covering the machine to enter between row. The objective of this research is to design a prime mover machine for fertilizer application especially for young oil palm tree. This research paper deal with the design of prime mover and especially will focus on the discussion of leaf lifting mechanism that enable the machine to enter oil palm row without breaking leaf midrib.

II. MATERIALS AND METHODS

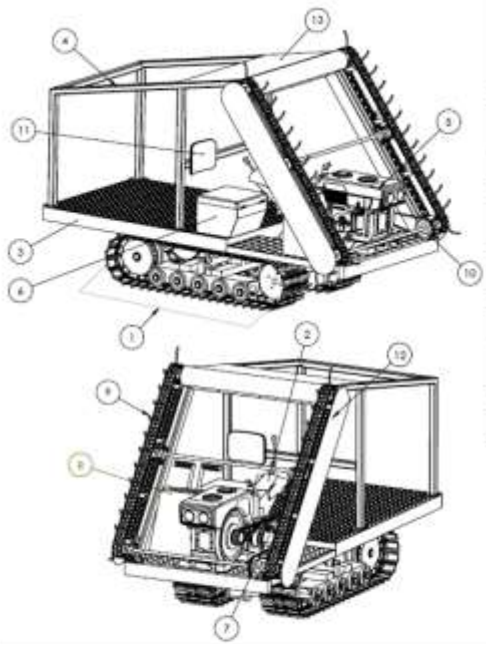
The method of this research follows typical machine design procedure including problem identification, formulation of design criteria, design analysis, design simulation, design engineering drawing, prototyping, and performance test of the prototype [4].

Problem identification was done in oil palm plantation belongs to private company which is located in Riau province. In this stage, all information for design criteria were collected and measured including technical characteristics of oil palm tree, plantation block layout, soil structure and bearing capacity. Design analysis and fabrication of prototype was done in the Department of Mechanical and Biosystem Engineering Bogor Agricultural University.

The materials used in this machine design are mainly construction carbon steel which is available in local market. Engine, gearbox and other machine elements are also bought from local market. This is important to fulfil high local content of the machine as well as to allow easy maintenance and spare part availability.

III. RESULTS AND DISCUSSION

Design criteria of prime mover for fertilizer applicator was formulated as follows: self-propelled machine: low ground clearance and total high, 1.5 m maximum width, low ground pressure, and be able to carry 1(one) ton maximum load. To fulfil the design criteria a crawler type self-propelled prime mover was selected where its design is shown in Fig. 1.



Note :
1. Under carriage
2. Gear box
3. Main chassis
4. Guide frame
5. Engine
6. Operator seat
7. Lifting device frame
8. Control lever
9. Lifting chain
10. Lifting shaft
11. Operator back rest
12. Lifting chain cover
13. Cabin roof

Fig. 1. Design of prime mover for fertilizer applicator

Main part of the prime mover chassis or mainframe, engine, transmission, undercarriage, and leaf lifting mechanism.

D. Chassis

The chassis or main frame was designed to hold other machine parts all together. The chassis was made from U shape 5x10 cm steel bar as shown in Fig. 2.

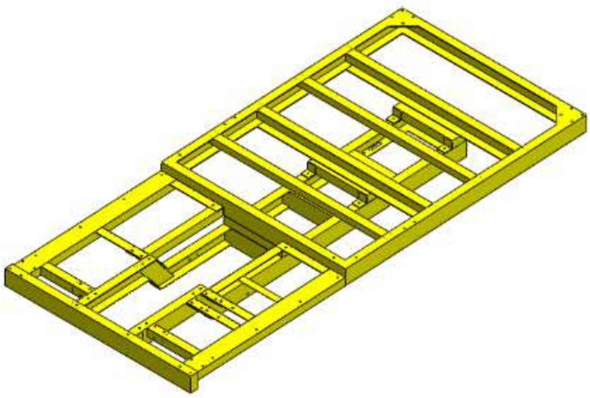


Fig. 2. Chassis (main frame)

E. Engine

Base on design analysis, the prime mover need engine power at least 6 hp. For this purpose, a 11.5 hp water cooled diesel engine was selected to provide enough power backup for the prime mover to operate fertilizer applicator which will be attached to the prime mover. Diesel engine was selected because it has good torque and low engine speed.

F. Transmission

Transmission was designed to transmit power from engine to undercarriage, lifting mechanism as well as to the PTO for operating fertilizer applicator. Hand tractor based transmission gear box was selected for this prime mover. This type of gear box is applicable for crawler type traction device because it has steering clutch that allows power engagement-disengagement for left and right axle separately. The gear has three position of forward speed and one reverse gear. It also has PTO shaft which was used to operate leaf lifting mechanism.

G. Undercarriage

The prime mover was equipped with crawler type traction device in order to provide high traction but generating relatively low ground pressure [5]. This undercarriage was specially designed to fit with selected gear box. The track link was made from attachment chain and the track shoe was made by casting carbon steel. The under carriage parts is shown in Fig. 3.

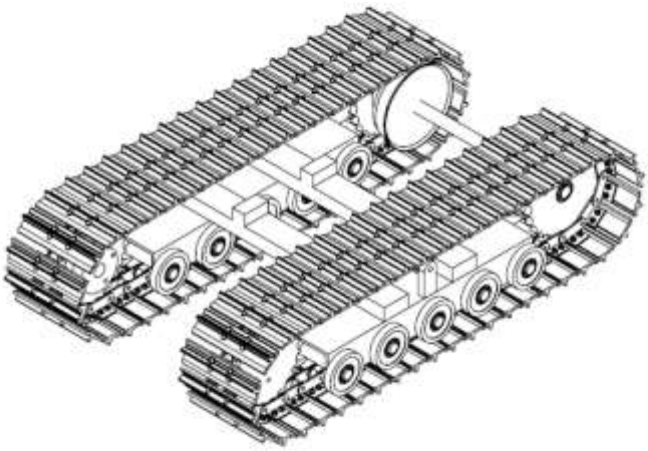


Fig 3. Track link and roller of undercarriage

H. Leaf Lifting Mechanism

Leaf lifting mechanism was specially designed with the purpose of lift the oil palm leaf midrib when the machine entering row between oil palm tree. By this mechanism, the prime mover machine can enter oil palm tree row without breaking its leaf as it is illustrated in Fig. 5. The horizontal speed of lifting mechanism is synchronise with forward speed of the prime mover to perform lift up action without pushing forward. Leaf lifting was made by using attachment chain with lifting finger as shown in Fig. 4.

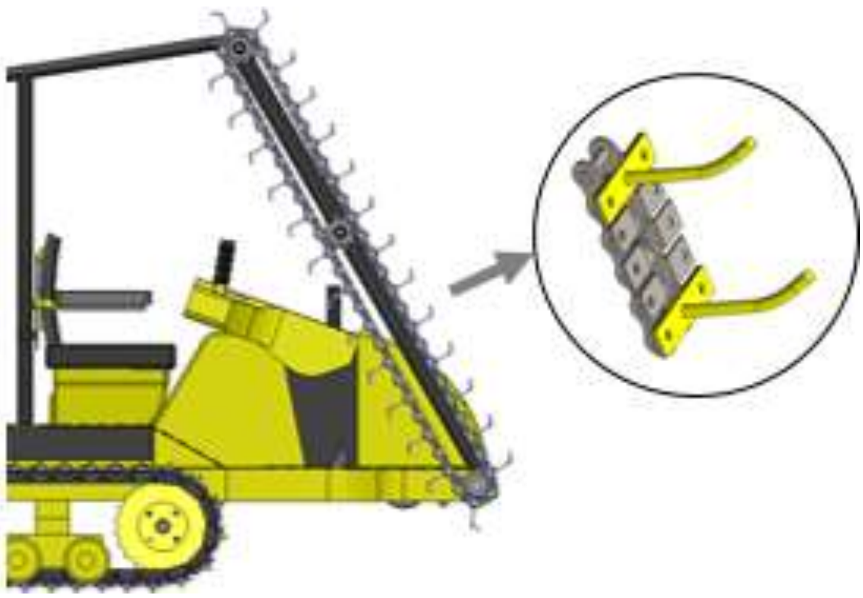


Fig. 4. Construction of leaf lifting mechanism

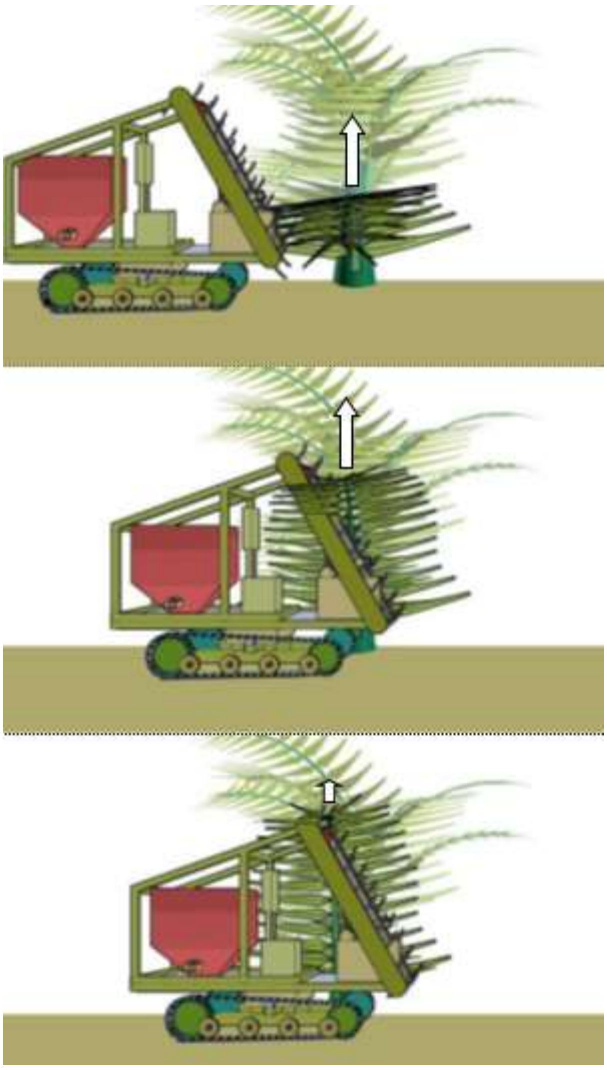


Fig. 5. Illustration of leaf lifting mechanism

I. Field Performance Test

Leaf lifting mechanism is very important conditions in this prime mover design, because it will indicate whether this machine can operate between oil palm tree without crushing the oil palm leaf or not. Prime mover forward speed and horizontal speed of leaf lifting mechanism should be equal to perform leaf lifting movement without pushing forward the leaf. Otherwise, the leaf will be pushed forward and might be broken or crushed. Field performance test of leaf lifting mechanism was conducted in the same oil palm plantation for problem identification. The parameter which were measured are actual forward speed, horizontal speed of leaf lifting mechanism, and leaf condition after passed by the prime mover. Prime mover was set in the 2nd gear, and engine speed was 2000 rpm. The result of speed synchronization without load (without lifting the leaf) is given in Table 1. From this results, it is confirm that actual average forward speed of prime mover and horizontal speed of leaf lifting mechanism are almost equal, than mean it is already synchronized.

Test performance of leaf lifting mechanism was took place at the field of 4 years old oil palm tree. The leaf canopy of oil palm tree still covering the area around tree trunk as shown in Fig. 6.

Measurement and analysis of actual forward speed of prime mover and horizontal speed of leaf lifting mechanism with load in the field was done by mean of time motion analysis using video editor software as shown in Fig. 7.

Test performance was done at the field of 4 years old oil palm tree. Based of time motion analysis, it can be seen from Fig. 5 that the actual forward speed of prime mover when working on load and lifting the leaf was found to be 0.530 m/s, while the horizontal speed of leaf lifting mechanism was found to be 0.544 m/s. In view of the fact that both speeds are almost equal, it can be said that it is already synchronized, which mean that the oil palm leaf will be lifted upward without pushed forward by the prime mover.

The performance of leaf lifting mechanism was also evaluated in term of percentage of broken leaf after passed by prime mover. The analysis was done based on 13 sample of oil palm trees in the same block. It was revealed that the leaf lifting mechanism could lift upward 91.38% of leaf midrib, however percentage of broken leaf midrib still comparatively high that is 8.62%. Main reason of broken leaf midrib is due to the position of leaf midribs were too low to be cached and lifted by the lifting mechanism, then

they were pushed upward by prime mover body. It is also found that the percentage of broken of individual leaf was 3.53%. Therefore, it can be said that design of the finger of leaf lifting mechanism was proper and do not crushing the individual leaf of oil palm tree.

Table 1. Speed synchronization between forward speed of prime mover and horizontal speed of leaf lifting mechanism

Replication	Forward speed of Prime Mover (m/s)	Horizontal speed of Leaf Lifting Mechanism (m/s)
1	0.561	0.586
2	0.573	0.572
3	0.568	0.569
4	0.555	0.582
5	0.559	0.582
6	0.561	0.586
7	0.551	0.593
Average	0.561	0.581

Fig. 6. The prime mover approaching oil palm tree

Fig. 7. Time motion analysis of speed synchronization

IV. CONCLUSION

Through this research, a prototype of prime mover for fertilizer applicator was developed and its performance was tested and evaluated accordingly. The advantage of this prime mover is that this machine has leaf lifting mechanism that enable the machine to enter and pass through between young oil palm three without destroying the leaf. The results of field performance test revealed that the machine could satisfactorily perform leaf lifting function with very small breakage of the leaf.

ACKNOWLEDGEMENT

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REFERENCES

[1] Pahan I. Kelapa Sawit Manajemen Agribisnis dari Hulu Hingga Hilir. Jakarta (ID): Penebar Swadaya. 2008

[2] Siallagan I. Optimasi pupuk organik dan NPK majemuk pada tanaman kelapa sawit (Elais guineensis Jacq) belum menghasilkan berumur satu tahun [tesis]. Bogor (ID): Institut Pertanian Bogor. 2008

[3] Sunarko. Petunjuk Praktis Pengolahan dan Budidaya Kelapa Sawit. Jakarta (ID): Agromedia Pustaka. 2007

[4] Harsokoesoemo H D. Pengantar Perancangan Teknik (Perancangan Produk). Dirjen Pendidikan Tinggi Departemen Pendidikan Nasional. Bandung. 1999

[5] Liljedahl, JB, PK Turnquist, DW Smith and M Hoki. Tractors and Their Power Units. Fourth Edition.An Avi Books. New York. USA. 1989.

A.6

STUDY OF HIGH ELECTROSTATIC FIELD PRETREATMENT TO MAINTAIN POSTHARVEST QUALITY OF CHERRY TOMATO

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ABSTRACT

Cherry tomatoes (*Lycopersico esculentum* var. cerasiforme) are categorized as high value agricultural product. However, its marketability were influenced by rapidly declining quality due to postharvest ripening. Therefore, it's necessary to select a specific treatment that can maintain the quality by delaying ripening. High electrostatic field (HEF) pretreatment, a non-chemical and low energy techniques, was known to be a viable method to delay fruit ripening. The present study aimed to evaluate the effect of field strength and exposure time of HEF pretreatment on postharvest quality of cherry tomatoes during storage. The fruits were treated by direct current HEF of 1, 2, or 3 kV/cm for 1 or 2 hours in a parallel plate electrode system. Then, the fruits were stored at 13 ^{o}C, 85-90% RH for up to 21 days and regularly measured for respiration rate and quality. The results showed that HEF was able to maintain high level of total soluble solids (TSS), despite the field strength and exposure time had no significant effect. HEF pretreatment also capable of reducing fruit weight loss 1.2-1.9 times and the effect increases with increasing field strength. Fruit softening percentage became lower when the field strength and exposure time increased. Climacteric peak was successfully postponed for 3 days in all HEF treatments and the most reduced respiration rate was at 2 kV/cm for 2 h pretreatment, indicating that it has the ability to inhibit metabolism. Finally, the greater field strength and longer exposure time used (2-3 kV/cm, 2 h) lead to a more sustainable cherry tomato quality during storage. Further research should be recommended to evaluate the mechanism maintaining the quality of cherry tomato by high electrostatic field, especially in its effect on electric field-dependent calcium-inhibited ethylene biosynthesis and signal transduction.

Keywords*:* high electrostatic field, postharvest quality, cherry tomato.

I. INTRODUCTION

Tomato fruit is the second most consumed vegetable after potatoes that has per capita consumption volume in fresh and processed form of about 20.2 kg/year in 2011. On a global scale, tomato production reached 163.7 million tonnes with a value of 96.3 billion dollars, acounting for 0.61% of the total or equivalent to 7.1 trillion rupiah produced in Indonesia [1]. It increased from four previous years which only 152.9 million tons. Unfortunately, losses of up to 50% can be recorded between the harvesting and consumption stages of the tomato distribution chain in tropical countries [2].

According to a report by [3], small and sweet cherry tomatoes are the most preferred type of tomatoes for fresh consumption. However, the shelf life is quite short around 5-7 days at room temperature which is marked by the occurrence of decay due to overripening. During ripening, there may be also losses in quality through many biochemical changes such as pigmentation, cell wall and carbohydrate metabolism, ethylene biosynthesis, and signalling tranduction. The delay of ripening in cherry tomato allowing it to be consumed in optimal condition for longer time.

Harvesting at breaker stage (<10% non green) for cherry tomato is usually done in order to restrain their losses caused by physical damage during transport and storage and are then allowed fruit to ripen just prior to or during marketing. Cold storage of breaker stage tomato fruit at 12.5-13 ^{o}C was also used to delay deterioration for up to 4 weeks [4]. However, their combination with other methods was considered capable to optimized the suppression of deterioration.

High electrostatic field (HEF) has been reported to be an effective treatment in keeping fruit quality longer by suppressing the respiration rate, as in apple [5], mature green round tomato [6], cranberry [7], and persimmon [8]. The treatment utilizes electric field exposure effects from high-voltage installations >1000 Vrms AC or >1500 VDC (IEC 60038: 2002) on the modulation of fruit cell physiology processes. It is reported that electric field can affect cells via interaction with charged molecules and proteins in the cell membrane that alters the flow of ions through the ion channels or redistribution of the membrane receptors, as well as direct field penetration inside the cell that then interact with charged entities in the cytoplasm. There are several advantages to HEF treatment, including: simple equipment, safety, no vestiges, and low energy consumption subsequently minimised economic constraints.

The use of HEF along with cold storage may be able of maintaining quality of cherry tomato better. However, it is not yet known clearly which configuration is most appropriately applied to cherry tomatoes. According to [9], improper use of HEF configurations, such as less exposure duration and field strenght, did not significantly retain the fruit quality associated with delayed ripening. Therefore, this study aims to evaluate the effectiveness of HEF pretreatment and to investigate the effect of field strength and exposure duration on quality of cherry tomato during cold storage. This paper further reports the effects of HEF configuration on the respiration rate, weight loss, fruit softening, and total soluble solids of cherry tomatoes.

II. MATERIALS AND METHODS

A. *Plant Material*

Breaker mature cherry tomatoes (*Lycopersicon esculentum* var. cerasiforme) were obtained from local farmland in Pamijahan, Bogor in March 2016. Fruits harvested on the morning were transported to Laboratory of Postharvest and Energy, Bogor Agricultural University within 2 hours. They were washed with chlorinated water (3.4 $mmolL^{-1}$ NaOCl) and stored temporarily. Uniform fruit based on shape, size, and absence of wound selected for experiment.

B. *HVEF Pretreatment*

The HVEF pretreatment was performed using modified equipment based on [6]. It was consisted of an high-voltage electrostatic generator (Spellman RHSR30PN60) lead to the generation of electric current into the two-tier copper plate had a shelf spacing of 10 cm. The output voltage between the cathode and the anode is adjustable resulting in different electric field strengths. Cherry tomatoes were placed between the two electrodes and the electric field was passed through the fruit. In this experiment which use of parallel plate configuration, when the output voltage is 10, 20, or 30 kV, the electric strength between the electrodes will be 1, 2, or 3 $kVcm^{-1}$, respectively. The treatment were conduct for 1 or 2 h and there was no electric field passes through the control fruit. After treatment, all fruit were stored in a refrigerated room for 21 days at 13 ^oC, 85–90% RH and each indicators were analyzed every three days.

C. *Respiration Rate*

Respiration rate is measured based on CO_2 evolution rate. About 500 g of cherry tomato was inserted into a 3.3 L closed jar and incubated for 2 hours at 13 °C per treatment slot. The results of CO_2 level measurements by continuous gas analyzer (IRA-107, Shimadzu) were used to calculate respiration rates as in [7].

D. *Weight loss*

Tomato fruit were weighed before pretreatment and at the end of each storage interval. Weight loss is calculated as a percentage on a fresh weigh basis and determined as the ratio of difference between initial and final fruit weight during that storage interval to initial fruit weight.

E. *Fruit Firmness*

Fruit firmness was determined by measuring the amount of force (1 Kg = 9.81 N) to puncture a hole on the equatorial region of fruit, using a rheometer (CR-300, Sun Scientific Co.Ltd, Japan) with a flat round 5 mm diameter head. The machine was set for maximum compression with a speed of 10 mm/min and maximum load of 10 kg. Softening is calculated as a percentage on fresh firmness basis and determined as the ratio of difference between initial and final fruit firmness during storage interval to initial firmness.

F. *Total Soluble Solid*

The TSS of cherry tomato were determined at room temperature using a handheld refractometer (PAL-α, Atago, Japan). The cherry tomato for each treatment were finger pressed to extract a couple of drops of juice that were placed on the refractometer prism. The TSS (^{o}Brix) of the juices was measured directly from the instrument. The readings were averaged for each replication value.

G. Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) under a Completely Randomized Factorial Design with 2 factor and a separate control using IBM SPSS version 23 and mean separations were done using Duncan Multiple Range Test (DMRT) at 5% level of significance. To evaluate the effectiveness of HEF pretreatment, the combination of the treatment was compared with control using orthogonal contrast test at 5% level of significance.

III. RESULTS AND DISCUSSION

A. Effect of HVEF on Respiration Rate

The respiration rate of control fruit reached a peak after 9 days of storage then decreased rapidly (Fig. 1). Meanwhile, there was a lower respiration rate in HEF-treated fruit compared to the control fruit in less than 9 days. Generally, the higher the CO_2 evolution rate, the shorter the storage life. By HEF, the peak of CO_2 producing was delayed by 3 days and the value of the peak was smaller than control fruit significantly. It was tested that HEF could restrain the respiration of cherry tomato which may subsequently result in longer storage life and consistent with earlier reports [6], [10].

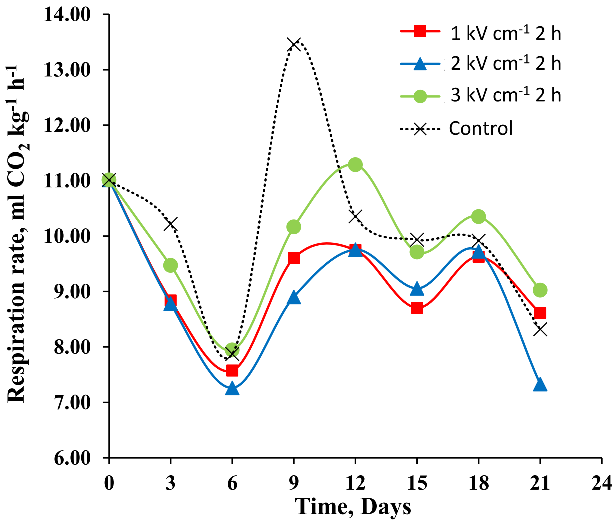

Fig. 1. Changes in respiration rate (mlCO_2 kg^{-1} h^{-1}) of cherry tomato fruits treated by different pretreatment conditions during cold storage

Fruit exposed to HEF for 2 hours has a lower CO_2 production rate than that of an hour (Table 1). This result is consistent with [5], [8] that the longer the exposure time the lower the CO_2 production of the fruit. In addition, the 2 kVcm^{-1} treatment relatively provides the most suppression on climacteric respiration rates among field strengths.

The mechanism of how HVEF influences the respiration of the postharvest fruit was not yet clearly known. However, during exposure to an external electric field, the side of the cell facing the anode is reported to have hyperpolarization while the near side of the cathode is depolarized. To compensate for that, the cell minimizes the dimensions of the surface exposed perpendicular to the electric field by converting the shape into a spindle. On the depolarized side, the inflow of $Ca2^+$ cations through ion channels increases and drives the increase in intracellular calcium ion concentrations [11]. As the concentration increases at least 1μM, intracellular calcium will be bound by calmodulin and form a calcium-calmodulin complex that modulates many of the physiological processes. With the reaction mediated by the complex, calcium ions may inhibit the pathway of ethylene biosynthesis by limiting the activity of the ACO enzyme catalyzing the formation of ethylene from ACC [12]. This inhibition is also reflected in the other report [6] that fruit subjected to HEF produces lower and delayed ethylene peak production. This may subsequently affect signalling transduction from ethylene receptors to ripening-related gene expression including delay and decrease in climacteric respiration.

B. Effect of HVEF on Weight Loss

The percentage weight loss increased during storage to differing degrees depending on the treatments. The weight loss of the HEF-treated fruit increased from the range of 2.12-2.72% to 10.85-17.2% on the 3 and 21 days of storage, respectively. Meanwhile, there were more increase in the control fruit from 4.52% to 20.70% on the 3 and 21 days of storage, respectively. Reference [13] reported that maximum acceptable weight loss values of tomato to remain salable range from 6 to 7%. In this study, the weight loss values of all samples used were found higher than those suggested. However, the final weight loss of HVEF-treated fruit 1.2-1.9 times lower than that of control indicates that there is a protective effect of HEF on weight loss of tomatoes in storage as stated by [8] previously.

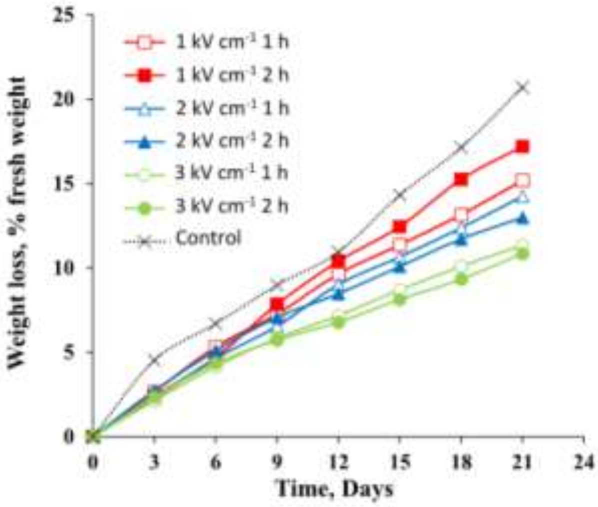

Fig. 2. Changes in weight loss (%) of cherry tomato fruits treated by different pretreatment conditions during cold storage

About 3-5% of the postharvest weight loss was caused by CO_2 evolution from the cells and the rest was due to the transpiration process. As described previously, HEF was able to suppress the respiration rate which affected to the limitation of carbohydrate conversion to CO_2 and water vapour. HEF also has ability to suppress transpiration by stabilizing the cell membrane and giving more hardness to the cell wall. It appeared that the outer skin surface of HEF-treated cherry tomato tended to harden whereas control fruit experienced premature decay. Similar conditions were also reported in apples treated with HEF 3-4 kVcm^{-1} [5].

The weight losses between HEF-treated fruits at each interval period of storage differed significantly due to the influence of field strength factors (Table 1). It was obvious that the 3 kVcm^{-1} treatment was the most effective field strength in suppressing weight loss up to 21 days of storage. These results were consistent with [5] which states that the greater the field strength of HEF, the lower the weight loss of fruit.

C. Effect of HVEF on Fruit Firmness

During storage, the value of fruit firmness tended to decrease from an initial value of 26.25 N to 11.57-16.93 N indicating a softening. Softening is an indication of the easier separation between cells due to decreased pectin gel cohesion. This softening may occur as the cell wall becomes increasingly hydrated and pectin in the middle lamella is modified and partially hydrolysed by the activity of pectinesterase (PE) and polygalacturonase (PG) enzymes.

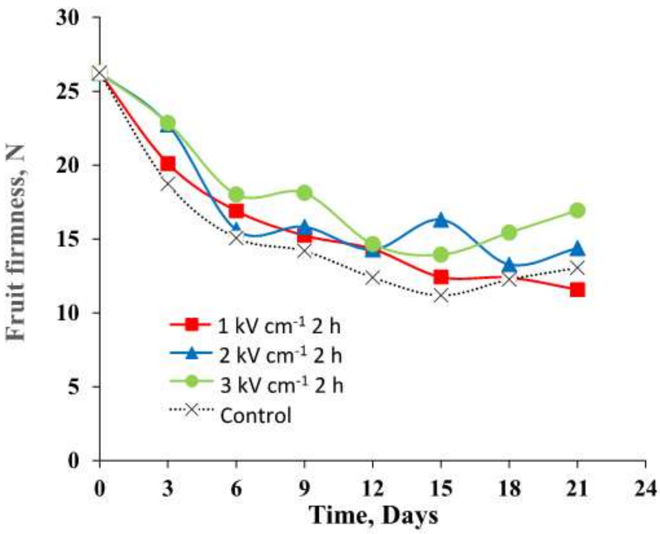

Fig. 3. Changes in firmness (N) of cherry tomato fruits treated by different pretreatment conditions during cold storage

It was obvious that control tomato had the lowest firmness or highest softening among all treatments at 3, 6, 12, and 15 days of storage. At the end of storage, fruit softening in control tomato was also significantly 7% higher than that average in HEF-treated tomato (Table 1) indicated that cherry tomato tissue exposed to HVEF is relatively more intact. This result was consistent with the previous studies [6], [8] stated that HEF can retain fruit firmness and delay softening during storage. Lower softening percentage on HEF-treated cherry tomato may be due to HEF's ability in limiting the activity of both PE and PG enzymes either directly or via ethylene signalling. This is further supported by the other study reported that HEF 6 $kVcm^{-1}$ pretreatment can suppress PE activity in persimmon.

Among the HVEF treatment levels, the percentage of fruit softening tends to be the same but shows significant differences in the end of storage period. This difference occurs due to the influence of field strength, duration of exposure, and interaction of both (Table 1). The 3 $kVcm^{-1}$ field strength treatment for 2 hours resulted in the lowest softening (35.49%) followed by 3 $kVcm^{-1}$ for 1 hour (40.60%) and 2 $kVcm^{-1}$ for 2 hours (45.21%). According to [14], fruit hardening is usually associated with weight loss control. In this study, cherry tomatoes subjected to HVEF 3$kVcm^{-1}$ treatment with the lowest weight loss also showed the lowest softening. Insufficient softening is required to give the edible fruits and the release of cell content when chewed for olfactory perceptions of aroma and taste. According to the final tomato firmness limit criterion [15], ie 1/3 of the initial firmness or maximum softening equivalent of 66%, all samples in this study were considered to be viable and not too soft.

D. Effect of HVEF on Total Soluble Solid

Total soluble solids of cherry tomatoes increased during observation with a slight decrease toward the end of storage period (Fig. 4). Increased TSS during ripening was due to the degradation of limited polysaccharides into simpler soluble sugars. Meanwhile, the decrease of TSS toward the end of the storage period was due to the ongoing use of sugar as a substrate in the fruit respiration process. The highest TSS values during observation (5.1 ^{o}Brix) occurred in control and 2 kVcm-1 for 2 h HEF-treated fruits on 15 and 18 days of storage, respectively. Nevertheless, the final TSS value in the control sample was significantly 10% lower than that average in HVEF-treated sample ($p < 0.05$). It was indicated that HEF treatments can maintain TSS at a higher level than that of control. These findings were also consistent with past research [10], [16].

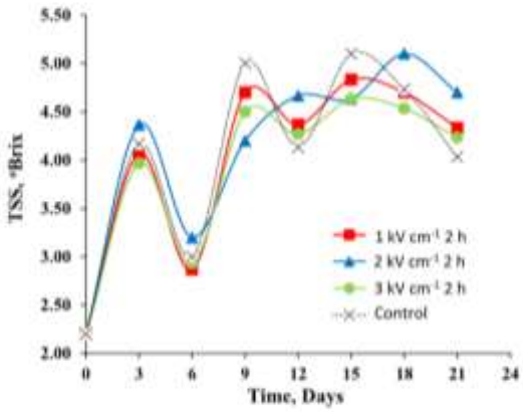

Fig. 4. Changes in TSS (^{o}Brix) of cherry tomato fruits treated by different pretreatment conditions during cold storage

Table 1. Quality parameter values of cherry tomato for various pretreatment conditions

Pretreatment Conditions		Quality Parameters			
Field Strenght ($kVcm^{-1}$)	Exposure Time (h)	Respiration rate ($mlCO_2\,kg^{-1}\,h^{-1}$)	Weight Loss (%)	Softening (%)	TSS (°Brix)
1	1	10.16 ± 0.60 b	15.18 ± 1.03 a	53.30 ± 1.98 b	4.60 ± 0.36 a
	2	9.60 ± 0.33 c	17.20 ± 1.32 a	55.92 ± 1.35 a	4.33 ± 0.29 a
2	1	9.42 ± 0.51 c	14.24 ± 0.85 b	49.69 ± 2.06 c	4.60 ± 0.36 a
	2	8.90 ± 0.28 d	12.98 ± 0.88 b	45.21 ± 1.31 d	4.70 ± 0.10 a
3	1	11.72 ± 0.43 a	11.35 ± 0.68 c	40.60 ± 1.63 e	4.60 ± 0.17 a
	2	10.16 ± 0.63 b	10.85 ± 0.70 c	35.49 ± 2.12 f	4.23 ± 0.21 a
Mean of HEF		9.99 ± 0.97 y	13.63 ± 2.40 y	46.70 ± 7.78 y	4.44 ± 0.25 x
Control		13.46 ± 0.53 x	20.70 ± 1.25 x	50.31 ± 3.26 x	4.03 ± 0.21 y

Description: The number followed by the same letter in the same column was not significantly different at the 5% test level

Inhibition of changes in TSS values by HEF could be the result of the HEF's ability to suppress respiration rates and the activity of polysaccharide degrading enzymes. This result supported [17] that reported the effectiveness of 1.75 $kVcm^{-1}$ HEF treatment in suppressing the activity of amylase enzymes in kiwi fruit during storage. The TSS values of all samples on 6 day of storage look much lower than the former and latter period of storage. It may be caused by a measurement error that can be derived from an instrument error at that time.

In all HEF treatments, the tested field strength and exposure did not cause significant differences in the TSS end value ranging from 4.23-4.7 ^{o}Brix. Similar results were also reported by [7] stated that the treatment of HEF 2, 5, 8 $kVcm^{-1}$ for 30, 60, or 120 min did not significantly differentiate the cranberry fruit TSS values. In contrast, apples subjected to HVEF of 1 $kVcm^{-1}$ had significantly higher TSS values compared with 0.5 $kVcm^{-1}$ [10].

IV. CONCLUSION

HEF pretreatment applications are effectively able to inhibit the rate of climacteric respiration, weight shrinkage, softening, and loss of TSS value in breaker mature cherry tomatoes. Longer HEF exposure (2 hours) proved to further suppress the increased rate of repiration and softening of cherry tomatoes. In addition, the use of higher field strength (2-3 $kVcm^{-1}$) has a greater ability to limit weight loss and softening. However, differences in field strength and duration of HEF exposure did not affect the TSS value of cherry tomatoes. Further research needs to be focused on the HEF mechanisms in influencing signaling transduction and ripening-related gene expression in climacteric fruit, especially in cherry tomatoes.

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REFERENCES

[1] FAOSTAT, "Crop Statistics and Value of Agricultural Production Data," *Food and Agriculture Organization of the United Nations (FAO)*, 2013. [Online]. Available: http://www.fao.org/faostat/en/#data. [Accessed: 01-Jan-2017].

[2] I. K. Arah, G. K. Ahorbo, E. K. Anku, E. K. Kumah, and H. Amaglo, "Postharvest Handling Practices and Treatment Methods for Tomato Handlers in Developing Countries : A Mini Review," *Adv. Agric.*, vol. 2016, 2016.

[3] S. Lê and S. Ledauphin, "You like tomato, I like tomato: Segmentation of consumers with missing values," *Food Qual. Prefer.*, vol. 17, no. 3–4, pp. 228–233, 2006.

[4] M. Gajewski, K. Mazur, J. Radzanowska, M. Marcinkowska, K. Ryl, and K. Kalota, "Sensory Quality of Cherry Tomatoes in Relation to 1-MCP Treatment and Storage Duration," *Not. Bot. Horti Agrobot. Cluj-Napoca*, vol. 42, no. 1, pp. 30–35, 2014.

[5] G. Atungulu, Y. Nishiyama, and S. Koide, "Electrode Configuration and Polarity Effects on Physicochemical Properties of Electric Field Treated Apples Post Harvest," *Biosyst. Eng.*, vol. 87, no. 3, pp. 313–323, 2004.

[6] Y. Wang, B. Wang, and L. Li, "Keeping quality of tomato fruit by high electrostatic field pretreatment during storage," *J. Sci. Food Agric.*, vol. 88, no. 3, pp. 464–470, 2008.

[7] V. Palanimuthu, P. Rajkumar, V. Orsat, Y. Gariépy, and G. S. V. Raghavan, "Improving cranberry shelf-life using high voltage electric field treatment," *J. Food Eng.*, vol. 90, no. 3, pp. 365–371, 2009.

[8] C.-E. Liu, W.-J. Chen, C.-K. Chang, P.-H. Li, P.-L. Lu, and C.-W. Hsieh, "Effect of a high voltage electrostatic field (HVEF) on the shelf life of persimmons (Diospyros kaki)," *LWT - Food Sci. Technol.*, vol. 75, pp. 236–242, 2017.

[9] K. S. Shivashankara, S. Isobe, M. I. Al-Haq, M. Takenaka, and T. Shiina, "Fruit Antioxidant Activity, Ascorbic Acid, Total Phenol, Quercetin, and Carotene of Irwin Mango Fruits Stored at Low Temperature after High Electric Field Pretreatment," *J. Agric. Food Chem.*, vol. 52, no. 5, pp. 1281–1286, 2004.

[10] W. Jie, L. Ite, Y. Qing, and D. Yang, "Effect of applied electric field on the post-harvest quality of 'red delicious' apple," *Trans. CSAE*, vol. 19, no. 5, pp. 135–140, 2003.

[11] D. O. Carpenter and S. Ayrapetyan, *Biological Effects of Electric and Magnetic Fields: Beneficial and Harmful Effects*. Elsevier Science, 2012.

[12] C. K. Njoroge, E. L. Kerbel, and D. P. Briskin, "Effect of Calcium and Calmodulin Antagonists on Ethylene Biosynthesis in Tomato Fruits," *J. Sci. Food Agric*, vol. 76, pp. 209–214, 1998.

[13] M. Nunes, *Color Atlas Postharvest Quality of Fruits and Vegetables : Solanaceous and Other Fruit Vegetables*. New York (US): J Wiley, 2008.

[14] C. Fagundes, K. Moraes, M. B. Pérez-Gago, L. Palou, M. Maraschin, and a. R. Monteiro, "Effect of active modified atmosphere and cold storage on the postharvest quality of cherry tomatoes," *Postharvest Biol. Technol.*, vol. 109, pp. 73–81, 2015.

[15] M. M. Lana, L. M. M. Tijskens, and O. va. Kooten, "Effects of storage temperature and fruit ripening on firmness of fresh cut tomatoes," *Postharvest Biol. Technol.*, vol. 35, no. 1, pp. 87–95, Jan. 2005.

[16] G. Atungulu, E. Atungulu, and Y. Nishiyama, "Electrode configuration and treatment timing effects of electric fields on fruit putrefaction and molding post harvest," *J. Food Eng.*, vol. 70, no. 4, pp. 506–511, 2005.

[17] Z. Yifan and R. Honghui, "Effects of High Voltage Electrostatic Field Treatment on Post-harvest Physiology of Kiwifruit," *New Technol. Agric. Eng. (ICAE), Int. Conf.*, pp. 994–997, 2011.

A.7

DESIGN AND PERFORMANCE ANALYSIS OF SEPARATION MECHANISMS OF PULP AND MANGOSTEEN SEEDS

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ABSTRACT

A separation machine of seeds and pulp of mangosteen fruit has been developed, However the capacity was low and the quality of the pulp was below the standard. The objectives of this research were 1) to analyze and obtain the best mechanisms for separation of seeds and pulp of mangosteen fruit, and 2) to manufacture and test a prototype of the separating machine. Research procedure includes identification of physical characteristic of mangosteen seeds, development and evaluation of mechanisms for separating pulp and seeds of mangosten fruit, engineering design, manufacturing, and performance testing. Three mechanisms were developped and analyzed in order to separate the seeds and pulp of the mangosteen fruit: 1) a horizontal cylinder mechanism with a rotating brush, 2) a mechanism of a vertical cylinder with a rotating brush, and 3) a vertical cylinder with a stationary brush. The evaluation result using Analytic Hierarchy Process showed that the horizontal cylinder mechanism with a rotating brush was the best mechanism for separating process to be implemented. A prototype of a separating machine using the mechanism was made and tested. The test result showed that the prototype can separate pulp and seed of manggosteen fruit with the capacity of 157.3 kg/hour without broken seeds.

Keywords **:** pulp, machine, manggosteen, seed, separation colon.

I. INTRODUCTION

Mangosteen (*Garcinia mangostana* L.) is one of Indonesia's main fruit commodities. Since the 1970s until now export demand has been continuing to increase, so it can be said that the mangosteen fruit is a leading export that became the mainstay of Indonesia. The contribution of mangosteen fruit exports is enormous in order to increase the country's income and farmer's income (Qosim 2007 in Qosim 2013). In 2008 the export volume reached 6 million tons of mangosteen fruit worth US $ 3 611 995. But the number is considered not to 10% of total production (Yatman 2012). In 2014 mangosteen production reached 114 755 tons with an average of 7.55 tons / ha (Directorate General of Horticulture Ministry of Agriculture 2015). The mangosteen production rate from 2010-2014 experienced to 13.82% (Ministry of Agriculture 2015).

Mangosteen fruit consists of many components such as fruit seeds, fruit flesh (pulp) and fruit peel. Utilization of mangosteen flesh is quite plentiful, among them as raw material for making syrup, juice, jam, jelly, and puree (Utami, 2008). Examples of high-value processed products include: mangosteen juice (US $ 20 per liter); Extract mangosteen (US $ 12.64 per 60 tablets); Mangosteen tablet (US $ 3.59 per 30 tablets); And mangosteen xanthone rich (US $ 12.98 per 60 tablets) (Kastaman 2007).

Separation of seeds and pulp in general has not been done mechanically and systematically. In fact, if we look further, there is a need for a separation system of flesh and pulp to produce mangosteen juice that can be consumed and has high economic value. The nutrient composition of the mangosteen pulp per 100 grams includes 79.2 grams of water, 0.5 grams of protein, 19.8 grams of carbohydrates, 0.3 grams of fiber, 11 mg of calcium, 17 mg phosphorus, 0.9 mg of iron, 14 IU of vitamin A, 66 mg vitamin C, vitamin B (thiamine) 0.09 mg, vitamin B2 (riboflavin) 0.06 mg, and vitamin B5 (niacin) 0.1 mg (Kwatiningsih 2009).

The need of mangosteen processing machine is important considering the widespread of creative industries processing mangosteen fruit is more profitable than just selling the fruit. Through the optimum fruit and mangosteen separator machine is expected to grow the creative industries of the producers of household mangosteen juice. Thus, the mangosteen fruit is no longer consumed in the form of fresh fruit that produces waste and is exported in the form of raw materials, but can already be processed into high-value processed products.

Separation of seeds and mangosteen pulp became one of the problems to increase the development of utilization of mangosteen fruit for household industries scale. One of the innovation for solving this problem is the presence of pulp and seed mangosteen separator machine. Difficulties of separation of seeds and mangosteen pulp caused by the characteristics of the flesh that is attached to the seed of the mangosteen fruit. The separator machines are still producing broken seeds in the process of separation. This will decrease the quality of the resulting pulp. Therefore, a mechanism capable of separation seeds and pulp mangosteen is required without damaging the seeds of mangosteen fruit and high yield. The objectives of this research were 1) to analyze and obtain the best mechanisms for separation of seeds and pulp of mangosteen fruit, and 2) to manufacture and test a prototype of the separating machine.

A machine for separated mangosteen seed and pulp was created, but it still has several aspects to be developed including low capacity and in the process of separation of mangosteen seeds and pulp still contained high percentage of broken seeds. The existence of the broken seeds mixed the pulp will reduce the quality and content of pulp nutrients. Therefore, it is necessary to find a better mechanism for the separation of pulp and seed of mangosteen, which can be obtained by design of separator machine which has best performance.

II. MATERIALS AND METHODS

A. Place and Time

The prototype testing process was carried out in Agricultural Mechanization Workshop and Laboratory of Food Processing and Agricultural Product of Bogor Agricultural University.

B. Materials and tools

The material used in this research was the machines of seeds and flesh of mangosteen fruit (*Garcinia mangostana* L.). Test materials were obtained from fruit merchants in Fruit Market, mangosteen fruit farmers, and mangosteen fruit processing industry in Bogor Regency. Mangosteen fruit used in this study has been ripening. The maturity level of mangosteen fruit is observed based on the color. The selected mangosteen fruit was the mangosteen fruit with reddish and purple. The selected mangosteen fruit grade is a large group of mangosteen fruit with fruit diameter> 6.5 cm; Fruit weight> 140 and medium group with fruit diameter 5.5-6.5 cm; Weight of 70-140 grams of fruit.

C. Research Procedure

1. Separation Concept

The concept of the design of the separation mechanism was carried out to determine mechanisms can be used in the process of separation of seeds and mangosteen flesh. There are several basic concepts that can be taken into consideration in the design such as Pulping Machine (Sharp et al. 1946), Summer Squash Seed Extracting Machine (Al-Gaadi et al., 2011), Fruit Presses, Treeshade pulper, and Pinnaple Crusher (Fellows 2004), Wild Pulper Machine (Dikson 2015), Machine For Cold Pulping of Tomato (Husain et al., 2010). From the various basic concepts, obtained three design concepts of the mechanism of separation of seeds and mangosteen fruit flesh. The three concepts were 1) horizontal cylinder with rotary brush, 2) vertical cylinder mechanism with rotary blade, and 3) vertical cylinder mechanism rotating with silent brush blade.

The best model was selected by using Priority Estimation Tool (Priest) software for decision making using AHP (Analytic Hierarchy Process) method. The criteria used in decision making using AHP are 1) power used, 2) manufacturing time, 3) complexity, 4) manufacturing cost, and 5) pulp percentage. Weighting on AHP is done on a scale of 1-5. Weight of 1 means equally important, weight 3 means a little more important, weight 5 means very important, and weight 2 or 4 is adjacent assessment.

2. Design analysis

Design analysis was carried out on the best concept that combined the expected design criteria. The design analysis consisted of functional design analysis and structural design. Functional design is the decomposition of the engine functions and selection of alternative components or mechanisms to perform functions, both main and support functions. The main function of the machine designed is to make the process of separation of seeds and flesh of mangosteen fruit without damaging the seeds. In addition to functional analysis, structural analysis will be carried out in the form of technical analysis that aims to take into account the shape, size, and materials of each component so compile the criteria of function, and strength.

3. Methode of testing the prototype performance

The testing process was carried out by inserting the material, with variations of 1 kg, 2 kg, 3 kg and 4 kg, and measuring : 1) the length of time required for the separation process, 2) the yield of the pulp and seeds produced. Each treatment was tested with three repeatations. The separation capacity was obtained by measuring the weight of the material and the time. The equations used to calculate the separation capacity as follows:

$$KP = BBT/tp \tag{1}$$

where,

KP = Separation capacity (kg/hour),

BBT = Total of material weight (kg),
Tp = time (hour).

The yield of this separator can be obtained from the data of the total of material used and the resulting output of the equation:

$$\eta = \frac{Wt}{BBT} \tag{2}$$

where,
η = Rendement (%)
Wt = Weight of material produced (kg)
BBT = Weight of material before treatment (kg)

The efficiency of separation (E) is calculated by the formula:

$$Ef = \frac{n_{awal} - n_{akhir}}{n_{awal}} \times 100\% \tag{3}$$

III. RESULTS AND DISCUSSION

A. Performance Evaluation of Three Design Concepts

The three mechanisms performed by the test were 1) The horizontal mechanism with the blades of the brush spinning, 2) the vertical mechanism with the blade of the rotating brush, and 3) the vertical mechanism with the static brush blade. The third images of the separation mechanism can be observed in Fig. 1. The analysis using the AHP method includes manual separation power, manufacturing time, complexity, manufacturing cost, and pulp percentage using 1 kg of mangosteen. The data used to perform the analysis was presented in Table 1.

Table 1. Comparison of the three concepts of separation

Model	Power	Contruction time (day)	Complexity	Cost (Rp)	Pulp (gram)
1	127.6	7	6	500000	12.6
2	126.0	15	8	1000000	11.4
3	90.6	13	9	800000	13.4

From the results of analysis using AHP found that the mechanical separation horizontally with spinning brush blade is the best mechanism of the three existing models. It was expressed as a percentage of 66.6% for the mechanism. The results of AHP analysis can be observed in Fig. 2.

Fig. 1. Mechanism of separation a) horizontal brush rotating mechanism, b) vertical mechanism with rotary brush, and c) vertical mechanism with static brush

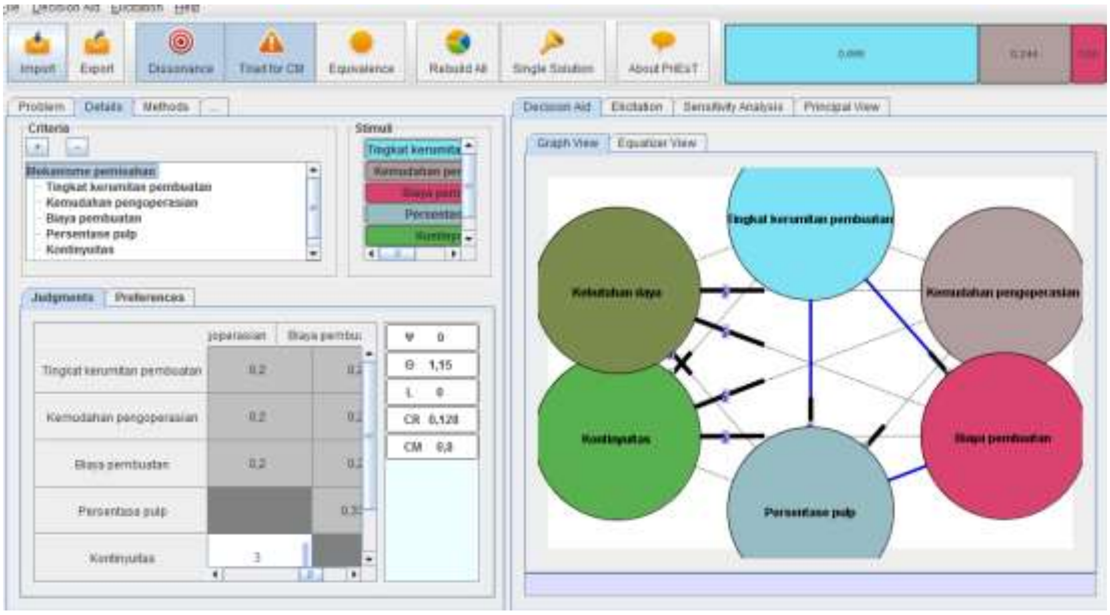

Fig. 2. The results of analysis using Priest software.

B. Machine prototype

The process of making a prototype began the construction of the framework as the support of other components. Installation of the separating cylinder and the pulp output door was carried out with an angle of 20˚ for the output of seeds used 40˚ slope. The separator cylinder was designed to be covered by 0.25mm diameter holes. So that automatically the seeds of mangosteen fruit sized more than 0.25mm will be directed to the special output of seeds and pulp mangosteen will come out through the spare-hole and out through output door. The cylinder separator design process was carried out by considering the physical properties of the mangosteen fruit in terms of the specific gravity of the mangosteen fruit and the size of the seed. This was done in order to perform the design of the total capacity of the separator and the cylinder diameter holes enveloped separator cylinder. Based on previous research it is known that the weight of mangosteen fruit of 1.508 gram / cm^3. Thus the separator cylinder was designed with a diameter of 20 cm and length of 75cm. So the total capacity of the mangosteen fruit in the cylinder can be of 15 kg. The mangosteen fruit seed size will determine the design of the door inside the cylinder output seed separator and the size of the vent holes that covered cylinder separator. The physical properties such as grain size was obtained based on the results of the literature which was the average length of seeds ranged between 2.26cm-2.48cm with an average width ranging between 1.5-1.68cm seed (Qosim et al., 2011). Therefore, the separator cylinder must be covered by the vent holes with a diameter smaller than 1.5 cm. The cylindrical image of the separator can be observed in Fig. 3.

Fig. 3. Separation cylinder

Separator cylinder made of stainless with a thickness of 0.2 cm. The thickness of the stainless cylinder combined with the diameter of the small holes surrounding it will affect the remaining mangosteen pulp on the sidelines of the hole. The cylind separator material using stainless steel was intended to keep food safety from corrosion. Another component that played an important role in the separation process is the brush. Brush serves to separate the seeds and flesh of mangosteen fruit. Brush assembled on the shaft. There are two brush blades installed opposite.

The driving force used was an electric motor with the power of 1,5 HP, rotation of 1410 PPM, and voltage of 220 volt.

The selection of the motor will be closely related to the desired rotational speed to move the engine. The motor with 1410 PPM rotation selected to be assembled with a 1 cm diameter, 2 pulley having a dimension of 15 cm and a gear with 10 and 40 gears, so the resulting rotation speed for turning the equipment engine axis was 141 PPM. Based on the measurement in the field, it was known that the resulting rotation speed was 148 PPM from 3 repeatations. Transmission systems used pulleys and v-belts that have an economical advantage over transmission systems using chains and gears. The downside of the pulley transmission system and v-belt was the possibility of slippage greater than the use of chain and gear transmission systems. The gear transmission system was selected to make changes to rotate direction. From the previous direction with the engine rotation, using the rotation gear can be directed of the shaft rotation.

C. Machine Performance

The mangosteen pulper machine successfully separated the seeds and the mangosteen pulp. This separation process took place due to the friction between the mangosteen and the inside of the separating cylinder and the friction between the brush and the mangosteen fruit. The machine successfully produced the mangosteen pulp through separation of seeds and mangosteen pulp. The mangosteen pulp passed through small holes in the separating cylinder and exit through the output door which has been designed for the mangosteen pulp. For the seeds of mangosteen fruit pushed toward the output door which was designed for the seed of the mangosteen fruit. The separation data can be observed in Table 2.

Table 2. Result of separation process in kg unit

Testing	4 kg	3 kg	2 kg	1 kg
Pulp	2.371 (59.27%)	1.762 (58.73%)	1.407 (70.35%)	0.706 (70.60%)
Seed	0.585 (14.62%)	0.186 (06.20%)	0.381 (19.05%)	0.117 (11.70%)
Seeds in the cylinder	1.044 (26.10%)	1.052 (35.06%)	0.212 (10.60%)	0.177 (17.70%)
Efficiency	40.72%	41.26	29.65%	29.4%

From Table 2 it can be observed that the pulp generated from the separation process has a value> 50%. The highest percentage of pulp was produced at the time of separation by using the material of 1 kg obtained percentage of pulp of 70.6%. The resulting pulp can be observed in Fig. 4.

Fig. 4. Pulp of mangosteen fruit of separation results

The seeds of mangosteen fruit separation were divided into two results, namely the seeds are perfectly clean and the seeds are still covered with pulp. In this separation process there were no seeds. This affected the increasing quality of the resulting pulp. The percentage of pulp which is still covered by pulp of 62% while the perfect clean pulp of 38%.

IV. CONCLUSION

1. Mechanism of separation of seeds and mangosteen fruit flesh managed to process the separation of seeds and mangosteen fruit flesh.
2. The process of separation of seeds and flesh of mangosteen fruit successfully done without the existence of seeds.
3. Engine separation capacity of 157.3 kg/hour
4. The seeds are retained in the cylinder and brush separator for ⩾3kg working process is ⩾1 kg.

REFRENCES

Al-Gaadi KA, Marey SA, Ahmed FS. 2011. Development and performance evaluation of a summer squash seed extracting machine. Middle-East Journal of Scientific Research. 7(3): 352-361.

Dikson M. 2015. Wild Fruit Pulping Machine. International Conference on Mechanical and Industrial Engineering (ICMIE'15); 2015 July 14-15; Harare, Zimbabwe.

Fellows P. 2004. Small-scale fruit and vegetable processing and products. Viena (AUT): The United Nations Industrial Development Organization.

Husain KA, Sabir, Muhammad S, Iqbal M. 2010. Development of a machine for cold pulping of tomato. Pak. J. Agri. Sci. 47(4): 383-387.

Kastaman R. 2007. Analisis prospektif pengembangan produk olahan manggis dalam upaya meningkatkan pendapatan petani (studi kasus di Kecamatan Puspahiang Kabupaten Tasikmalaya). Bandung (ID). Fakultas Teknologi Industri Pertanian Universitas Padjadjaran.

[Kementan] Kementrian Pertanian. 2015. Statistik produksi hortikultura tahun 2014. Jakarta (ID). Direktorat Jenderal Holtikultura Kementrian Pertanian.

[Kementan] Kementrian Pertanian. 2015. Rencana strategis Kementerian Pertanian tahun 2015 – 2019. Jakarta (ID). Kementrian Pertanian.

Kwatiningsih S, Wiyatno, Triyono. 2009. Zat pewarna alami tekstil dari kulit buah manggis. Ekuilibrium. 8 (1): 41-47.

Qosim WA. 2007 Januari 22. Buah manggis primadona ekspor Indonesia. Pikiran Rakyat. Edisi Hari Ulang Tahun Pikiran Rakyat.

Qosim WA. 2013. Pengembangan buah manggis sebagai komoditas ekspor Indonesia. Jurnal Kultivasi, 12 (1): 40-45

Sharp BJ, penemu; United States Patent Office.1945 April 3. Pulping machine. United States (US).

Yatman E. 2012. Kulit buah manggis mengandung xanton yang berkhasiat tinggi. Wawasan Widya. 29 (324):1-8.

A.8

DESIGN OF MACHINE FOR SHELL REMOVAL OF OIL PALM SEED

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ABSTRACT

Seed germination is quite difficult, because the seeds have a thick and hard shell and dormancy. To accelerate germination, it is necessary to shell removal for seed germination. The objective of the research is to machine design for the shell removal of palm seed.. Cracking of shell palm seed required a force of 0.8-3.0 kN. The working mechanism of the palm kernel shell crusher applies to the compressive force. The force is produced from two cylinders rotating in opposite directions. The oil palm seeds are divided into 3 parts based on the size of oil palm seed in 3 dimention of large, medium and small. The testing of cracker machine is a loose shell of the kernel, the kernel is not defective and is mechanically defective. The result of this cracker testing is that the shell still attaches to the kernel for small, medium and large seed sizes of 30%, 23% and 20%, no kernel at shells of 52%, 61% and 64% and defective kernels of 18% 14% and 16%. Kernels that can be germinate with small, medium and large seed sizes are 70%, 77% and 80%. The cracker testing for one cylinder are that the shell still attaches to the kernel 10%, damage kernel 4% dan whole kernel 86%.

Keywords : shell, cracking, seed, germination, and kernel

I. INTRODUCTION

The planting of oil palm crops in general still uses seed from plant breeding. Palm oil seeds can not be directly germinate after harvest, because the palm kernel is dormant. According Farhana, et al. (2013) the process of germination of oil palm seed is quite difficult because the seed has a hard shell that is dormant. The existence of this dormancy condition causes the seeds to be treated to break the dormancy. The process of seed germination of high quality oil palm takes about 3 months with dry heating method at 40 °C.

Drying of palm kernels is intended to prevent palm kernels from being attacked by microbes. Due to the drying of palm kernels, there will be a cavity between the kernel and the palm kernel shell. This happens because the kernel shrinks when it is dried. Depreciation of kernel volume is higher than shrinkage of shell volume. This is because the kernel water content is higher than the water content of the shell.

Palm kernel can germinate, then the kernel content of palm kernel seed must reach 25 - 30%. There are two things that inhibit water up to the kernel inside the shell that is, a) hard palm kernel shell, so the water is rather difficult to enter through the shell to get to the kernel. B) there is a cavity between the kernel and the palm kernel shell, this will inhibit water from the shell to the kernel. C) The thickness of palm kernel shell and seed size are also not uniform. This will cause the water time to go through the seed shell and get to the kernel takes a long time. To achieve a 25-30% kernel moisture content for the germinated kernel requirement requires timeout. As a result germinate become not uniform. It is also found that there is a decrease in the germination of seeds that have been stored for 5 months, if it is germinated by konvensional. To solve this problem for quick germination of palm kernels can be done by solving hard shells of palm kernels.

The principle of the palm kernel shell breaker is the seeds are pressured with a certain style. Only the shell is under heavy pressure, while the kernel inside the shell gets a light pressure. This happens because the seed is dry, between the kernel with the shell there is a cavity. This cavity allows the kernel not to experience mechanical stress. Constraints faced is the size of the shell is not uniform. So in practice, before the shell in peel, the shell first separated in 3 levels of size, namely large, medium and small. Peeling is also done with 3 types of distances between rollers that are adjusted to the size of the shell.

A. Seed of Palm Oil

Anonymous (2012) states that good seeds require high quality sprouts (germination and high levels of uniformity) so that oil palm crops planted in the field will be of high quality. This means that the nursery process can affect the quality and production of oil palm crops in the future. A good seed and legitimate comes from a clear and superior breed.

B. Imbibition

Imbibition is a very important first stage in seed germination, because it causes an increase in the seed water content required to trigger biochemical changes in the seeds so that the seed germinates (Asiedu et al., 2000). If the process is inhibited then germination will also be inhibited. According Widyawati, et al. (2009) inhibition of imbibition cause germination of the seeds of palm sugar long enough and when germination is not simultaneously. In the cultivation of palm trees, it causes inefficient nursery processes both in terms of funding, energy allocation, time and place use and cause viability in seedling growth. To overcome this required various ways done to break the dormancy of seeds, so the seeds can germinate. Seed generally have dormant period before germinating for finish his life. (Soerodikoesomo,1994).

The cracking machine of oil palm shell in patent on behalf of Sun Y. Kim. Drawing of the machine sketch as follows:

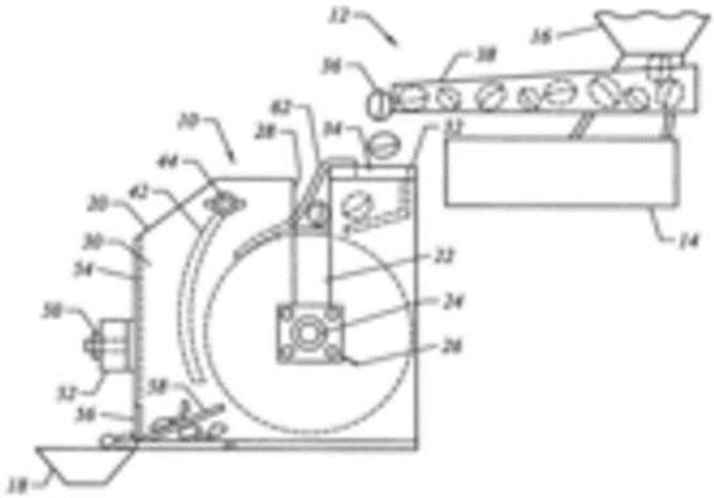

Fig. 1. Sketch of a hard peeler

The working mechanism of this machine in general is a rotating cylinder with the outer surface of the cylinder having a breaker. The machine is equipped with a static plate as contribute to suppress the hard seed. The curvature of the static plate is equal to twice the curvature of the cylinder. Hard seeds that are between the cylinders with the plate will break.

There are many types of palm kernels crusher. One of them is a ripple mill (Fig. 2). The peeling result of this machine is kernel and palm kernel shells. Getting the kernel in one piece is one of the determinants of quality to produce quality palm kernel oil, as more and more of the palm kernel is intact, the palm kernel losses are getting smaller. To know the ripple mill to work to the performance maximumly, it is necessary to check on the output ripple mill is like mixed shell with kernel.

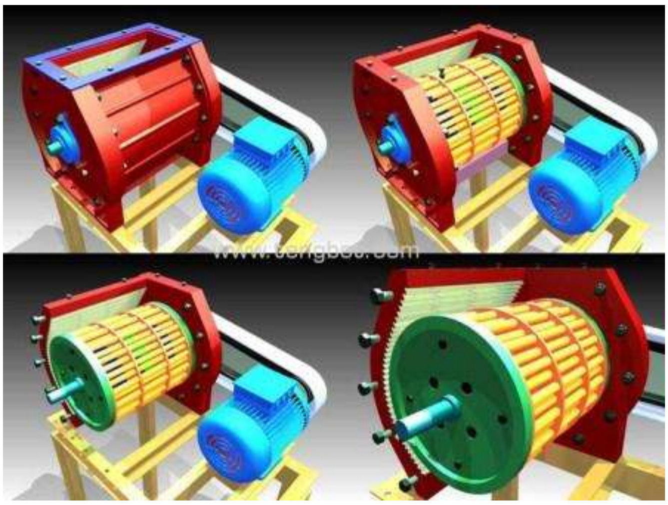

Fig. 2. Riple mill machine (Anonimus, 2013)

II. MATERIALS AND METHODS

The research was conducted from February to June 2017 at Agricultural Engineering Workshop, University of Lampung.

The research threat to compare with two cylinder cracking machine with one cylinder cracking machine. Drawing sketch for cracking machine of oil palm shell two cylinder can be seen at Fig. 3 and 4. This machine test to know the machine performance from cracking machine two cylinder with one cylinder. It is used 50 – 100 seed for testing machine per experiment unit. It is observated for shell crack, but sticky shell with kernel, damage kernel, whole kernel and seed pass. Data is analysed by average, grahp and percentace.

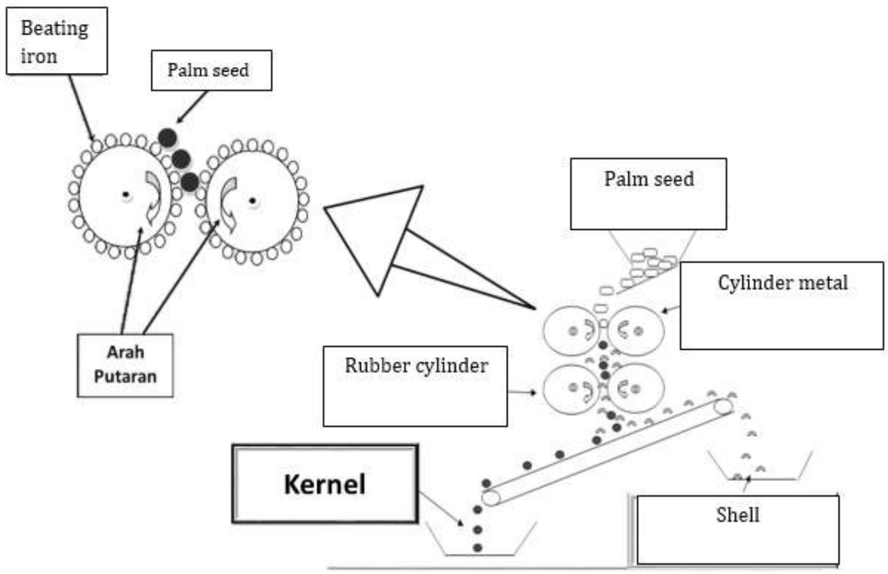

Fig. 3. Drawing sketch for cracking machine of oil palm shell two cylinder

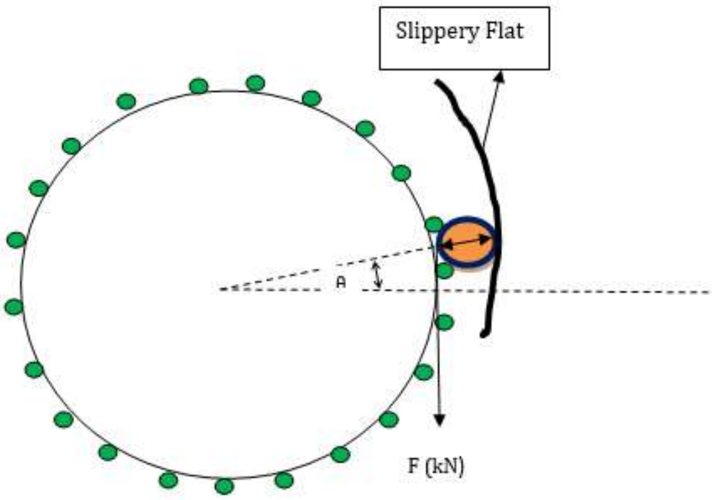

Fig. 4. Drawing sketch for breaking of palm oil seed one cylinder

III. RESULTS AND DISCUSSION

A. Measurement of hardness of palm kernel

Hardness of palm kernel is measured using Compression machine 2000 KN. This tool uses a compressive force with a hydraulic principle working mechanism. The oil-shaped liquid is pumped into the chamber plate of the upper steel plate and the bottom plate is compressed, so the palm kernel is compressed. Press with a certain style, then the palm kernel shell will break.

Fig. 5. Compression machine 2000 kN

The level of hardness of palm kernel ranged from 0.7 to 3.4 kN equivalent to 70.2 - 345.5 kg load, Palm seed hardness level due to varying shapes, the level of seed shell thickness and the size of palm kernel. The results of the measurement of the level of hardness of palm kernel as in Table 1 below :

Table 1. Level of hardness of palm kernels in kN

Number sample of palm kernel	Shortest dimensions of palm kernel		
	14,2 mm (small)	17,4 mm (midium)	20,7 mm (big)
1	1,3	3,5	1,9
2	0,9	1,7	2,3
3	0,8	1,1	0,8
4	0,7	1,3	2,4
5	0,8	1,4	2,7
6	3,0	1,3	2,2
7	0,4	1,9	2,2
8	1,1	0,5	3,2
9	1,2	2,9	0,9
10	0,8	1,7	1,2
average	1,1	1,7	2,0

B. Manual splitting

Manually splitting palm kernels using mechanical press (Ragum). The working principle of similar tools of ragum used to press the palm kernel to shell crushed palm kernel is using a system of leverage. Manually break the shell of palm kernel like in the Fig. 6.

Fig. 6. cracking of oil palm seed manually

By using ragum can break the 100 seeds for 55 minutes. For a more careful solution, the breakdown capacity is lower for 100 palm kernels for 70 minutes. Seed were damaged 1-2% when it breaks by manual. Damage to this seed can be reduced by doing the breaking carefully.

C. Break machine of palm seed

Palm seed shell crusher using 2 rollers rotating opposite direction. But both rolls of this tool are static or can not shift when breaking the palm kernel. This tool uses 8 hp. mechanical breaker machine can be seen in Fig. 3. The results of mechanical testing of two rollers in breaking the shell of palm kernel can be seen in the following table:

Table 2. Test result to cracking performance of oil palm shell (%)

Breaking criteria	dimension								
	small			Medium			Big		
	1	2	3	1	2	3	1	2	3
Breaking shell> 50%	10	8	12	8	6	2	12	12	10
Breaking shell < 50%	24	16	20	6	6	4	16	20	12
Whole kernel	44	64	48	72	72	76	60	62	68
cracking kernel	4	6	12	4	6	0	6	2	2
Breaking Kernel	18	6	8	8	10	14	6	6	4
Passing seed	0	0	0	2	4	4	0	0	4
Time(minute)	3.1	3.7	3.0	1.5	1.5	1.5	2.0	1.3	1.5

Testing masin in breaking palm kernel shells using three sizes, namely small, medium and large. The shortest dimensions of palm kernel with small, medium and large that is 14.2, 17.4 and 20.8 mm. The shortest dimension of palm kernel is used as a guide in determining the distance between cracking rolls of palm shell (clearance). If the clearence rollers exceeds the length of the diameter of the palm kernel, the palm kernel will pass, or the palm shell is not broken. Conversely, if the size of the diameter of palm kernels is too large from the clearence size, the shell of palm kernel is difficult to break. Clearence of palm kernel crusher with small, medium, and large size of 12.14 and 16 mm respectively.

The results of the breaking of palm kernel seeds as in Table 2. Palm oil seed shells are still stickyto the kernel is high enough, it is because some shells are still sticky with the kernel, so the kernel is not separated from the shell. Another reason is the shape or structure of unbroken palm kernel, because partly irregular, so when pressed, then there is only partial breaked of palm kernel.

Breaked seeds and cracked seeds are also encountered during the breaking of the oil palm shells. Breaked and cracked seeds are also the impact of sticky kernels with shells. Because the kernel is sticky with the shell, some kernels are carried by the shell. breaked and cracked seeds are also caused by improperly mounting the beater on the cylinder, so that the position of the beater presses the palm kernel like in Fig. 7, but shifts a few mm, so that the kernel can be compressed by a beating iron.

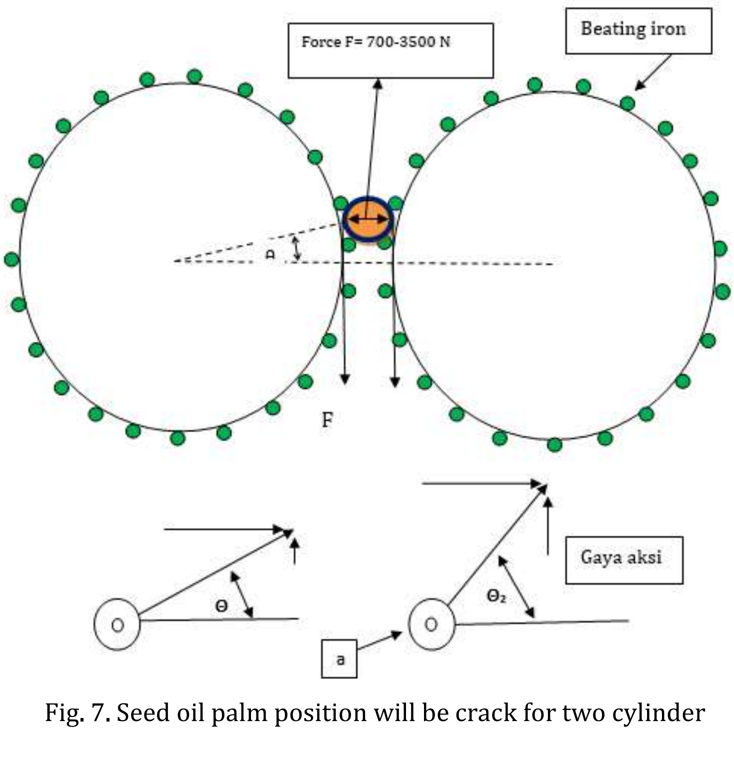

Fig. 7. Seed oil palm position will be crack for two cylinder

The breaked results show a whole peeling above 70% and breakage or crack reaches 6-22%. Damaged or cracked seeds can not be germinated, because the seeds will be attacked by fungus for a few days when they are germinated To improve the seeds are not damaged, it is necessary to modify the peeler with one cylinder accompanied by slippery plate as a pressure barrier from the rotating cylinder. Modification of the machine with the working principle as in the picture will be able to reduce damaged seeds or bruises. Prototype of a two-cylinder coconut shell crusher with opposite direction of rotation as shown in Fig. 8 and Fig. 9 and prototipe of one cylinder to breaked palm oil seed as show in Fig 10.

Fig. 8. Cracking machine used smal pulley

Fig. 9. Craking machine used big pulley

Crushing palm kernel with one cylinder equipped with slippery sloped plate will condition the mechanism of this machine as follows; If the diameter is large, the palm kernel shell will be split at the top, because the clearence is quite large, if the size of the small palm kernel, the palm kernel will be split at the bottom, because the clearence on the bottom is small. Modification of palm kernel breaking machine can be seen in Fig. 10 below:

Fig. 10. Modification of breaking machine of palm seed shell

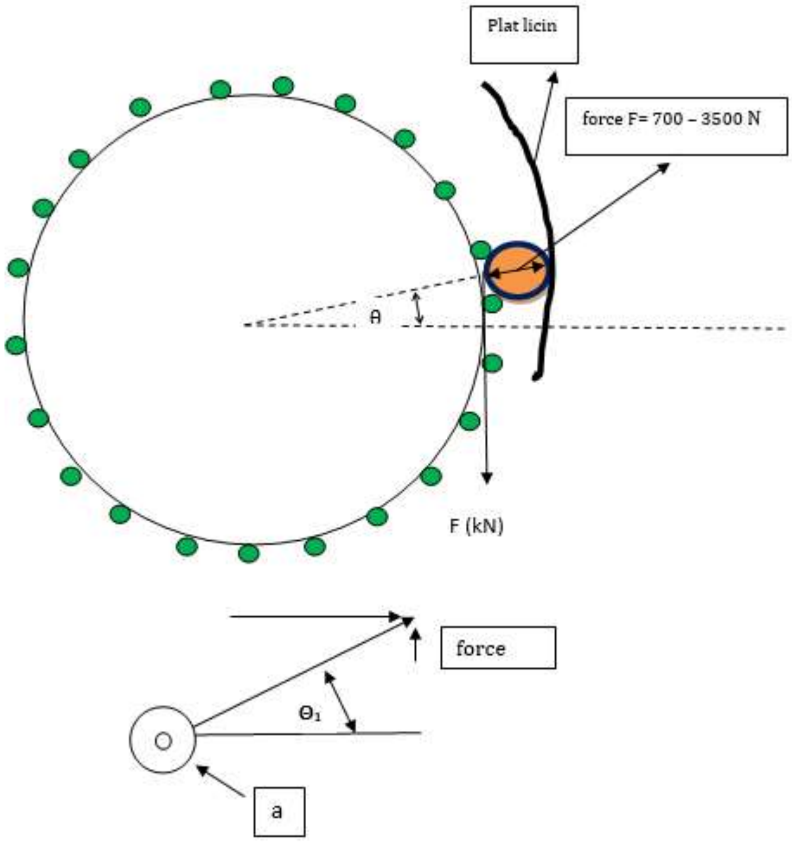

Fig. 11. Cracking machine Skecth for one cylinder

Table 3. Results of machine breaking of palm oil shell with one silinder for 100 seeds at average time 5,2 minute in percent

No	Criteria	replication		
		1	2	3
1	Part cracking shell	8	9	11
2	Damage Kernel	4	3	5
3	Whole kernel	88	88	84

IV. CONCLUSION

1. The result of this cracker for two cylinder testing are that the shell still attaches to the kernel for small, medium and large seed sizes of 30%, 23% and 20% repetively, no kernel at shells of 52%, 61% and 64% and defective kernels of 18% 14% and 16%. Kernels that can be germinate with small, medium and large seed sizes are 70%, 77% and 80%.
2. The cracker testing for one cylinder are that the shell still attaches to the kernel 10%, damage kernel 4% dan whole kernel 86%.

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REFERENCES

Anonim ,2012. Cara pembibitankelapa sawityang baik. http://tipspetani.blogspot.co.id/2012/08/cara-pembibitan-kelapa-sawit-yang-baik.html. Diakses pada minggu,22 Mei 2016.

Asiedu,E.A.,A.A. Powell, T.Stuchbury.2000. Cowpea seed coat chemical analysis in relation tostorage seed quality.Afric. CropSci. J. 8(3):283-294.

Farhana,B.,S. Ilyas andL.F.Budiman. 2013. Pematahan Dormansi Benih

Kelapa Sawit (*Elaeisguineensis*Jacq.)dengan Perendaman dalamAirPanas dan VariasiKonsentrasi Ethephon.Bul. Agrohorti 1 (1) : 72– 78,

Soerodikoesomo,Wibisono,1994,Anatomi dan FisiologiTumbuhan,Depdikbud, Jakarta.

Widyawati,N,Tohari,P. Yudono dan I.Soemardi,2009. Permeabilitas dan PerkecambahanBenihAren (*Arenga pinnata*(Wurmb.) Merr.) J.Agron. Indonesia37 (2): 152– 158.

A.9

DESIGN AND PERFORMANCE OF TEA SHOOTS CHOPPER: THE FISRT STEP TO OBTAIN OPTIMUM TEA STALKS AND TEA LEAVES SEPARATION

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ABSTRACT

The quality of dried tea depends on the condition of raw materials and processing methods. The problem in the tea processing is the mixture of crushed stalks and leaves. This research aims to examine the performance of tea shoots chopping machine to obtain optimum stalks and tea leaves separation based on the aerodynamic properties of the material. The chopping machine designed referred to the physical and mechanical properties of tea shoots. The design concept of the chopping machine is a vertical type chopper with five main components: hopper and output units, chopping blade, power source, transmission system, and the frame. The performance of the chopper was assessed by calculating the chopping effectivity and determining three physical appearances of chopped tea shoots, namely: a) chopped leaves, b) tea shoots which not chopped properly, and c) chopped stalks. The combination of three different blade spacings (6 mm, 8 mm, and 10 mm) and three different blade rotation speeds (450 rpm, 630 rpm, and 950 rpm) in the chopping machine performance test resulted that the most optimal combination of the chopping process was 8 mm blade spacing and 630 rpm blade rotation where the effectiveness of the chopping process obtained was 88.05%.

Keywords : tea shoots; chopping machine; chopping effectivity.

I. INTRODUCTION

Tea (*Camellia sinensis*) is one of the main commodities of Indonesian plantation. In 2011, Indonesia was in the eighth position as a tea producer in the world, with a market share of 3.24%. In addition, Indonesia is also the world's ninth largest tea exporter with a market share of 2.40% [1]. However, over the past ten years, the performance of Indonesian tea agribusiness has declined. This was indicated by the decline in tea plantation area by 2.02% per year, followed by a decrease in production by 2.49% [2].

The main problems facing tea plantations today are quality degradation, increasing costs and decreasing quantity of tea produced. Ref. [3] shows the condition of technological components (technoware, humanware, infoware, and orgaware) owned by Indonesian tea industry is in medium category. The strategies that can be done to improve the quality of tea product are: 1) Produce product according to customer's wishes, 2) Technical response or production process priority: handling quality of tea bud, withering, and roll-milling, 3) Application of ISO 9001 management system [4].

The quality of tea product is strongly influenced by the potential of its own shoots quality as well as its processing method and technology. Tea product in Indonesia is divided into three classes, first grade (generally distributed for export market), second grade (generally distributed for domestic market) and off grade (generally distributed for domestic traditional market) [5]. Hence the quality improvement becomes one of the critical factors in the effort to save the national tea industry. Ref. [6] suggests that if a company lacks the capability of process and product innovation, it must at least have the ability to implement incremental changes to existing technologies according to consumer demand.

Efforts to improve the quality of tea product to obtain more objective results are conducted through analysis of physical and chemical quality of tea products. Physical quality analysis of tea was conducted through image processing application ([7]-[10]), analysis of chemical quality especially aroma with application of electronic nose sensor ([11], [12]), and artificial intelligence application using Fuzzy logic ([13]-[15]). But the application of these technologies was only implemented on the final product of tea, so there is no effort to repair and improve the quality of tea on the first step of tea processing technology.

The weakness in the tea processing is the mixing of stalks and tea leaves. The mixing of the stalks and tea leaves can decrease the quality of the end product of the dried tea. This is because the main product of high-quality processed tea comes from tea leaves, while the stalk is more functioning as an impurity when the stalk skin is released. The advantage of separating the stalks and tea leaves is the increased quality of the final tea product. The quality of tea derived from the leaves will increase the selling value of the product. But if the stalk of tea leaves is not detached the skin, it will be processed into a special high quality tea.

The first step before separating the stalks and tea leaves is by designing a crusher machine capable of crushing the stalks and tea leaves into certain sizes for proper edible use. This research aims to design and examine the performance of withered tea shoot crusher machine for the first step of tea stalks and tea leaves separation system.

II. MATERIALS AND METHODS

The research was conducted with design and fabrication and was continued testing the performance of the chopping machine to ensure the machine is running well.

A. Design of the Chopping Machine

The design of this machine was made with 200 kg/hour chopping capacity. The power source was designed using an electric motor. The chopping machine was designed per part. There are four main parts of the machine, include hopper and output unit, chopping blade, frame, motor, and transmission system.

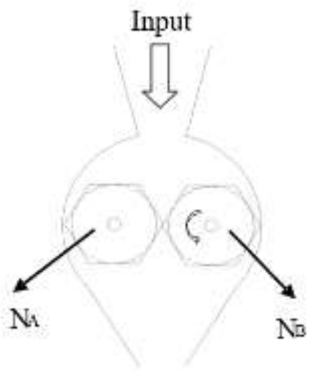


Fig. 1. Conceptual design vertical type chopper with static blades (N_A) and clockwise rotating blades (N_B)

The design criteria of the chopping machine refers to the output of the final product where the stalks and tea leaves are should be separated easily. Criteria of the chopping machine, including: 1) stalks and leaves should be separated or not tied to one another; 2) There is no friction between the blades when the chopping takes place.

To meet the desired design criteria, the design concept of the chopping machine is a vertical type chopping machine with a series of rotating blades and a series of other static blades (Fig. 1). A series of blades rotates clockwise. This mechanism aims to overcome friction between the blades, because the gap between the blades is quite tight.

B. Chopping Machine Performance

To ensure the chopper operate in accordance with the objectives and criteria to be achieved then the performance test conducted as much as ten replications. The combination of chopping rotation speeds (450 rpm, 630 rpm, and 950 rpm) with three different blade spacings (6 mm, 8 mm, 10 mm) is expected to produce optimal chopping system for stalks and leaves separation. From the two factors, then obtained the treatment combinations as follows :

Table 1. Treatment combination on chopping machine performance test

Blade space (mm)	Rotation speed (rpm)		
	450 (A)	630 (B)	950 (C)
6	6A	6B	6C
8	8A	8B	8C
10	10A	10B	10C

The material used in this performance test is withered tea shoots with water content 68.68% obtained from PTP Nusantara VIII plantation, Gunung Mas, Bogor, West Java. Measurement of stalk and leaf yield from tea shoots chopping was conducted to determine the velocity of the airflow to suck the tea leaves and as a reference to the separation capacity criteria. Yield of stalks and tea leaves of the chopping was measured by a randomly sampling method. 200 gram chopped tea shoots snippet randomly, and separate into several parts, namely: chopped leaves, chopped stalks, and not chopped properly. Each of these sections is then weighed and the proportions are calculated using Equation 1, 2, and 3.

$$R_s = \frac{W_s}{W} x\ 100\% \quad (1)$$

$$R_l = \frac{W_l}{W} x\ 100\% \quad (2)$$

$$R_m = \frac{W_m}{W} x\ 100\% \quad (3)$$

The chopping effectivity is determined by calculating the percentage of chopped material to the overall weight of the material as follows

$$E = \frac{W_s + W_l}{W} x\ 100\% \quad (4)$$

III. RESULTS AND DISCUSSION

A. Chopping Machine Design

1. Hopper and Output Unit

Hopper was made of stainless steel plate 304 with a thickness of 2 mm. This hopper is shaped like a rectangular inverted prism with a beam-shaped buffer that is also a hopper holder. Hopper is removable that aims to simplify the process of cleaning the chopping blades. Hopper can be seen in Fig. 2. Chopping capacity is calculated based on hopper volume and cutting speed. Capacity is planned at 200 kg/hour.

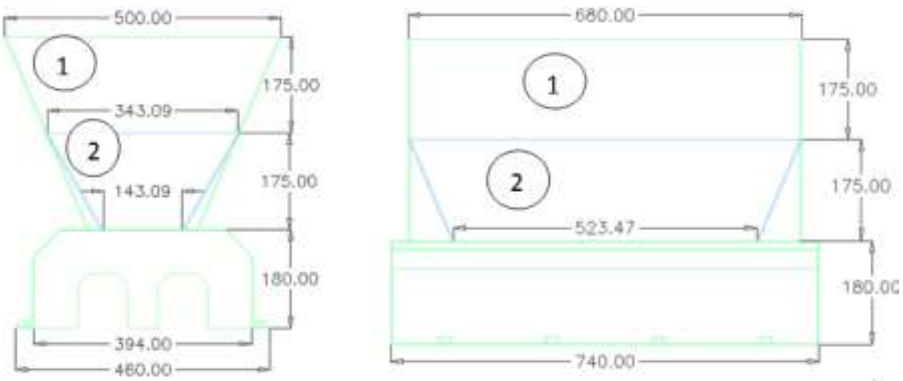


Fig. 2. Hopper and ouput unit

2. Chopping Blade

There are two axes as a holder of rectangular polygon chopping blades. The space between the blades on the shaft is 0.8 mm. A series of cutting blade rotates clockwise and the other is a static cutting blade, accordingly the stalks and leaves coming into the chopper blades will be squashed and cut off. The Chopping blade design is shown in Fig. 3.

3. Machine Frame

Machine Frame was made of UNP50 steel. There are two main holder position, at the top is used as a holder for chopping blade and hopper while at the other side as a power source holder.

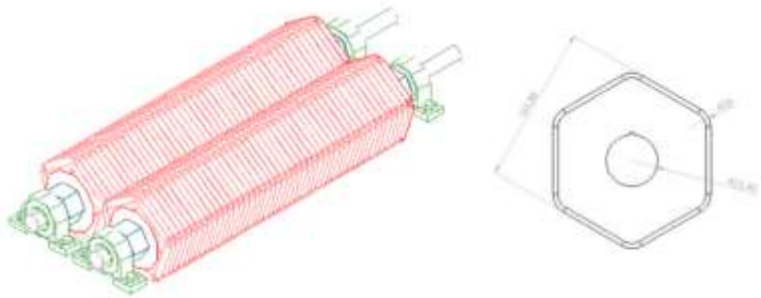


Fig. 3. Chopping blade

4. Power Soucre and Transmission Systems

There was 1 HP electric motor with initial rotation speed of 1400 rpm used as power source. Power transmitted from electric motor to chopping blade by pulley and belt trasmission system. The motor will drive the pulley 1 which is directly connected to the motor shaft. The belt which is connected to the pulley 2 directly drive the main chopping blade shaft. The diameter ratio of pulley 1 and pulley 2 is 1:2. Pulley 2 will rotate the shaft of the main chopping blade with clockwise rotation. The arrangement of frame, power source, and power transmission is shown in Fig. 4.

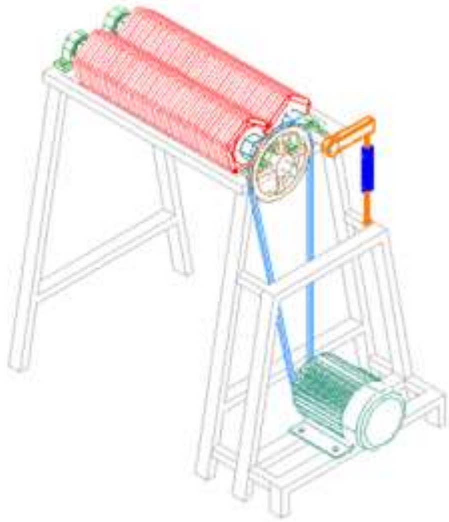
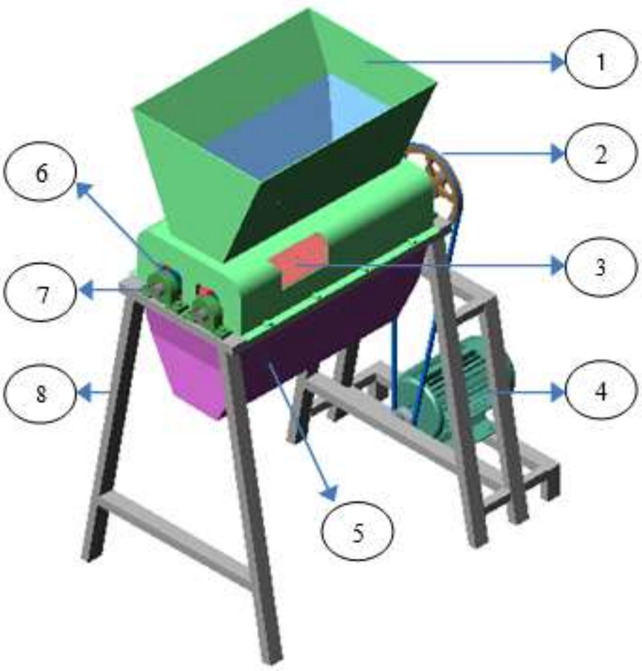


Fig. 4. Power source and transmission system on machine frame

The design of each part was assembled to arrange prototype of chopping machine which main function of chopping the withered tea shoots as shown in Fig. 5.



Note :
1) hopper;
2) transmission system;
3) chopping blades;
4) electric motor;
5) output unit;
6) bearing;
7) chopping blades shaft;
8) frame

Fig. 5 Design of the tea shoots chopping machine, Results of Chopping Machine Performance

The results of the chopping machine performance test focused on the capability of the machine in chopping the stalks and tea leaves perfectly. Thus, the proportion of tea shoots which not chopped properly was expected to be as small as possible. Fig. 6 shows the result samples of the chopping machine. There are three physical appearances of chopped tea shoots, namely: chopped leaves, not chopped properly, and chopped stalks.

The results in Fig. 7 shows that at 6 mm and 8 mm blades space, the character of the chopped tea shoots is not significantly different at 450 rpm, 630 rpm, and 950 rpm blade rotation respectively. This is indicated by the proportion of each fraction which value is not much different. Nevertheless, on 6 mm blade spacing test, congestion due to both friction between the chopping blades and the excessive feeding caused the material squashed between the blades.

Testing with a 10 mm blade spacing resulted in a smaller proportion of chopped stalks and chopped leaves, while for the proportion of tea shoots which not chopped properly was much greater than that with a blade spacing of 6 mm and 8 mm. In an experiment with a 10 mm blade spacing, the difference in rotation of the chopping blades showed different results of cuttings. The higher blade rotation, the higher proportion of tea shoots which not chopped properly.

The difference was caused by the wider space of the blade, allowing the material just missed, especially if the position of the material perpendicular to the arrangement of the blade at the time of feeding. In addition, the higher blade rotation caused the material to pass quickly through the chopping blades and more potentially to not being chopped properly.

Fig. 6. Physical appearance of chopped tea shoots, (a) chopped leaves, (b) not chopped properly, and (c) chopped stalks

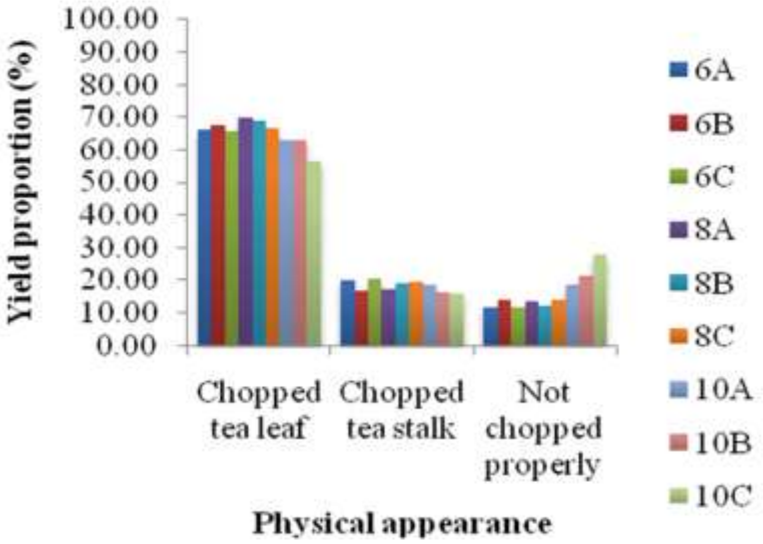


Fig. 7. Chopping yield proportion of each performance test treatment

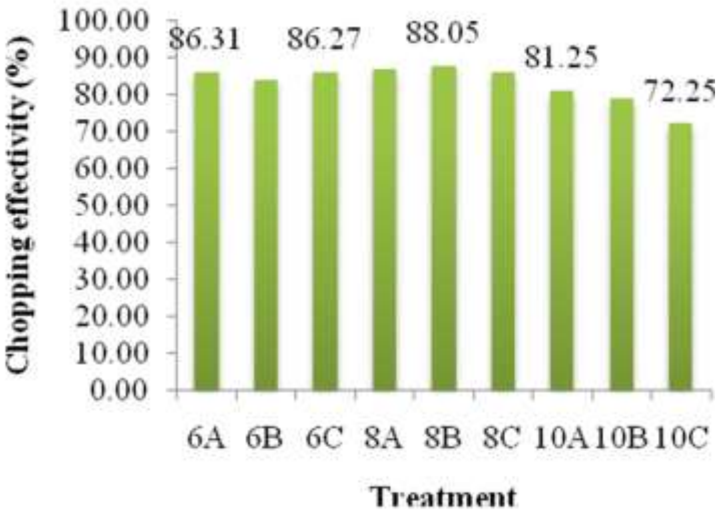


Fig. 8. Chopping effectivity of each performance test treatment

Fig. 8 shows the chopping effectivity. From the histogram, the highest chopping effectivity is 88.05 %. This score was obtained from the test with a blade spacing of 8 mm and 630 rpm blade rotation. This combination is expected to be the most optimum result in tea shoots chopping before the proper separation of tea stalks and tea leaves pneumatically.

IV. CONCLUSION

The prototype of the tea shoot chopping machine has been manufactured with a vertical cutting system. The main components of the chopping machine are: hopper and output unit, chopping blade, power source, transmission system, and the frame. The results of machine performance testing shows the optimal combination of the chopping process is 8 mm blade spacing and 630 rpm blade rotation where the effectiveness of the chopping process obtained for 88.05%.

NOMENCLATURE

R_s	Yield proportion of chopped stalks	%
R_l	Yield proportion of chopped leaves	%
R_m	Yield proportion of tea shoots which is not chopped properly	%
W	Overall weight of chopped tea shoots	g
W_s	Weight of chopped stalks	g
W_l	Weight of chopped leaves	g
W_m	Weight of of tea shoots which is not chopped properly	g
E	Chopping effectivity	%

REFERENCES

[1] [FAO] Food and Agriculture Organization in http://faostat.fao.org. [accessed on 17th February 2014].

[2] [BPS] Statistics Indonesia, 2011, Plantation Statistics 2011. Direktorat Jenderal Perkebunan, Departemen Pertanian.

[3] R. Suprihatini, E. G. Sa'id, Marimin, D. Mangunwidjaja, 2005, "Analisis kondisi komponen-komponen teknologi pengolahan di industri teh curah Indonesia", J. Teknol. Ind. Pertanian, 14(3):101-106.

[4] Marimin, E. Karmila, 2004, "Kajian strategi peningkatan kualitas teh hitam orthodoks di PT. Perkebunan Nusantara VIII (PTPN VIII Persero) Unit Kebun Gedeh, Kabupaten Cianjur", J. Teknol. Ind. Pertanian, 14(1):6-16.

[5] [PPTK] Pusat Penelitian Teh dan Kina, 2007, Petunjuk Teknis Pengolahan Teh. Edisi Kedua, Bandung : Pusat Penelitian Teh dan Kina.

[6] E. G. Sa'id, Rachmayanti, M. Z. Muttaqin, 2001, "Manajemen Teknologi Agribisnis, Kunci Menuju Daya Saing Global Produk Agribisnis", PT. Ghalia Indonesia dan MMA-IPB.

[7] I. S. Suwardi, R. P. Jenie, 2008, "Rancang bangun perangkat lunak analisa hubungan antara variabel fisik dan kelas mutu teh hitam" in Seminar Nasional Teknologi Informatika - Yogyakarta, 22 November 2008.

[8] G. S. Gill, A. Kumar, R. Agarwal, 2011, "Monitoring and grading of tea by computer vision – A review", Journal of Food Engineering, 106 (2011): 13–19.

[9] G. S. Gill, A. Kumar, R. Agarwal, 2013, "Nondestructive grading of black tea based on physical parameters by texture analysis", J. Biosystems Engineering, 116 (2013): 198 – 204.

[10] A. Laddi, N. R. Prakash, S. Sharma, H.S. Mondal, A. Kumar, P. Kapur, 2012, "Significant physical attributes affecting quality of Indian black (CTC) tea", Journal of Food Engineering, 113 (2012): 69–78.

[11] J. Nugroho J, D. Muryani, S. Rahayoe, N. Bintoro, 2008, "Aplikasi jaringan syaraf tiruan untuk identifikasi aroma teh menggunakan electronic nose" in Seminar Nasianal Teknik Pertanian - Yogyakarta, 18-19 November 2008.

[12] R. Banerjee, P. Chattopadhyay, B. Tudu, N. Bhattacharyya, R. Bandyopadhyay, 2014, "Artificial flavor perception of black tea using fusion of electronic nose and tongue response: A Bayesian statistical approach", Journal of Food Engineering, 142 (2014): 87–93.

[13] R. Suprihatini and Marimin, 2000, "Penerapan teknik pengambilan keputusan – kelompok fuzzy untuk penilaian mutu teh hitam indonesia dan strategi peningkatannya", J. Teknol. Ind. Pertanian, 9(3): 127 – 132.

[14] R. Kastaman, S. Zain, S.B. Prayudo, 2007, "Penerapan logika fuzzy untuk penilaian mutu teh hitam orthodox, JTEP, 21(3): 283 – 294.

[15] Rohmatullah and Marimin, 2007, "Logika fuzzy dan jaringan syaraf tiruan untuk peningkatan mutu teh hitam", J. Teknol.Ind.Pangan, 18(2): 96 – 101

A.10

FERTILIZING PERFORMANCE BY USING HAND GRANULE SPREADER TASCO GS-10

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ABSTRACT

National paddy production in 2015 was reached 75.39 million ton harvested from 14.12 million ha of area. Each ton of paddy produced, in shape of dried milled rice (GKG), was need 17.5 kg of nitrogen (N), 3 kg of fosfor (P) and 17 kg of kalium (K). Fertillising can be done manually or mechanically. This research was aimed to test fertillising performance by using hand granular spreader and compared with performance of manual fertilization. Performance test was conducted in closed room to determined fertilizer distribution and in paddy field to determine fertilization capacity. Parameters used as spreading effectiveness included (1) effective spreading width, (2) rate of applied fertilizer, (3) field capacity, (4) optimum walking speed and (5) fertilization cost. Research was conducted on 4 spreading method based on spreader structure included (1) 10-opening spreader (B1), (2) 7-opening spreader (B2), (3) 4-opening spreader (B3) dan (4) manual spreading (B4) done in angular speed of hand 70-80 rpm and walking speed in accorting to field condition of second fertilization while handle of feed position was kept fixed on center position. Result of this research show effective spreading width for B1, B2, B3 and B4 are 4.67 m, 3.89 m, 2.96 m and 1.55 m, respectively. The biggest rate of applied fertilizer is 159.55 kg/jam was reached in B1 treatment and walking speed of 0.63 m/s. The biggest field capacity is 1.53 ha/jam was reached in B1 treatment and walking speed of 0.91 m/s. The optimum walking speed for B1, B2 and B4 are 0.36 m/s, 0.13 m/s and 0.57 m/s, respectively. The lowest fertilization cost is Rp 616,642/ha was reached in B1 and walking speed of 0.86 m/s.

Keywords ***:*** fertilizing, spreader, granular, Tasco GS-10, optimal cost**.**

I. INTRODUCTION

Paddy production in form of dried milled rice (re: GKG) in 2015 was 75.39 million ton have been rising since 2014 where production only reached 70.85 million ton (BPS, 2016). Every ton of those GKG requires 17.5 kg nitrogen, 3 kg phosphor and 17 kg kalium. So that mean the more GKG to produced the more fertilizer it needed. Paddy categorized as annual plant that has life term as much 3 month so cultivation can be done 3 times per year. With these number of cultivation soil could loss much nutrient and cannot recoveried so fertilizer need to be added to replenish plant nutrient need. Provision of fertilizer is done on a scheduled basis based on growth phase 7 days after planting (re: HST), 21 HST and 42 HST (BPPadi, 2016). Fertilizer is also added into paddy field before it is planted or commonly called the basic fertilizer.

There are three factors related to rice productivity, i.e. fertilizer, seed and labour (Maulana, 2004). According to BPS (2016) data, the cost of paddy production per hectar for a single planting period is 12.7 million with details for each factor aforementioned are 1.3 million, 0.4 million and 4.5 million, respectively. The good fertilization practice is the one that meet the nutrient need while minimized production cost.

Based on the survey of fertilizer using in Cikarawang, Bogor regency show the majority of paddy farmers applied fertilizer in form of granular. There are three ways of fertilization using granular fertilizer that is spread, placed between the run and placed on the plant hole. Fertilization in paddy field done by spread because paddy planted at a dense distance, high doses and high solubility of fertilizer. Granular fertilizer can be spread manually or by mechanically using spreader. Musyarofah (2014) conducted research about granular spreading manually in paddy field showed that there are 11 different spread pattern done by farmer and in one trajectory of fertilization farmer tend to used combination of different pattern spread. Those combination of spread pattern resulted in ununiform distribution of fertilizer so for some part of field lack of nutrient and the other part overdoses. Manual fertilization consumes more time than mechanical one so the cost of labour is greater. This paradigm was exist on majority farmer and would be answer in this paper.

The mechanical granular fertilizer spread has been using equipment commonly known as spreader. Fertilization using spreader is believed could increase fertilization performance. The spread patterns of mechanical fertilization teoritically are uniform and steady so it eases to meet the amount of fertilizer to throw as regard of fertilization doses. There are two kind of spreader based on the power and tools its used, namely semi-otomatic spreader and otomatic spreader. Capacity of otomatic spreader are higher than semi-otomatic. For small-size field it is better to use semiautomatic spreader because of lesser operational costs. Agricultural cencus data of 2013 on the number of farming households (re: RTP) by area of field controlled shows from 26.13 million RTP, 73.37 % were farmers with area of land controlled under 1 ha. Those farmers have no economic power to buy or even rent spreader, especially otomatic spreader. Tasco as spreader producent have been producing semi-otomatic spreader such as hand granular spreader Tasco GS-10. This spreader address to farmers with area land of controlled less than 1 ha to a better fertilization performance compared with manual fertilization.

There are 3 kind of spreader based on spread mechanism namely gravity spreader, rotary spreader and pneumatic spreader. Hand granular spreader Tasco GS-10 works according to the rotary spreader mechanism. The quality of fertilization using rotary spreader is based on the distribution of fertilizer on field surface which is influeched by 3 factors namely the structure and the way spreader operation, the physical characteristic of the fertilizer and the effect of external condition (Przywara, 2015). On this research, fertilizing utilized compound between urea and NPK relating on second fertilization for paddy plant so the characteristic of the fertilizer is a blend from both of urea and NPK. Testing was conducted in laboratory (closed hall) so there was no effect of surrounding weather such wind and in paddy field to determine spreading capacity. This spreader have equipped with opening adjustment for setting the amount of spread and direction adjustment for directing the spread distribution.

The purpose of this research was testing the performance of fertilization by manually and mechanically using hand granular Tasco GS-10, specifically purposed for:

1. Determined effective spread width fertilization using granular fertilizer.
2. Determined rate of applied fertilizer and field capacity of fertilization using granular fertilizer.
3. Calculated optimum walking speed and optimum fertilization cost manual and mechanical fertilization.
4. Compared performance of mechanical fertilization using hand granular spreader Tasco GS-10 and manual fertilization.

II. MATERIALS AND METHODS

Spreader structure and the way it's operated, characteristic property of fertilizer, and effect of external condition are some factors influenced spreding quality according to Przywara (2015). Those factors become the basics of treatment conducted on this research. Firstly, this spreader equipped with opening adjustment as much 10 kind of different opening range from 1 to 10, eventhough in this research only involved 3 different opening namely 10-opening (B1), 7-opening (B2), 4-opening (B3) and plus fertilization conducted manually as a extra treatment relating to structure of spreader. Fig. 1 show spreader output capacity in kg/hour of each opening of spreader. The flowing of granular fertilizer only exists from 4-opening until 10-opening. That why there were only 3 ways of opening as treatment to represent big opening, medium opening, and small opening for B1, B2 and B3, respectively. This spreader also equipped with direction adjustment that have 3 kind of direction that are left, middle and right. This adjustment worked by change the position of feed orifice. Even though this research only conducted in a way of middle position.

Tasco GS-10 is a mechanical spreader powered by human so the operation of fertilization related to walking speed and hand angular speed. Fig. 2 shows walking speeds in paddy field for phase of second fertilization (21 days after planted) are ranging from 0.63 m/s to 0.91 m/s. The walking speed was carried out in paddy field with 15-30 cm mud depth without puddle. The hand angular speed is set steady at 70 to 80 rpm as accordance to the tool usage instruction shown on the body of spreader.

Secondly, the flow of fertilizer is influenced by characteristic of the granular fertilizer. Table 1 shows the physical characteristic of urea, NPK and urea plus NPK combined with ratio of 1 to 3 as relating to the second fertilization dose as much 200 kg/ha.

Thirdly, the effect of external condition such as different depth of paddy field could affect walking speed and temperature could change the physical characteristic of fertilizer. The actual fertilization in paddy field showed at 4 opening there was no fertilizer coming out of the spreader due to a blockage. The effect such sunlight and heat caused the fertilizer to melt then triggered the blockage.

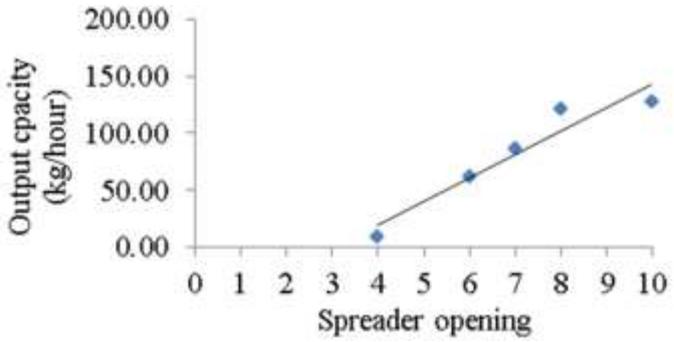

Fig. 1. Output capacity for each opening of spreader

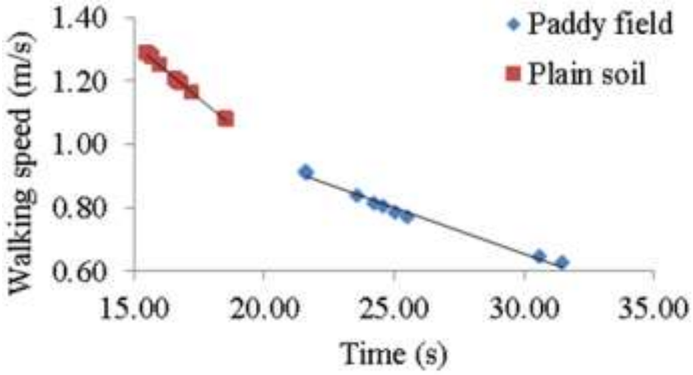

Fig. 2. Range of walking speed different field condition

Table 1 Physical property of granular fertilizer

Property	Kind of Fertilizer		
	Urea	NPK Phonska	Urea + NPK (1:3)
Large diameter (cm)	1.97	4.89	-
Small diameter (cm)	1.58	3.90	-
Mass density, (kg/m^3)	821.41	605.93	787.87

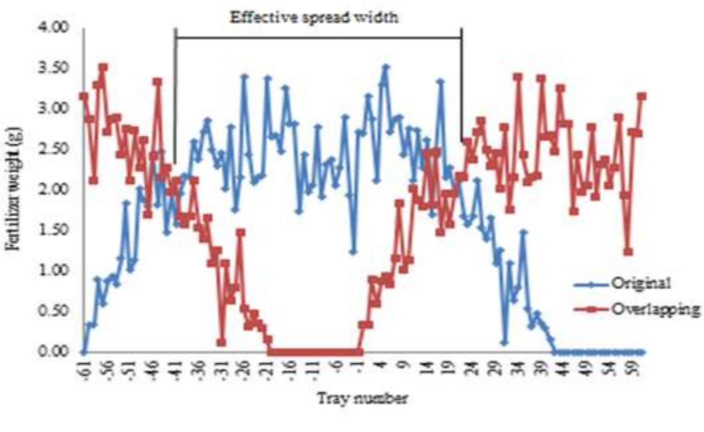

Fig. 3. Graph of effective spread width

Standardisation of spreader testing has not been performed so the performance test was refered to the standard of granular fertilizer applicator issued by Philippine standardization agency (PNS/PAES 166:2011). There were two kinds of testing that is indoor testing and outdoor testing. Indoor testing to determined fertilizer distribution that measured parameter of effective spread width (re: LPE) using testing tool of patternator. Data obtained in the form of fertilizer weight that is accommodated on each tray during 20 second of fertilization. The data then inserted into the overlapping graph, Fig. 3, to created original curve. The original curve could be shift left or right to produce some overlapping curves. The selection of an overlapping curve was based on the smallest CV value obtained by the following equation:

$$SD = \sqrt{\frac{\Sigma\,(xi - \bar{x})^2}{n - 1}} \quad (1)$$

Outdoor testing was aimed to determine throughput capacity, optimum walking speed and optimum fertilization cost that required this parameter of rate of applied fertilizer and field capacity to determined first. Some of the equations used are:

$$KO = (Wi - Wo) / t \quad (2)$$

$$KLE = l \times v \times 3600 / 10000 \quad (3)$$

$$KT = KO / KLE \quad (4)$$

$$BO = (BT + BTT) \times KLE \quad (5)$$

Fertilization cost be affected by fixed cost and unfixed cost. Fixed cost included depreciation cost for 5-year economic year and cost of capital interest. The others factor such as tax and warehouse cost did not count in determined fixed cost. Unfixed costs entirely are operational cost included labour cost and fertilizer consumption cost. Data was measured on outdoor testing included amount of applied fertilizer, fertilization time and length of 1 fertilization trajectory.

III. RESULTS AND DISCUSSION

Fertilizer distribution pattern of manual and mechanical fertilization are differ, Fig. 4, 5, 6, and 7, respectively, In every openings of mechanical fertilization, the majority of granular fertilizer distributed toward left side from the center of spreading than the right side. The mechanical fertilization shaped curve with only one peak, where from the center of spreading curve decrease ramp toward left side while decrease steeply toward right side. In manual fertilization distribution of fertilizer also ununiform, dominant in one side. Manual fertilizing done using right hand with direction of spread toward three times as many so the majority fertilizer distributed toward the right side. Manual fertilization curve consist of two peaks due to ununiform distribution of fertilizer.

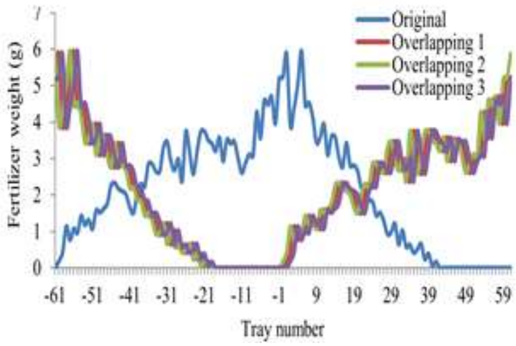

Fig. 4. Distribution of fertilizer for 10-opening

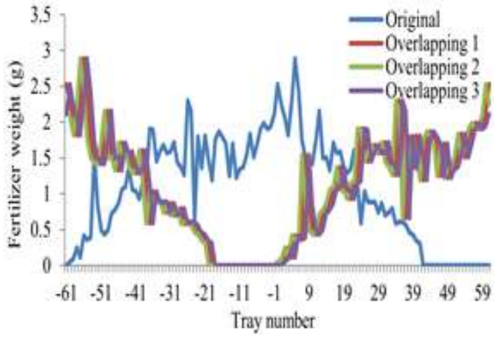

Fig. 5. Distribution of fertilizer for 7-opening

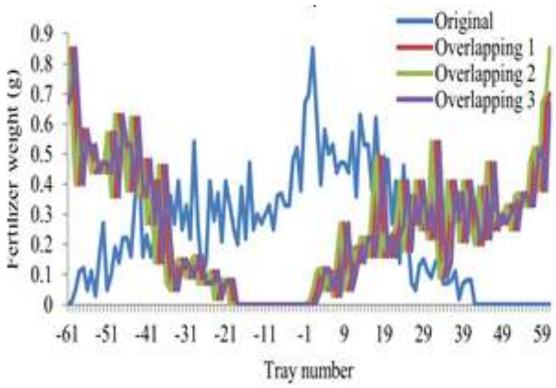

Fig. 6. Distribution of fertilizer for 4-opening

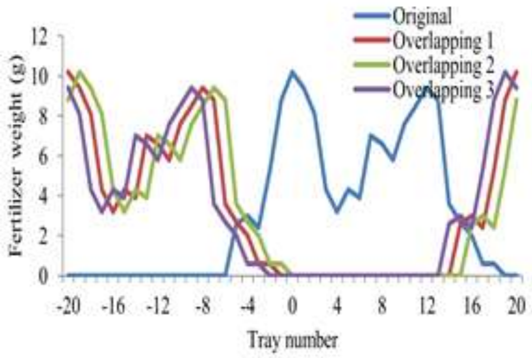

Fig. 7. Distribution of fertilizer for manual

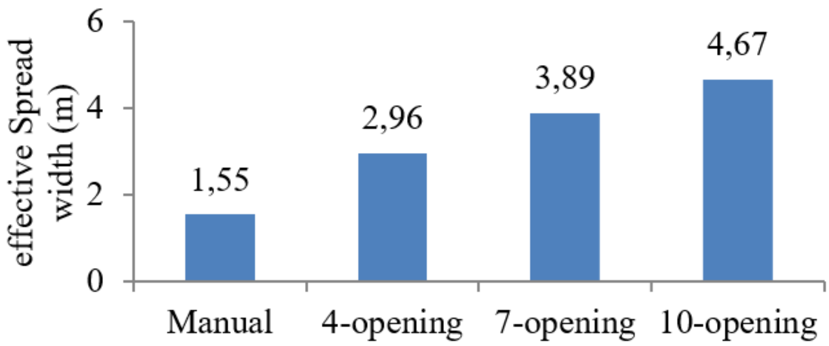

Fig. 8. Effective spread width of each fertilization method

Fig. 8 show the effective spread width of fertilization, where the bigger the opening of spreader so the bigger the effective spread width. Generally effective spread width of mechanical fertilization is bigger than manual fertilization with 10 opening is the biggest one. The effective spread width of fertilization is not affected by walking speed.

The rate of applied fertilizer mechanically, 10-opening even 7-opening were higher than done by manually. Performance of mechanical fertilization affected by condition of paddy field. When walking on field paddy the position of spreader change intermittently while moving along. The change of spreader position affected opening of spreader. When the position of spreader are rectangular to field so the flow of fertilizer are high and decrease relating to change of position toward left or rigt side afflicted by walking on field paddy.

Determination coefficient (Fig. 9) of curve, relation between rate of applied fertilizer and walking speed are low, indicate the rate of applied fertilizer can be vary. Fig. 9 shows rate of applied fertilizer mechanically higher than manually, with 10 opening are the highest. The slower the walking speed the higher the rate of applied fertilizer. Fig. 9 indicate that both of method manual and mechanical has ununiform distribution of fertilizer.

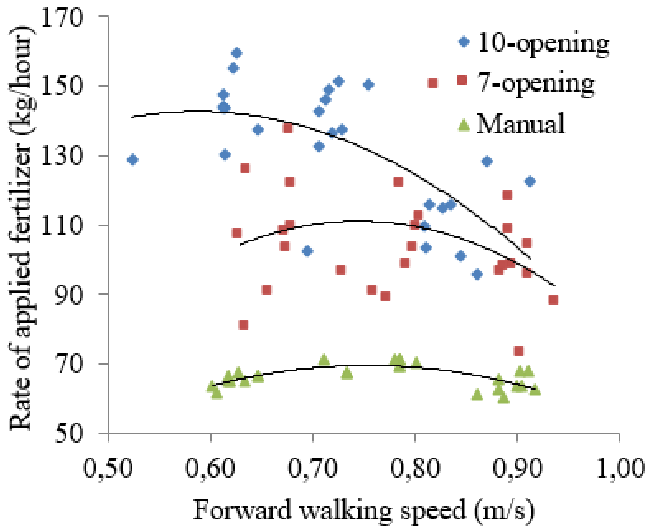

Fig. 9. Rate of applied fertilizer pf fertilization

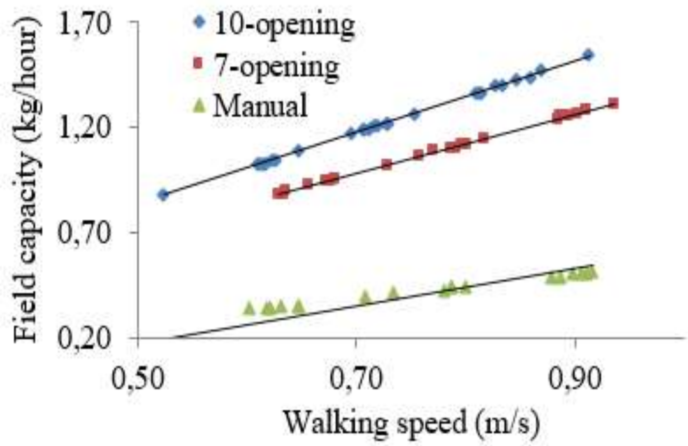

Fig. 10. Field capacity of fertilization

Mechanical fertilization field capacity is higher than manual fertilization. The measured field capacity in this research conducted for one trajectory. The higher the effective spread width the higher the field capacity, while the faster walking speed produced higher field capacity.

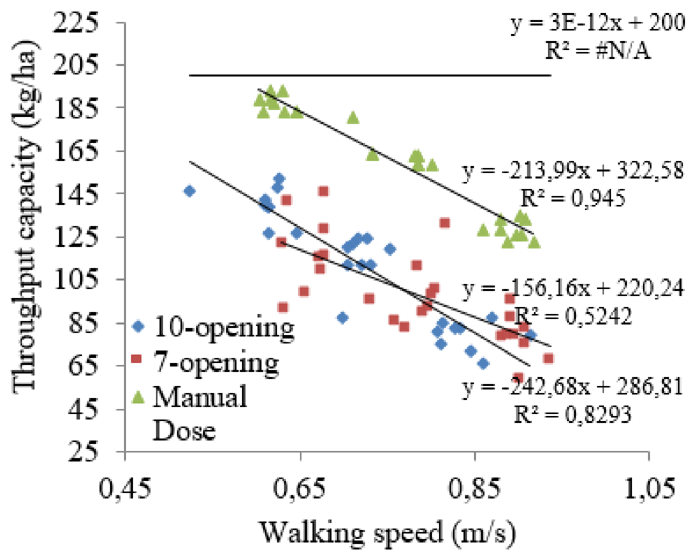

Fig. 11. Throughput capacity of fertilization

Good fertilization practice marked by the precision of amount of applied fertilizer toward dose of fertilizer required. Second fertilization required granular fertilizer of urea as much 50 kg/ha and NPK as much 150 kg/ha. Throughput capacity is a parameter to know amount of fertilizer distributed to a certain area. Fig. 11 shows throughput capacity manually is higher than mechanically, include 10-opening or even 7-opening. The slower the walking speed the higher the throughput capacity. In one trajectory of both mechanical and manual fertilization carried out with walking speed condition of paddy field for second fertilization, its throughput capacity was below the second fertilization dose. Table 3 show the optimal walking speed to achieve throughput capacity equal to dose of second fertilization for each treatment.

Table 3. Optimum walking speed for throughput capacity equal to dose

Fertilization method	10-opening	7-opening	Manual
Throughput capacity, (ha/hour)	200	200	200
Regression equation	y = -242.68x + 286.81	y = -156.16x + 220.24	y = -213.99x + 322.58
Walking speed, (m/s)	0.36	0.13	0.57

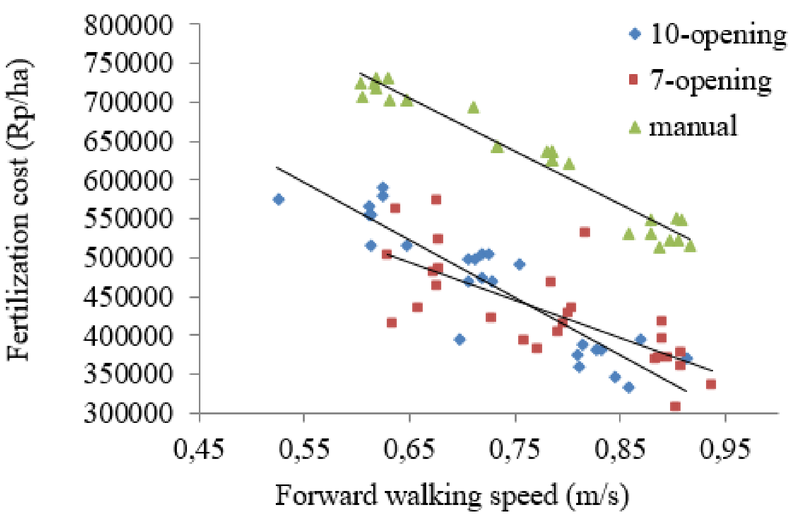

Fig. 12. Fertilization cost mechanically and manually

Fertilization costs are shown in Fig. 12 where the cost of 10-opening is lower than 7-opening and manual fertilization. The operational costs of manual fertilization and 7-opening are actually larger than 10 opening, but the field capacity of 10 opening higher than both of its.

IV. CONCLUCION

1. The effective spread width of 10-opening is 4.67 m higher than 7-opening, 4-opening and manual fertilization respectively of 3.89 m, 2.96 m and 1.55 m.
2. The rate of applied fertilizer on 10-opening is the highest for mechanically as much 159.55 kg/jam was reached on walking speed of 0.63 m/s.
3. The highest mechanically field capacity is 10-opening as much 1.53 ha/hour was reached on walking speed of 0.91 m/s.
4. The fertilization cost of 10-opening as much Rp 331605.93/ha was reached on optimum walking speed of 0.86 m/s is the lowest cost.

REFERENCES

[BBPadi] Balai Besar Padi. 2017. *Pemupukan pada Tanaman Padi* [internet], [downloaded 2017 Jan 7]. Tersedia pada: http://bbpadi.litbang.pertanian.go.id/index.php/berita/info- teknologi/content/226-pemupukan-pada-tanaman-padi.

[BPS] Badan Pusat Statistik. 2017. *Impor Beras menurut Negara Asal Utama Tahun 2000 – 2014* [internet]. [downloaded 2017 Jan 7]. Tersedia pada: https://www.bps.go.id/linkTabelStatis/view/id/1043

Buckmaster DR, Goering CE, Rohrbach RP, Srivastava AK. 2006. *Engineering Principles of Agricultural Machines.* Texas (US): ASABE.

Field HL, Solie JB. *Introduction to Agricultural Engineering Technology*. Oklahoma (US): Springer.

Musyarofah N. 2013. *Analisis Sebaran Pupuk Butiran pada Berbagai Metode Penebaran Pupuk di Lahan Sawah secara Manual oleh Petani* [skripsi]. Bogor (ID): Institut Pertanian Bogor.

Octiasari. 2011. *Hubungan Penguasaan Lahan Sawah dengan Pendapatan Usaha Tani Padi* [skripsi]. Bogor (ID): Institut Pertanian Bogor.

Pratama NA. 2012. *Rancangbangaun Rangka Unit Penebar Pupuk Butiran Laju Variabel* [skripsi]. Bogor (ID): Institut Pertanian Bogor.

Przywara A. 2015. *The Impact of Structural and Operational Parameter of the Centrifugal Disc Spreader on the Spatial Distribution of Fertilizer* [internet]. [downloaded 2017 April 5]. Journal of Agriculture and Agricultural Science Procedia. 7(2015):215-222. Tersedia pada: http://www.sciencedirect.com/science/article/pii/S2210784315300218.

Sinaga DR. 2009. *Kapasitas Lapang, Efisiensi dan Tingkat Pelumpuran Pengolahan Tanah Sawah di Kelurahan Situ Gede, Kecamatan Bogor Barat, Kota Bogor* [skripsi]. Bogor (ID): Institut Pertanian Bogor.

A.11

MODIFICATION OF CORN (*Zea mays* L.) SHELLER BY ELECTRIC MOTOR POWER SOURCE

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ABSTRACT

Corn (*Zea mays* L.) is a the one of strategic plant to be cultivated, because it is not only can be substitute material of rice but also can be used for animal feed and industrial raw materials. This study aims to modify the sylinder corn sheller by using rubber as the gear sheller and the electric motor as the resource. This research uses modification method, then test the modification to know the performance of machine. The parameters observed were moisture content, work capacity, yield damage, percentage of isolated, unspoiled percentage and loss rate. The best result obtained is the level of damage of corn snack obtained by 0 %. By using of rubber material as the gear sheller can decrease the damage level of the result because rubber has a good elasticity value.

Keywords **:** Modification, Sylinder corn sheller, Corn, Rubber sheller.

I. INTRODUCTION

Corn (*Zea mays* L.) is one of the great commodities as a source of carbohydrates. According to Firmansyah *et.al* [1], The proportion of corn as one of the producers of carbohydrate is 16.6%, while rice 55.5%, and the rest is occupied by cassava, sweet potatoes and others. The utilization of corn not only as a substitute material of rice but also for animal feed and industrial raw materials.

The increasing of corn production through improved cultivation technology can be quite successful. However, the it hasn't been followed by good postharvest handling, one of them in the Sheller process. The occurrence of damage to the seeds of corn in some of the process of pinched due to corn size mismatch with the pemmer.

Corn sterilization in home and small industries is mostly done in traditional and semi-traditional ways. With that way is used a long time and the power used is big enough. According to Hariyono [2], Adult women can shave the corn by hand in 2-9 kg/hour. For manual type sharpener (TPI type) can shave it in 20-30 kg/hour, and for car tire sheller model can shave it in 40 kg/hour. For industrial scale screwers have a very large working capacity and use a large power. For example, the capacity ranges from 1-2 tons/hour and power used by 6 HP. These machine have large dimensions, so the cost of producing this class of corn sheller is certainly huge. Mislaini *el al* [3] also said that, For industrial scale has capacity ranges from 1-2 tons/hour and the power used by 6 HP.

Aswanda [4] had modified corn sheller machine uses a material that almost entirely uses iron, including the cylinder shrinkers made with bolt as gear shrink. The proccess of snacking generate an average percentage of damage of 6.1 %. The factors that cause the occurrence of such damage is the gear pemmeril on the cylinder sharper made of bolts, thereby allowing the occurrence of damage to the results of corn poultry process. It is necessary to modify the corn sheller cylinder, so it can reduce the percentage of damage results.

Based on the background, modifications to the existing corn sheller cylinders in the hope of decreasing the percentage of corn damage during the process of peppering. The tool that will be modified is designed to have a difference with the previous. The difference is on the cylinder sheller by using rubber as the gear sheller. Because rubber has a cost of manufacture and maintenance is relatively cheap and easy to operated.

This study aims to modify the corn sheller cylinder with electric motor power source.

II. THE MATERIALS AND METHODS

A. Time and Place

This research was done from August to October 2016 at Laboratory of Production and Management of Agricultural Equiprment and Machenary, Agricultural Engineering Study Program, Andalas University, Padang.

B. Material and Tools

The material used in this research such as iron plate and iron strip with thickness 3 mm, nut, bolt, rubber and 250 kg of corn with varieties BIMA 20. The tools used in this research are drill, hammer, key Combination, welding equipment, hacksaw, stopwatch and scales.

C. Research procedure

This research was conducted by using modification method with stages of preparation of tools and materials. In conducting the research, the corn was dried to 14%, 18%, and 22% moisture content, and the rpm of the sheller cylinder was adjusted to 400 rpm, 500 rpm, and 600 rpm. The electric motor used power of 0.5 HP. Data retrieval was performed in 5 repetitions at each treatment.

D. Observation

The parameters observed were the measurement of corn water content, work capacity, percentage of yield damage, percentage of collected corn, percentage of uncollected corn, and loss rate.

1. Water Content

The water content of corn was measuring with Grand Mousture Tester. According to Bintoro *et al* [5], water content of corn used has ranging between 17-20%. While corn is based on SNI 3920-2013, maximum water content is 17% [6].

2. Work Capacity

The equation To measured the work capacity using :

$$\mathrm{WC} = \frac{\mathrm{WCC}}{\mathrm{T}} \tag{1}$$

3. Percentage of Yield Damage

To calculated the percentage of yeald damage using equation :

$$\mathrm{YD} = \frac{\mathrm{WBC}}{\mathrm{WSC}} \times 100\ \% \tag{2}$$

4. Percentage of Shelled Corn

To calculated percentage of shelled corn using equation :

$$\mathrm{SC} = \frac{\mathrm{WCC}}{\mathrm{WCC} + \mathrm{WUC}} \times 100\ \% \tag{3}$$

5. Percentage of Unshelled Corn

To calculated percentage of unshelled corn using equation :

$$\mathrm{UC} = \frac{\mathrm{WUC}}{\mathrm{WUC} + \mathrm{WCC}} \times 100\ \% \tag{4}$$

6. Loss Rate

To calculated percentage of uncollected corn using equation :

$$\mathrm{LR} = \frac{\mathrm{WAC} - \mathrm{WCC} - \mathrm{WUC}}{\mathrm{WAC}} \times 100\ \% \tag{5}$$

III. RESULTS AND DISCUSSION

Based on the research that has been done in the Laboratory of Production and Management of Agricultural Equiprment and Machenary, the focus of testing discussion such as water content, work capacity, yield damage, percentage of isolated, unspecified percentage and loss rate.

After modifyed the components of the corn shepper machine that is on the teeth sheller then obtained the specification of the tool can be seen in Table 1.

Table 1. Tool Specifications

Component	Information
Cylinder Sheller	Iron Strip 3 mm
Gear Sheller	Rubber
Motor Power Pulley	Ø 3 inch, Ø 4 inch, Ø 5 inch
Sheller Pulley	Ø 10 inch
V-belt	58 mm, 59 mm, 60 mm
Bearing	Ø 1 inci
Engine	Electric Engine 0,5 HP

The Cylinder of corn sheller was modified on the gear of the pemmer. It made from rubber tires. The picture of the gear of cylinder sheller can be seen in Fig. 1.

Fig. 1. Gear Sheller

In the process of making the cylinder of corn sheller by cutting of iron strip, pipe iron and rubber tire. Iron strips and rubber tires are drilled using a drill to facilitate the installation of such components when the sheller cylinder has been put together. The components are incorporated using welding techniques using an electric welding machine. Then, the cylinder shaft is paired with a 10-inch diameter pulley, and is paired with two bearings and joined to the main frame. The cylinder gear can be seen in Fig. 2.

Fig. 2 .The Cylinder of Corn Sheller

A. Water Content Measurement

The measurement of the water content of the corn was carried out using a previously calibrated Grand Mousture Tester tool. The measurement of water content of corn was done in 5 repetitions using samples from 5 corns that have not been sheller. The aims to measured it was to see the percentage of water content contained and become a reference for measuring different levels of corn water with different percentages. The measurement of moisture content of corn can be seen in Table 2.

Table 2. Water Content measurement

No	Water Content (%)
1	29,0
2	30,0
3	29,5
4	32,0
5	31,0
Sum	151,5
Average	30,3

Table 2 shows the average value of corn water content of 30.30%. According to Firmansyah *et al* [7], the survey results show that moisture content of corn harvested during the rainy season is still high. It was between from 25-35%.

After the initial water content is obtained, then the water content decrease by oven. At this observation, the water content is lowered to 14%, 18% and 22%, it cause to the time of excision the resultant damage can be avoided. Compared with damage to yields obtained by Aswanda [1] of 6.1%, the damage to the results obtained after modification is obtained at 0%. It was cause influenced by the treatment of different water content and the gear sheller made of rubber material. Decrease in moisture content using oven can be seen in Fig. 3.

Fig. 3. The Process of to Decrese Water Content Using Oven

B. Work Capacity

Working capacity is obtained from the division between the weight of the corn and the time needed to split the corn. After doing the observation, rpm and time of panning have an effect on the work capacity. Table 3 shows that the higher the rpm value the greater the working capacity, this is due to the rapid rotation of the cylinder spin causing the shortest corn in a short time, so that the process of panning can be solved quickly and produce a lot of corn. For each rotation frequency of the shipping machine, it is applicable that if the higher the water content the poultry work capacity increases. Graph of the working capacity of the corn sheller machine can be seen in Fig. 4.

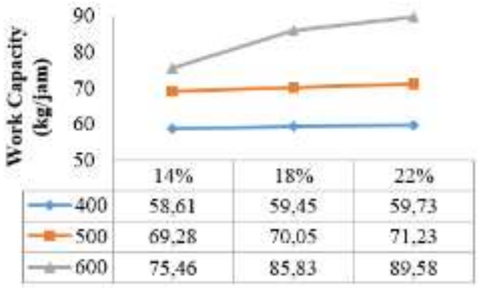


Fig. 4 Grafic of Work Capacity

If compared with the work capacity by Aswanda [1] (45.50 kg), work capacity obtained after modification is higher than before. Because the influenced by the treatment of RPM and different water content. So that the value of the higher work capacity is obtained.

C. Persentage of Yield Damage

The percentage of yield damage is the ratio of the weight of damaged corn to 200 gram of the sample from the weight of the corn in one repetable. Water content will give affect the level of damage during the process of separation of corn kernels from the cob, especially if the water content of corn to be released the seeds are high. Then the kernel of corn will be difficult to release and suffered. According to Handerson and Perry [8], before the process of corn pelleting is needed the drying process to avoid the occurrence of broken seeds. Therefore, the seed moisture content should be lowered to 20%. The Persentage of yield damege in this reaserch show in Table 3.

Table 3. Persentage of Yield Damages

RPM	WC (%)	YD (kg)	CC (kg)	YD (%)
	14	0,00	10,36	0,00
400	18	0,00	11,06	0,00
	22	0,00	11,34	0,00
	14	0,00	11,60	0,00
500	18	0,00	12,20	0,00
	22	0,00	12,54	0,00
	14	0,00	12,30	0,00
600	18	0,00	12,42	0,00
	22	0,00	12,74	0,00

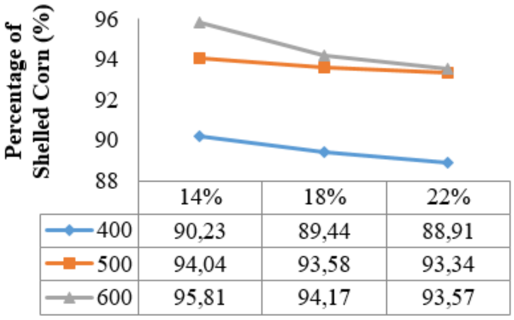
Table 3 shows the result yield damage by 2 factors, in example RPM and water content. In that table also the average percentage of yiled damage is 0%. It is cause of the proccess removing the corn kernel is done at the water content standart (14% and 18%). So no one corn seeds are broken. Other wise, not only in water content standart but also corn with moisture content of 22% having damage percentage 0% . This lower damage caused by the gear of cyllinder sheller was made from rubber. As we know, rubber more elastic than iron.

At proccess of removing korn kernel from cob, the rubber shrinking gear will follow the texture of the corn. So that corn can be isolated without damage. In contrast to iron-shaped teeth with low elasticity, the teeth exert great pressure during the process of shaking. So the process causes friction and collisions that cause corn kernels to be damaged. The results of the poccess can be seen in Fig. 5.

Fig. 5 The Result of Corn after using Corn Sheller

D. Percentage of Shelled Corn

To get the percentage of shelled corn has done by comparing the weight of shelled corn with sum of shelled corn and unshelled corn. In Fig. 6 states that the higher the RPM used will be the higher the percentage of the corn shelled. The grafic of Percentage of Collected Corn show in Fig. 6. It couse of in high RPM give a high power to shelled the corn. So many of korn kernel released from the cob.

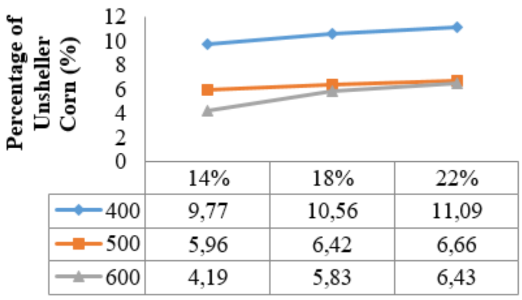


	14%	18%	22%
400	90,23	89,44	88,91
500	94,04	93,58	93,34
600	95,81	94,17	93,57

Fig. 6. The Grafic of Persentage Collected Corn

E. Persentage of Unshelled Corn

The percentage of unshelled corn is obtained by dividing the unbroken corn by the weight of the unpolished corn plus the weight of the corn that is split and multiplied by 100%. The unshelled corn in this observation is the kernel corn that is still attached to the cob. This value is inversely with the persentage of shelled corn. Graphic percentage of unsheller corn can be seen in Fig. 7.



	14%	18%	22%
400	9,77	10,56	11,09
500	5,96	6,42	6,66
600	4,19	5,83	6,43

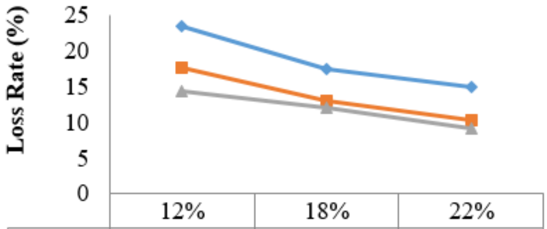
Fig. 7. The Grafic of Percentage of uncollected corn

Fig. 7 shows that water content also gave affects for the shelled process. Because high water content made corn dificult tu released from the cobs. So the gear of cylinder corn sheller will be difficult to worked. Unshelled corn can be seen in Fig. 8.

Fig. 8 The Unshelled Corn

F. Loss Rate

The loss rate in this result cause of when the shelled process many corn kernel throw out from the cylinder, not went out in outlet. The loss rate shows that if the water content was low, so the loss rate will high. This is caused by the lower water content made the corn kernel harder to shelled. Not only that, the high rotation of the cylinder corn sheller causes the corn with low water content spill out and not entirely out of the outlet. That made the loss rate higher. The graph of loss rate can be seen in Fig. 9.



	12%	18%	22%
400	23,47	17,47	14,93
500	17,73	13,07	10,40
600	14,40	12,00	9,20

Fig. 9 The Grafic of Loss Rage

IV. CONCLUSION

1. Has been modified the corn sheller machine in the cylinder corn using electric motor power source with specifications :
   a. Gear sheller made from rubber.
   b. The sheller Cylinder pulley with 10 inch.
   c. Motor Power pulley with 3, 4, dan 5 inch.
   d. Transmision using V-belt with 58, 59 dan 60 mm.
2. Persentage of yield damage was 0 %.

NOMENCLATURE

LR	Loss rate	%
SC	Percentage of shelled corn	%
T	time	hour
UC	Percentage of unshelled corn	%
WC	Work capacity	kg/hour
WCC	Weight of collected corn	kg
WAC	Weight all of corn	kg
WBC	Weight of broken corn	kg
WCC	Weight of collected corn	kg
WUC	Weight of uncollected corn	kg
WT	Water Content	%
YD	Percentage of yeald damage	%

REFERENCES

[1] Firmansyah, I.U., M. Aqil, dan Yamin Sinuseng. 2011. Penanganan Pascapanen.Maros :Balai Penelitian Tanaman Serelia.
[2] Hariyono. 1995. Teknologi Tepat Guna Membuat Alat Pemipil Jagung. Jakarta : Kanisius.
[3] Mislaini, Santosa, Widyawati. 2015. Study of Techno-Economic of Corn Sheller Type MPJ-01-TEP-2014 Design of Study Program Agricultural Engineering, Andalas University. International Jurnal on Advanced Science Engineering Information Technology. Vol.5 No.1. p. 23-26.
[4] Aswanda, I. 2014. *Rancang Bangun Alat Pemipil Jagung dengan Sumber Penggerak Motor Listrik*. Skripsi. Padang : Andalas University.
[5] Bintoro N., Apriadi., dan Amanah H.Z. 2011. Analysis of Heat and Mass Transfer Process Drying Corn Cobs On Some Simple Drying Method. Proceedings National Seminar PERTETA 2011. Jember, Indonesia
[6] Indonesian National Standardization Agency. Corn (SNI 3920-2013). Jakarta.
[7] Firmansyah, I.U., S. Saenong, B. Abidin, Suarni, dan Y. Sinuseng. 2006. Proses Pascapanen Untuk Menunjang Perbaikan Produk Biji Jagung Berskala Industri dan Ekspor.Maros : Final Report Reaserch, Balai Penelitian Tanaman Serealia. p. 20-25.
[8] Handerson, S.M and R.L. Perry. 1982. Agricultural Process Engineering. Westport : Third Edition. The AVI Publishing Company Inc. p. 277-311.

A.12

ANALYSIS OF WORKING CAPACITY AND FUEL CONSUMPTION OF HAND TRACTOR ON DRY LAND IN NAGARI TANJUNG BONAI LINTAU BUO UTARA TANAH DATAR

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ABSTRACT

Hand tractors are very useful in the territory of Indonesia which was famous as an agrarian country. Its location on the equator lane brings its own advantages for soil conditions in Indonesia. Land in Indonesia can be processed into agricultural land so that agriculture can become the main livelihood of Indonesian people in general, especially in Nagari Tanjung Bonai Kabupaten Tanah Datar . Nagari Tanjung Bonai was one of the areas of horticultural crop development, where people really need a tool to cultivate the land. However, cultivating the soil in farming manually will be more difficult for farmers. For that, farmers need a tool or machine to facilitate their work in cultivating their plantation land. One of them was by using hand tractors. The results of soil treatment using hand tractors are influenced by the depth of tillage and the speed of the tractor works, while the depth of tillage and the speed of work will affect the working capacity and fuel requirements. The purpose of thwas research was to calculate the amount of fuel requirement and the working capacity of hand tractor with the ground tool of steel claw plow with variation of soil preparation, depth of tillage and speed of work. The soil cultivation pattern was carried out by varying the back and forth pattern and the pattern of traveling. Research method used was Randomized Complete Block Design (RCB) with factorial arrangement. The first factor was the depth of the plow conswasting of 2 levels of treatment that were: 20cm and 30 cm plow depths. The second factor was the speed of the tractor conswasting of the gear speeds of 0,25 m/sec and 0,5 m/sec. The parameters measured were the fuel consumption and hand tractor working capacity for each pattern of soil treatment. The results showed that the average fuel requirement at 20-30 cm depth of tillage and the working speed of V1 on the alternating pattern was 1,35 L/hour, in the circular pattern 0,99 L/hour and at velocity V2 on the alternating pattern was 1,48 L/hour and the circular pattern was 1,35 L/hour. The average working capacity at 20-30 depth with velocity V1 in the alternating pattern was 10,65 hour/ha and the circular pattern was about 7,65 hour/ha, and at velocity V2 the alternating pattern was 9,85 hour/ha and the circular pattern was 5,5 hours/ha

Keywords : Working Capacity, Fuel Consumption, Pattern of Soil Preparation.

I. INTRODUCTION

In Indonesia, horticulture cultivation was still done conventionally using human (manual). Therefore, the use of soil-preparation machines was very important to increase production. Thwas was caused by the lack of knowledge of the farmers on technological developments that make more prioritize the preparation of land manually (Haerani, 2001).

Hand tractor was the equipment used by human, working system that was needed by hand tractor impulse, and of course using human. Handtractor serves to cultivate the soil, has a high efficiency because the reversal and cutting the soil can be done at the same time. Thwas two-wheeled tractor was a versatile tractor because it can serve as a driving force for other tools such as water pumps, processors, trailers and others (Sutrwasno, 1999).

Agricultural tractors are now an integral component of agricultural and rural development. Residents have benefited from the use of tractors to do land-grinding work quickly and many have switched to picking tractors rather than using animals or muscle power for the same job. Thwas was because they can compare that it turns out to be treating the soil with a tractor more profitable than any other way. The same thing was done by the farmer community of Tanjung Modang Nagari Tanjung Bonai Kecamatan Lintau Buo Utara Kabupaten Tanah Datar. Farming communities have very large antuasias with the use of hand tractors, especially for dry land. When viewed in terms of economic use of hand tractors compared with human labor was very more efficient, can produce greater capacity and fewer working hours.

The pattern of tillage using a hand tractor was closely related to the time lost due to bends during tillage. Based on thwas the pattern of preparation should be determined to minimize turning time because at the time the tool was not working.In order to see the efficiency of hand tractor usage, it was necessary to test the hand tractor of steel claw hand tract with some soil preparation pattern so it was expected to produce the best alternative soil farming pattern to help farmers to increase production, farmer income and reduce production cost and improve farmer's welfare.

The principle of construction of thwas small tractor conswasts of: drivingforce motor drive, landing chaswas and body, power successor components, tires wheels, implements soil preparation equipment. As for the preparation in the use of hand tractors before operation so that thwas tractor can work smoothly and economically, that was to prepare the clothes of the operator, conduct inspection, check the clutch, the tractor must walk straight, check the tire pressure, check the parts that need to be lubricated (Hardjosentono, 2002).

Soil preparation was the hardest part of the entire cultivation process, where it consumes about one-third of all the energy required in agricultural cultivation. How to cultivate the land will affect the results of preparation and energy consumption (Mundjono, 1989).

Mardinata and Zulkifli (2014), Patterns of soil preparation are closely related to time lost due to bends during tillage. The pattern of treatment should be chosen in order to minimize as much as possible the removal of the apparatus to reduce as much of the time as possible because at the time of removal the device does not work. Therefore it should be cultivated plow or rake keep working during the operating time in the field. The more app removal at turns, the lower the efficiency of the work.

The speed of vehicles and fuel consumption has a strong relationship. The faster the tractor goes, the more fuel consumption will increase. High speed tractor because pwaston burn more fuel. The more fuel that was burned the more banyk power generated so that the faster the vehicle moves.

II. MATERIALS AND METHODS

The experiment was conducted by using factorial randomized block design (RAK) on the land with the pattern of back and forth back and forth. The research was conducted in the farmer's group Sago Lestari Jorong Tanjung Modang Nagari Tanjung Bonai Kecamatan Lintau Buo Utara Tanah Kabuapten Tanah Datar June 2017. Research using a Quick hand tractor with a steel claw tillage tool. The size of the land plot used was 20 x 20 m. The first factor was into the plow (D) conswasting of two (2) levels of treatment that was within 20 cm and a depth of 30 cm. The second factor was the speed of the tractor (V) conswasting of velocity 1 ie gear 1 (0,25 m/sec) and velocity 2 using 2 gear (0,5 m/sec).

Research procedure: before the tractor engine was turned on it was ensured that all supporting equipment or tractor components are fitted perfectly. The fuel tank was fully charged before the tractor was run. The cultivation of the land begins with a velocity of V1 and a velocity of V2 at a depth of 20 cm, 30 cm for a pattern of back and forth arranging the field. After completing the preparation of one tractor machine the hand was turned off then the fuel tank was fully charged and record how much fuel was added to the tank. The land treatment was done 3 replications for each treatment and land treatment pattern.

Calculation of fuel consumption and working capacity can be used the following formula:

$$\text{Fuel Consumption (l / hour)} = \frac{\text{Added Volume}}{\text{Working time}} \tag{1}$$

$$\text{Working Capacity (hour / ha)} = \frac{\text{Working time}}{\text{Land area}} \tag{2}$$

III. RESULTS AND DISCUSSION

Observation of the results of research with the pattern of land preparation back and forth tightly and around as shown in Table 1.

Table 1. Result of Observation of Fuel Consumption and Working Capasity

Treatment		Parameter			
Depth	Speed	Pattern Back and Forth		Pattern Around	
		KBBM (l/hour)	KK (hour /Ha	KBBM (l/ hour)	KK (hour /Ha)
20 cm	V1 (0,25m/sec)	1,27	9,4	0,94	7,2
	V2 (0,5 m/sec)	1,43	9,2	1,30	4,9
30 cm	V1 (0,25 m/sec)	1,43	11,9	1,05	8,1
	V2 (0,5 m/sec)	1,53	10,5	1,40	6,1

Seen in Table 1, the highest fuel consumption was at a velocity of V2 at a depth of 30 that was 1,53 l / h on a pattern of back and forth groundwater treatment. The lowest consumption was seen at a depth of 20 cm, velocity V1 in the pattern around 0,94 l / h. The highest work capacity was seen at 4,9 hours/ha on the inside of 20 cm in the circular pattern.

Mardinata and Zufkifli (2014), in the use of hand tractors fuel consumption factors and work capacity are the main factors seen in tractor selection. Tractors that consume small fuel for the same mileage are the options to be achieved. Meanwhile, for the work capacity of tractor with the largest working capacity becomes the choice.

The results show that the fuel consumption in the surrounding pattern was smaller than the fuel consumption of the back and forth pattern. The depth of tillage also gives more influence in tillage also requires greater fuel. For work capacity using velocity V2 indicates higher capacity than velocity V1 and depth factor also affect work capacity, the deeper the tillage the smaller work capacity.

A. Fuel Consumption (L/Hour)

The results show the fuel consumption on soil tillage and different depth as shown in Table 2.

Table 2. Result of Fuel Consumption Analysis

Soil Preparation Pattern	Depth	Speed		
		V1 (0,25m/sec)	V2 (0,5 m/sec)	Average
Pattern Back and Forth	20 cm	1,27	1,43	1,34
	30 cm	1,43	1,53	1,48
	Average	1,35	1,48	1,41
Pattern Around	20	0,94	1,3	1,12
	30	1,05	1,4	1,23
	Average	0,99	1,35	1,18

The average fuel consumption based on the speed of the tractor was found that the highest fuel consumption was at the speed of tractor 2 and the alternating treatment pattern was 1,48 l/hour. While the average consumption of the lowest fuel was at the speed to 1 that was 0,99 l/hour in the preparation of land pattern. The average consumption of fuel based on the depth of soil preparation found the highest fuel consumption was at a depth of 30 cm that was 1,48 l/hour on the preparation of land back and forth meetings. While the average consumption of the lowest fuel was obtained on soil preparation around 20 cm depth of 1,12 l/hour.

Djoyowasito (2002), the deeper the depth of the soil the speed of work was lower. Thwas phenomenon occurs because the wheel slip was very high at the time the tool works and also the number of weeds that are cut off and chunks of large-scale soil, so that the time to travel the dwastance determined to be long.

Tractor fuel consumption will be greater if the penetration of the soil was greater. Penetration of land will be greater if the depth of the soil deepens. The deeper the tillage the slower the tractor will run because the required tractor power will be greater. As a result the greater the power required to move the tractor. Tractor power was generated from rotation of pwaston in cylinder. The more cylinder pwaston rotation, the more fuel will be spent. The results also show the longer the length of tractor dwastance.

Yuswar (2004), speed was one method to increase the work capacity of agricultural equipment that was by increasing the speed of the tractor means to increase the working capacity of the soil preparation equipment without having to increase the weight and the number of propulsion units that burden the soil.

The results of thwas study showed the higher the speed of the tractor the more fuel needed and the more deeply preparation the soil also the fuel needs. According to Pramuhadi (2004), the addition of tractor power requires greater combustion so that the tractor fuel consumption was also greater than that the penetration of soil penetration also affect the fuel consumption.

B. Working Capacity (Hour/Ha)

The results show the working capacity of the soil preparation for alternating velocities and the circular pattern as shown in Table 3.

Table 3. Results of Work Capacity Analysis (Hour/Ha)

Soil Preparation Pattern	Depth	Speed		
		V1 (0,25m/sec)	V2 (0,5 m/sec)	Average
Pattern Back and Forth	20 cm	9,4	9,2	9,3
	30 cm	11,9	10,5	11,2
	Average	10,65	9,85	10,25
Pattern Around	20	7,2	4,9	6,05
	30	8,1	6,1	7,1
	Average	7,65	5,5	6,58

The capacity of the average hand tractor work based on the speed of the tractor was found that the highest working capacity was at the speed of the tractor 2 and the circular of 5,5 hours/ha. Meanwhile, the lowest average hand tractor work capacity was at the 1st speed of 10,65 hours / ha on the backyard pattern preparation. The average hand tractor work capacity based on the depth of soil preparation found the highest working capacity was at a depth of 30 cm ie 6,58 hours / ha on the preparation of ground around. Meanwhile, the lowest average hand tractor work capacity of the fuel was found on alternating soil treatment at 30 cm depth at 11,2 hours / ha.

The average work capacity of tillage speed treatment has an effect on the work capacity. The faster the tractor works the greater the work capacity of the tractor. Rizaldi menurur (2006) work capacity of a preparation equipment was influenced by several factors, namely: 1) size and shape map; 2) topographic area; 3) the state of the tractor; 4) the state of vegetation at the soil surface; 5) soil condition; 6) operator skill level; And 7) land treatment pattern.

The soil treatment pattern will affect the working capacity of the tractor used. The soil tilling pattern gives the best capacity because at the time of operation with the alternating pattern it will take time to turn so that the work capacity will be smaller. Thwas was in accordance with the statement (Suastawa et al, 2000) the pattern of soil preparation was closely related to the time lost due to curves during the preparation of the soil. The pattern of treatment should be chosen in order to minimize as much as possible the removal of the apparatus, since at the time of removal the device does not work, the more the apparatus was removed at turn time, the lower the working efficiency. The results showed that the difference in speed and depth of soil preparation gave effect to the fuel consumption and the working capacity of the tractor during the preparation of the soil.

IV. CONCLUSION

A. Conclusion

1. The average fuel requirement at a tillage depth of 20-30 cm and at the working velocity of V1, for the alternating pattern was 1,35 L/hour, and for the circular pattern was 0,99 L/hour. At the working velocity of V2, for the alternating pattern fuel requirement was 1.48 L/hour and for the circular pattern fuel requirement was 1,35 L/ hour.
2. The average working capacity at a tillage depth of 20-30cm, at the working velocity of V1, for alternating pattern was 10,65 hours /ha and for the circular pattern was 7,65 hours /ha. At the working velocity of V2, for the alternating pattern working capacity was 9,85 hours /ha and for circular pattern working capacity was 5,5 hour/ha.
3. Based on the efficiency of fuel consumption and working capacity, the circular pattern was the best soil tilling method.

B. Suggestion

In the preparation of land by hand tractor using a circular pattern of traveling around with a speed tractor V2 with a depth of 20 cm.

REFERENCES

Djoyowasito, G. 2002. Pengaruh Kecepatan Maju Bajak Terhadap Beberapa Sifat Dinamik Tanah Dalam Pengolahan Tanah. Teswas. Institut Pertanian Bogor. Bogor.

Haerani, A.2001.Kajian Awal Perancangan Alat dan Mesin untuk Budidaya Sayuran, Skripsi. Jurusan Teknik Pertanian,IPB. Bogor.

Hardjosentono, M., Wijayanto., Elon R., I.W. Badra., R. Dadang. T., 2002. Mesin-mesin Pertanian. Bumi Aksara. Jakarta.

Mardinata, Z dan Zulkifli. 2014. Analwaswas Kapasitas Kerja dan Kebutuhan Bahan Bakar Traktor Tangan Berdasarkan Variasi Pengolahan Tanah, Kedalaman Pembajakan dan Kecepayan Kerja. Agritech. Vol 34. No. 3.

Mundjono.1989. Pengolahan tanah cara gejlokan sebagai alternatif menanggulangi terbatasnya penyediaan bibit tebu. Prosiding Seminar Budidaya Tebu Lahan Kering .Pasuruan ,23-25 November 1988.

Pramuhadi, G. 2004.Studi Hubungan Antara Beban Mesin Traktor dan Efwasiensi Pengolahan Tanah. Teswas. Program Studi Ilmu Keteknikan Pertanian. Institut Pertanian Bogor. Bogor.

Rizaldi, T. 2006. Mesin Peralatan. Departemen Teknologi Pertanian universitas Sumatera Utara. Medan

Suastawa, I. N., W. Hermawan, dan E. N. Sembiring. 2000. Konstruksi dan Pengukuran KinerjaTraktor Pertanian. Teknik Pertanian. Fateta.IPB. Bogor.

Sutrwasno. 1999. Mesin-Mesin Peralatan.Bumi Aksara:Jakarta.

Yuswar, Yunus. 2004. Perubahan Beberapa Sifat FWasik Tanah dan Kapasitas Kerja Traktor Akibat Lintasan Bajak Singkal pada Berbagai Kadar Air Tanah. Teswas. Program Pascasarjana UNSYIAH. Banda Aceh.

A.13

CURING TOOL DESIGN OF MEAT AND FISH

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ABSTRACT

Kanum tribesman in Yanggandur village besides gardening they are also hunt. The hunted area of the Kanum Tribe is a Savanna, a forest overgrown with bus trees and others with a very wide swamp with the abundant Gastor (Channa Striata) fish. The existence of the village is quite isolated, the position of the village of Yanggandur about 4 km from the highway and 49 km from the city of Merauke. There is no special transportation that connects Yanggandur village with the city of Merauke. With the conditions mentioned above then the hunting area and the deep gardens in the forest of Kanum tribesman are very difficult to sell the yield hunts and fish catches. The purpose of this study, the first is to design a meat / fish curing tool so as to extend the age of consumption desirable hunting and the catchment of the villagers. Secondly to the dependent villagers can increase their income by selling the hunt and catch, thirdly, the citizens can process the hunt and catch as soon as possible and be guaranteed cleanliness. The target of this program is the village community who daily in their living needs are gardening, hunting deer, cassowary and kangaroo and catch fish. At the beginning of the dry season the catch is very abundant. The method in this research is the making curing tool that made of iron elbow, stainlees steel sheet with tool dimension 60 cm length, width 60 cm and height 80 cm, test the tools and application in society by doing comparison of economic value obtained between the sell of the hunt directly with curing first. It is expected that the results of curing of meat and fish have a longer consumption-worthy time.

Keywords : Curing Tool, Hunting Result, Tribe Kanum

I. INTRODUCTION

Merauke Regency is one of 29 districts in Papua Province located in the Southern part which has the widest area among districts in Papua. Geographically the location of Merauke Regency is between 1370 - 1410 BT and 600 - 900 LS. Merauke Regency is the easternmost of the archipelago with the following limits: 1). North side by Boven Digoel Regency and Mappi Regency, 2). East by the State of Papua New Guinea, 3). South by the Arafura Sea, and 4). The west is bordered by the Arafura Sea (Anonymous, 2006).

Merauke district has Wasur National Park. Wasur National Park is a national park in wetland form, and this wetland is the most widespread wetland in Papua or Irian Jaya but Wasur National Park has little disruption due to human activities. Wetlands in Wasur National Park are wetlands with many important functions such as wetlands providing enough food for valuable ecosystems such as crabs, shrimp and fish. Besides this wetland also serves as a refuge for the ecosystems in it.

In the Wasur National Park there is the Rawa Biru area. The Rawa Biru area is the savanna of life. In a swampy expanse of approximately 4,000 hectares, the Kanum tribe, Marind sub-sub-district, in Merauke District, Papua, they are put their live at there. Hunting and gathering is performed every day by four large families (settlers) who live in the village located in the area of Wasur National Park, namely clans Dimar, Banggu, Maiwa, and Sanggra.

Hunting life is thick in Kampung Rawa Biru inhabited by about 60 families or 248 Kanas. Grown men, even boys of primary school age, hunt animals every time. Savannah overlay, swamps and trees bus habitat for kangaroo land, roomy kangaroo, deer, pigs, fish, and little crocodile. Since childhood Kanum tribe has been familiar with the "mercy" of nature. By their parents, the children are taught how to support themselves through hunting or gathering.

Usually, one time in hunted, people travel through kole-kole (small boat from tree Bus) to the location along the swamp. One trip takes 6 hours and they have to stay in the forest 1 - 2 nights. Hunting by Kanum people is more driven by economic factors.

Problem that arise until now is the people of Kanum tribe still sell their game without processed first. To retard the damage of meat, they hunted out the organs in the hunted animals and then stacked on wood (Picture 4). Often, the community to preserve their prey by burning it on fire so untill it is dark brown or black. The problems that arise are:

1. Not guaranteed of freshness of meat and fish.
2. Because meat or fish thata placed or hung in open places will be damaged or rotten. Meat and fish belong to the most perishable foods group.
3. Meat or fish that burned, looks less attractive so that consumers are reluctant to buy it.

According with the problems then there should be a solution to overcome. It needs a tool to secure the game, one of them is meat and fish sauce.

II. MATERIALS AND METHODS

The method used in this research: (1) Designing meat and fish sauce. (2). Conduct a test run of the tool. (3). Observing the fumigation results with the observed indicator is the temperature of curing, the duration of curing. The final temperature of the smoked material. (4) Comparing observations with traditional fumigation results, especially for temperature and time. The parameters observed in the design of this tool are tool length, tool width, and tool height.

The research stages are as follows.

Specifications of the smoker are:

1. The framework of the smoker is made of hollow iron so it is strong enough to withstand the load.
2. The frame cover is made of an aluminum plate to avoid other rust with the same thickness of aluminium lighter than the steel plate.
3. Curing shelves made with 3 shelves to be able to load the material to be smoked quite a lot.
4. Curing tool can be removed with the aim can be moved in accordance with the required maturity.
5. Curing device made with Knock Down system for easy disassembling so easy to carry it,
6. Size of the curing tool is length 125 cm, width 100 cm height 150 cm. Meat sauce is made with these sizes so that one clan can use it together.
7. The tool designed is equipped with thermo control that serves to determine the temperature of meat / fish.

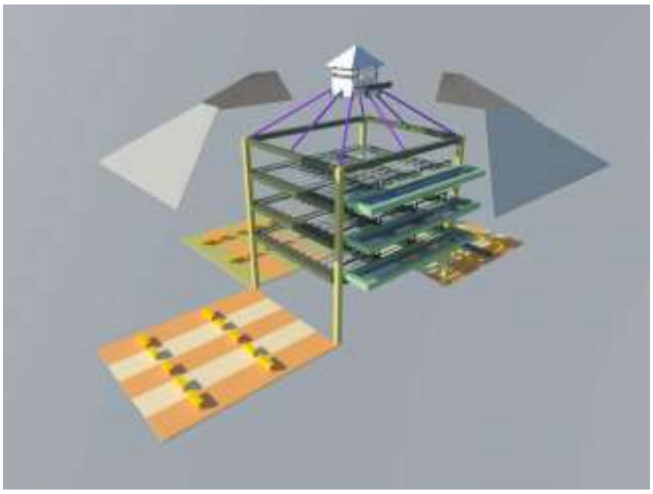

Fig. 1. Design of Curing Tool

III. RESULTS AND DISCUSSION

A. *Description of Curing Tool*

Meat and fish curing tool's is divided into three spaces, namely the furnace room, curing room / space as much as 3 space products, and the vented chamber (chimney) (Picture 1). With an overall size of 60 x 60 x 80 cm shaped box with a frame made of iron rods with a diameter of 1 cm and a wall of stainless steel plate with a thickness of 3.5 mm, and the top of the truncated pyramid-shaped with a height of 40 cm and a flue section has a door set Smoke exit.

On the inside there is a curing room consisting of 3 shelves. This tool is made by minimizing the gap so that the smoke can be trapped inside so that the curing process runs perfectly although the amount of fuel is relatively small. This tool is made with knock down system with the intention to be easily taken to the hunt.

The working principle of this curing tool is similar to the working process of other curing tools, but the difference lies in a tool that is easily dismantled and reassembled. The purpose of the tool is made with the system knockdown is easier to take it to the hunting place and more concise in its storage and easy to clean.

Fig. 2. Installation of Curing Tool

Fig. 3. Installation of Curing Tool

B. Temperature and Humidity of Curing Room

The results of the curing test show the air temperature in the curing chamber at the beginning of fogging is 1650 C. The initial process of smoke formation is used twigs sufficiently and 8 pieces of coconut coir from 2 coconuts. Coconut husk works to produce a considerable amount of smoke.

Fig. 4. Measuring The Temperature

C. Smoke Volume

Furthermore, Leksono et al., (2009) states that factors that may affect the amount of fuel used for fumigation include: duration of fumigation, cubic chamber capacity or the number and size of smoked meat and fish, as well as the desired water content of meat or smoked fish. The smoke volume in the curing process is also strongly determined by the fuel conditions. The setting of the flame affects smoke formation. To make enough smoke first make fire from twig to burn coir.

D. Organoleptic Quality of Smoke Fish

To know the quality of smoked fish, conducted organoleptic analysis that is favorite test. The results of the analysis show that the panelists give a fairly good appreciation of the meat and smoked fish produced, ie the average organoleptic value above 3 (like). Appearance of smoked fish and chicken meat slightly golden yellow gives a high rating. This condition is closely related to the smoke and smoke formation process. The smoke produced at the beginning of fogging will be attached when the meat and fish are still in wet conditions. Coupled with a fogging design that allows the smoke to spread evenly. Smoke with various chemical substances especially phenol will react with fat and fish protein to form a golden yellow color's.

Phenol and carbonyl compounds act to give flavor to smoked fish (Martinez et al., 2007). Specific volatile compounds, especially phenolic compounds, can influence the sensory characteristics of smoked fish (Cardinal et al., 2006). Some phenolic compounds such as guaiacol and siringol are very distinctive compounds in smoked fish (Jónsdóttir et al., 2008). Coconut shells including hardwoods that can produce a good volume of smoke will affect the organoleptic value of smoked fish (Marasabessy 2007). The reaction between the carbonyl and protein compounds generally affects the formation of color on the surface of the smoke product, while the phenolic compounds absorbed into the product act to produce flavor and aromatic of the smoke product (Kjällstrand and Petersson, 2001).

Fig. 5. Measuring The Temperature

Fig. 6. Meat and Fish after Smoked

IV. CONCLUSION

This meat and fish sauce has advantages:

1. Extend the age of consumption of meat and fish.
2. The process of curing meat and fish only takes 75 minutes with an initial temperature of 1650° Celcius.
3. The appearance and taste of smoked meat or fish is much more attractive and healthy than when burned.

REFERENCES

Cardinal M, Cornet J, Serot T, and Baron R. 2006. Effects of the smoking process on odour characteristics of smoked Herring (*Clupea harengus*) and relationships with phenolic compound content. *Food Chemistry* 96:137-146

Jónsdóttir R, Olafsdóttir G, Chanie E, and Haugen JE. 2008. Volatile compounds suitable for rapid detection as quality indicators of cold smoked salmon (*Salmo salar*). *Food Chemistry* 109:184-195

Kjällstrand J and Petersson G. 2001. Phenolic antioxidants in wood smoke. *The Science of the Total Environment* 27: 69-75

Leksono C, Bustari Hasan dan Zulkarnaini. 2009. Rancang bangun instrument dehidrator untuk pengasapan dan pengeringan hasil-hasil perikanan. *Jurnal Perikanan dan Kelautan 14(1)*:

Marasabessy Ismael dan Royani DS. 2014. Perbaikan teknologi pengasapan dan manajemen usaha pengolahan ikan asap. *Jurnal Bakti 6(1).*

Martinez O, Salmeron J, Guillen MD, and Casas C. 2007. Sensorial and physicochemical caharacteristics of salmon (*Salmo salar*) treated by different smoking process during storage. *Food Science and Technology International* 13(6):477-484 12-25

Marasabessy, I. 2007. Produksi asap Cair dari Limbah Pertanian dan Pemanfaatannya Dalam Pembuatan Ikan Layang Asap. Thesis. IPB, Bogor.

A.14

PERFORMANCE AND ERGONOMIC ANALYSIS OF CHILI (*Capsicum annuum* L.) PLANTING TOOLS USING TUGAL MECHANISM

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ABSTRACT

Chili is an important commodity in Indonesia because of its high economical value especially in several celebration days such as Ramadhan Month, Chrismast, Eid Day, also in rainy and transition season. However, the planting of chillies in Indonesia are conducted in manual way by farmers. The activity is conducted using farmer's hand in squatting or bending over condition in a long time. That kind of activity could give a negative impact such as muscle injuries, back pain, joint pain, etc. The objectives of this research were to examine the chillies planting tool using tugal mechanism that would increase planting area and to analyze ergonomics aspect using Rapid Upper Limb Assessment (RULA) method that would increase the speed and reduce the risk of chillies planting activity. This tool can form a planting hole with diameter around 105,56 mm and depth around 85,196 mm. Beside that, this tool also increase the speed of activity around 24-27 seconds faster compared with manual method and the efficiency of planting activity was 88%. Through RULA analysis, the risk of potential injury with final score 5 (medium injury risk) using manual method could be lowered to final score 2 (low injury risk), so this tool can be applied to communities.

Keywords : Chili, ergonomic, planting tool, RULA, tugal mechanism

I. INTRODUCTION

Chili (*Capsicum annuum* L.) is an important horticultural plant, generally consumed freshly or through a postharvest process [1] and the most consumed vegetable in the world [2] including Indonesia [3]. Chillies are widely cultivated, which are large Chili and curly peppers, which belong to C. annuum species whereas cayenne pepper belongs to C. frutescens [4]. Global production has grown on average by 3,9% per year during the last decade [5].

The needs of chili in Indonesia reach 150 thousand tons per day. The three types of chilli in Indonesia and each contribution e.g large chili contributes 20% of the total production and the price is relatively stable, the curly chili contributes 50% of the total production and the price is slightly fluctuating and the cayenne chili contributes 30% of the total production and the price fluctuates. The curve of chilies' price form the letter U because the price will be low during drought due to the chili harvesting time in almost all production centers. This can be overcome by setting the pattern of planting, production and supply chain. Chili production centers are located in several areas, which are Java. Sumatera, Sulawesi which contributes 51%, Sumatra 17%, Sulawesi 4%, respectively and several other areas.

One of the factors that influence in the production or cultivation of chili is during the seeding activity, then proceed with planting the seeds. One of the obstacles of farmers in Indonesia is the process of planting the seeds, because it is conducted conventionally by planting the seeds manually using soil piercing tool and planting the seeds without piercing the soil. This conventional seedling activity is potentially cause a muscle injury or majority of the musculoskeletal symptoms [6], because the activity is conducted in a hunched or squatting position continuously.

A solution for the handling problem is through the design development of seedling tool with tugal mechanism. Tugal mechanism is a way to perforate the soil, then put the seed into soil. It is expected to have an increasement in the speed of chili seed planting, improve the crop quality, and pay attention to the ergonomic factor/human factor [7].

The objective of this study was to test the performance of chili planter and to evaluate the work posture while using tools compared with the conventional seedling method.

II. MATERIALS AND METHODS

A. Vanue and Times

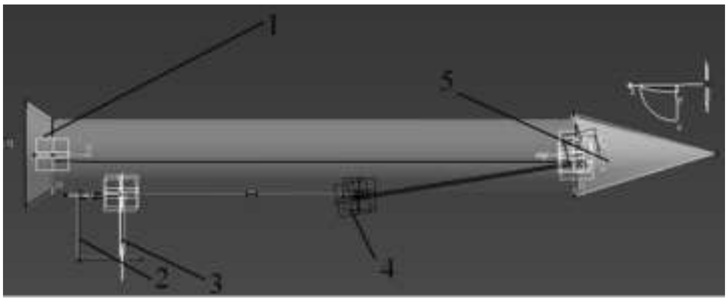
The implementation of design was conducted in March until May 2016 in Agricultural and Food Machinery Engineering, Graduate School, Bogor Agricultural University.

B. Tools and Materials

Protactor and digital vernier caliper were used to measure the dimensions of chili seeds, the dimensions of several observed components. Stopwatch and digital camera were used to determine the working time and documentation of each planting activity, tool's operation and the material testing. In the ergonomic analysis part (work posture), the used equipment was Computer Aided Design (CAD) CATIA.

C. Specifications

The cropping tool in this research is shown in (Fig. 1) which show the design with the cone mechanism which open into two directions. The cone dimensions is conical with the angle of repose is ±30^{o} designed with radius 8 cm (adjusted with the polybag diameter) and able to plant the chili seed with the depth of soil penetration of 3-5 cm.



where:
1 Seed hopper
2 Tool grip
3 Pull lever
4 Wire towing
5 Cone (making hole)

Fig. 1. Engineering drawings of chili planter

For height frames of the tool used a size of 60 cm drawn from ergonomic data on CATIA software using the Japanese population on the 50th percentile with an average height of the legs to the elbows is 91,7 cm [8]. The average height of the beds was 20-30 cm so that the overall height of the tool is approximately 75 cm.

The planter is divided into four important components, which are :

1. *Seed hopper:* a part that used to move the chili seed, this hopper consist of a cilinder tube where the seed pass through into the media.
2. *Tools grip:* a part that used to grip the tool and transmiting the force from the user through cone to the soil to make a hole planting.
3. *Levers and Wires:* part that used to pull the levers that is connected to the cone for lifting mechanism.
4. *Ground cover:* a conical part that can be pulled through the pull lever, so that the chili seed goes to the plant media and when the tool is lifted, the ground (plant media) automatically covered with soil.

Table 1 shows the spesification of chili planter which is known from the mathematical calculation of the design.

Table 1. Chili Planter Specifications

No	Components	Symbols	Scales	Dimensions
1	Diameter	D	80	mm
2	Radius	R	40	mm
3	Height	T	160	mm
4	Hypotenuse	s	16,62	mm
5	Angle	θ	38,65	degree
		α	15,705	degree
6	Wide of conical blanket	L	31,41	mm^2
			80,3	cm^2

D. Performance Testing

Soil that was used in this research was latosol soil, that is grained, have a gray to black color, and the textur is clay, in contrast, the soil structure is crumb with the consistency of crumbly. The chili planting was conducted with

60 cm x 40 cm spacing, that the space between rows is 40 cm and the space between plant is 60 cm. The heights of beds is 20 cm, wide is 100 cm, and the space between beds is 40 cm, the length of a beds is ±20 m, and in one beds can be planted 10 chili seeds.

Chili seeds used have a planting age ranging from 5-7 weeks. This study examined two conventional methods that are often conduct in Indonesia, namely by planting the seeds manually using the tool of perforation of the soil, and planting the seeds without using perforations of the soil. The performance of these two conventional seedling methods will be compared with the method of planting seedlings using the tool. The tests were repeated five times.

There are two parameters that become the focus in the performance testing, which are the work speed and the quality of chili seed which well stand after planted.

E. Ergonomic Analysis

Ergonomic analysis in this reseacrh was to evaluate the work posture using Rapid Upper Limb Assessment (RULA) method [9] that was conducted using CATIA software [10]. RULA observation is method for posture analysis that focusses in the upper body, but includes the lower body [11].

III. RESULTS AND DISCUSSION

A. Physical and Mechanical Properties of Soil

The physical properties of the soil is one of the important things to note because this data analysis is used as a consideration in designing the falling distance of the seeds from the top of the seeds into the hole. In planting chili seedlings using this planting tools need to be given water when going to planting. This step is conducted to facilitate removal of seeds from polybags.

Table 2 shows the value of physical properties of soil at different depths that can be calculated to determine the required cutting strength of the soil.

Table 2. Soil physical properties

Depth of soil (cm)	Bulk density (g/cm^3)	Porosity (%)	Saturated water conductivity (10^{-3}cm/s)
0 – 10	1.16 ± 0.04	56.74 ± 4.22	4.41 ± 1.60
10 - 20	1.18 ± 0.02	52.18 ± 0.23	3.10 ± 0.59

B. Performance of Chili Planter

Chili planter works in a simple way, the farmer only prepare the ready planting seedling, then plugged the cone into the ground (the process of making the planting hole), pressing the lever puller (lever pulled cone opening), insert the seeds into the hopper, pull the chili planter to the soil and the seed will enter the planting hole through the sleeve of the planting tool. Fig 2. Shows how the planting tools penetrate above ground level and the process of planting chili.

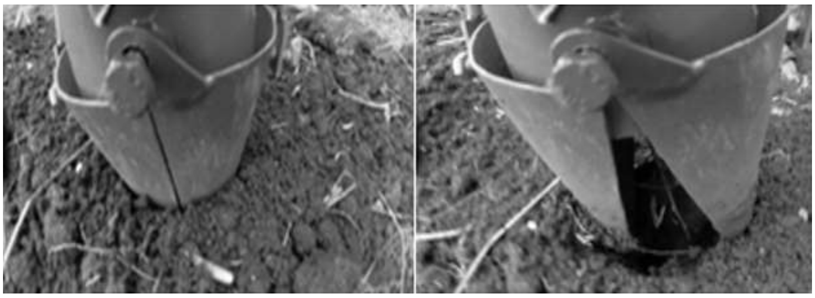


Fig. 2. Planting mechanism using tools

The next activity is enough to pull the handle up, immediately the ground will cover the rooting of the seeds, and the seeds embedded perfectly. The process of closing the planting hole is conducted by utilizing the gravity force so that when the tool is lifted then the ground on the outer surface of the cone will fall and cover the planting hole that has been planted seeds. If the seeds are not planted properly then simply step on the ground around the seedlings slowly without having to use hands and bend.

Based on the observations made the average of hole diameter is 105,86 ± 5,80 mm and the average of depth is 85,196 ± 4,56 mm so that the chili seedlings can be planted.

Fig. 3 presented the performance of chili planter that was analyzed based on the work duration. The performance of chili planter while planing the chili seedlings is more quickly than the conventional which using perforation tools that has an average work duration of 8,1 seconds cropping, seeding method without using perforation of 8,42 seconds per plant, while using the chili planter is so much faster is 5,7 seconds per plant, so every single planting using this tool can save working time 24-27 seconds per plant.

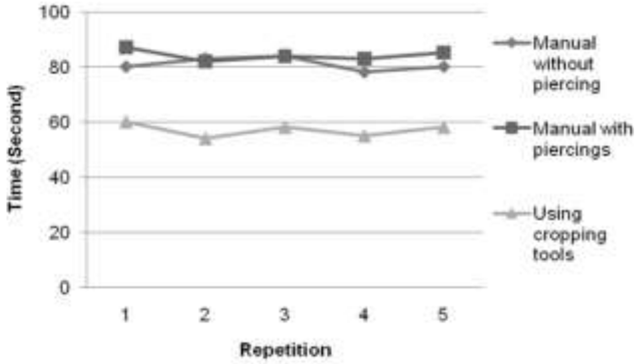


Fig. 3 Duration of work performance of chili planting tools

Performance of the quality of chili plant that well stand after planted using chili planter presented in Table 3. From the data, the performance presentation of chili planting equipment works effectively, with the successful presentation of chili seed planting reaches 88%, 10% of the plant is not fully embedded, and only 2% of plants are not planted.

Table 3. Quality of plant stands

Repetition	Time (second)	Seeds embedded perfectly	Seedlings embedded sloping position	Seeds are not embedded
1	60	9	1	0
2	54	8	2	0
3	58	10	0	0
4	55	9	1	0
5	58	8	1	1
Average	57			
Percentage (%)		88	10	2

C. Ergonomic Analysis

Stages of work posture analysis was conducted by converting the user image into corners formed between the motion made into the mannequin form. In (Fig. 4a), a mannequin with planting position manually is shown, and in (Fig. 4b), the mannequin with planting position using chili planter.

(a) (b)

Fig. 4. Mannequin of chilli planting (a) manual posture (b) posture using tools

From Fig. 5 we got the results of the RULA value of 5, which indicates that the conventional chili planting position is dangerous, and if it is still conducted continuously, it will cause an injury in farmers. If the final score is 5, it is recommended to investigate the work positions and immediately making a changes [9].

The position of the body that must be repaired when planting the chili conventionally are wrist, arm, neck, trunk, and leg because in that position get score > 3 which indicate that the body part is high potentially get a muscle injury. While wrist, especially on the muscle, has a score < 3 but if the position is conducted continuously, it can lead to a high potential injury, this is known from the red indicator on the program.

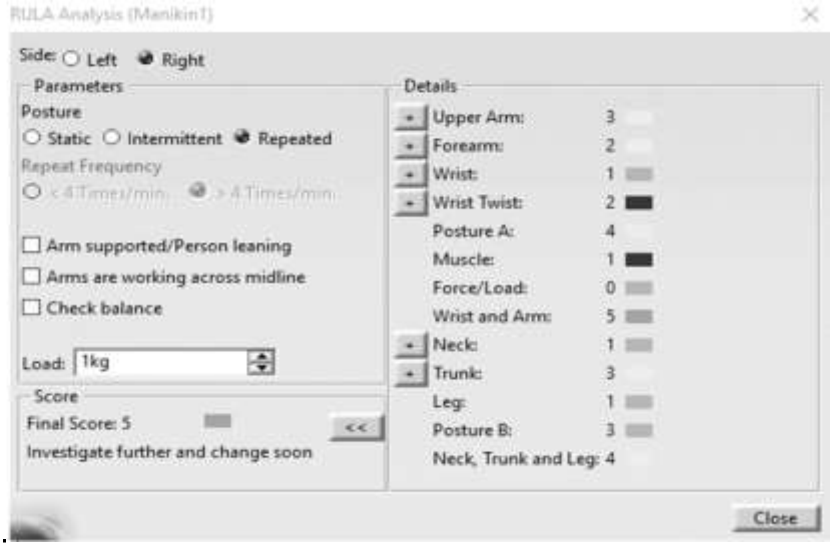


Fig. 5 Example of an unacceptable low-resolution image

Fig. 6 shows the results of RULA analysis obtained using CATIA software with the final result is 2. The score indicates that by using chili planter, the farmer's work posture is considered safe when applied in the field. In this analysis used weight loading of 1 kg in the right hand and do the work continuously or more than 4 times treatment in one minute.

The highest detail score can increase to the potential injury when using the tool in the forearm, the forearm has a score of 2 but with a yellow indicator. Studies suggest that musculoskeletal disorders or muscle disorders, joints and tendons [12] may occur due to abrupt interruption caused by severe activity or unexpected movements.

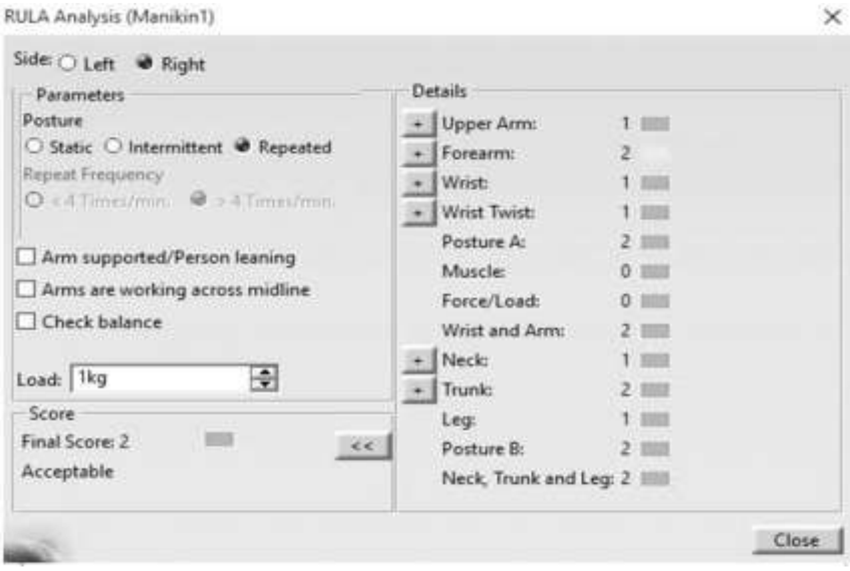


Fig. 6 Example of an image with acceptable resolution

From both of the results above obtained that planter indicates a smaller value compared with the manual, analyzed from the ergonomic aspect using RULA analysis method.

IV. CONCLUSION

By planting the chili seedlings using this chili planter, farmers can save planting time of 24-27 seconds per plant, because the conventional methods have been replaced. The chili planting activity is easier. In additiion, through the analysis of posture, planting chili seedlings using chili planter is able to reduce the potential injury obtained when farmers continue to plant using the conventional methods.

This tool can be made a new breakthrough on chilli planting technology in Indonesia, but of course the application of technology is not easy. Therefore, it is suggested that there is synergy between universities, stakeholders, farmers, manufacuring, and the government to develop this chili planting technology.

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REFERENCES

[1] S. Rokayya and E. Khojah, “Physical-mechanical Estimation of Pepper (Capsicum annuum L .) Fruit Varieties,” *J. Northeast Agric. Univ.*, vol. 23, no. 3, pp. 61–69, 2016.
[2] V. C. S. Rao and G. V. K. Rap, “An Insight Into Chilli Cultivation and Risk Management Procedures with Special Reference to Karnataka & Andhra Pradesh,” *Int. J. Bus. Adm. Res. Rev.*, vol. 2, no. 3, pp. 144–155, 2014.
[3] M. Rahul, P. V Unakal, and C. Gopinath, “Design and Development of a Pepper Plucking Equipment to Facilitate Pepper Harvesting,” vol. 11, no. 2, pp. 74–81, 2012.
[4] S. H. Hidayat *et al.*, “OCCURRENCE OF CHILI VEINAL MOTTLE VIRUS (CHIVMV) IN INDONESIA AND RESPONSE OF CHILI GERMPLASMS TO CHIVMV INFECTION,” vol. 18, no. 2, pp. 55–61, 2012.
[5] J. Mariyono, “Impacts Seed Technology Improvment on Economic Aspects of Chilli Production in Central Java- Indonesia,” vol. 17, no. 1, pp. 1–14, 2016.
[6] L. Yuan, “Reducing ergonomic injuries for librarians using a participatory approach,” *Int. J. Ind. Ergon.*, vol. 47, pp. 93–103, 2015.
[7] J. R. Wilson, “Fundamentals of systems ergonomics/human factors,” *Appl. Ergon.*, vol. 45, no. 1, pp. 5–13, 2014.
[8] M. F. Syuaib, “Anthropometric study of farm workers on Java Island , Indonesia , and its implications for the design of farm tools and equipment,” *Appl. Ergon.*, vol. 51, pp. 222–235, 2015.
[9] L. McAtamney and E. Nigel Corlett, “RULA: a survey method for the investigation of work-related upper limb disorders,” *Appl. Ergon.*, vol. 24, no. 2, pp. 91–99, 1993.
[10] B. Deros, N. Hassanil, H. Hassan, D. Darina, and I. Daruis, “Incorporating Malaysian ’ s Population Anthropometry Data in the Design of an Ergonomic Driver ’ s Seat,” *Procedia - Soc. Behav. Sci.*, vol. 195, pp. 2753–2760, 2015.
[11] S. Dockrell *et al.*, “An investigation of the reliability of Rapid Upper Limb Assessment (RULA) as a method of assessment of children ’ s computing posture,” *Appl. Ergon.*, vol. 43, no. 3, pp. 632–636, 2012.
[12] E. Valero, A. Sivanathan, F. Bosché, and M. Abdel-wahab, “Musculoskeletal Disorders in Construction : A Review and a Novel System for Activity Tracking with Body Area Network,” *Appl. Ergon.*, vol. 54, pp. 120–130, 2016.

A.15

ANALYSIS OF BLADE FROM PORTABLE CHOPPER MACHINE FOR PALM OIL FROND USING FINITE ELEMENT METHOD

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ABSTRACT

As an agrarian country and the world's largest producer of palm oil, Indonesia has problem with palm frond waste. A portable chopper machine is required for handling palm frond waste. Engineering design analysis required before manufacturing process. Finite elemen method (FEM) in modern engineering has been used as one of the methods in the analysis of engineering design. The objective of this study was to analysis of portable chopper machine blade for palm oil frond through FEM approach. Engineering drawing and FEM of portable chopper machine used SolidWorks software. Simulation FEM was conducted to know the strength or the ability of material to receive the load, its can support engineering design analysis. The material blade is using Carbon steel sheet (SS) 1023 which modulus elastic 205 Gpa and tensile strength 425 Mpa. The results show that the minimum shaft diameter is 34.56 mm. The length, width and thickness chopper blade is 120 mm, 40 mm, 4.55 mm, respectively. The power needed of portable chopper machine is 13.16 hp. The result of simulation consist of maximum stress value, yield strength and displacement value on the index bar. The maximum stress on the index bar used to evaluate the design is secured.

Keywords *:* FEM, blade, portable chopper, carbon steel sheet, palm oil.

I. INTRODUCTION

In tropical region, Oil Palm (Elaeisguineensis) is one of the plantation crop which develop very fast [1]. Palm oil plantations in addition to producing fresh fruit bunches (FFB), it's also produce waste in the form of palm frond or palm stems. The palm stems waste can be utilized as organic fertilizer. One of the machines required for the produced of organic fertilizer made from palm stem is the chopper machine. Area of oil palm plantations in indonesia (11.6 milion ha (2016) [2]) require chopper machine that have high mobility (portable). The main components of the chopper machine consist of a blade, transmission, engine and frame.

Finite Element Method (FEM) is used as the methods in the analysis of engineering design [3]. FEM based designing approaches give more effective, efficient labor costs and its can minimize errors in manufacturing processes[4]. Static simulation based using software SolidWorks was conducted to know the strength or the ability of material to receive the load. The aim of this paper is to analysis of blade portable chopper machine through FEM approach. The minimum shaft diameter and dimension of chopper blade is to analyzed using the law of classical mechanics approach.

II. MATERIALS AND METHODS

The methodology of this research took care of the design analysis of the portable chopper machine (FEM and laws of classical mechanics approach), material selection for each component designed and engineering drawings of the portable chopper machine.

A. Research Prosedure

The research begins with a review of former research on the characteristics of palm frond. The physical and mechanical properties (Table 1) of the palm stem are used to determine mechanism of the portable chopper machine. The laws of classical mechanics are used to analyze the dimensions of the chopper blade, the dimensions of the machine shaft and power needed. The result of analysis are verified using the static simulation to obtain visual design quality. The component that have the right design criteria are then drawing to become the conceptual design of a portable chopper machine.

Table 1. Some physical and mechanical properties palm frond

Parameter	Size	Unit	Source
Weight of leaf sandfrond	5.7 – 8.3	kg	[5], [6]
Width of frond area cutting	15 – 20	cm	[6]
Area of cutting frond section	41.25 – 62	cm^2	[5], [6]
Length of per leaf	7.0 – 9.0	m	[6], [7]
Amount of leaves	200 – 320	leaf	[6], [7]
Friction coeficient	0.39	-	[6]
Cutting Force	5.25 – 7.90	N/cm^2	[8]

B. Laws of Classical Mechanics Analysis

Analysis to determine the dimension (thickness) of the chop-per blade is using laws of classical mechanics approach [9], [10]. Resultan forces will be determine the maximum bending moment (M, N.mm) on the chopper knife (Fig. 2). The maximum bending moment is then used to calculate the cross section modulus (Z, mm^3) using Equation 1. The type of blade used is carbon steel sheet (SS) 1023 with tensile strength (σ_i) 425 Mpa. Model of the chooper knife is a rectangle. The thickness of the counting blade (b, mm) is determined by Equation 2.

$$Z = \frac{M}{\sigma_i} = \frac{F \cdot R}{\sigma_i} \quad (1)$$

$$b = \left(\frac{6Z}{h}\right)^{1/2} \quad (2)$$

The analysis for determining the shaft diameter of the portable chopper machine using laws of classical mechanics [4]. The maximum bending moment (M, N.mm) is determined by the resultant forces on the machine shaft. Equation 1 is used to calculate the cross-sectional modulus (Z, mm^3). The type of shaft material used is carbon steel sheet (SS) 1023 with tensile strength (σ_i) 425 Mpa. The diameter of machine shaft (d, mm) is determined using Equation 3.

$$d = \left(\frac{32Z}{\pi}\right)^{1/3} \quad (3)$$

The required power of palm frond chopper machine (P, Watt) is determined using Equation 4 [9]. The power requirement of chopper machine is based on the maximum engine rotation speed (n) of diesel that is 2400 rpm. Cutting force of palm frond (TP, N/cm^2) is used as the force to be achieved by the machine (F, N).

$$P = \frac{2\pi n R F}{60} \quad (4)$$

C. Finite Elemen Method

Finite Elemen Method was conducted to know the strength or the ability of material to receive the load, its can support engineering design analysis. Its drawn with Solidworks software helped. Solidworks is one of CAD software to create engineering drawing and do some simulation. One of simulation can be done by solidworks is load static simulation. The design has been analyzed and right in accordance with the engineering design criteria then its called the conceptual design. After that, its generate in the form of detailed engineering drawings. Table 2 is used as material characteristic in FEM simulation.

Table 2. Characteristics carbon steel sheet (SS) 1023

Characteristics	Size	Unit
Elastis modulus	2.045×10^{11}	N/m^2
Poisson's ratio	0.29	-
Tensile strength	4.250×10^{8}	N/m^2
Yield strength	2.827×10^{8}	N/m^2
Mass density	7858	kg/m^3
Hardenign factor	0.85	-

III. RESULTS AND DISCUSSION

A. Construction Portable Chopper Machine

The construction of the chopper blades is shown in Fig. 1. Portable chopper machine is use impact cutting method with engine rotation speed at 2400 rpm. The engine rotation speed of portable chopper machine was suggested by Persson i.e 20 - 40 m/s [11]. It is a good cutting for impact cutting method. The count of knives in a circle is 3 units. Feeding rate portable chopper machine based on research of Bulan is 0.5 m/s [5]. Chopped palm frond will be shredded to a size of ≤ 0.5 mm. The chopped coefficient of chopper machine is 85%. The requirement analysis of the portable chopper machine knife is presented in Table 3.

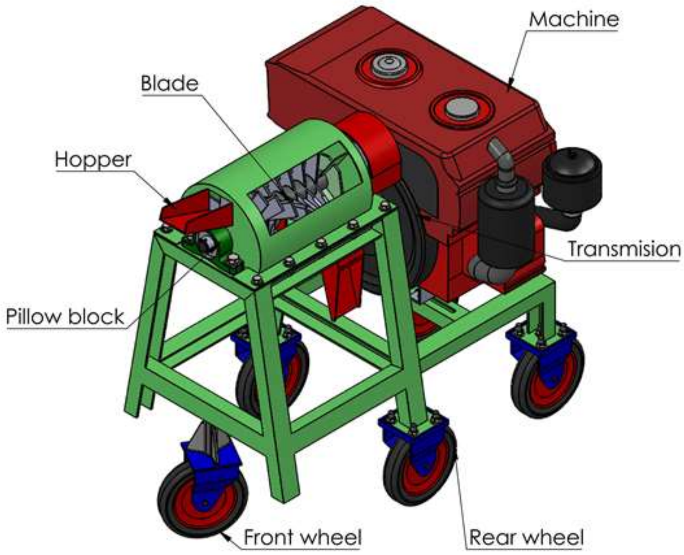


Fig. 1. Portable Chopper Machine

Table 3. Construction of portable chopper machine blade

Parameter	Size	Unit	Equation
Amount cutting knife (A_c)	1176.47	cutting/second	$A_c = \frac{V \times 10^3}{S_c \times K_c}$
Total blade choper machine (T_c)	30	unit	$T_c = \frac{A_c \times 60}{n}$
Total blade choper machine in line (T_s)	10	unit	$T_s = \frac{T_c}{A_n}$

Total of blade in portable chopper machine is 30 units with revolutions at 0.33 clockwise. The blade is consists of 10 blade in rows with 3 blade every single circle. Spacing of thr blade in a row is 25 mm. The length of the blade is 120 mm with a width of 40 mm. The thickness of the blade is above 4.55 mm with the material of Carbon steel sheet (SS) 1023. The blade is made with angle 45° and length 80 mm. Length of shaft machine is 270 mm.

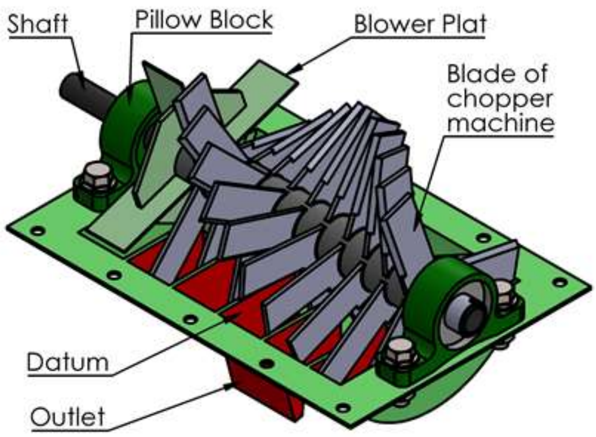


Fig. 2. Blade of Portable Chopper Machine

The result of load stress simulation on the chopping blade is shown in Fig. 3. The simulation results show that the stress that occurs in the chopping blade is in the range of 10.1 kPa to 110 Mpa (Table 4). These results indicate that the chopper blade design is within safe limits for the Carbon steel sheet (SS) 1023 type material which modulus elastic 205 Gpa and tensile strength 425 Mpa. The maximum strain and displacement occurring in the chopper knives is also at a very low level at 4.2×10^{-4} and 0.4 mm, respectively. At the end of the blade is a plate mounted plate that serves as a blower with the number of plate 4 units. The length, width and thickness of the plate is 95 mm, 50 mm, 2 mm, respectively.

Table 4. Results of blade simulation in portable chopper machine

Parameter	Type	Min	Max	Unit
Strain (Fig. 3a)	ESTRN: Equivalent Strain	2.15×10^{-8}	4.20×10^{-4}	-
Stress (Fig. 3b)	VON: von Mises Stress	1.01×10^{4}	1.10×10^{8}	N/m^2
Displacement (Fig. 3c)	URES: Resultant Displacement	0	0.40	mm

The classical mechanics law approach indicates that the minimum diameter of shaft chopper is above 34.56 mm using carbon steel sheet (SS) 1023 material. The resultant force in the shaft is 9765 N. The resultant force is the total force acting on the blade of the chopper. The result of load stress simulation on chopper shaft is shown in Fig. 4. The simulation result shows that the stress maximum that occurs on the chopper shaft 171 Mpa (Table 5). These results indicate that the design of the chopper shaft is within safe limits for the carbon steel sheet (SS) 1023 type material which modulus elastic 205 Gpa and tensile strength 425 Mpa. The maximum strain and displacement occurring on the counter shaft is very low level at 7.85×10^{-4} and 0.46 mm, respectively.

Table 5. Results of blade simulation in portable chopper machine

Parameter	Type	Min	Max	Unit
Strain (Fig. 4a)	ESTRN: Equivalent Strain	3.6×10^{-11}	7.85×10^{-4}	-
Stress (Fig. 4b)	VON: von Mises Stress	0	1.71×10^{8}	N/m^2
Displacement (Fig. 4c)	URES: Resultant Displacement	0	0.46	mm

B. *Power Requirement*

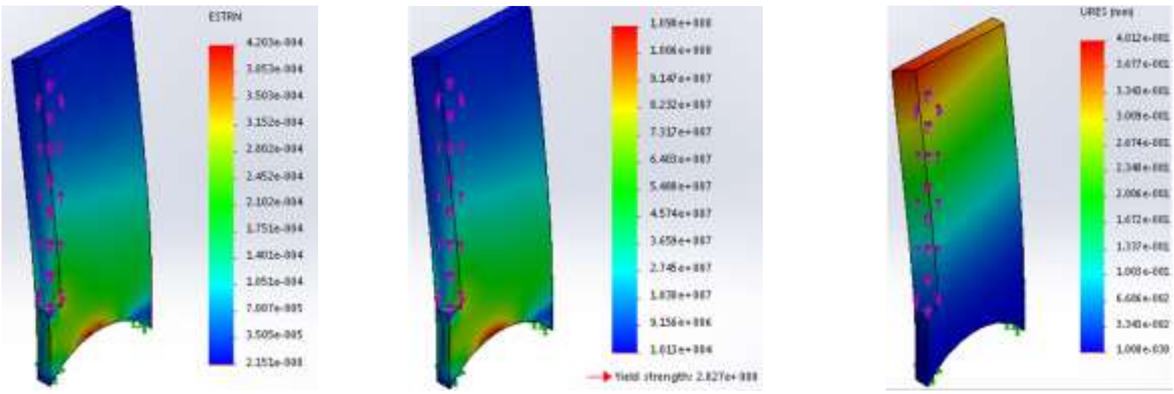
The results of the analysis show that the portable chopper machine needed power of 13.16 hp with engine rotation speed at 2400 rpm. The greatest power is used to pass the cutting style of palm stem. The rotating speed of the chopper with the blade radius 120 mm will be produce a linear velocity of 30.14 m/s. This is in accordance with the cutting method suggested by Persson [11] which states that the cutting impact cutting method requires a linear velocity of 20-40 m/s.

C. *Center of gravity*

Center of gravity of the portable chopper machine in the coordinates of X, Y, Z is -432 mm, -146 mm, 0 mm, respectively. The value is based on the distance from the center of point drawing. Determination of center of gravity using Solidworks software. Center of gravity of chopper machine on X axis inclined to front. This enables the chopper to be more easily to move. Center of gravity on the Y axis shows that the portable chopper machine is stable to stand while operating. This is because the center of gravity on the Z axis tends to lower. Center of gravity on the Z axis tends to be right in the center of the simentris of the portable chopper machine. This indicates that it will be stable during operation.

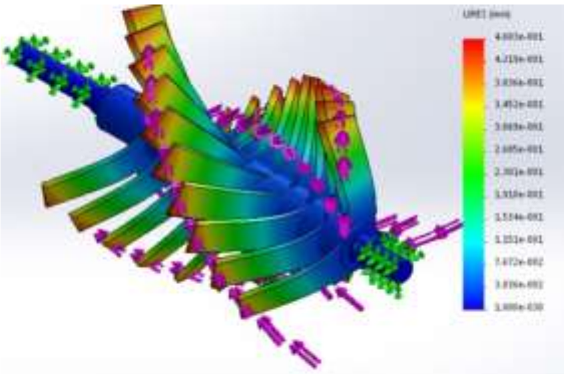
D. *Conseptual Design Portable Chopper Machine*

The conceptual design of the portable chopper machine has been successfully designed. it has length, width and height of 880 mm, 572 mm, 919 mm, respectively. Conceptual design of a portable chopper machine uses five wheels. One wheel works for steering and 4 wheels that function to withstand the load of the chopper machine. It aims to support the mobility of the portable chopper machine in order to reach all area of the oil palm plantation.

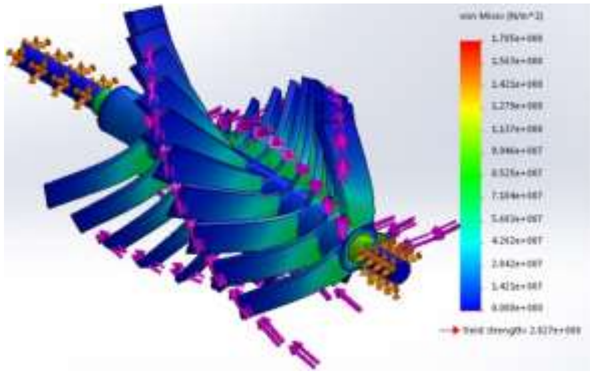


(a) (b) (c)

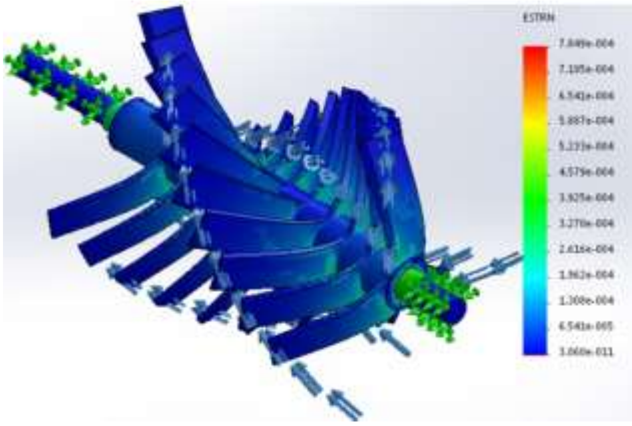
Fig. 3. FEM display on the blade (a) strain analysis (b) stress analysis (c) displacement analysis



(a)



(b)



(c)

Fig. 4. FEM diplay on the shaft (a) strain analysis (b) stress analysis (c) displacement analysis

IV. CONCLUSION

1. The engineering analysis (FEM) of the chopper blade obtained the length, width and thickness is 120 mm, 40 mm, 4.55 mm, respectively. The total blade portable chopper machine is 30 pieces with 3 pieces per circle and 10 row.
2. The shaft portable chopper machine using the type of material carbon steel sheet (SS) 1023 with a minimum diameter above 34.56 mm.
3. Power recruitment portable chopper machine is 13.16 hp with engine rotation speed at 2400 rpm.
4. Center of gravity analysis shows that the portable chopper machine has a good stability to operate be-cause the center of gravity is at a safe level.

NOMENCLATURE

CAD	: Computer aided design
M	: Bending moment (N.mm)
Z	: cross section modulus (mm^3)
σ_i	: Tensile strength (Mpa)
SS	: Steel sheet
b	: Thickness blade (mm)
F	: Force (N)
R	: Radius (mm)
h	: Height (mm)
d	: Diameter (mm)
π	: Phi (3.14)
P	: Power (watt)
TP	: Cutting Force (N/cm^2)
n	: Rotary speed (rpm)
A_c	: Amount cutting knife
V	: Linear speed (m/s)
S_c	: Chopped dimension (mm)

K_c : Chopped coefficient (%)
T_c : Total blade portable chopper machine
T_s : Total blade portable chopper machine in line
A_n : Total blade chopper per cycle
X, Y, Z : Cartesian coordinate

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REFERENCES

[1] Sheil, D., Casson, A., Maijaard, E., Noordwijk, M.v., Gaskell, J., Sunderland-groves, Wertz, J., Kanninen, M., The Impacts and Opportunities of Oil Palm in Southeast Asia, Center for International Forestry Research (CIFOR), Bogor [ID], 2009.
[2] Directorate General of Estate Crops. Tree crop estate statistics of indonesia. 2014-2016. Jakarta (ID).
[3] Paul, S., Pawan G., Milan, S., Navmesh, S. (2013). Conceptual Design and Development of Automated Drilling system. International Journal of Scientific & Engineering Research (IJSER). 4(7), 1138-1142.
[4] Akinnuli, B.O., C.O., Osueke, P.P., Ikubanni, O.O., Agboola, A.A. Adediran. (2015). Design Concepts Towards Electric Powered Gari Frying Machine. International Journal of Scientific & Engineering Research (IJSER). 6(5), 1043-1051.
[5] Bulan, R., Tineke, M., Wawan, H., Desrial. (2015). Physical and Mechanical Properties of Palm Frond for the Development of Palm Oil Waste Chopper and Pressing Machine Design. International Journal of Scientific & Engineering Research (IJSER). 6(2), 117-120.
[6] Intara, Y.I., Suastawa, I.N., Setiawan, R.P.A. (2005). Physical and Mechanical Properties of Parenchyma of Leaf and Fruits Stem of Palmoil. Jurnal Keteknikan Pertanian (JTEP IPB). 19(2), 117-126.
[7] Bulan, R., Tineke, M., Wawan, H., Desrial. (2016). Pertimbangan Sifat Mekanik Pelepah Sawit Terhadap Proses Pengomposan Sebagai Acuan Desain Mesin Pencacah. Jurnal Keteknikan Pertanian (JTEP IPB). 4(2), 123-130.
[8] Intara YI, Mayulu H, Radite PAS. (2013). Physical and Mechanical Properties of Palm Oil Frond and Stem Bunch for Developing Pruner and HarvesterMachinery Design. Internat. J. of Sci. and Eng. (IJSE). 4(2), 69-74.
[9] Khurmi, R. S., Gupta, J. K. (2005). Machine Design. S. Chand.
[10] Field, H., Solie, J. (2007). Introduction to agricultural engineering technology: a problem solving approach. Springer Science & Business Media.
[11] Persson S. (1987). Mechanics of cutting plant material. st. Joseph Michigan. An ASAE Monograph.

A.16

DEVELOPMENT OF HOLER TOOL FOR PLASTIC MULCH WITH ELECTRIC HEATER

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ABSTRACT

The purpose of this research is to develop the electric mulching tool using heat conduction principle, while the benefit is by using plastic mulch mulching tool can to simplify and speed up the process of perforating plastic mulch. The method used is a tool design method and then tested a series of tools that have been engineered to determine the performance of the tool. Tool design methods have 3 stages: identification of problems that occur in farmers when perforating mulch, associated with the use of tools that heat energy is reduced and the use of a relatively long time. This electric mulch plastic piercing device can be used by operators with a fairly heavy category workload level with a power demand value of 0.0543 kW. This tool has been able to perforate effective plastic mulch with effective capacity of 218 hole / hour, with damage yield of 8.13% and perfect perforated percentage of 91.88%. And has an inverter with efficiency 82% and load power on appliance using inverter is 328 Watt with electricity cost equal to Rp. 985,608 / day with battery power 0,54 kW and working time 1,35 hour / day.

Keywords : Modification, holer tool, Plastic mulch, Electric heater.

I. INTRODUCTION

Generally, mulch is often used in the cultivation of hortilkultura and vegetable crops. Giving mulch is intended to minimize The competition of plants with weeds, suppress weed growth, reduce evaporation, prevent erosion, and maintain soil structure, temperature, and humidity. According Purwowidodo [1], the basic ingredients and way of making, mulch can be grouped into three, namely organic mulch, inorganic mulch, and synthetic mulch. Organic mulch is derived from agricultural residues such as straw and leaves. Inorganic mulch is derived from rock material in various shapes and sizes such as gravel, and synthetic chemical mulch comes from plastic materials such as black silver plastic mulch.

Synthetic mulch derived from plastic materials such as black silver plastic mulch that has been entrenched in cucumber, tomato, strawberry and cabbage flower plants. Black silver plastic mulch has two faces and two colors, the first face is black and silver second face. The black color to cover the ground surface, the silver color as the top surface where plant a cultivated plant. According to Fahrurrozi et al. [2], the use of black silver plastic mulch that is considered good in the subtropical region is a black color with a thickness of 50 microns. However, in the tropics, the effect of plastic mulch on the activity of microorganisms (as a result of rising rhizosphere temperature) contributes greatly to the growth and yield of plants through increasing the concentration of carbon dioxide in planting zones.

According to Bhella [3], benefits of using mulch are improving yields, controlling weeds, reducing fertilizer losses due to leaching and maintaining the temperature and humidity that support plant growth.

II. MATERIALS AND METHODS

The method used in this study is a tool design method and then tested a series of tools that have been engineered to determine the performance of the tool. Tool design methods have 3 stages: identification of problems that occur in farmers when perforating mulch, associated with the use of tools that heat energy is reduced and the use of a relatively long time. Next is an inventory of ideas to solve existing problems. In the third stage there is a design that can solve the problems that arise.

A. Design of Holer Tool for Plastic Mulch

1. Identification of Problems

Problem identification was done to find out the problems that existed on the farmers, the problem that existed at the farmers today is when punching the mulch is still using the manual by using cans. Perforation by using cans that contain embers will take a long time, and hot energy quickly run out.

2. Inventory Ideas

The design idea of this tool arises after knowing the problems that exist in the farmers who take a long time in perforating the mulch in a manual way, by converting electrical energy into heat energy with the help of electric heating, electrical energy from the dry battery to be streamed through the inverter to the electric heater to Then converted into heat energy. The use of electric heaters is expected to increase the work capacity of farmers in perforating mulch and reducing working time. Therefore the authors adapted the heating system and applied it to the design of electric mulch plastic mulching device.

3. Design Concepts

Data collection aims to analyze existing issues and gather problem-solving ideas that take into consideration some related aspects. Subsequent activities are formulated to produce some functional and structural design concepts equipped with sketch drawings, technical analysis, theoretical field capacity estimate, prasarat and systems that support the operational effectiveness of field tools, it aims to obtain a tool that has a relatively light weight and Has a dimension that is not too large that is easy to move.

4. The Working Principle of the Tool

The working principle of the tool begins with the installation of mulch in the bed. Furthermore, the inverter is turned on until the heater reaches 80 ^{0}C, then the mulch is hollowed by pressing the mulch mulch into mulch plastic until finished.

5. Functional Design Analysis

A functional design analysis is performed to design the function and location of components required for mulching tools.

1. Frame, serves to support batteries and batteries inverter
2. Stick Punch, serves to grip the hole in the mulch.
3. Inverter, serves to change the current DC to AC current.
4. Accumulator (battery), serves as an energy source.
5. Cable, serves to conduct electric current.
6. Heater, serves to convert electrical energy into heat energy.

According to Hurt[4], design is the ability to combine ideas, scientific concepts, sources and results into solving a problem.

6. Structural Design Analysis

a. Main Frame

Frame bag of this tool serves as a place of the inverter components and dry batteries. The frame is made of pipe iron with size 1.5 cm and 18 cm x 11 cm elbow. The frame shape can be seen in Fig. 1.

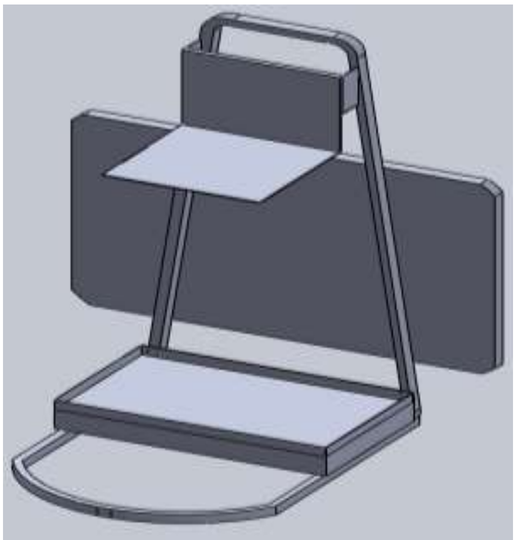

Fig. 1. Main Frame

b. Stick Punch

Hole punches made of iron pipe with a length of 100 cm, diameter 2.5 cm. The use of pipe iron is aimed at hollowing out plastic mulch as holder and iron pipe which is 7 cm in length, 12,7 cm in diameter which mounted heater to punch hole plastic mulch. The piercing can be seen in Fig. 2.

Fig. 2. Stick Punch

c. Inverter

Inverter is a circuit that serves to convert the input voltage direct current (DC) into a voltage output voltage back and forth (AC) a large voltage and frequency can be adjusted as desired, Saragih [5]. The inverter is used to convert electrical energy from DC 12V to AC 220V which is connected with a cable mounted heating element on the piercing wand. Inverter can be seen in Fig. 3.

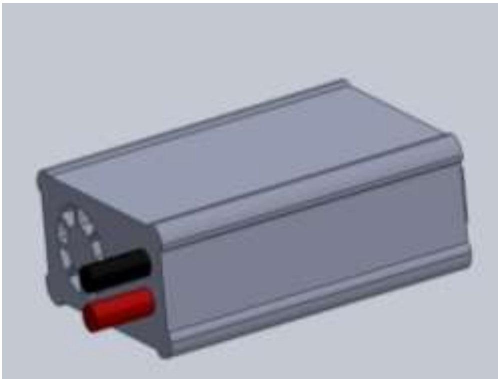

Fig. 3. Inverter

d. Accumulator (battery)

The working mechanism of the inverter is connected to a battery that enables a supply of energy that can convert electrical energy to heat through a heater. Specifications of the battery have a voltage of 12 V, DC current, weight 7 kg and 45 Ah. The battery can be seen in Fig. 4.

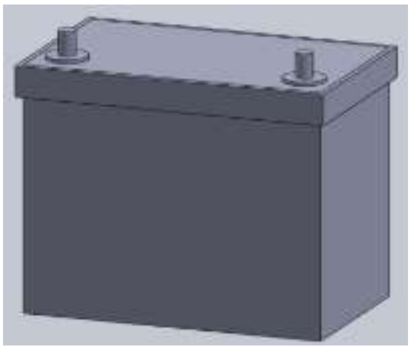

Fig. 4. Accumulator

Calculation of electric power used to support the implementation of heater on the piercing baton that utilizes the energy on the battery. Technically the effect on the availability of energy covered by the battery, the technical approach can be seen in the following calculations :

Heater load = 400 Watt
Total load = 400 Watt
Battery = 12 V, 45 Ah

$$P = V \times I \tag{1}$$

where :
P = Electricity with unit Watt (W)
V = Voltage with Unit Volt (V)
I = Electric current with Ampere unit (A)

So, The battery current is:
I = 400 watts ÷12 V
I = 33.33 A
So long battery life on the battery can be calculated by the formula:

$$t = Is / Ib \tag{2}$$

where :
t = time (hours)
Is = Accumulator Flow Capacity (Ampere Hour)
Ib = Load Current (Ampere)
So, The durability of energy is:
t = (45 Ah) / (33.33 A) = 1.35 hours

After instrument testing, the remaining energy is measured with a voltmeter and calculates the power efficiency of the inverter.

e. Cable

The cable used 2 meters and connect from the inverter to the heating element on the piercing rod.

f. Heater

Heater used for heater is a heater type barrel band that has a diameter of 12.7 and 400 Watt power.

g. Switch

Switches are used for circuit breakers and current connectors from current sources on batteries and inverters.

B. Testing Tools

The test of the instrument is done three times replication of the plastic mulch is installed on three beds according to the length of the bed is 5 meters. The process of perforation of plastic mulch is done with a distance corresponding to the pattern of plants to be planted. The stages of observation of the test work tool is as follows:

1. Percentage of Submitted Results

Percentage measurement results perforated by dividing the perfect perforated plastic mulch (perforated in diameter) with the whole hollowed mulch multiplied by 100%. Mathematically can be written by the equation:

$$HTK = \frac{MS}{MK} \times 100\% \tag{3}$$

where :
HTK = Percentage of hole results (%)
MS = Number of perfect perforated plastic mulch
MK = Number of plastic perforated holes

2. Percentage of Result Damage

Measurement of the percentage of damage to the result can be determined by dividing the hollowed out plastic mulch (not according to diameter, perforated holes and not perforated) with the plastic mulch wholly perforated multiplied by 100%. Mathematically can be written with the following equation:

$$KH = MR / MK \times 100\% \tag{4}$$

where :
KH = Percentage of result damage (%)

MR = Number of broken plastic mulch perforated
MK = Number of mulch Plastics perforated

3. Effective Capacity of Plastic Mulching Tool

Measurement of the effective capacity of the tool by dividing the perforated plastic mulch by the time of perforation or can be written by the equation:

$$Ke = MS / t \tag{5}$$

where :
Ke = effective capacity (Holes /hour)
MS = Hollow plastic mulch (hole)
t = Time required on mulching process (hour)

4. Operators

Operation power can be determined by using operator heart rate to measure the weight of the workload. Heart rate observed at rest and after working with 5 repetitions. Heart rate sensitivity to changes in body loading received by the body is quite high. Heart rate can be calculated by using stopwatch, then note the operator heart rate per minute. The recorded heart rate per minute was then matched on the workload level table by Christensen (Wanders)[6] based on per minute heart rate in humans aged 20-50 years.

Results of the category of heart rate per minute operator then calculated interpolation, interpolation results multiplied by the human thermal efficiency of 0.15 kW obtained the results of operator power required. Interpolation can be written by the equation:

$$Y = Y1 + (X-X1) / (X2-X1) (Y2-Y1) \tag{6}$$

where :
Y = Required power requirements (kW)
Y1 = Minimum power requirement (kW)
Y2 = Maximum power requirement (kW)
X = Heart rate at work per minute
X1 = Minimum heart rate per minute
X2 = Maximum heart rate per minute

5. Electric power and inverter efficiency

Calculation The electrical power and efficiency of the tool can technically be written by the equation:

a. Battery used

$$W = V \times A \tag{7}$$

where :
W = Power (Watt)
V = Voltage (Volt)
A = Current (Ampere)

b. Inverter Efficiency

$$H = (P\ battery) / (P\ inverter) \tag{8}$$

where :
H = Efficiency of inverter
Battery = Power on battery (Watt)
Pinverter = Power on Watt inverter)

c. Load power on the appliance

$$P = P\_alat \times \eta \tag{9}$$

where :
P = Power load on tool (Watt)
Palat = Power required by tool (Watt)
η = Efficiency of inverter

d. Electricity cost

$$L = P \times K \tag{10}$$

where :
L = Electricity cost
P = Power (Watt)
K = Price per kWh (Rp 1.352 / kWh)

III. RESULTS AND DISCUSSION

The design result of plastic mulch mulching tool consists of piercing rod made of pipe iron, dry battery, inverter, skeleton made of pipe iron and elbow iron. The description of the design result of plastic mulch piercing tool can be seen in Fig. 5.

This plastic mulch mulching device uses its energy source dry energy. Energy from dry batteries is used to convert electrical energy into heat energy in the heating element to the material until it is perforated.

Fig. 5. Design Results of Plastic Mulch Hollow Tool

A. Testing Tools

The test of this plastic mulching tool is electrically performed with five replications, with each repeat using a 5 meter long plastic mulch and 30 cm spacing between holes. Prior to the testing of plastic mulch mounted on a bed with a length of 5 meters. After that is cooked the edge of plastic mulch with bamboo so that plastic mulch is tense and not loose. The first test is done by placing a plastic mulch along the 5 meters and then plastic mulch at mark the distance between the holes to facilitate the test. Subsequently the switch on the inverter and the piercing wand switch are turned on during the hot time ie for 2 minute until the temperature is constant on the electric heater. The plastic mulch is perforated on the first side of 16 holes and the second side 16 holes with a distance of 30 cm between the holes, so the total holes in a single hole 32 holes and continue in the second, third, and so on in the previous way. The data of the plastic mulch mulching testing process using five replicates can be seen in Table 1.

Table 1. Plastic Mulch Plastic Testing Data

Rep	Number of plastic perforated hoops (hole)	Result Damage (%)	Perfectly Performed Results (%)	Effective Capacity (hole / hour)
1	32	9.38	90.63	181
2	32	9.38	90.63	223
3	32	6.25	93.75	250
4	32	9.38	90.63	223
5	32	6.25	93.75	214
Total	160	40.63	459.38	1092
Mean	32	8.13	91.875	218
SD	0	1.71	1.71	25

In Table 1 it can be seen that the average damage of imperfectly perforated results is 8.13% and perfect perforated results 91.875%. To perforate plastics an average of 32 holes has an effective capacity of 218 holes per hour.

1. Percentage of Perfect Perforated Results

Based on the research that has been done, the percentage of perfect perforations is 98.87%. The percentage of perfect perforated plastic mulch results can be seen in Table 2.

Table 2. Perfect Perfected Percentage of Results

Rep	Perfectly Hollow Plastic Mulch (hole)	Number of plastic perforated hoops (hole)	Submitted Results (%)
1	29	32	90,63
2	29	32	90,63
3	30	32	93,75
4	29	32	90,63
5	30	32	93,75
Total	147	160	459,375
Mean	29.4	32	91.87
SD	0.55	0.00	1,71
CV(%)	1.86	0.00	1,86

In Table 2 it can be seen that the percentage of results that are perfected perfectly in replication show different results. This is due to repeat 1, repeat 2 and repeat 4 beds where the texture of the soil is still in the form of chunks that cause damage to the results. The picture of the perfect perforated plastic mulch can be seen in Fig. 6.

(a)

(b)

(c)

Fig. 6. Perfectly Performed Results (a) repeat 1, (b) repeat 2, and (c) repeat 4

2. *Percentage of Results of Hollow Plastics is Not Perfect*

The magnitude of the percentage of perforated plastic mulching results can be calculated by dividing the broken plastic mulch by hollowing out the whole plastic mulch multiplied by 100%. Based on the results of research that has been done, it is found that the percentage of broken hole mulch perforated on plastic mulch piercing device is equal to 8.13%. The percentage of broken hollow mulch results in mulch piercing tools can be seen in Table 3.

Table 3. Percentage of Improperly Performed Results

Rep	Results of Damaged Plastic Mulch Hollowed (holes)	Number of Hollow Plastics Mulch (hole)	Result Damage (%)
1	3	32	9.38
2	3	32	9.38
3	2	32	6.25
4	3	32	9.38
5	2	32	6.25
Total	13	160	40.63
Mean	2.6	32	8.13
SD	0.55	0	1.71

The results of plastic mulch are categorized perforated is not perfect ie the results of holes that do not fit the diameter, half perforated, and not perforated. The resulting image of the unplanned plastic mulch damage can be seen in Fig. 7.

Fig. 7 Results Not Perfect Holes

3. *Effective Capacity of Plastic Mulching Tool*

The effective capacity of the tool is obtained by dividing the hollowed plastic mulch with the time required for the perforation process. The result of the research has been found the effective capacity of plastic hole mulching tools 219 holes / hour. The value of the effective capacity of the tool can be seen in Table 4.

Table 4. Effective Capacity Tool

Rep	Number of Hollow Plastics Mulch (hole)	Timing Perforation		Perfectly Hollow Plastic Mulch (hole)	Effective Capacity (hole / hour)
		Second	Hour		
1	32	571	0.16	29	181
2	32	465	0.13	29	223
3	32	445	0.12	30	250
4	32	465	0.13	29	223
5	32	495	0.14	30	214
Total	160	2441	0.68	147	1092
Mean	32	488.2	0.14	29.4	218
SD	0	50	0.014	0.55	25
CV(%)	0	10.2	10.16	1.86	11.31

The capacity of this plastic mulching tool is influenced by several factors: electrical energy required, electric heater, bed, plastic mulch installation, plastic mulch probe time and operator power. The average time gained in the testing tool is 0.14 hours. So 0.14 hours of time is needed to puncture 218 hole plastic mulch.

4. *Operator Power*

The workload of the operator can be known by the pulse or heart per minute of the operator. This heart rate can be measured using a stopwatch, as using the operator's heart rate stopwatch in minutes can be recorded. After getting the heart rate at rest and work then matched with the workload level table by Christensen (Wanders)[6] based on the human heart rate per minute aged 20-50 years. Based on observations and calculations of physical work levels based on heart rate can be seen in Table 5.

Table 5. Physical Work Rate Based on Heart Rate per Minute

Rep	Heartbeat Per Minute	
	Break	Work
1	85	100
2	81	102
3	76	104
4	86	107
5	84	105
Mean	82.4	103.6

Based on the data in Table 5 it can be concluded that the mulching process is included in the rather heavy category with a power requirement of 0.0543 kW. With a power requirement value of 0.0543 kW, this tool is capable of being operated with human power.

Sembiring [7], the human working ability is generally 7-10 kg m / s and for continuous work can produce 8 kg m / s or about 0.1 HP, while for short period of time can produce 0.4 HP. Generally the magnitude of the force that can be generated human average 1/10 of his body weight.

B. Equipment specifications

The end result of this tool is with the specification of manufacture and testing tool which can be seen in Table 6.

C. Electrical Power and Inverter Efficiency

After performing the plastic mulch mulch testing, the remaining power remaining on the battery tested using a voltmeter is 22.34 Ah and the battery time runs out for 0.68 hours. The inverter efficiency test is technically 82% and the load power on the appliance using the inverter is 328 Watt.

D. Electricity cost

The cost of electric mulching device plastic this type of carrying his cost is Rp. 985,608 / day with battery power 0,54 kW and working time 1,35 hour / day.

Table 6. Specifications Punch Tool Plastic Mulch

Parameter	Description
Tool Dimensions	Frame Bags: 23 cm x 18 cm x 38 Stick Punch: High : 90 cm Diameter : 12.7 cm
Number of operators	1 person
Work Tool Capacity	219 hole/hour
Percentage of results perforated	91,87 %
Construction of the frame	Iron Pipe and Iron Elbow
Weight tool	12 kg
Materials tested	Plastic Mulch

IV. CONCLUSION

Based on the research that has been done can be concluded that:

1. This electric mulch plastic piercing device can be used by the operator with the workload level rather heavy category with a power demand value of 0.0543 Kw.
2. Plastic punching device with electric heating type generated from this research has been able to perforate effective plastic mulch with effective capacity of 218 holes / hour, this plastic mulching tool has a damage of 8.13% and the percentage of perfect perforated results of 91 , 88%.
3. Plastic punching mulch with electric heater has an inverter with 82% efficiency and the load power of the appliance using inverter is 328 Watt.
4. Plastic punching mulching device with electrically heating type has electricity cost Rp. 985,608 / day with battery power 0,54 kW and working time 1,35 hour / day.

REFERENCES

[1] Purwowidodo, 1983. Mulch Technology. Jakarata : Dewaruci Press.
[2] Fahrurrozi, K.A. Stewart, S. J. 2001. *The early gowth of muskmelon in mini-tunnel containing a thermal-water tube. I. The carbon dioxide concentration in the tunnel*. J. Amer. Soc. For Hort. Sci. 126:757-763. 4445
[3] Bhella, H.S. 1998. Effect of Trickle Irrigation and Black Mulch on Growth, Yield and Mineral Composition of Watermelon. Hort.Sci. 23 (1) : 123-125.
[4] Hurst, K. 2006. Principles of Engineering Design. Erlangga. Jakarta.
[5] Saragih, B. 2008. One Phase Inverter Performance Improvements Using Signal Control Pulse Modulation. [Thesis]. Medan. Faculty of Engineering: University of North Sumatra.
[6] Wanders, A. A. 1978. Measurement of Energy in Agricultural Mechanization Strategy. Department of Mechanization of Agriculture . Bogor: IPB.
[7] Sembiring, Namaken. 1991. Source of Power in the Field of Agricultural Cultivation. Bogor: IPB.

A.17

STUDY OF LOW TEMPERATURE PROCESSING WITH DOUBLE JACKET VACUUM EVAPORATOR FOR IMPROVING QUALITY OF DRAGON FRUIT-MILK CANDY

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ABSTRACT

The problem arising in the processing of traditional candy is that the temperature process is high and not exact controlled. The process in high and uncontrolled temperature make the nutritional content come be damaged. This process will reduce the sensory quality of the candy as well. In order to improve the nutritional quality of milk candy products, the processing is done by using the vacuum evaporator. The working principle of a vacuum evaporator is that the pressure of evaporator chamber is below 1 atmosphere so that the boiling point of water is below 100 ^{0}C and the process of thickening process occurs at low temperatures. This research was conducted with candy processing using a double jacket vacuum evaporator in which the process can be controlled at a low and specific temperature so that there was no caramel in the product and the nutrient content can be maintained. The raw material for produce milk candy contained 1 liter of milk, 200 grams sugar, 2 grams of margarine, 1 ml of vinegar food. In order to enrich the content of vitamin C, the dough was coupled with dragon fruit extracts. All raw materials are put into the chamber of vacuum evaporator, heated and mixed with mechanical stirrer. The temperature and stirring speed was controlled with Fuzzy logic-based coding. The temperature was set at 85 ^{0}C and a stirrer rotation was set at 150 RPM. The product of candy was analyzed and compared with conventional process. Energy input for production of milk candy was relatively high. The quality of milk candy production with vacuum evaporator is better than the quality of milk candy production with conventional processing but the energy input is higher than the conventional processing.

Keywords : Double jacket vacuum evaporator, low temperature process, dragon fruit-milk candy.

I. INTRODUCTION

The problem of traditional candy processing is that the temperature is not be able controlled. It cause over heated on the material and decrease the nutrient content and sensory quality of the candy. In order to improve the process it was used Double Jacket Vacuum Evaporator. The processing chamber of this machine has double jacket. Between inner and outer jacket has fluid for transferring heat that there is no over-heating on the interface of product and inner jacket. This evaporator is also completed with vacuum system, that the water is able to be evaporated in low temperature. With the lower and constant temperature of evaporation, the degradation of nutritions is minimum and the candy will be better quality. The processing with vacuum evaporator maintain the quality of agricultural materials (Muhlisin et al., 2015).

Milk contains essential nutrients and balanced substances i.e. protein, fat, carbohydrates, minerals, and vitamins (Saleh, 2004). On the other side the high nutrients on milk is as the ideal substrate for growing and developing of the microorganism as well. The microorganism degrade the quality of milk. The processing of milk to be milk candy prevent and inhibit the degradation of milk nutrients, increasing the shelf life and improving the add-value. Milk candy is a kind of candy made using diary ingridients and sugar with caramelize system for changing into amarphous form (Hendrawan et al., 2016). Milk candy is also diary products which populer especially for the childrens, so the diversification of this product is useful. Diversification of milk candy can be made by substitution with other materials such as fruits or vegetables to improve the nutrition and taste of milk candy. One of the potential fruit for substitution of milk candy is dragon fruit (*Hylocereus costaricensis*).

Dragon Fruit (*Hylocereus costaricensis*) is one of the tropical fruits that is classified as cactus family (*Cactaceae*) (Hardjadinata, 2010). It has a red-purple flesh with many small black seeds, pleasant texture and good taste (Le

Bellec and Vaillant, 2011). Many studies are reported that the red flesh of dragon fruit varieties, including *H. costaricensis* have a rich sources of nutrients and mineral such as vitamin C (ascorbic acid), water-soluble fiber, protein, lipid, sodium (Jeronimo et al., 2015), thiamin (Vitamin B1), riboflavin (Vitamin B2), niacin, Vitamin B3, lycopene, carotene, calcium and zinc (Halimoon and Hasan, 2010). It is also rich in phytoalbumin which are highly value for their antioxidant properties (Choo and Young, 2011). Futhermore, *H. costariciensis* rich in betalain pigmens such as the betacyanins and betaxanthin (Wybraniec et al., 2007). Betalains are used as natural food colorants in various areas of food industry (Choo and Young, 2011).

Candy is produced traditionally by evaporating the materials in an open pan and heated using a wood fired stove until it becomes concentrated. The problem of traditional candy processing is the temperature is not able to controlled. It caused over heated on the material and decrease the content of nutrient and sensory quality of the candy. In order to improve the process, it was used Double Jacket Vacuum Evaporator (DJVE). The processing chamber of this machine has double jacket. Between inner and outer jacket has fluid for transferring heat so that there is no over-heating on the inner jacket. This evaporator is also completed with the vacuum system, so that the water is able to be evaporated in low temperature. With the lower and constant temperature of evaporation there is no degradation of nutrition contents and the candy will be better quality. The processing with vacuum evaporator can be maintain the quality of agricultural materials (Muhlisin et al., 2015).

This research was conducted with candy processing using DJVE in which the process can be controlled at a low and specific temperature that there was no caramel in the product and the nutrient content is able to be maintained. The vacuum pressure make the water evaporate at the temperature lower than 100 ^{o}C as well as the temperature of the processing of milk candy. Thus, the nutrients, especially vitamin C can be maintained or the level of the damage can be minimized.

II. MATERIALS AND METHODS

The DJVE prepared for the processing of milk candy. System vacuum is generated by jet-ejector system with temperature and rotation is controlled by the Fuzzy logic-based coding. . The temperature was set at 85 ^{0}C and a stirrer rotation was set at 150 RPM. The raw material sample contained 1 liter of milk, 200 grams of sugar, 2 grams of margarine, 1 ml of vinegar food and 100 ml of extract of dragon fruit. All raw materials are put into the chamber of DJVE and then turn on for processing of 100 minutes. The dough was homogenized by stirring during the cooking process. The dough concentrated with high viscosity because of water contents evaporation. The process is stopped at 100 minutes processing or when the agitator is not enough power to work because of the high viscosity of the dough. The hot dough was molded with a size of 3 cm x 3 cm as sample of experiment and wrapped with aluminum foil.

A. *Determination of the Chemical Properties*

The protein content and vitamin C content of the candy product was measured. The protein content of milk candy was analyzed with semi micro Kjeldahl method and the content of reducing sugars was analyzed with Luff Schoorl methods. Vitamin C was measured with titration using a 2,6-dichlorophenolindophenol sodium salt solution. The intensely colored extracts was determined with chloroform (Fardiaz, 1984). Ash Content of the sample was measured with ash total based on National Standard Agency (NSA, 1992). In order to determine the water content, the sample of milk candy was heated in the oven at 105 ^{0}C. It was heated until the weight was constants. The water contents is obtained by calculating the difference between initial weight and the constants weight divided by initial weight.

B. *Determination of Specific Energy*

The energy input for processing of milk candy using double jacket vacuum evaporator using equation (1) and (2) respectively.

$$E = P.t \tag{1}$$

$$E_{sc} = \frac{E}{M_p} \tag{2}$$

where,

P = Power of double jacket vacuum evaporator (kJ/s)
t = Time of Process (s)
M_p = Mass of Product (kg)
E = Energy (kJ)
E_{sc} = Specific energy for milk candy processing (kJ/kg)

III. RESULTS AND DISCUSSION

A. Chemical Properties

Chemical properties of milk candy using conventional and vacuum processing observed was protein, vitamin C, reducing sugar, ash content and water content shown in Tabel 1.

Table 1. Chemical properties of milk candy

Processing Method	Conventional	Vacuum	NSA***)
Protein (%)	5.15#)	4,74	-
Vitamin C (mg/100g)	2,61 – 2.79*)	14,04	-
Reducing Sugar (%)	9,259##)	15,52	Max. 20
Ash Content (%)	1,603#)	1,49	Max. 2
Water Content (%)	9,615##)	8,95	Max. 7,5

Source : #)Himma (2015), ##) Meylinda (2015), *)Islam et al. (2012), **) Result of this research, ***) NSA (2008)

B. Protein Content

Indonesian National Standard SNI 01-3547-1994 does not provide the minimum protein content requirement of milk candy, but the protein is one of the important of nutrient. Table 1. shows that the protein content using vacuum processing was lower (4.74%) than that the processing with the conventional processing. It was caused by the initial content of fresh milk so the protein content affect the final result on milk candy. The protein content of fresh milk is between 3-5% (Saleh, 2004). The content of protein is not so high is caused by the denaturation of milk proteins during processing.

Denaturation of protein is a change or modification to the structure of secondary, tertiary, and quaternary of the protein molecule without breaking covalents bond (Winarno, 2008). The treatment of milk at temperature of 80-100 ^{0}C can damage the proteins (Purba, 2012). Swastawati et al. (2013) reported that changes in protein caused by processing with high temperature. The protein content can be decreased due to protein denaturation and the heating process.

C. Vitamin C

Table 1. show that vacuum processing produce milk candy with higher content of vitamin C (14:04%) compared with the conventional processing conducted by Islam et al (2012) that produced of 2.61-2.79% C vitamin. Dragon fruit is used as a raw material in this study. The fruit has a high content of vitamin C, so the products of milk candy also have a high content of vitamin C. Vitamin C will begin to break down at a temperature of 40 ° C and the total damaged at a temperature of 80 ^{o}C. Although the temperature the process was set at 80 °C but the real temperature of the dough will not reach that temperature. The temperature setting of 80 °C is the temperature that occurs at the interface between the inner wall and the dough. Therefore, the degradation of vitamin C can be blocked because in this process using a vacuum evaporator, where the process undergo at low temperature. Pantan (2012) stated that in the process of vacuum processing food nutrients will be relatively maintained. Food or vegetables are processed with vacuum method will be produced products which contain nutrients such as protein, fat and vitamins remain intact.

D. Reducing Sugar

Reducing sugar is an important parameter in determining the quality of candy. Indonesian National Standard 3547.2 (NSA, 2008) signaled maximum of reducing sugar contained in milk candy is 20% and the milk candy. The results of the research still fulfill the standards. Table 3 also shows a reducing sugar candy with vacuum processing (15.52%). This content in this research was higher than that the content with the conventional processing (9.259%). The difference value due to the long process of making different candies. In conventional processing by Himma (2015) a time of processing for making candy is 80 minutes, while in this study the time processing is 100 minutes. The longer the processing time can increasing reducing sugars are formed. Gaewchingduan and Pengthemkeerat (2010) stated that the increase in heating times have a positive influence on reducing sugar. The longer the heating time can increase the hydrolysis process that will increase the levels of reducing sugars. Similiar statment was also delivered by Trissanthi and Susanto (2016) that reducing sugar of syrup "alang – alang" increased with increasing duration of heating. It's caused the longer of heating time, more sugar (sucrose) inverted into glucose and fructose.

E. Ash Content

The ash content show a total minerals in foodstuffs that in the combustion process will be not burned like organic component. The degradation of organic material during the process make the ash content be high. The process at high temperatures damage the organic material so the percentage of mineral content will be higher.

Consequently the ash content is high. Tabel 1. show ash content of milk candy with vacuum evaporator processing was lower than that the processing with open pan heating. Risky et.al (2014) state that the ash content in food is influenced by the initial minerals in the raw materials. The greater the ash content in a food ingredients showed the higher the mineral content contained in these foods. The ash content in this research is higher than the conventional process. It indicates that the process with vacuum evaporator is able to maintain the organic matter content compared with conventional process because the process undergoes at low temperature. The results of ash content of this study was already fullfil the requirements of Indonesian National Standard 3547.2 (NSA, 2008) where the ash content for soft candy maximum is 2.0%.

F. Water Content

Tabel 1. show the moisture content of milk candy using conventional processing was higher than that the processing using evaporator vacuum. The rate of evaporation depend on surface area, temperature, pressure and superheated levels (Susilo and Dwi Argo, 2010). The superheated level is most important factor affecting the evaporation rate. The superheated level is the difference between the real temperature of vapor and the boiling point at the same temperature. The boiling point of water at gauge pressure of – 70 cm Hg or absolute pressure of 6 cm Hg is 41 ^{o}C. If the process undergo at – 70 cm Hg and temperature of 80 oC, the superheated level is 29 ^{o}C. It is high level of superheated condition. The consequence is that the evaporation rate is high and the product has low water content.

On the other hand the conventional process undergo in high temperature, but the boiling point is of water is high as well so the superheated level is not as high as the processing with vacuum evaporator. In addition the process at high temperature causes the forming of caramel so the water trapped in the caramel and causes evaporation is inhibited. The temperature of conventional processing is not controlled that the maillard browning reaction occurs perfectly. Winarno (1994) stated that browning mechanism on Maillard reaction and caramelization are the carbonyl group of the sugar reacts with the amino group to produce N-glikosamin and water. The unstable group of glikosamin undergo rearrangement to form ketosamin and then ketosamin can undergo a further process for producing water and redukton and form brown nitrogen polymer (melanoidin). The high temperature have capability for removing water molecules from the caramelization when sucrose molecule is broken. At the time of splitting and dehydration will be followed by polymerization so that some kind of acid will arise from the process, so the method of making milk candy are conventionally obtained percentage of water content is higher than vacuum processing (Amri et al, 2015). The water content of milk candy also affected by the reducing sugar levels and environmental conditions. Water content will be higher with the higher of reducing sugars, especially fructose. Fructose is hygroscopic, so it can easily absorb the water. High environmental humidity will be increase the absorption of vapor by the sugar so as to increase the moisture content and decrease in texture (Sudarmadji et al., 1989). Although the moisture content in this study is lower than the water content of the conventional milk candy, it was still higher than the national standard of candy moisture content i.e 7.5%. the vacuum process is still possible to make the lower water content up to the national standard, but the used machine have not been able to process at high viscosity. Therefore the electromotor power of the machine must be increased in order to keep the power capable to stir the dough with a low water content and high viscosity. The machine uses 1 kW electric motor power and it has not been able to produce candy with a moisture content standards. It needs to be reviewed in designing the next engine to calculate the proper power.

G. Specific Energy

The specific energy is the energy required to produce a unit mass of product. Energy input includes all energy that arrives in all process from the handling of raw materials to the product ready for consumption. The energy input in this study is only calculated specifically for processing of dough into milk candy before it is molded. The total power of the machine is 1000 Watt and the process undergo 100 minutes or 6000 second that the total input of energy is 6000 kJ. The calculations show that the specific energy to process the dough into milk candy is 38,461.5 kJ/kg. Jalil (1997) state that the energy requirements for pasteurization was 1309.3 kJ/kg, for full cream milk 2462.497 kJ/kg and for skim milk was 1921.571 kJ/kg, and for cream milk was 1995.764 kJ/kg. Rostamah (2006) state that total of energy input for processing of candy was 1263.4 kJ/kg and for mixing was 764.3 kJ/kg. the energy requirement for this study is much larger than the energy input of conventional processing. The next research we need designing of vacuum evaporator with low input energy and appropriate for small scale industry.

IV. CONCLUSION

Testing of double jacket vacuum evaporator for processing of milk candy with the addition of dragon fruit has been carried out. The testing show that nutrient with vacuum evaporator was better than conventional processing especially the content of vitamin C. Energy input for production of milk candy was 38.461,53 kJ/kg, it is high level of energy input. The milk candy production with vacuum evaporator is better than the processing with production with conventional processing but need more energy input. The designing of vacuum evaporator with low energy requirement is important in order to develop appropriate technology as diversification of dairy products for small scale industry.

REFERENCES

Amri, M.N., B. Susilo, and Y. Hendrawan. 2015. Effect of Temperature Control Based on Fuzzy Logic And Stirring Speed on Vacuum Evaporator Double Jacket to Physical Characteristics Milk Candy (*in Indonesia*). Bioprocess Journal of Tropical Commodities 3(2): 9 – 16.

Buckle, K. A., R. A. Edward, G. H. Fleet dan M. Wooton. 1987. Food Sciences *(In indonesia)*.Interpreter by Hari Purnomo and Adiono. Universitas Indonesia Press. Jakarta.

Choo, W.S., and W.K. Young. 2011. Antioxidant properties of two species of *Hylocereus* fruits. Advances in Applied Science Research 2(3): 418-425.

Fardiaz, D. 1984. Laboratory Guidelines for Nutrient Evaluation (*In Indonesia*). Inter-University Food and Nutrition, Bogor Agricultural University. Bogor.

Fuca, N.,C. Pasta, G. Impoco, M. Caccamo, and G. Licitra. 2013. Microstructural properties of milk fat globules. International Diary Journal 31: 44-50.

Gaewchingduang, S and P. Pengthemkeerati. 2010. Enhancing efficiency for reducing sugar from cassava bagasse by pretreatment. International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering 4(10): 477-480.

Halimoon, N., and M.H.A. Hasan. 2010. Determination and Evaluation of Antioxidative Activity in Red Dragon Fruit (*Hylocereus undatus*) and Green Kiwi Fruit (*Actinidia deliciosa)*. American Journal of App. Sciences 7(11):1432-1438.

Hardjadinata, S. 2010. Organic Cultivation of Super Red Dragon Fruit *(in Indonesia)*. Penebar Swadaya. Jakarta.

Hendrawan, Y., B. Susilo, A.W. Putranto, D.F. Al Riza, D.M. Maharani, dan M.N. Amri. 2016. RSM-CCD Algorithm for Optimizing Waterjet Vacuum Evaporator Using *Fuzzy* Temperature Control inThe Milk Candy Production (*In Indonesia).* Agritech 36(2): 226-232.

Himma, F.M. 2015. The effect of addition of Super Red dragon fruit (*Hylocereus costaricensis*) on the protein content, fat, ash, carbohydrates and fiber in milk caramel (*in Indonesia*). Bachelor Thesis UB. Malang.

Islam, M.Z., M.T.H. Khan, M.M. Hoque and M.M. Rahman. 2012. Studies on the Processing and Preservation of Dragon Fruit (Hylocereus undatus) Jelly. The Agriculturits 10(2): 29-35

Jalil,A. 1997. Audit Energi pada Produksi Susu Pasteurisasi di Unit Usaha pengolahan dan Pemasaran susu GKSI Ujung Berung Bandung Jabar. Fakultas Teknologi Pertania Institut Pertanian Bogor. Bogor.

Jerônimo, M. C., J.V.C. Orsine, K.K. Borges and M.R.C.G. Novaes. 2015. Chemical and Physical-Chemical Properties, Antioxidant Activity and Fatty Acids Profile of Red Pitaya [Hylocereus Undatus (Haw.) Britton & Rose] Grown In Brazil. J Drug Metab. Toxicol 6(4): 1-6.

Le Bellec, F., and F. Vaillant. 2011. Pitahaya (pitaya) (*Hylocereus* spp.) *in* Yahia, E.M (eds). Postharvest biology and technology of tropical and subtropical fruits Volume 4. Woodhead Publishing Limited. Oxford.

Maharani, D.M., R. Yulianingsih, S.R. Dewi, Y. Sugiarto, and D.W. Indriani. 2014. Influences of Sodium Metabisulphite and Evaporation Vacuum Temperature on Brown Sugar Cane Quality (*In Indonesia*). Agritech 34(4): 365-373.

Meylinda, M. 2015. The influence of Addition of Super Red Dragon Fruit (*Hylocereus costaricensis*) on Water Activity (Aw), Moisture content, Reducing Sugar and Antioxidant Activity in Milk Caramel (*In Indonesia)*. Bachelor Thesis. UB. Malang.

Muhlisin, A., Y. Hendrawan, dan R. Yulianingsih. 2015. Performance Analysis and Mass Balance of Water Jet Vacuum Evaporator With Double Jacket System in Brown Sugar Cane Process Production (*Saccharum officinarum L.*) *(in Indonesia).* Journal of Tropical Agricultural and Biosystem Engineering University of Brawijaya 3(1): 24-36.

NSA (National Standard Agency). 1992. Test method of Food and Beverages (SNI 01-2891-1992) (*in Indonesia*). National Standard Agency (NSA). Jakarta.

NSA (National Standard Agency). 2008. Candy-Part 2: Soft (SNI 3547.2-2008) (*in Indonesia*). National Standard Agency (NSA). Jakarta.

Pantan, S.R. 2012. The study of effect of Frying Vacuum Temperature on the Quality of Dried chili (*In Indonesia*). Bachelor Thesis. UNHAS. Makassar.

Purba, M. 2012. Formation of Poultry Meat Flavor by Heating Process and Lipid Oxidation *(In Indonesia)*. Wartazoa 24 (3): 109-118

Risky, I., and E. Liviawaty Rostini. 2014. Characteristics of biscuits with the addition of Fish Bone flour of Jangilus (*Istiophorus sp*.) (*In Indonesia*). Aquatics Journal 5 (1): 30 -39

Rostamah, D. 2006. Analisis Konsumsi Energi pada Pengolahan Permen di PT Sweet Candy Indonesia Purwakarta Jawa Barat. Fakultas Teknologi Pertania Institut Pertanian Bogor. Bogor.

Saleh, E. 2004. Teknologi Pengolahan Susu dan Hasil Ikutan Ternak. USU *digital library*. Medan.

Sistanto, E., Soetrisno, dan R. Saepudin. 2014. Sifat Fisikokimia dan Organoleptik Permen Susu (Karamel) Rasa Jahe (*Zingiber officinale* Roscoe) dan Temulawak (*Curcuma xanthorriza* Roxb). Jurnal Sains Peternakan Indonesia 9(2): 81-90

Sudarmadji, S., B. Haryono, and Suhardi. 1989. Analysis of Food and Agriculture 1st Edition (*in Indonesia)*. Liberty. Yogyakarta.

Susilo,and B.Dwiargo. 2010. Termodinamika. UB Press. Malang.
Swastawati, F., T. Surti, T.W. Agustini and P.H. Riyadi. 2013. Characteristics of Quality of Processed Fish Smoke Using Different Method and Types of Fish (*In Indonesia)*. Journal of Food Technology Application 2 (3): 126-132
Trissanthi, C.M and W.H. Susanto. 2016. Effect of Citric Acid Concentration and Heating Time on Chemical and Sensory Characteristics of Syrup "Alang-Alang" (*Imperata cylindrica*) (*In Indonesia*). Journal of Food and Agro-Industry 4 (1): 180-189
Winarno, F. G. 2008. Food Chemistry and Nutrition (*in Indonesia)*. M-Brio Press. Bogor
Wybraneic, S., B. Nowak-Wydra, K. Mitka, P. Kowalski and Y. Mizrahi. 2007. Minor Betalains in Fruit of Hylocereus spesies. Phytochemistry.

A.18

PERFORMANCE TEST OF COMPOST APPLICATOR

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ABSTRACT

Fertilization is important to increase crop production. The use of compost can provide benefits for soil and plants. The compost as fertilizer on agricultural land must be in large quantities (high doses). Fertilization using compost applicator technology is expected to maximize plant growth so as to increase crop production. The purpose of this research is to know the efficiency of compost applicator on dry land. This compost applicator uses ration of belt conveyor with power for rationing come from wheel rotation using transmission chain. The results showed that the applicator can function well and able to ration compost to dose of 10 tons / ha. Factors affecting the amount of efficiency include effective speed, total time spent and operator skills.

Keywords : Performance test, compost applicator, compost, efficiency

I. INTRODUCTION

Fertilization is an important thing to increase production, even until now regarded as a dominant factor in agricultural production. The use of chemical fertilizer is increasing from year to year, has worried environmentalists because of the impact of the pollution they cause. Until the end of the 20th century fertilization is an important factor to increase production because there is no other alternative to replace (Rosmarkam and Yuwono 2002)

Recently, organic fertilizer (compost) has been considered the heart of organic farming systems (Hoitink and Keener, 1993). Compost by function are classified as soil conditioner. In terms of increasing the soil bearing capacity, compost is clearly superior and environmentally friendly than synthetic chemical fertilizers because it can increase the content of organic matter in soil. The content of organic matter in the soil has a very important and the amount of organic material that is often used for directly measuring soil fertility index

The use of compost can provide benefits for the soil and plants, among others: provide nutrients for the plants, improve soil structure, increase the population and activity of soil organisms, improve the ability to water holding and soil aggregates, increases infiltration, preventing erosion, supporting the deployment and penetration of plant roots, and to strengthen plant resistance to pests and diseases.

The use of compost as a fertilizer on agricultural land must be in large amounts (high dose), this is caused by the nutrient content of the compost is low when compared with inorganic fertilizer so that to get an equivalent dose of the nutrient needs of plants.

Problems that occur at the time of application of compost is needed manpower and considerable expense, so it needs an appropriate technology like mechanical equipment that is simple and easy to operate

Applicator compost is one alternative problems solver in the application of compost on the farm. This study was conducted to test the compost applicator performance for horticulture crop. Compost applicator is designed to help the process of fertilization use compost on farm. Compost applicator design has previously been performed by Iqbal (2014) were used for the process of fertilization on sugarcane plantations. The Results of research, shown the rationing metering device mechanism using a type of conveyor belt has been able to function properly (Iqbal, 2014). The spending rate of compost can be adjusted to the height of door openings regulator or the percentage of door openings regulator. The width of the door opening and the forward speed of the applicator can be adjusted to the rate of expenditure or dose of compost desired when the application of compost in the cane fields.

The application compost equipment or applicator compost in the field is a specifically designed to apply organic fertilizer or compost into the soil or in between the plants with specific dose of compost. Compost applicator is a trailer pulled by a tractor. The components of applicator are auger, pit where the discharge of compost, regulator doors, conveyor belt as a metering device, and fertilizers bin as the main framework. Applicator will be operated by hand tractor.

The general objective of this study was to modify the sugarcane applicator compost on dry land so that it can be used on land horticultural (vegetables).

II. MATERIALS AND METHODS

The tools used in this study are: Hand tractor and implement, fertilizer technology (compost applicator), ring sample, hoe, stamp, and label. The materials used in this study are compost and horticultural crops.

Static testing of compost applicators is a test done when applicators are not operating on field, not using a tractor but using a crank, which aims to rotate the axle of the applicator wheel so that the belt conveyor belt to move and send the compost into the auger (cylinder rationing).

This test is done by blocking the applicator so that the applicator's wheel does not touch the ground and can move freely. The parameters measured are the rate of compost discharges that are influenced by the height of the door and the speed of the tractor.

Fig. 1. Applicator compost for Horticulture

III. RESULTS AND DISCUSSION

A. Field Capacity of Compost Applicators on Dry land Plants

Table 1. Compost Discharges rate at several height of outlet door

No	Height of outlet Door (cm)	Revolution Number (n)	Compost Weight (kg)	Discharges Rate (kg/rev)
1	2,5	56	50	0,893
2	5	43	50	1,163
3	7	36	50	1,389

Table 1 showed that each the height of outlet door has different rate of discharge. At height 2.5 cm having a discharge rate of 0.893 kg/rev, at height 5 cm has a discharge rate of 1,163 kg/rev and at 7 cm outlet door height having an rate of 1.389 kg/rev. The rate of compost discharges is increasing according the height of outlet door and the number of revolutions of the crank. This is in accordance with Iqbal (2012) which states that the discharge rate can be adjusted by the height of the adjustment of outlet door. The width of the outlet door and the applicator's forward speed can be adjusted to the rate of discharge or compost dose according crop requirement.

B. Field Test of Compost Applicator

This field test was conducted at PG. Takalar. This test is a function of the applicator's width, actual speed and effective time consumed during operation. The applicator's working width is 1.3 m according to the spacing of sugar cane in PG. Takalar. Actual speed is influenced by several factors such as the applicator wheel design system, type and condition of soil, operator skills, and tractor attraction. The effective time is the time spent during the operational of applicator that influenced by the number time loss (the time of setting or time repair the minor defects, turning time, the time of adding the fertilizer and etc).

The result shows that on the site of the test a distance of 30 m each row obtained an average travel time of 56 seconds per row or 449 seconds for 8 rows while the wasted time used for turning is 50 seconds per row so that the total time for turning is 350 seconds. So the total travel time for a land area of 300 m^2 is 799 seconds or 0.222 hours. The speed of this compost applicator at each plot is 1923,664 m/h, so that theoretical capacity of the applicator is 4 hours/hectare and the applicant's effective field capacity is 7.40 hours/hectare.

The field capacity is obtained from field test that are influenced by the total time spent during operation, by the amount of time lost such as the turning time using the edge pattern and the area of the experimental field. This is in accordance with Rizaldi (2006) which states that factors affecting the field capacity include time lost to turn.

C. Efficiency of Compost Applicator

The test results show that the compost applicator can function well, with efficiency of 54%. However, in the operation of this compost applicator, there are still some weakness such as skill of the operator in operating the compost applicator and at the time of turn. This is in accordance with Rizaldi (2006) which states that the reliability of time usage on individual machines becomes even more important if multiple machines or parts of the machine are used in combination. For an individual tool, the lost time is 5 or 10% due to damage, adjustment, setting, or other stops relating to the machine.

The height of the outlet door influenced the amount of discharge compost to the auger cylinders, so that caused occurrence of solids, this is influenced by the type of compost used.

IV. CONCLUSION

The results showed that the prototype model of applicator conveyor belt type had been made. It is functioning properly. The efficiency of applicator compost is 54% or 7.4 hour/hectare.

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REFERENCES

Hoitink, H.A., and H.M. Keener. 1993. *Science and Engineering of Composting: Design, Environmental, Microbiological, and Utilization Aspect*. Ohio Agric. Res.Dev.Or., The Ohio State Univ. Wooster. OH. 728 pp.

Iqbal, 2012. *Study of Farm Machinery in Sugarcane Litter Management on Dry Land Sugarcane Plantation PG Takalar*. Bogor Agricultural University.

Iqbal, 2014. *Design of Compost Applicator For Dry Land Sugarcane*. JTEP Vol. 28 Number 1. PERTETA. Bogor

Rizaldi Taufik, 2006. *Tools Machine*. Depertement Of Agricultural Technology, Faculty of Agricultural. North Sumatera University.

Rosmarkam, Afandie dan Nasih Widya Yuwono. 2002. *Soil Fertility Science.* Kanisius, Yogyakarta.

A.19

DEVELOPMENT OF SAWMILL-WASTE GRADING FOR COMPOSITE MATERIAL UTILIZATION

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ABSTRACT

Timber harvesting and wood processing in Indonesia produces wastes in large quantities. The waste materials come in variety of shapes, sizes and quantities. For adding the value of these wastes, such as for composite raw material, the particle-size should be uniform, and segregated into different categories. The general particle-size for manufacturing composite materials are 80, 40, 20 and 10 mesh. Therefore, separating the sawmills wastes based on these sizes is necessary in order to utilize it as raw materials for composite production. The study aims to develop a prototype of sawmill-waste grading machine for composite material utilization and added the value of the waste for application as a raw material for the composite design. The methods included design and manufacturing of a sawmill-waste grading machine as well as performing different tests. The prototype successfully grades and segregate the sawmills-wastes into four different particles-sizes in a single operation process. The results showed that the machine working capacity is 28.49 Kg.hr-1, while the materials segregated into four particle-sizes obtained mean of modulus of fineness for each group-size (10, 20, 40 and 80 mesh) are 889, 651, 431, and 168 grams respectively. While for the uniformity index of large (10 mesh), medium (20 and 40 mesh), and fine (80 mesh) particles are 5, 4, and 1 respectively, obtained from three replication tests. The specific power required to achieve the working capacity of 28.49 Kg / hr. is 0.0001568 kW.hr.kg-1. Overall, the machine performance achieved the efficiency of 77,37%, and the cost for grading the sawmill-waste material is Rp. 243,36 kg-1.

Keywords : Sawmill-waste, grading, particle-size, solid waste utilization.

I. INTRODUCTION

Human needs for timber as building materials for both construction, decoration and furniture purposes continue to increase, along with the increasing number of people. Priyono (2001) stated that the demand for wood industry in Indonesia is 70 million m3 per year, with an average increase of 14.2%. Until now, the harvesting and processing of timber in Indonesia still produces waste in large quantities. Wood waste generated in the processing can be divided into two groups, namely waste exploitation and wood processing industries waste. The largest wood processing industry waste comes from the sawmill and plywood industry. Sanusi (1993) defines the sawmill waste as a part of the timber produced from the sawing process because its shape, size and defects are no longer possible to be made as sawn wood sorts.

The composite material is a macro composite material so that the composite material can be defined as a material system composed of mixtures or combinations of two or more elements that are macro distinct in form and or material composition essentially inseparable (Schwartz, 1984). Some factors that need to be considered in the manufacture of composite materials such as the size of sawdust are used. In general sawdust from wood industry has diverse forms, sizes and quantities, while for utilization as raw material of composite mixture required different size of sawdust material, but with certain size. The general size used for the manufacture of composite mixed materials comprised particles of 80 mesh, 40 mesh, 20 mesh, and 10 mesh. The separation of sawdust size based on the four mesh sizes is needed to facilitate the acquisition of composite raw materials, to facilitate the separation process is necessary grading tool that is able to separate the size of the various sawdust. The important role of this tool will be to speed up the process of separating the size of sawdust that will be used as raw material of composite mixture, so that it can support the particle board industry.

The purpose of this research is to design grading tool of sawdust waste to be used as raw material of composite mixture. The benefits gained will be the solution for the utilization of powder waste and can reduce environmental pollution due to the waste of sawdust that is not utilized. In addition, this research is able to accelerate the grading process of sawdust waste according to size, which can be utilized as raw material of composite mixture, to add product value.

II. MATERIALS AND METHODS

The study was conducted from June 2016 - August 2016 at CV. Citra Dragon, and Agricultural Machine Production and Management Laboratory, Andalas University. The research is divided into two stages, namely the design and manufacture of machinery and stage testing tools.

A. Tools and Materials

The materials used in this study are: iron elbow, iron axle (steel shaft) forging, chain, iron *stallbus*, sprocket, putty, paint, and sawdust. The tools used in the research are: welding machine, iron bend, hacksaw, grinding wheel, grinding cut, meter, ruler and sound level meter, scales. Stopwatch is used to search for long sieving, tacho meter is used for motor speed (RPM), sound level meter is used to determine noise of appliance and environment.

B. Research Procedures

The method of this research is the development of simple tools that already exist, then will be tested work tools that have been so. The working principle of this tool is to use human power, move the pedal as the source of the sieve movement, connected to the crank lever as the driving tool.

The design is done by making a grading tool that uses a four-level sieve arranged in series starting from the largest sieve hole in a row down. For self-propellers using human power, the sprocket transmission is connected as a power connector to the sieving bath. The ingredients that will be grading are made on top of the tool and how to insert it by sprinkling sawdust as much as half the volume of the tool on the top of the sieve. The frame design is designed to support all components of the tool, the frame must be able to withstand vibration and pressure during grading.

The process of designing the grading tool of sawdust waste is the main thing that needs to be done is to make the design or drawing of the grading tool, it aims to simplify the researcher in the design process and not experience a fatal mistake in the implementation. Making a design or image that needs to be paid attention is the height, length, width and shape of the tool to be designed. The design process of this precision is one of the factors that need to be considered the goal is that the results and objectives of the design of this tool in line and according to the desired researchers.

The working principle of this tool is to utilize the human power to move the Sievers with power transmission using sprocket. So this tool does not need to use an electric motor as a source of energy. Functional design analysis was conducted with the aim to design the function and location of grading tools of sawdust. This tool consists of 7 main parts, namely :

1. The main frame (frame) is the basic framework of the tool that serves to support and simultaneously as a holder of the components, so it must be made strong for the tool is stable.
2. The crankshaft serves to hold the load of the sieve and to transmit power from the pedal to the sieve as a sieve driver.
3. Sprocket serves as a power supply, in this tool the transmission system used sprocket. The power coming from the bicycle pedal will then rotate the crankshaft so it can pull and push the sieve.
4. Chain serves as the successor of motion energy generated on the pedal, the motion energy on the pedal will be channelled to a small gear that is in front of the paddler.
5. Expenditure funnel serves as a place of exit grading of sawdust.
6. Saddle serves as a seat for the operator while pedalling the sieve drive.
7. A woven metal wire sieve serves as a sawdust separator by size.

III. RESULTS AND DISCUSSION

A. Design Results of Mechanical Grading Tool Sawdust Waste

The resulting tool (Figure 1) consists of several major components. The main frame is a rectangle made of iron elbow with a length of 150 cm, height 73 cm, and 68 cm wide. Frame size based on the size of the sieve used. The use of angled iron aims to make the framework more robust while holding the weight of the constituent components of the appliance and the vibration during the sawdust. The size of the sieving box can accommodate material capacity up to 60 litres. Constraints faced when the tool operates is the amount of vibration, the need for propulsion, as well as the distance of the translational movement of the sieve is still far away. All paragraphs must be indented. All paragraphs must be justified, i.e. both left-justified and right-justified.

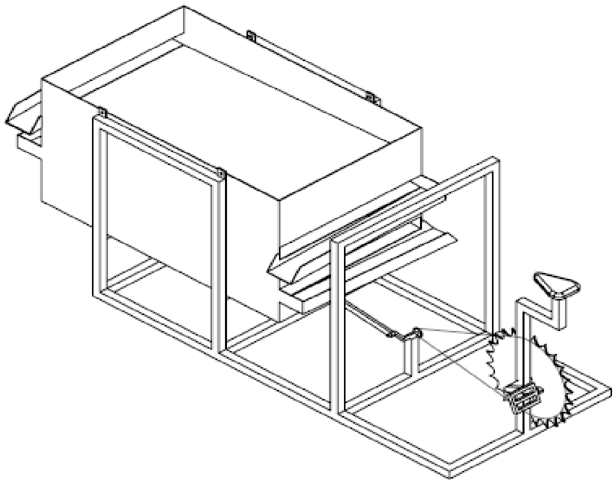

Fig. 1. Design of the Prototype generated

Vibration tool can reduce the ease and efficiency when operated. Adjustment of the crank lever size from 10 cm to 8 cm can solve the problem. With modifications, the translational distance of the tool becomes smaller, and the speed increases. As a result, the required energy is getting smaller. In the design of the tool also note the important factors of production, namely labour, work tools, and work objects. As a tool with a source of human propulsion, it is necessary to consider the safety and health of operators when operating this tool.

The second tool part is a sieve. This section is made of metal wire that is woven on 4 (four) sizes in different mesh units, i.e. fine (80 mesh), medium (40 mesh), coarse (20 mesh), and large (10 mesh). The sieves are designed to firmly withstand sieved sawdust and no spillage occurs during sieving. The sieve is arranged in parallel as many as three piles, each made of iron plate with length of 100 cm, width 68 cm, and height 7 cm. The portion of the sieve is mounted on a swing stick holder that is disputed by the sieve frame.

The third tool part is the casing. The casing serves as a place to lay a sieve component arranged in a stratum and protects so that sawdust does not fly while the grading process takes place. In this sifter casing there are also 4 funnel expenditure results grading, it aims to simplify the separation of the sieve, this casing has a width of 60 cm, height 50 cm, and length 100 cm. The funnel or outlet is the outlet for grinding of sawdust. In this sieve tool there are 4 pieces of shopping funnel that is on the front and back side of the sieving tool. The cornerstone of the spending funnel is tilted to make the screen shooting process easier, for the size of the self-loading funnel that is 10 cm wide, and 65 cm long. The screen output outlet on this tool is made on the side, for a 10 mesh, 20 mesh, and 40 mesh sieve out with a slope of 10 °, based on an angel of friction sawdust test. As for sieve sized 80 mesh, the outlet is on the bottom side of the sieve tub with the same slope. This outlet is made of iron plate with length 64 cm, width 8 cm.

The saddle section serves as a seat for the operator when pedalling the sieve drive. Saddle is adjusted to the size of the adult holder with a comfortable seat material. To channel the driving force used chain transmission system and sprocket. Chain serves as the successor of motion energy generated on the pedal. Sprocket on a large pedal is connected to a small-sized propeller sprocket using a chain. motion energy channelled with the crank of the sieving force. The rotary power generated on the sieve shaft is larger and capable of producing horizontal motion with high speed. In this sieving tool used chain size with number 40, in accordance with the calculation of chain size. The ratio of the small sprocket size and the large sprocket used on the tool is 1:25, in accordance with the calculation of the sprocket and chain size. Large sprocket diameter 21 cm with 48 eye counts, and a small sprocket 7 cm with the number of eyes 20 fruit. The axis spacing is 45 cm. Sprocket is driven by pedalling the tool clockwise.

The crankshaft serves as the successor to power received by a small sprocket, to drive the sieving. The crank lever is the connecting and driving source of the sieve, with a crank length of 8 cm. The crank lever is driven by a small sprocket connected to the bearings to facilitate the movement of the crank lever.

B. Results of Elaborate Testing

The sieving results obtained from each mesh are different. In this research, the highest yield was found in mesh size 10, while the smallest yield was found in mesh size 80. Various factors influencing this result include duration of sieving process, intensity of sieving vibration and sampling method. When viewed the 20 mesh and 40 mesh sieves have a uniform and clean sieve quality, in contrast to the mesh and mesh 10 mesh sieves which still have a mixture of sawdust flying around during sifting (Figure 2). The results of this study are the initial stage of the process of utilization of waste sawdust. The next stage of this sieving result can be used as raw material of composite mixture.

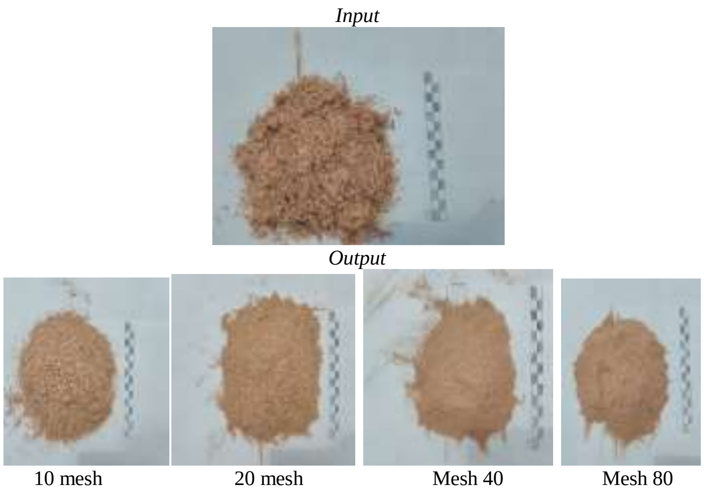

Fig. 2. Results sorted Saw-dust in 4 Size (Reference scale is 15 cm × 1 cm)

The operator's power requirement to operate the sieving is calculated based on the operator's pulse per minute. From observation, the operator's pulse rate after sifting is 95 times per minute pulsation. Thus, sawdust saw works are categorized into light working groups, with an energy of 0.0447 kW. The difference in human power required to operate the tool is not very significant when compared with manual use, which has been calculated in the initial study of 0.0625 kW. However, this tool can perform sieving with four meshes at the same time with a 0.0447 kW energy input and is very effective when compared to manual Sievers that require 0.0625 kW to perform one mesh only (Figure 3). The value of energy released is then connected to the working capacity of the apparatus, thus obtaining a specific power requirement of 0.0001568 kWh/kg.

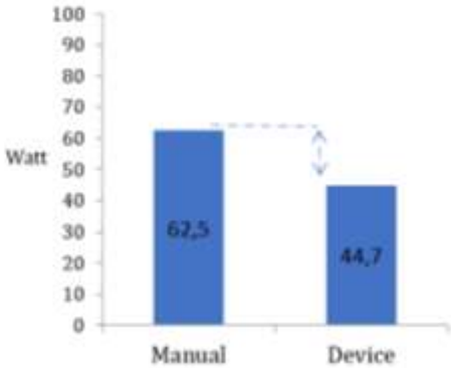

Fig. 3. Mechanical Advantages of the Prototype

C. Performance Results

In the tool test, the amount of sawdust is 8.4 kg. Observations were made three replications, each using a material of 2.8 kg with a measured water content of sawdust by 20%. From the measurement results obtained working capacity of the tool as shown in Figure 4.

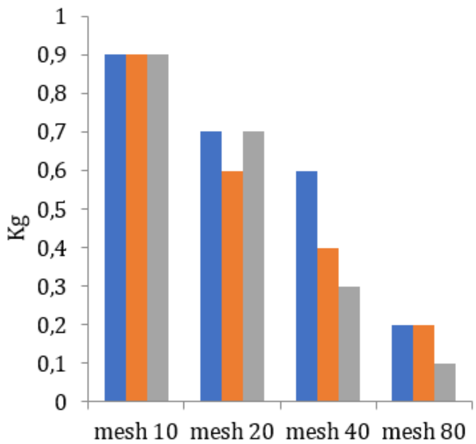

Fig. 4. Test Results of the Working Capacity With 3 Replications

From the result of the research, the average grading tool capacity for sawdust is 28,49 Kg / hour. This result is obtained from the experiment conducted by using sawdust sample as much as 2.8 kg with the average time of sifting the sawdust is 4 minutes 6 seconds. The working capacity of this tool is influenced by several things, including the duration of the sieving time, the sample mass, and the intensity of the sieve vibration. The pile of material on the mesh of this tool is quite high at about 5-7 cm, this can affect the capacity of sieving and prolonging the time of sifting, therefore the wider mesh size used will speed up the process of sifting and the capacity of the tool is increasing. To increase the capacity of the grading tool it is necessary to enlarge the sieving volume, so that the distribution of materials will be much and speed up the process of sieving.

The sieving ratio is calculated based on the weight ratio of sawdust sieved with the weight of the material. From the test results, the percentage of yield of the material is affected by the working time of the tool. The longer the sieving process takes place, the yield of the material will decrease, because the sieving material is getting less. The average yield of degraded sawdust waste material is 77.37%. The results of this yield show the performance of the tool that has not been optimum because making the sieve with four mesh size requires the size of the sieve hole that must be precision. In the designed device, the wire on the sieve hole is less tightly installed, resulting in a lot of sawdust material left behind. For that need to make improvements on the tool for the yield of sieving results can increase.

The fineness modulus of the material is measured to determine the index of the fineness or grain size of the aggregate particles of the sieved material. The grain refinement modulus (FM) is defined as the percent amount of cumulative residual filter above the sieve. The fine modulus of fine aggregate grains ranges from 1.5 to 3.8 (SNI 03 - 1750 - 1990) (Putro, 2007). To analyse the results of sieving, a comparative test with a standard sieve is arranged in series in one pile. The arrangement of sieves starting from the sieve has smaller mesh sizes up to larger sizes respectively (10 mesh 20 mesh, 40 mesh and 80 mesh). Each mesh size has a different fineness modulus, depending on the material retained on the mesh of the sieve. The greater the value of the fineness modulus indicates that the larger the aggregate grains. The result of material fineness modulus testing is presented in Table 1.

Table 1. Modulus of fineness of sorted materials

Mesh Number	Diameter (mm)	Replication	Sorted Materials (gr)	Fineness Modulus (%)
10	2	1	940	37,5
		2	861	42,85
		3	866	45
		Average	889	41,78
20	0,842	1	612	29,16
		2	635	28,57
		3	707	35
		Average	651,3	35,31
40	0,4	1	612	25
		2	411	19,04
		3	272	15
		Average	431,6	21,11
80	0,177	1	171	8,33
		2	229	9,52
		3	105	5
		Average	168,3	7,61

In the test, the sieved saw-grain fineness modulus showed that the material with the smallest particle size had the smallest percentage of sieve yield. At mesh size 80 obtained the percentage of material retained on the third repeat of 5%. This indicates that the sieved sawdust material is still less smooth. Overall, other sieve sizes show the results of modulus of fineness with the largest percentage being 45%, 35%, 25% and 9.52% for mesh sieve sizes 10, 20, 40, and 80.

This fineness modulus relates to the remaining material held by the sieve. Since the mesh difference for each layer of the screen is large enough, the amount of material retained due to having a larger particle size of different sieve holes for each level of sieving (Figure 5). The larger the size of the sieve hole, the more retained sawdust material. This happens because of the variety of sawdust sizes obtained. However, in the test of this apparatus, the sieved material has a uniform particle size, corresponding to the level of sieving made (10, 20, 40, and 80 mesh). Comparison of material fractions (rough, medium, and smooth) has a range of 10 mesh and multiples (Irfan and Sarif 1989). The largest uniformity index of results was obtained from sieving results with 2mm mesh size (mesh 10), then sequential according to the size of the shrinking mesh (mesh 20, 40, and 80). Thus, the size of the sieve hole affects the uniformity index of the results. The measurement result of uniformity index of materials presented in Table 2.

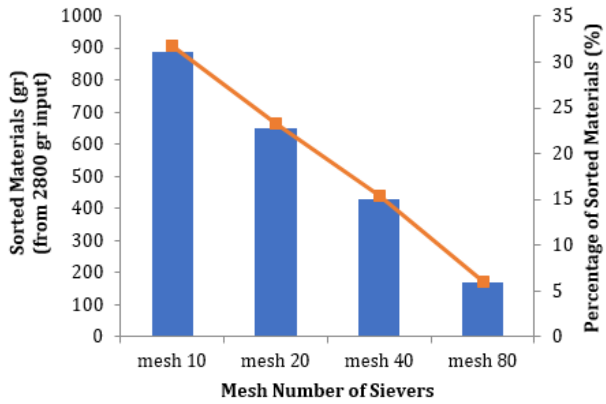

Fig. 5. The Material Weight In Each Screen Size

Table 2. Uniformity Index for Sieving

Replication	Uniformity Index (Coarse, Medium, Smooth)
1	5 : 4 : 1
2	5 : 4 : 1
3	5 : 4 : 1

The noise test when the device operates is performed to determine how unwanted noise power (expressed in decibels (Db)) is exposed to the operator when the device is in operation. Noise occurs because there is a part of the tool that rubs and slams like a hard sieve during sifting takes place. The noise level in this tool is determined using a sound level meter device. The resulting noise results range from 79 to 92.9 Db. Can be seen on the table noise level using materials and without materials not much different, this is because the processed sawdust material has a light weight, so it is not able to muffle the sound generated sieve tool. Some components that become the source of noise in the tool is the occurrence of friction between the swing lever to the sieve tub, crank lever gestures, and the sound of sieving tub. The noise level of this device is still above the permissible threshold in accordance with occupational safety standards (Figure 6). To that end, the equipment operator needs to use a sound protector during the operation of the device.

Table 3. Prototype noise level during operation

Replication	At Operator		1 meter away		2 meter away		3 meter away	
	No-Load (dB)	With Load (dB)	No-Load (dB)	With Load (dB)	No-Load (dB)	With Load (dB)	No-Load (dB)	With Load (dB)
1	91,8	90	88,5	86,5	87,7	84,4	83,3	82,4
2	92,9	92,4	87,6	85,9	86,3	86	82,3	79
3	90,6	91,5	88,7	87,2	85,7	84,2	82,6	81,2
Average	91,76	91,3	88,26	86,53	86,56	84,33	82,73	80,86
SD	1,14	1,21	0,57	0,65	1,01	1,17	0,5	1,72

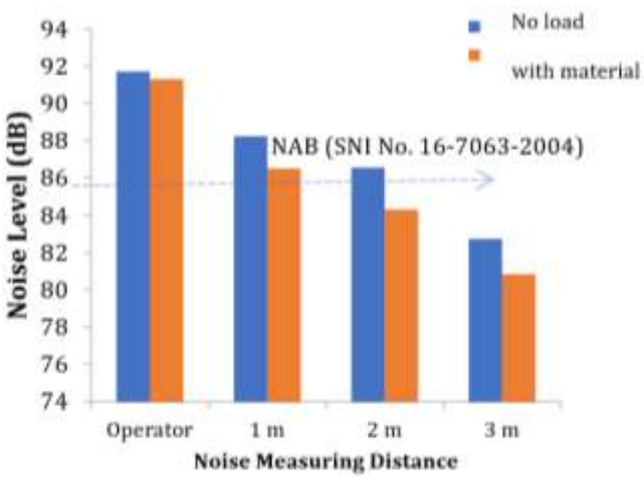

Fig. 6. Noise Level of the Prototype during operation

The noise level of 85 dB is the work safety margin (NAB) value defined in SNI No. 16-7063-2004, for Indonesian workers who work for 8 hours per day. Based on noise measurement results, then when operating, the appliance noise level exceeds the allowable threshold. In 1405 / MENKES / SK / XI / 2002 mentioned the requirements of the office and industrial work environment, to avoid deafness, noise thresholds are permitted for the operation of the appliance for 8 hours a day in a closed room. It is therefore necessary to have noise control at the receiver level by using earplugs to reduce noise levels up to 25 - 45 db. Completion of the tool design needs to be done to minimize the noise level generated. Particularly provides bearings of bearings on rotational rubbing sections.

The process of sifting sawdust using the manual way, causing the operator to work by pedalling the tool to move the sieve. The size of the seat and the frame on the tool are adjusted to the anthropometric position of the Indonesians. Several anthropometric sizes used include, range of forward range, dimensions of height while sitting, knee height and hand dimension. The comparison between anthropometric dimensions of operators and ideal conditions is presented in Table 4.

Table 4. Anthropometrical data

Dimension of	Ideal Anthropometri (cm)	Device Anthropometri Data (cm)
Reach	69,45	70
Seat Height	81,58	82,5
Knee height	52,02	53
Front reach	67,02	68
Hand Length	18,11	19

There are several factors that need to be taken into account in the manufacture of seating dimensions and pedalling positions, between anthropometry and the strength of tool materials. In Table 4, there is no significant difference between the anthropometry position of the appliance operator and the Indonesian standard size. The height adjustment of the tool, the height of the sitting position and the range of the handle on the tool are designed to be tailored to the operator's requirements. Thus, the operator can adjust his working position as comfortable as possible so that it can operate the tool in a long time. In this tool the operator moves the tool with the sitting position and the legs are not too bend, thus, operating the tool in a long time does not cause extreme stretching of the operator muscle. The position of the operator during the sifting can be seen in Fig. 7.

Fig. 7 Operator Position

D. Techno-Economic Analysis

The cost of the tool consists of fixed and variable costs. Non-fixed costs include the cost of maintenance or pension costs (Rp 540 / hour), and operator fees (Rp 6,250 / hour). The tool uses human power, so there is no fuel cost in the operation of the equipment. Fixed costs consist of depreciation cost of equipment and interest cost of capital. From the research that has been done obtained the cost of depreciation of Rp. 540,000 / year. Depreciation cost is due to the long use of the tool so that the decrease of the initial price of the tool. The interest cost of capital is Rp. 148,500 / year so that the fixed cost to be incurred in one year is Rp. 668.500 / year. Thus, the principal costs incurred in each of these equipment operations (1, 2, and 3 replication) are Rp. 243,36 / Kg, Rp. 247,99 / Kg, and Rp 249,84 / Kg.

The break-even point (BEP) represents the minimum amount of material processed by the tool (sawdust) in order to balance the profit and loss per unit of time. From the data analysis, there was a break-even of sawdust sieve in replicates 1, 2 and 3 respectively of 21,000 Kg / year, 24,598 Kg / year, and 26,278 Kg / year. This break-even point is also influenced by sieving capacity, sawdust selling price after sieving, yield, fixed cost, and equipment fixed cost.

IV. CONCLUSION

Based on the results of research that has been done, the grading tool sawdust waste generated has a working capacity of 28.49 Kg / hour. The tool can separate the sawdust waste by the particle size of 2 mm (mesh 10), 0.842 mm (mesh 20), 0.4 mm (mesh 40), and 0.177 mm (mesh 80) with mean value of modulus of fineness of each mesh are 889 grams, 651 grams, 431 grams, and 168 grams, respectively. While the uniformity index of the coarse mesh (10 mesh), medium (20 and 40 mesh), and fine (80 mesh) were 5, 4, and 1. Specific power required to achieve working capacity 28.49 Kg / h is 0.0001568 kWh / Kg, and the yield is 77.37%. The cost of operating equipment is Rp. 243,36 / Kg, is cheaper when compared to manual way. From this research resulted a tool design that can be adapted to anthropometry condition of Indonesian people.

REFERENCES

[1] Anonymous. 1985. USP XXI-NF XVI. Washington D.C.: The United State Pharmacopeia Convention Inc
[2] Brown. 1950. Screening distalia. U.S Sieve Series and Tyler Equivalents Inc.
[3] Forestry Department, 2006, Executive, Forest Strategic Data 2006, Centre for Forestry Statistics Plan, Forestry Planning Board.
[4] Leo, S.N. 2016. Development of Grading Tools Sawdust Slaughter as Composite Mixture Material. Essay. Andalas University
[5] Priyono SKS, 2001, Commitment of Various Parties in Tackling Illegal Logging, Indonesia Forestry Congress III, Jakarta.
[6] Sanusi, Dj, 1993. Composition of Saw Industry Waste and Its Utilization Efforts. UNHAS Research Bulletin. Research Institute of Hasanuddin University. Vol VII. No.23.
[7] Schwartz, M.M, 1984, Composite Material Handbook, Mc Graw Hill, Singapore
[8] Sidabutar, N. Paraffin PART on the Making of Particleboard of Random Coconut Fibre. 2009. Universitas Suamatera Utara. Field.

B

AGRIBUSINESS

B.1

CONCEPTION-ADOPTION MODEL OF CRYSTAL GUAVA (A CASE STUDY OF BANDUNG REGENCY, WEST JAVA)

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ABSTRACT

Crystal Guava in Bandung Regency at the first time was introduced in Cimaung District, Tirta Mulya farmer group at 2013. Previously, farmers in Bandung Regency had grew the pink guava. Appearance of crystal guava for farmers is a new thing, because crystal guava came to Indonesia historically as an breeding between Indonesia's guava which was using bottom section of trunk with Taiwan's guava which was using its top section. The appearance of its variety as a technique artefact in social life of farmers, generate the changes as adaptation of relations between social, economic, technology and environment aspects. Is crystal guava an invention or innovation? The relations are identified and analyse in a system thinking framework for knowledge management using System Archetype. The result show that objective, knowledge, technology, learning and people are determine the successful of crystal guava conception-adoption process. Conception-adoption process which is started from local government programme, become a starting point that continue until adoption stage. Better economic prospect furthermore become an accelerator of crystal guava adoption process until now. Support from geographical location where very suitable for crystal guava is an important thing that determine the first stage of crystal guava adoption. According to the passage, interaction between social, economic, technology and environment aspects in a conception and adoption process could not be ignored, it need a well managed for a better conception-adoption process. Crystal guava as an technology is successful to encourage from invention to innovation for fruit farmer in Bandung Regency.

Keywords : conception-adoption, knowledge management, crystal guava, system thinking.

I. INTRODUCTION

Crystal guava is a new variant of guava, it is more preferable because the texture of its body more crunchy and the core is smaller. Crystal guava as a technology artefact is a new thing which is named as invention that defined as new idea or new scientific discovery [1] [2].

Bandung Regency as one of crystal guava development area in West Java since the beginning have been cultivated crystal guava (Fig.1). Statistically, the data about crystal guava that release by Statistics Indonesia Agency or BPS spesifically not available, crystal guava was grouped into guava commodity. However, crystal guava development in Bandung Regency in 2016 spread out in five districts or "kecamatan" (Pacet, Kertasari, Ibun, Ciparay and Cimaung) [3]. According to the positive trend about population of crystal guava trees, it can be estimated that crystal guava which is including into guava follow the increase of guava trees population. Bandung Regency have the best potential land for crystal guava around 400 hectare, and 210 hectare of them have been cultivated with guava. It means still available around 200 hectare potential land for crystal guava development in Bandung Regency [1] [4].

As a new technology, crystal guava was born from research and development activity. Crystal guava came to Indonesia as an breeding between Indonesia's guava which was using bottom section of trunk with Taiwan's guava which was using its top section. The problem of new technology adoption in production sector is failing, which a backlog of problems will discourage further adoption while encouraging abandonment by existing adopters (Fig. 2). Technological change in agriculture is complex, it significantly increases income and also contributes sharpening inequality [5] [6] [7].

Conception-adoption is a chain of innovation. Process of innovation should be managed properly since the conception until adoption that involved social, economy and technology elements. Agriculture as a complex system was built in interdependent structure. Social institution have an important role in a conception-adoption process and economically adoption an innovation should provide equitable benefit, not only stopped at invention stage. Knowledge creation and adoption become the critical sources for innovation, then as a dynamic human process, knowledge built in a structure and work based on the function and role. [8] [9]

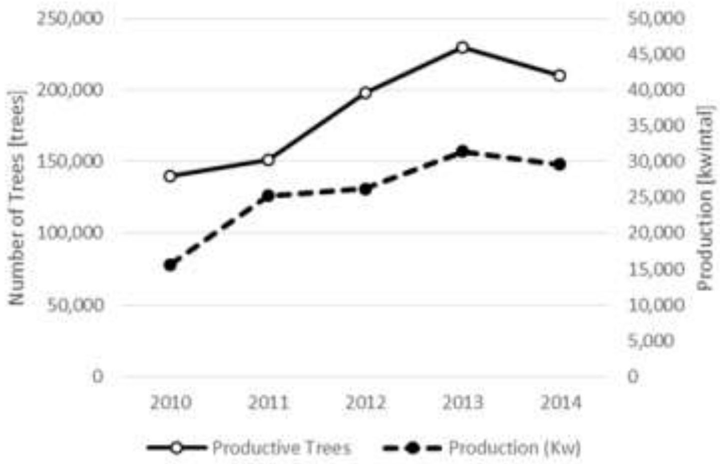

Fig. 1. Number of Crystal Guava Trees and Crystal Guava Production in Bandung Regency from 2010 until 2014

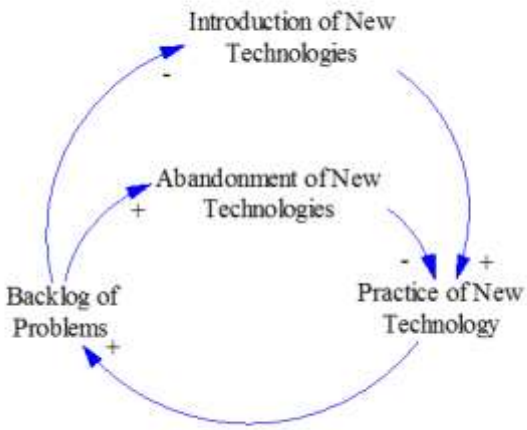

Fig. 2. Feedback loops in the implementation process limiting the spread of new technologies [6]

This paper analyse how technological innovation process of crystal guava from conception until adoption at crystal guava farmer in Bandung Regency. What is the determinant of conception and adoption process of crystal guava? Which the crystal guava including, technology innovation or technology invention?

II. MATERIALS AND METHODS

This research is case study in qualitative method. Qualitative methodology is holistic account that develop a complex crystal guava picture in order to get an in depth understanding [10].

Conception and adoption process of crystal guava is draw using system archetypes that capture the “common stories” in system thinking and dynamic phenomena that occur repeatedly in diverse setting. Archetypes capture the essence of “thinking” in system thinking. Crystal guava technological innovation process defined both “problem” and “closed loop” archetypes. Archetypes problem and solution links are interrelated and often confused, simplification and reduction the number of system archetypes improve their usability to give better understanding about the main problem. [11] [12]

A. Study Area

This study case is technological innovation process in Bandung Regency, West Java located in separated district, initially was started from Tirta Mulya farmer group in Cimaung District. Crystal guava is one of new horticultural commodity in Bandung Regency, especially for fruit grower in the highland.

B. Data sources

Data collection is draw on multiple sources of information about innovation process of crystal guava, such as observation, interview, and documents. Interview was conducted with several informant who are consist of farmer, farmer group management, extension worker, local trader, and exporter in Bandung Regency. Observation in order to validate the data that received and collected by causality tracing as result from interview and document study. Boundary of this research built in the innovation process which is technological conception of crystal guava as the beginning and technological adoption or diffusion of crystal guava as the ending.

Actor who are involve in crystal guava supply chain became the starting point for causality tracing. Tirta Mulya farmer group was the first farmer group in Bandung Regency who cultivated crystal guava in Cimaung district Bandung Regency. In the next step, the source or informant for interview was chosen purposively using snow ball technique follow the causality about crystal guava both conception process and adoption process. Overall there were five crystal guava farmer groups, one local trader, one government extension worker, and one exporter that interviewed.

Information obtained during the interview categorized as mental data base, information obtained from document categorized as written data base. The mental database is vastly richer than the written database in the form of books, magazines, and newspapers. In turn, the written database is far more informative about how society operates than the numerically recorded information [13].

III. RESULTS AND DISCUSSION

Crystal guava conception process for Indonesian farmer was started since 1998 with several research and development activity by Taiwan Technique Mission under International Cooperation and Development (ICDF) as diplomate cooperation between Indonesia and Taiwan. Through research and development networking, crystal guava introduced in Bandung Regency at the first time in 2013 under local government programme. Tirta mulya farmer group is the first farmer group who has been developing crystal guava until now.

Conception-adoption model refer to conceptual theory such as technology management, knowledge management, and adoption and diffusion innovation. Methodologically, this paper using system thinking approach to describe and analyse about the process of conception to be adoption decision.

A. Determinant of Crystal Guava Conception

Relationship between off-farm and on-farm generating many activities interrelated one to another. On-farm activities of crystal guava systematically have strong relationship with off-farm activities both physical and decision flow. Before decide to adopt or cultivate crystal guava, the farmers have passed the conception phase which is selling price of crystal guava that higher than conventional guava. Price is one of the significant push factor for farmer so that the farmer cultivate crystal guava trees. Exceptional case of Tirta Mulya farmer group in Cimaung district who categorized to innovator, on-farm factor influence stronger especially farmer knowledge as result from training and dissemination by local government of Bandung Regency (see Fig. 3). Innovators are active information seekers about new ideas, they have a high degree of mass media exposure and large interpersonal network [14] [15].

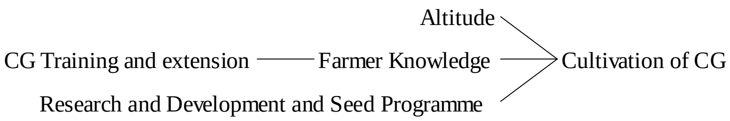

Fig. 3. Causes Tree Diagram of Innovator about Crystal Guava Conception in Bandung Regency

When the first time adopt crystal guava cultivation, Tirta Mulya farmer group faced a big risk especially on-farm in land compatibility and technology, it become higher when off-farm enhance the risk from market price and buyer. High uncertainties as innovator are the risk which have faced by Tirta Mulya farmer group in the beginning of crystal guava cultivation in 2013. In line wit Rogers that innovators are able to cope with higher levels of uncertainty about an innovation [15].

Another farmer groups who follow Tirta Mulya farmer group in other districts of Bandung Regency have lower risk about adoption decision. Benefit economic factor and market demand have established before because of fruit specification are liked by the consumer. Crunchy fruit bodies and small size of its core are liked and causes market demand increasing especially modern retail such as supermarket.

Increased market demand directly reduce off-farm risk which is in some cases of agricultural technology innovation stop the conception process to be adoption or in product view inhibit an invention to become an innovation. Crystal guava price in famer level is about 15,000 to 20,000 rupiahs per kilogram, the price is better than conventional guava that sell only about 3,000 to 6,000 rupiahs per kilogram.

The difference of their conception-innovation track between innovator farmer group and early adopter and early majority is about the decision reasoning. Early adopter and early majority farmer groups have much more consideration than the innovator farmer group in decision tu cultivate crystal guava plant or not. The innovator effort on this view harder than early adopter or early majority. Brazil's and Peru's case show that support from public policy is very important to encourage the process of an invention to be an innovation. Innovator contribution is needed in order to push an invention to become an innovation through improving existing products, responding to adversity with determinant and resilience and honing their creative skills [15] [16].

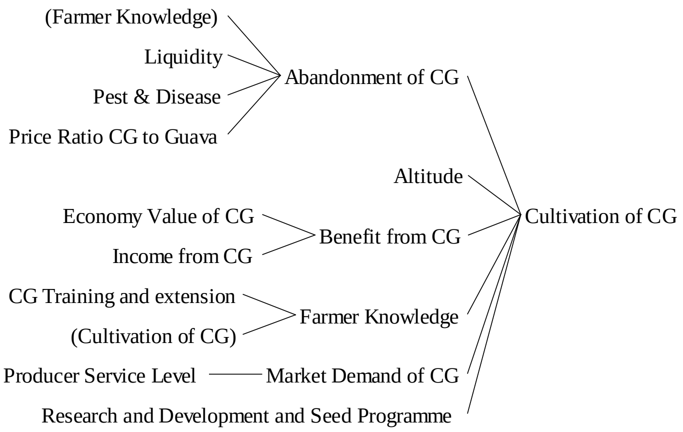

Fig. 4. Causes Tree Diagram of Early Adopters and Early Majority about Crystal Guava Conception in Bandung Regency

In crystal guava case, inventor institution in Indonesia was ICDF who managed by IPB (Bogor Agricultural University). Tirta Mulya farmer group as the nearest innovator to inventor until now still have a good relationship and communicate actively with ICDF-IPB about crystal guava development. When farmer group met a lot of problem in crystal guava cultivation such as pest and disease, ICDF-IPB gave their assistance intensively in extension and training form. The role of inventor institution effective to increase farmer knowledge capacity which is directly improve farmer farming skill.

Local government of Bandung Regency also very concern with crystal guava extensive through seed and training programme. At policy level, technology improvement in developing countries is an effort to accelerate the economic growth, indeed introduction process of new technology before practice new technology. [1] [16] [6]

Furthermore in early adopter and early majority farmer group, event market risk have reduced but their conception process become more complex than the innovator farmer group. Beside government programme and farmer knowledge, abandonment of technology determine farmer decision as a constraint like pest and disease, market price, and farmer liquidity to access the required technology in crystal guava farming.

B. Determinant of Crystal Guava Adoption

Adoption on this paper is the next step after conception. Adoption phase is started when farmer group decide to cultivate the crystal guava trees. There are some factors should be noticed during the adoption process such as the grow sustainability of young trees, farmer knowledge and the requirement of technology. These three adoption elements are collaboration among human, technology and environment. In general, an adoption needs to be inline with the available human resources, if not, the adoption may face serious problem in adaptation [17].

Attempts on this adoption process intent to increase farmer competitiveness. Keep being innovative will keep the company, this case is farmer group to be competing among the turbulence changes in business environment. Market driven with customer focus will lead the farmer group to fulfil willingness of consumer, differentiation crystal guava from conventional as usual will make the consumer easily to switch their buying to the new one [18].

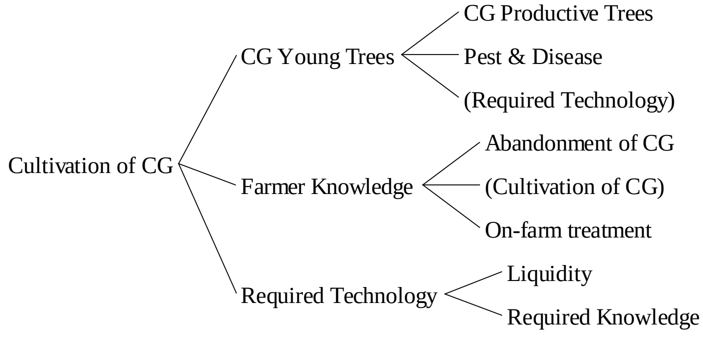

Fig. 5. Causes Tree Diagram about Crystal Guava Adoption in Bandung Regency

The sequel process of adoption is a big challenge. Inventor guidance for innovator farmer group at this phase is needed. How to use technology and treatment in crystal guava cultivation require many input dynamically according to the age of trees. ICDF-IPB and local government of Bandung Regency are inventor and policy institution who are together with Tirta Mulya farmer group go through the challenge in crystal guava development like pest and disease, fruit growing, event market penetration [19] [1] [16].

Moreover for early adopter and early majority, event innovator have gave a good sample, but the challenge in cultivation is still a big thing for them. According to crystal guava farmer around Tirta Mulya group who cultivate crystal guava, limitation of capital especially in the first year of cultivation restrict the farmer to improve their plants or trees intensively. It is because of character of annual crop that in first year not produce fruit in optimal condition, so that farmer income slightly low. Meanwhile, farmer invest a lot of money for cultivation technology and worker. These condition cause a complication of crystal guava farmer in adoption phase.

Beside of economic problem, the lack of farmer knowledge about cultivation technique causes some fault in crystal guava treatment. Pest and disease handling effectively and efficient produce an optimal crystal guava production.

Accumulation from funding limited liquidity and lack of farmer knowledge, if ignored in a long period it will impact to abandonment of technology in this case crystal guava. Farmer unable to access the technology based on interview caused to low yield productivity per tree, so that crystal guava production is not optimal. The impact of low production means low income, low quality will push down the price and small number of harvest will push down the quantity.

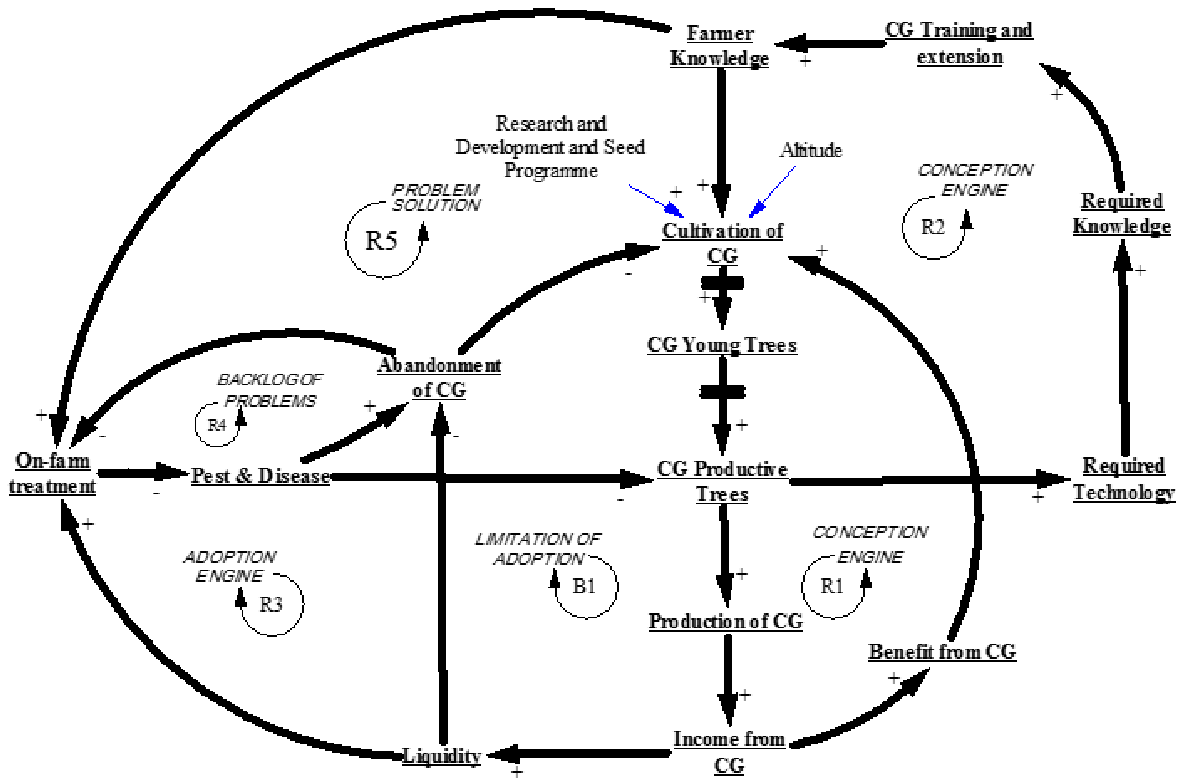

Fig. 6. Main Feedback Loop of Crystal Guava Conception-Adoption Process in Bandung Regency

C. Conception-Adoption Model

Conception-adoption model is a chain process of conception an adoption decision which is captured in an interrelated between conception phase and adoption phase in a causal loop diagram structure. Relationship of conception and adoption are interconnected one to another in an innovation process (Fig.6), conception phase and adoption phase structurally is difficult to different when they frame in an one causal loop diagram of innovation process, all elements are interconnected both direct or indirect.

Generally there are for types of main archetype in conception and adoption process of crystal guava. The main archetypes are feedback loop of a big causal loop diagram which is complex and detail with hundred of feedback loop. The four main archetypes explain how conception and adoption process in knowledge and technology management, technological innovation and agricultural technology production.

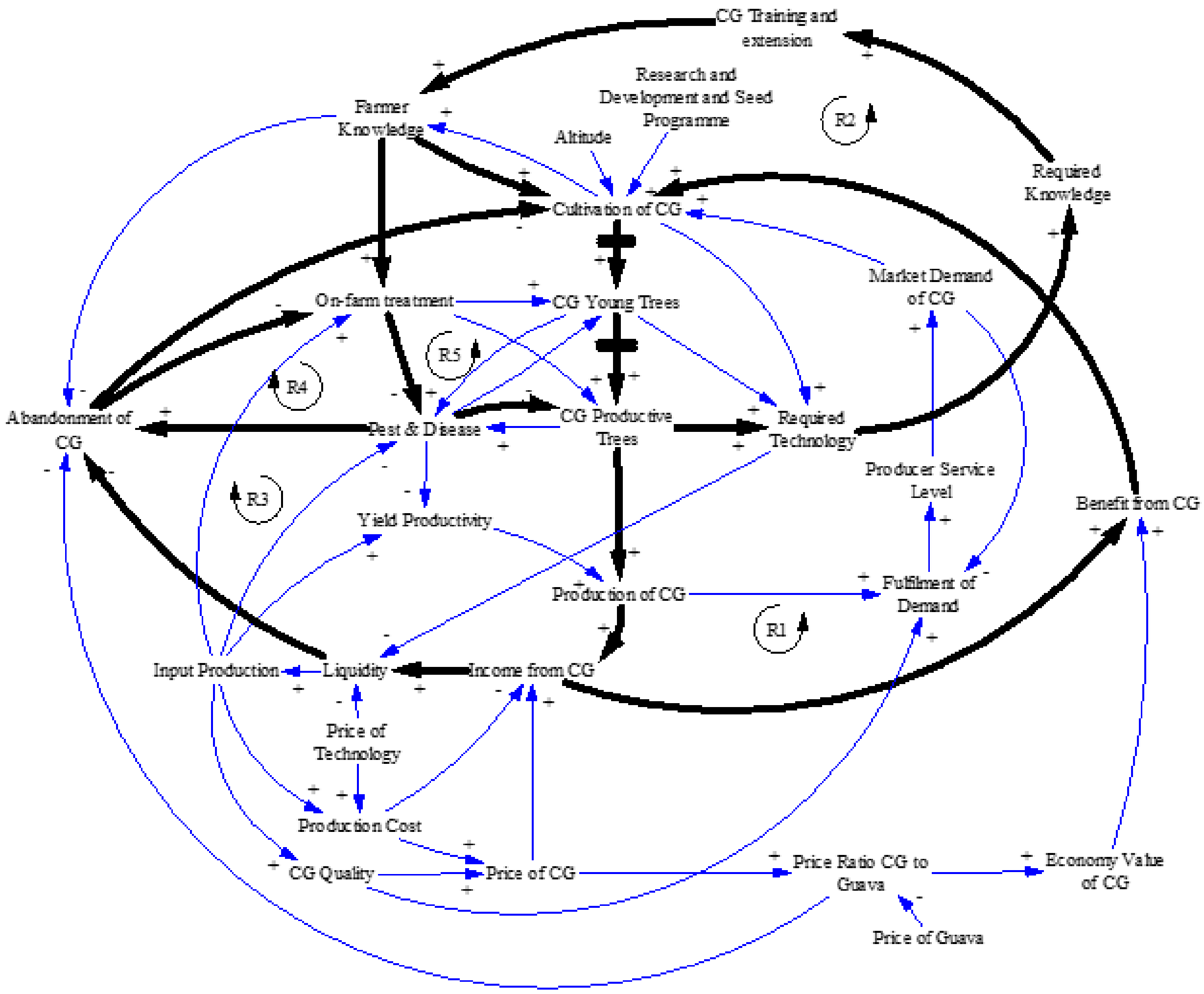

Fig. 7. Complex Causal Loop Diagram of Crystal Guava Conception-Adoption Process in Bandung Regency

1. *Conception Growth Engine (R1 and R2)*

Conception engine in causal loop structure diagram push strongest with R1 and R2 feedback loops. R1 feedback loop is about economy factor that encourage the farmer to adopt (cultivate) crystal guava, price of crystal guava on this feedback is determinant how strong the benefit that received by farmer. Higher price of crystal guava, caused better economy benefit received by farmer and motivate farmer to cultivate and develop crystal guava. Result from these process is positive feedback which push farmer and farmer group cultivate crystal guava in Bandung Regency. Positive feedback in system archetype is a growth engine in system (20).

The second reinforcing process in causal diagram structure is R2 feedback loop. This feedback explain how knowledge management work in conception-adoption process. Number of crystal guava trees determine the required technology and required farmer knowledge, increasingly the number of crystal guava cultivation, increase required technology and farmer knowledge. Training and government programme in order to improve the farmers knowledge, this pattern create a reinforcing process (positive feedback) to encourage farmers cultivate crystal guava. Farmers knowledge is intangible basic capital that influence farmer in adoption decision. Lack of know-how about technology and maintenance (treatment) reduce conception process which push the crystal guava adoption. [8] [21]

2. *Adoption Growth Engine and Limitation of Adoption (R3 and B1)*

Adoption phase is a process of innovation in decision making about crystal guava cultivation. Farmers liquidity is important determinant in adoption decision, because of farmer capability in access the technology is determine by financial capability which source from farmer income. Better financial liquidity of the farmer increase production ability so that more effective and efficient during production process, better access to technology in treatment and maintenance reduce pest and disease attack to crystal guava. This process draw in a R3 feedback loop which encourage farmers to adopt continuously.

Although in the process of adoption face a big challenge especially in access to technology, but if wrong in managing the challenge, abandonment of technology will increase in a big movement among the adopters. This problem usually happen in the first year of annual crop because of investment cost do not match wit the revenue from production. Abandonment of technology will inhibit adoption process in the next year farming and configure a negative feedback (balancing loop: B1 feedback loop). Negative feedback limits to growth of adoption speed in macro level [6].

3. Backlog of Problems (R4)

The problem of conception and adoption in causal loop diagram represent in abandonment of technology. Abandonment of crystal guava adoption will influence to decrease the optimization of plant maintenance and treatment, there will be more pest and disease un solve because farmer do not have enough capability (technology and knowledge) to manage it. Unfortunately this backlog of problems archetype configure a R4 positive feedback loop and must be watch and manage carefully so that the reinforce growth of R4 can be reduced in order limit the abandonment of crystal guava. If pest and disease growth uncontrollable, the possibility of crystal abandonment will increase and harm the crystal guava population in Bandung Regency.

4. Problem Solution

The worried problem on this archetype is about growth of R4 feedback loop named abandonment of technology. It can be solved with a better knowledge of farmer in crystal guava cultivation. Farmer knowledge is a very important intangible capital which needed in crystal guava management farming include the pest and disease management.

Larger population of crystal guava cultivated caused higher potential attack of pest and disease of crystal guava. Activity to increase farmer knowledge capacity such as extension and training, properly inline with the growth of crystal guava population. Likewise with the government programme will be more effective if set in farmer knowledge and skill improvement in crystal guava farming.

IV. CONCLUSION

Determinant of conception-adoption process of crystal guava that received by farmer fruit in Bandung Regency is influenced by many factors. Conception determinant and adoption determinant explicitly can be different because they together have the same role in push or resist the cultivate decision in crystal guava development. The determinants are benefit form crystal guava, farmer knowledge, market demand, altitude, abandonment of crystal guava, and research and development seed program. The conception determinants are causes by another element such as economic (liquidity, income, economy value, price), social (training and extension), technology (cultivation, pest and disease), and environment (altitude).

So many benefit that received by the farmer especially in economic aspect, crystal guava farmer income can be higher than conventional guava caused of crystal guava price is better than another guava and better yield of productivity. Socially the increasing of farmer knowledge is intangible benefit for farmer group and their society. According to economy and social benefit, so that crystal guava can be classified as innovation [16], crystal guava as an technology is successful to encourage from invention to innovation for fruit farmer in Bandung Regency.

ACKNOWLEDGEMENT

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REFERENCES

[1] Damayanti NT. *Potensi Pengembangan Tanaman Jambu Kristal (Psidium guajava L) Berdasarkan Aspek Agroklimat di Jawa Barat*. Institut Pertanian Bogor; 2016.

[2] Diaconu M. *Technological Innovation: Concept, Process, Typology and Implications in the Economy. Theor Appl Econ*. 2011;XVIII(10):127–44.

[3] Dinas Pertanian Tanaman Pangan Provinsi Jawa Barat. *Standar Operasional Prosedur Jambu Kristal Bandung Regency*. Bandung; 2016.

[4] Dinas Pertanian Tanaman Pangan Provinsi Jawa Barat. Data Statistik Tanaman Pangan dan Hortikultura tahun 2010-2014. Bandung; 2014.

[5] Ridwan M. *Analisis Usahatani Jambu Kristal Desa Cikarawang Kecamatan Dramaga District Bogor*. Institut Pertanian Bogor; 2013.

[6] Saeed K. *Managing Technology for Development : a Systems Perspective*. Socio-Economic Plan. 1990;24(3):217–28.

[7] Rahman S. *Impact of Technological Change on Income Distribution and Poverty in Bangladesh Agriculture: an Empirical Analysis.* J Int Dev. 1999;11:935–55.

[8] Heryanto MA, Sukayat Y, Supyandi D. *Conception-adoption Model of Organic Rice Innovation: Farmer's Social Economy (Case Study in Tasikmalaya, West Java)*. War KIML. 2014;12(2):139–50.

[9] Gao F, Li M, Nakamori Y. *Systems thinking on knowledge and its management: systems methodology for knowledge management.* J Knowl Manag. 2002;6(1):7–17.

[10] Creswell JW. *Qualitative Inquiry and Research Design_ Choosing among Five Approaches*. 2nd ed. Lincoln: Sage Publication, Inc.; 2007.

[11] Kim DH. S*ystems Archetypes I: Diagnosing System Issues and Designing High-Leverage Interventions*. Waltham: Pegasus Communications, Inc.; 2000.

[12] Wolstenholme E. *Using generic system archetypes to support thinking and modelling.* Syst Dyn Rev. 2004;20(4):341–56.

[13] Forrester JW. *Some Basic Concepts in System Dynamics*. 2009;1–17.

[14] Morris W, Henley A, Dowell D. *Farm diversification , entrepreneurship and technology adoption : Analysis of upland farmers in Wales*. J Rural Stud [Internet]. 2017;53:132–43. Available from: http://dx.doi.org/10.1016/j.jrurstud.2017.05.014

[15] Rogers EM. *Diffusion of Innovations*. 2nd ed. New York: The Free Press, A Division of Macmillan Publishing Co., Inc.; 1971.

[16] Stephany L, Fontinele E, Maria V, Barros C, Moraes D. *From invention to Innovation — challenges and opportunities : a multiple casestudy of independent inventors in Brazil and Peru*. RAI Rev Adm e Inovação [Internet]. 2017;14(3):180–7. Available from: http://dx.doi.org/10.1016/j.rai.2017.05.002

[17] Dijken K van, Yvonne P, Wolters T, Frey M, Mussati G, Kalf P, et al. *Adoption of Environmental Innovation. The Dynamics of Innovation as Interplay between Bbusiness Competence, Environmental Orientation and Network Involvement*. Springer Science + Business Media Dordrecht; 1999.

[18] Utami HN, Sadeli AH. *Marketing communication innovation of fresh fruit and vegetables (FFV) modern retail local supplier: competitiveness of small holder to enter modern retail*. Sosiohumaniora. 2014;16(3):282–8.

[19] Heryanto MA. M*odel Perilaku Petani Dalam Adopsi Sistem Usahatani Padi Organik: Paradoks Sosial-Ekonomi-Ligkungan*. Sosiohumaniora. 2016;18(2):149–54.

[20] Braun BW. T*he System Archetypes*. 2002;1–26.

[21] Ramani S V., SadreGhazi S, Gupta S. *Catalysing innovation for social impact: The role of social enterprises in the Indian sanitation sector*. Technol Forecast Soc Change [Internet]. 2016; Available from: http://dx.doi.org/10.1016/j.techfore.2016.10.015

B.2

AGRICULTURAL SECTOR AND AGROINDUSTRY LINKAGE IN CREATING REGIONAL ECONOMIC MULTIPLIER IN NEW REGIONAL AUTONOMY

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ABSTRACT

The objective of this research are to (1) examine the economic base sector which contribute to regional economic growth (2) analyze the linkages between agricultural and agroindustrial sector (3) to examine the multipliers impact of regional output. The data collected include (a) GDP of 2010-2014, and (b) I-O (Input-Output) Table as an update version of I-O 2010, using RAS Method of Lampung Province. I-O Table of 2014 of Mesuji District is derived from I-O 2010 using LQ (Location Quotient). The results show that (1) agriculture and industrial processing are the economic basis. (2) the plantation, livestock, as well as food and beverages sub-sectors have forward linkages, spread effect, and spread coefficient.Those sectors are able to encourage and attract the downstream and upstream of sector growth, respectively. (3) the industrial processing sector has a greater multiplier impact than the agricultural sector.

Keywords : regional economic, I-O Tabel, linkage, multiplier effect.

I. INTRODUCTION

Mesuji district is a new regional autonomy splitted from the main district of Tulang Bawang District through Law No. 49 of 2008. With the existing authority Mesuji District is entitled to take care of its own "household". According to Kuncoro (2012), improving the welfare of local people is the fundamental reason for regional separation, in addition to improving services, and shortening the span of control. Autonomy should be understood functionally, in which the autonomy orientation is interpreted as an effort to maximize government functions, namely arrangement, service, and empowerment that can be done as quickly, as closely, and as precisely as possible to society needs (Badrudin 2012).

Based on data (BPS Provinsi Lampung 2016), during the period of 2012 to 2015, the position of economic growth rate and Gross Domestic Regional Product (GDRP) per capita of Mesuji District are consistently at higher criteria. In 2012 and 2014, Mesuji District is in a position equivalent to Tulang Bawang District as the main District,however in 2013 and 2015 the Tulang Bawang District quadrant shifts to a lower growth rate and Mesuji District in an equal position with Bandar Lampung City which is the capital of Lampung Province.

These data indicate that mesuji district as a new regional autonomy can be well developed as its main district, i.e.,Tulang Bawang District. Whereas according to Bappenas and UNDP (2008), the level of economic growth in the main district is higher than the new regional autonomy. the main district has a better per capita gdrp than the new regional autonomy.

Mesuji District is categorized as a district with high economic growth rate and high per capita income that is also a positive indication for the newly established separation regions. Mesuji District as a separated district from Tulang Bawang District has similar economic characteristics from its main district with an average share of agriculture to its GDRP of 47.88% as shown in Table 1. The contribution of GDRP based on economic sectors in Mesuji District can be seen in Table 1.

The agricultural sector is the sector that gives the largest contribution to GDRP of Mesuji District during the period of 2009 to 2013 in the amount of 47.88 percent. The second largest contribution comes from the processing industry sector with an average share of 23.69 percent. The condition of mesuji district as a new regional autonomy, with the economic growth that becomes interesting to be studied further as what aspects of the economic base sector are able to encourage the regional economic growth? What is the relation of the economic base sector to the region's economy?

The objectives of this study are (1) to examine the economic base sector that drives regional economic growth, (2) to analyze the linkages of agricultural and agro-industry sectors in the regional economy, and (3) to analyze the impact of output multipliers.

Table 1. GDRP contribution by economic sectors in District Mesuji Period 2009-2013

No.	Sector	2009	2010	2011	2012	2013	Average
		Percent (%)					
1	Agriculture	49,28	49,50	47,67	46,59	46,34	47,88
2	Mining	0,20	0,22	0,21	0,20	0,20	0,21
3	Processing industry	24,52	23,48	23,87	23,52	23,05	23,69
4	Electricity, Gas & Water	0,02	0,01	0,01	0,01	0,01	0,01
5	Building / Construction	1,43	1,61	1,80	1,83	1,79	1,69
6	Trading, hotel and restaurant	14,55	14,93	16,05	16,98	18,15	16,13
7	Transportation and Communication	2,87	3,09	2,96	2,94	2,90	2,95
8	Finance	3,04	2,92	2,85	2,69	2,56	2,81
9	Services	4,08	4,24	4,58	5,24	5,00	4,63
	Amount	100,00	100,00	100,00	100,00	100,00	100,00

Source: BPS 2014 (data were analyzed)

II. MATERIALS AND METHODS

The location of the research was conducted in Mesuji District as the new autonomous region, result of the separation from the main district of Tulang Bawang District in 2008. The used data is the secondary data consists of GDRP on the basis of 2010-2014, Input-Output Table (IO) of Lampung Province Year 2014 which is the result of updating with RAS Table IO method in 2010 and lowered to Table IO 2014 for Mesuji District through Location Quotient (LQ) approach. Input analysis used in this study is based on the analysis of the economic inter-sectoral linkages, spread effect, and output multiplier impact.

A. Location Quotient (LQ) Analysis

The basic sectors are considered to be able to encourage economic growth. One indicator that is able to describe the existence of the base sector is through the LQ index which is a simple indicator that can indicate the strength or the role of a sector in an area compared with the area above it. How to measure LQ from a sector in a region's economy with a value-added approach or GDRP. Mathematically LQ measurement as follows:

$$LQ = \frac{Vi/_{Vt}}{Yi/_{Yt}} \tag{1}$$

where Vi, Vt, Yi, and Yt denote the value of sector I GDRP at the lower level of the region, total GDRP at the lower region level, the value of sector I GDRP at the upper region level, and total GDRP at higher regional level, respectively.

A sector with an LQ>1 means that the sector is a base sector that becomes a regional power to export its products outside the region concerned. Conversely, if LQ <1, the sector becomes an importer. Whereas, if LQ = 1, there is a tendency that the sector is closed because it does not conduct transactions to and from outside the region, however such conditions are difficult to find in the region's economy.

B. Input Output Analysis

The IO method can be used to see which sectors can be a sector of leaders in regional development. According to Arief (1993) in Daryanto and Hafizriandra (2010), these sectors can be detected in four ways:

- A sector is considered a key sector if it has a backward link and a forward link
- A sector is considered a key sector if it produces relatively high gross output, thus maintaining a relatively high final demand
- A sector is considered a key sector if it is capable of generating relatively high net foreign exchange earnings
- A sector is considered a key sector if it is able to create relatively high employment opportunities.

Rustiadi *et al*. (2011) also explained that the Input-Output (IO) table structure is used as a linkage tool for economic sector linkages. For the purposes of analysis, the most important parameter is the coefficient of technology which is mathematically formulated as follows:

$$a_{ij} = \frac{X_{ij}}{X_j}\ atau\ X_{ij} = a_{ij}.X_j \tag{2}$$

where a_{ij} denotes the ratio between the number of outputs of sector *i*used as input sector *j* (X_{ij}) to total input sector *j*(X_j) or also known as input coefficient. Thus, Table I-O or Equation 2 can be mathematically formulated as the following matrix equation:

$$\begin{bmatrix} a_{11} & a_{12} & \vdots & a_{1n} \\ a_{21} & a_{22} & \vdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & a_{nj} & a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \\ X_n \end{bmatrix} + \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_n \end{bmatrix} \tag{3}$$

GDRP of sector *i (Vi)* is further notated as *Yi*, where $Y_i = F_i^d - M_i =$ GDRP of the *i* sector. With the above matrix notations then can be formulated as AX + Y= X, where matrix A is a direct relationship coefficient matrix between sectors (technological coefficients), thus

X – AX = Y,
(I - A) X = Y,
X = (I - A) -1.Y.

The matrix (I - A) is known as the Leontief matrix, an important parameter in the I - O analysis. The inversion of the matrix, matrix $(I-A)^{-1}$or B is Leontief's inverse matrix (interconnected sector matrix) or also called as multiplier matrix. Since $(I-A)^{-1}Y = BY$, the production increase (X) is the result of the pull of the final demand Y. The gradient of increase is determined by the elements of the B matrix.

C. Technical parameters in I-O Analysis.

1. Direct Backward Linkage

It demonstrates the effect of a sector's demand on a change in the level of production of sectors that directly provides the intermediate input for the sector, i.e., by adding up each column a_{ij} in each column j, where

$$B_j = \sum_i^n a_{ij} \tag{4}$$

For the need to measure relative (comparison with other sectors), there is a normalized measure which is the ratio of the direct backward linkage of sector *j* to the backward linkage average of other sectors, hence

$$B_j^* = \frac{B_j}{\frac{1}{n}\sum_j B_j} = \frac{n.B_j}{\sum_j B_j} \tag{5}$$

The value of above B_j^* is 1 that indicates the *j* sector has a strong backward linkage in penegrila having a stronger influence on the growth of other sectors in meeting the derived demand posed by this sector.

2. Direct Forward Linkage

It shows the output of a sector used by other sectors as

$$F_i = \sum_j a_{ij} \tag{6}$$

Normalized F_i or F_j^* is formulated as follows

$$F_j^* = \frac{F_i}{\frac{1}{n}\sum_i F_i} = \frac{n.F_i}{\sum_i F_i} \tag{7}$$

3. Direct And Indirect Backward Linkage

It indicates the indirect effect of an increase in the final demand of a particular sector unit (*j*) that can increase the total output of all sectors of the economy. This parameter shows the strength of a sector in driving the improvement of all sectors of the economy, mathematically formulated as follows

$$BL_j = \sum_i bij \tag{8}$$

where *b* is the matrix elements *B* or $(I\text{-}A)^{-1}$which is the inverse of the Leontief matrix.Backward linkages effect ratio or backward power of dispersion (β_j) expressed as :

$$\beta_j = \frac{\sum_j b_j}{\frac{1}{n}\sum_i \sum_j b_j} = \frac{n.\sum_j b_j}{\sum_i \sum_j b_j} \tag{9}$$

It demonstrates the relative strength of a sector's final demand in driving the total production growth of all sectors of the economy. If β_j > 1, then the relative demand for *j* sector in stimulating production growth is greater than the average.

4. *Direct and Indirect Forward Linkage*

The role of a*i* sector can meet the final demand of the entire economy, where

$$FL_i = \sum_j b_{ij} \tag{10}$$

When the final demand for each sector of the economy increases one unit (which means the increase in the final demand for all sectors of the economy is in *n* units) thus *i* sector contributes to the fulfillment of FL_i.

The sensitivity to end-market signal or sensitivity index (forward power of dispersion, α_j) is expressed as

$$\alpha_j = \frac{\sum_j b_j}{\frac{1}{n}\sum_i \sum_j b_j} \tag{11}$$

It demonstrates the contribution of relatif a sector in meeting the overall demand of the economic sector. If a sector has characteristics with $\alpha_j > 1$, then the sector is a strategic sector. This is because it can relatively meet the final demand above the average capacity of the sector.

III. RESULTS AND DISCUSSION

A. *Base Sector of Regional Economic Growth Drivers*

After the separation, the agricultural sector is still the base sector (LQ = 1.39) in Mesuji District as the main district of Tulang Bawang with positive growth. Food crops and plantations are the dominant sub-sectors to the contribution in the agricultural sector. Main food crops other than rice are cassava produced in 97% of the total land area for food crops of 32,618 ha. In the plantation sub-sector, oil palm and rubber crops dominate the plantation sub-sector. 45% of the plantation area is for palm oil crops and 54% for rubber from the total plantation area of 45,351 ha. The area of Mesuji District is 218,400 ha. The agricultural sector as a base is supported also with a potential labor base. With sector contribution to GRDP 46%, this sector is able to absorb labor 78%.

Another base sector in Mesuji District after the separation is the manufacturing sector. The local growth of this sector tends to slow down. But it is still possible to develop, considering that this sector is also the basis of sector for labor. There are 4 units of medium / large industry and 749 units of small industry in Mesuji District which contributes to GDRP in manufacturing industry sector. The mining and quarrying sectors, and the service sector, are the non-base sectors which allow to become potential sectors because they have positive growth (Endaryanto 2015).

According to Endaryanto (2015), the two basic sectors in Mesuji District are agriculture and processing industries similar to the existing base sector in Tulang Bawang both before and after the separation. This is likely to occur because the split region has characteristics of potential economic sector that are relatively similar to the main district. It includes area after separation that is sufficient for sector development such as agriculture sector. If this sector is well managed and developed, hence it is expected to be able to increase people's incomes and reduce poverty.

According to Gyimah-Brempong (1988), high growth of agricultural sector can increase relative income and decrease income inequality. The strategy is by providing price incentives, improving the village road infrastructure, and the availability of inputs. However, because there are still many poor people in the agricultural sector, the strategy for development is not enough to only reduce the inequality of income, but it must also reduce the level of poverty.

Based on the analysis of Klassen Tipologi, in Mesuji District, the agriculture, mining, quarrying sectors and services, processing and gas, electricity, and drinking water industries are categorized as potential sectors or can still grow rapidly as shown in Fig. 1. As a new regional autonomy, to develop potential sectors, Mesuji District needs to manage the region well and efficiently. Distance center of the capital district and the provincial capital are far enough, as well as road infrastructure.

If it is viewed from Human Development Index (HDI) Mesuji District (68.79) that is still under the HDI of the main district and Lampung province, hence the improvement of quality and service of education, as well as health and economic improvement is very important to be noticed. If the management can be well and efficiently performed, hence the potential development of potential sectors such as agriculture and industry sectors with commodities such as cassava, rubber, and oil palm can greatly contribute to the region. Especially with the support of large medium, medium, and small industries in the industrial sector.

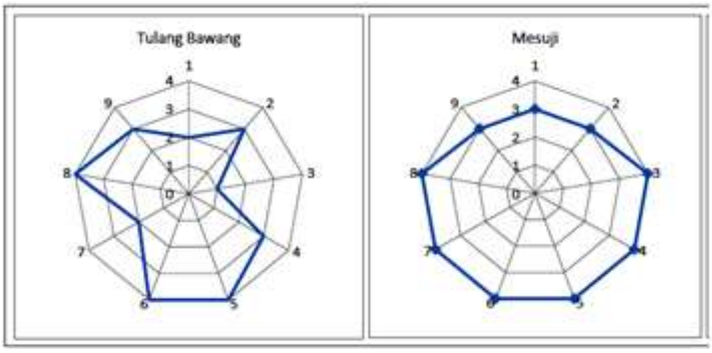

Fig. 1. Radar Diagram of Klassen Typology Sector In Tulang Bawang and Mesuji Districts 2009-2013

In general, based on the classification of classification for the district, it is still quite a lot of sectors in the category of relatively lagging behind. Nayak and Mishra (2009) states that some aspects of structural change in Meghalaya include reduced employment in the agricultural sector and are converted with an appropriate increase in the tertiary sector, especially in the suburbs. The manufacturing and mining sectors are gradually becoming more prominent. Furthermore, income per capita increases. However, improved infrastructure is not balanced by the increasing number of vehicles on the road that are increasing rapidly. Mesuji District as a newly created district, during the period of 2010-2013 post-2008, was able to show an encouraging economic performance as shown in Fig. 2.

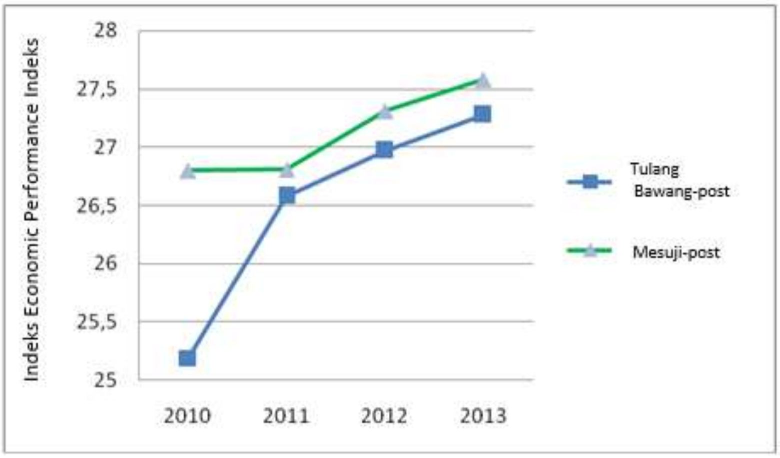

Fig. 2. Economic performance of Tulang Bawang and Mesuji Districts

The average Economic Performance Indeks (EPI) of Mesuji District is of 27.13 higher than the parent district of Tulang Bawang which is 26.51. Indicators that encourage the economic performance of Mesuji District are the growth of increasing GDRP and the level of poverty in the district of the lower expansion of the parent district, so that the average of (EPI) Mesuji District (expansion) during 2010-2013 is higher than Tulang Bawang.

B. The Linkage of Agricultural Sector and Agroindustry in the Regional Economy

To determine the impact of changes in the final demand of a sector on the output of all economic sectors in a region, it can be seen from the value of backward linkage. By knowing the value of backward linkage, hence it can be searched the index of power dissemination of sector concerned. Then, to know the impact of changes in the final demand of a sector on the output of all economic sectors in a region, it can be seen from the value of forward linkage. By knowing the value of future relevance, hence it can be searched index of degree of sensitivity of sector concerned.

The forward linkage is divided into two categories, i.e., (1) direct forward linkage and (2) direct and indirect linkage (total linkage). The direct forward linkage shows that if there is a final increase of one unit, hence the output of the sector allocated directly to other sectors including the sector itself will increase by the value of its linkage. The direct and indirect linkages indicates that the sector has direct or indirect linkages to other sectors including the sector itself. In addition, the future linkage is the linkage of the upstream production sector to the downstream.

Based on the Table 2, the results of the analysis of direct and indirect output (total linkage) output in the future generally show that the economic sector in Mesuji District has a value of total forward linkage of more than one. The sub-sectors with the greatest forward-looking linkage were the food and beverage industry sub-sector of 1.414816, followed by food crops sub-sector of 1.366707. These values indicate that each increase of 1 (one) unit of final demand for the food and beverage subsector will result in an increase in total output of 1.414816 and any increase of 1 (one) unit of final demand for food crop sub-sector will result in an increase in total output of 1.366707. This shows the role of the food and beverage industry sub-sector and the food crop sub-sector in providing the output generated for the use as input by other sectors in the production process and used to meet the substantial end-demand.

Then the result of analysis of direct linkage of economic sector in Mesuji District is the sector that has the largest direct linkage which is the livestock sub-sector of 0.293848 and the food and beverage industry subsector of 0.377560. This means that any increase of 1 (one) unit of final demand of the livestock sub-sector will directly result in an increase in total output of 0.293848 through the path of increasing of the output of livestock subsector used as the input by other sectors. Each increase of 1 (one) unit of final demand of the food and beverage subsector will directly result in an increase in total output of 0.377560 through an increase in the output of the food and beverage industry subsector used as the input by other sectors.

Table 2. Direct Linkages, Direct and Indirect Linkages of Mesuji Distric, 2014.

No.	Sector	Forward Linkages		Backward Linkages	
		Direct	Direct and Indirect	Direct	Direct and Indirect
1	Food Crops	0.275897	1.366707	0.121271	1.138932
2	HorticultureCrops	0.056640	1.063423	0.072850	1.195100
3	Plantation	0.221757	1.277858	0.156336	1.195089
4	Animal Husbandry	0.293848	1.355733	0.233298	1.194914
5	Agricultural Services, and Hunting	0.131686	1.157391	0.147339	1.184353
6	Forestry and Logging	0.024074	1.025165	0.224020	1.174390
7	Fishery	0.235225	1.290273	0.138820	1.174334
9	Food and Beverage Industry	0.377560	1.414816	0.138588	1.174024
10	Wood And Products Of Wood, Cork And Wickerwork From Bamboo, Rattan And Similar Products as well As The Furniture Industry	0.036154	1.038574	0.213185	1.173699
11	Transportation Industry	0.000123	1.000123	0.138586	1.173683

The backward linkage is divided into two categories, i.e., (1) direct backward linkage and (2) direct and indirect backward linkage (total linkage). The direct backward linkage shows that if there is an increase in one-unit of the end demand, hence the sector's inputs directly allocated to the other sectors including the sector itself which will increase by their corresponding value. Whereas the direct and indirect linkage indicates that the sector has direct or indirect linkages to other sectors including the sector itself. The backward linkage is the downstream sector linkage to the upstream production sectors.

The result of direct and indirect output linkage analysis (linkage total) in general shows that the economic sector in Mesuji District has a total backward value of more than one. The agricultural sector which has the greatest forward linkage is horticulture crop sub-sector of 1.195100, which means that every increase of 1 (one) unit of final demand of horticulture crop sub-sector will result in increase of total input equal to 1.195100. As for the industrial sector, the sector which has a total value of backward linkage is the food and beverage industry sub-sector of 1.174024. This means that every increase of 1 (one) unit of final demand of the food and beverage industry subsector will result in an increase in total input of 1.174024.

The agricultural sector which has the largest direct backward value is the livestock sub-sector of 0.233298. This means that every increase of 1 (one) unit of final demand of livestock sub-sector will result in increase of total input equal to 0.233298. While in the industrial sector, the food and beverage industry sub-sector has the largest direct backward linkage with the value of 0.213185. This means that any increase of 1 (one) unit of final demand for the food and beverage industry sub-sector will result in an increase in total input of 0.213185.

The dispersion analysis results in spread sensitivity (forward spread) and spread coefficient (backward spread). Spread sensitivity is a value that indicates a sector's ability to directly or indirectly drive the downstream industry's capabilities. While the spread coefficient is the effect caused by a sector due to the increase of output of that sector to the output of other sectors used as input either directly or indirectly (upstream sector) by the sector.

Based on Table 3 it also can be seen that there are several economic sectors in Mesuji District which have high spread sensitivity index , i.e., ß> 1.The agricultural sector: food crops, plantation, animal husbandry, and fishery sub-sectors have more than one sensitivity index. The sub-sector that has the greatest value is the food crop with the value of 1.130285. While industrial sector that is sub-sector of food and beverage industry has index of the highest degree of spread sensitivity, that is of 1,170072. A sector with a high degree of spread sensitivity index means that output from these sectors is widely used as input by other sectors of the economy or output generated by the sector which is able to encourage the growth of its downstream sectors. This value also shows the role of these sectors in pushing the Mesuji District economy.

The data in Table 3 also shows that some economic sectors in Mesuji District have a high spread coefficient index i.e., α> 1. The agricultural sector, the estate sub-sector, and the livestock sub-sector have a spread coefficient index of 1.013492 and 1.018914. While for the industrial sector which has the highest spread coefficient index is the food and beverage industry sub-sector of 1.140315. Economic sectors with a high spread coefficient index α> 1 mean that the sector has a high influence or in its production activities. Hence, the sector requires a lot of output from other sectors as the inputs. This value also means that the sectors are able to attract the growth of upstream sectors in Mesuji District.

Table 3. Spreading Power of Mesuji District, 2014.

No.	Sector	spread sensitivity	spread coefficient
1	Food Crops	1.130285	0.941912
2	Horticulture Crops	0.879465	0.895455
3	Plantation	1.056806	1.013492
4	Animal Husbandry	1.121209	1.018914
5	Agricultural Services, And Hunting	0.957178	0.909736
6	Forestry And Logging	0.847825	0.868501
7	Fishery	1.067073	0.961302
9	Food And Beverage Industry	1.170072	1.140315
10	Wood And Products Of Wood, Cork And Wickerwork From Bamboo, Rattan And Similar Products As Well As The Furniture Industry	0.858915	1.008942
11	Transportation Industry	0.827115	0.977440

C. Impact of Output Multiplier

The multiplier impact analysis aims to look at the effect of changes of endogenous variables in the event of a change in exogenous variables such as the final demand. The multiplier effectconsists of two types, i.e., Type I and Type II. It should be noted that Type II multipliers always have a value greater than the Type I. This is because the household effect is taken into account.

The initial impact is an economic stimulus that is assumed as an increase or decrease in sales in one unit of monetary unit. On the output side, this initial impact is assumed to be an increase in sales to the final demand of one unit of monetary unit. In this case it is simulated that there is an increase of one million rupiah of final demand from a sector.

The results of the output multiplier impact analysis, i.e.,Type I and Type II, plantation and livestock sub-sector have higher multiplier value compared with the other agricultural sub-sectors. The value of output multiplier impact Type I sub-sector livestock of 1.232041. That is, if there is an increase in the final demand for livestock subsector by 1 unit, if will increase the output in all sectors of the economy of 1.232041. When it is viewed from the value of the impact of Type II output multiplier impact, the livestock sub-sector is amounted to 1.978625. This value means that by including the effect of household consumption, if an increase in the final demand for the livestock sub-sector by 1 unit, hence it increases the output in all sectors of the economy of 1.978625.

As for the manufacturing sector, the food and beverage industry sub-sector has the highest multiplier value, i.e., Type I and Type II, compared to other industrial sub-sectors. The value of output multiplier impact of Type I sub-sector of livestock is of 1.378836. That is, if there is an increase in final demand for livestock sub-sector of one unit, hence it will increase the output in all sectors of the economy of 1.378836. When it is viewed from the value of the impact of Type II output multipliers, the breeding sub-sector is amounted to 1.966101. This value means, by entering the effect of household consumption, if an increase in the final demand for the livestock sub-sector by one unit, it increases output in all sectors of the economy of 1.966101.

Table 4. Impact of Output Multiplier

No.	Sector	Impact Of Output Multiplier			
		First	Total	Tipe I	Tipe II
1	Food Crops	1.000000	1.522195	1.138932	1.522195
2	Horticulture Crops	1.000000	1.650628	1.082758	1.650628
3	Plantation	1.000000	1.898751	1.225485	1.898751
4	Animal Husbandry	1.000000	1.978625	1.232041	1.978625
5	Agricultural Services, And Hunting	1.000000	1.895263	1.100027	1.895263
6	Forestry And Logging	1.000000	1.660695	1.050166	1.660695
7	Fishery	1.000000	1.685588	1.162379	1.685588
9	Food And Beverage Industry	1.000000	1.966101	1.378836	1.966101
10	Wood And Products Of Wood, Cork And Wickerwork From Bamboo, Rattan And Similar Products as well as the furniture industry	1.000000	1.706183	1.219983	1.706183
11	Transportation Industry	1.000000	1.877456	1.181892	1.877456
	Average		1.784149	1.177250	1.784149

IV. CONCLUSION

The results of this research show that (1) agriculture and industrial processing are the economic basis. (2) the plantation, livestock, as well as food and beverages sub-sectors have forward linkages, spread sensitivity, and spread coefficient.Those sectors are able to encourage and attract the downstream and upstream of sector growth, respectively. (3) the industrial processing sector has a greater multiplier impact than the agricultural sector.

REFERENCES

Badrudin R. 2012. *Ekonomika Otonomi Daerah*. Yogyakarta (ID): UPP STIM YKPN.

Bappenas, UNDP. 2008. *Studi Evaluasi Dampak Pemekaran Daerah 2001-2007*. Jakarta: BRIDGE (*Building and Reinventing Desentralised Governance*).

BPS Provinsi Lampung. 2014. *Lampung Dalam Angka*. Bandar Lampung (ID): BPS Provinsi Lampung.

BPS Provinsi Lampung. 2014. *Tinjauan Ekonomi Regional Di Provinsi Lampung 2013*. Bandar Lampung (ID): BPS Provinsi Lampung.

BPS Provinsi Lampung. 2016. *Tinjauan Ekonomi Regional Daerah Otonom Di Provinsi Lampung 2015*. Bandar Lampung (ID): BPS Provinsi Lampung.

Daryanto A, Hafizrianda Y. 2010. *Model-model Kuantitatif untuk Perencanaan Ekonomi Daerah: Konsep dan Aplikasi*. Bogor: IPB Press.

Endaryanto, 2015. Dampak Pemekaran Wilayah Terhadap Kinerja Ekonomi Regional dan Kesejahteraan Masyarakat Di Provinsi Lampung. Disertasi. Tidak dipublikasikan. IPB. Bogor.

Gyimah-Brempong, K. (1988). "Agricultural development and the size distribution of personal income: The tropical African experience." World development **16**(4): 483-488.

Kuncoro M. 2012. *Perencanaan Daerah: Bagaimana Membangun Ekonomi Lokal, Kota, dan Kawasan?*: Salemba Empat.

Nayak, P. and S. K. Mishra (2009). "Structural change in Meghalaya-theory and evidence." North East India-Approaches Towards Sustainable Development: 25-40

Rustiadi E, Saefulhakim S, Panuju DR. 2009. *Perencanaan dan Pengembangan Wilayah*: Crestpent Press dan Yayasan Obor Indonesia.

B.3

STRATEGY BUSINESS CILEMBU SWEET POTATOES CHIPS MAUTIK (CASE STUDY OF SWEET POTATOES CHIPS MAUTIK, CILEMBU VILLAGE, PAMULIHAN, SUMEDANG, WEST JAVA)

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ABSTRACT

MaUtik is a home industry that developing a carolus products from sweet potato cilembu. The business model approachment is an important factor in the success of an organization. Well applied being of business model application could be increasing revenue to higher number. This study used to identify the problem, mapping and to get an alternative business strategy. This study uses descriptive-qualitative method by applying the nine-block of business model canvas and SWOT analysis as tools. Information used based on observations, interviews, documents, and triangulation. We used primary data, secondary data either. Primary data was obtained from several informants who determined intentionally (purposive). The next informant was selected by snowball sampling technique continued till the data is saturated (homogeneous). The qualification of informants is someone engaging and actors in the business of sweet potato cilembu MaUtik. Study literature was key of secondary data.The results showed that the expansion of customer segmentation and increased marketing activity will affect revenue growth. Marketing is the key activities performed optimally. A good value proposition had correlation customer relationship and key partnership. Integrated Channels are affected revenue steam and cost structure. Increaseing of customer segments and the management of key resources into an alternative strategy needs to be applied by MaUtik.

Keywords : Business Model, Business Canvas Model, SWOT Analysis

I. INTRODUCTION

Sweet potato is a major crop widely consumed as agricultural commodities sourced carbohydrate after rice and cassava in 2015 (Statistics of consumption, 2015).

According to agency statistics wichh showes the data of sweet potatoes harvest Indonesia in 2015, West Java is one of sweet potato production centers in Indonesia with total production of 456.176 tonnes. Sumedang is an area that developing sweet potatoes as the main food commodities in 2015. The sweet potatoes were planted in Sumedang has a uniqueness that no other areas do not have it is a sweet potatoes harvest Indonesia in 2015. Sweet potato is known as the name of cilembu sweet potato. The name of cilembu sweet potato is taken from the name of a village in Pamulihan sub-district, Sumedang district, West Java. Before the cilembu sweet potato is deciphered, the original name of this type of sweet potato is nirkum (Fathonah, 2002).

Sweet potato as alternative staple food requires a product innovation that supports the success of the diversification program. According Susongko (2009) to support the success of the acceleration program of food consumption diversification, there are several alternative products that can be developed from sweet potato commodity. Cilembu sweet potato chips become a breakthrough in the field of processed products chips. MaUtik is a home industry engaged in processing cilembu sweet potato into various products. Not only chips made from sweet potato baking, MaUtik also markets other pruduct such as potato oven, dodol potatoes, chocolate chips (kiricok), aci hui (cihui), chistik potatoes, and some pastries made from sweet potato baking.

MaUtik is able to produce approximately 500 Kg of raw cilembu sweet potatoes into chips every day. Supply of raw materials of chips is strongly influenced by cilembu sweet potato harvest period. MaUtik production process is currently being disrupted due to the scarcity of cilembu sweet potato which is the main ingredient of making chips. Scarcity is very influential activities, especially production activities. In addition to the scarcity, limited infrastructure and labors to be one of the factors that affect the ability of potato chips production cilembu MaUtik.

Moreover, the limited facilities and infrastructure and labor became one of the factors that affect the production ability of sweet potato chips. Therefore, a strategy is needed that can increase the business of MaUtik.

Business modeling becomes necessary to see the business sustainability of MaUtik business. Applying the right business model can increase the company's revenue (Gunawan, 2016). Therefore, the formulation of the strategy is necessary for the organization to achieve determined objectives. MaUtik must know the opportunities, threats, strengths, and weaknesses so that it can be known competitive and comparative advantage owned. Competitive and comparative advantage is an important to create a new strategy. The Business Model Canvas approaches (BMC), which is described by Osterwalder and Pigneur (2015) entrepreneur or business person can know and understand what strategic steps that must be done. Business Model Canvas is more applicable in applying strategic design that will be applied by businessman.

Based on the information, the problems that can be identified as follows: (1). How is the business model of sweet potato cilembu MaUtik chips? (2) What are the strengths, weaknesses, opportunities, and threats of sweet potato cilembu? (3) What kind of strategy is appropriate for sweet potato cilembu MaUtik business with Business Model Canvas?

II. MATERIALS AND METHODS

A. Types and Sources Of Data

Primary data includes information and opinions about the existing condition of cilembu sweet potato chips business sourced from the owners, labors, partners, and consumers. Secondary data obtained through literature study.

Primary data obtained from the key informants who are determined intentionally (purposive). The next informant was selected by snowball sampling technique and will develop until the data is saturated (homogeneous). Criteria of the selection of informants are people engaging, and actors in the business of sweet potato cilembu MaUtik chips.

B. Data Collected and Information

Data collection was done by parsitipative observation, in-depth interviews, documents, and triangulation. Parsitipatif observation was done to see the condition in the field. In-depth interviews were conducted to get the data more fully. Supporting data collection was done through literature study of related documents. Triangulation is done to obtain data from various sources of informants.

C. Data Analysis Design

Processing and data analysis on this research include descriptive analysis, mapping of existing business model, identification and SWOT analysis, and designing alternative business improvement strategies MaUtik which refer to business model canvas.

III. RESULTS AND DISCUSSION

A. The Business Concept of MaUtik

MaUtik is a business engaged in processed business based cassava cilembu. In the early days of this business pioneered, no market needs analysis. Focusing on production activities and striving to achieve high product efficiency, low cost, and using mass distribution is the primary goal at the earliest. But as the times progressed, Maity's orientation has now reached the concept of marketing. Not only create the product but also how to get the product to the consumer well started to be noticed by the MaUtik. The main activity that happened was progressing. The marketing activity which consist of consisting of distribution and product sales are two activities in MaUtik today. MaUtik marketing activities have not reached the optimum stage. If managed well, marketing can be a key activity of MaUtik in developing its business. The design and execution of the marketing system that becomes the main activity can affect other blocks in the business model canvas MaUtik.

B. Business Model Canvas MaUtik

1. Customers Segments

The niche market is a customer segment that is now a target in the marketing of MaUtik products. Resellers are the customers who they choose. They are selected because they can perform two activities at once that are buying and marketing products to consumers. MaUtik has two types of resellers: resellers who buy directly to production houses and resellers who make purchases online. The untouched customer is droppshiper.

2. Value Proposition

Customer Jurney's graphic image of the product shows that the offered value is not fully up to the consumer. As for some of the value of customers who have arrived are the taste, price, product variety, and service.

Fig. 1. Customer Jurney

Product tastes and variations are best illustrated by the consumers who encountered during the study. The taste is a major component of consideration in food products. The flavors offered on the cilembu sweet potato products themselves vary from original flavors, onions, balado, chocolate, cheese, spicy cheese, corn, and caramel. Balado, caramel, and chocolate are the three most widely purchased by consumers. The choice or variation of the product becomes the pull factor in the purchase. A variety of other products such as chocolate chips, chips, dodol and kremes be an option in shopping snack there.

Price is a sensitive part of the customer. Cheaper price on similar products will affect the purchase decision. Compared with similar products the price offered MaUtik can be reached by various circles. The offered price starts from Rp 8,000 for each flavor per pack with a net of 170-210 gr or Rp 40,000 / kg for direct purchase to the production site.

Good service becomes the strategy and pull factor of consumers who come and remain loyal to be customers MaUtik amid the development of similar products. In addition, the direct view of the process of making these sweet potato chips into added value in service and the proportion of value offered to customers MaUtik. Aspects of service can be key values of MaUtik because value is not always related to price, but the value created when the customer receives more than they expected. Through the services provided by MaUtik to the customers are able to create customer value.

Ease of access to production sites and innovation are two aspects that have little value in MaUtik business. Access to production sites or production houses that are still difficult to reach by public transport and location is less strategic. This is what lies behind the giving of customers. Other access barriers are the lack of a road guide to the location.

Product innovation can be a strategy to increase the sales. However, innovation on the processing of products made from sweet potato is not yet delivered well to the consumer. Some of the customers interviewed argued that there was a new breakthrough by MaUtik in processing cilembu sweet potato.

3. *Channels*

The process of delivering value to customers is done directly and indirectly. Is done through word of mouth and optimizing the social media as way of delivery. Indirect way is done by working with partners who will deliver value or products to the end consumer. As online sales grow, it encourages MaUtik to expand its services into messaging and transfer payments through banks. In cooperation with some delivery service such as JNT and JNE was also done to facilitate the delivery of goods to various areas that are difficult to reach directly by MaUtik.

4. *Customer Relationship*

Customer relationships can be linked from word of mouth and loyalty built to customers. Both aspects are created through customer experience. Word of mouth information can have an effect on acquiring customers. Meanwhile, loyalty built on customers can retain customers. These aspects become the motivation in establishing customer relationships. MaUtik to customer acquisition by introducing products to the public through word of mouth. In addition to acquiring customers, MaUtik also retains customers through services such as discounting. Another motivation in customer relationships in MaUtik is to increase sales. Increased sales are done through the addition of innovation and product variety and increase the number of resellers and create value creation with customers.

5. *Revenue Stream*

The Revenue Flow of MaUtik only comes from the sale of assets / products. This type of income is included in the recurring income that is the condition of the customer is willing to make repeat purchase / repeat order to provide proportion of value to customers as well as providing post-purchase customer support. Pricing is closely related to revenue streams. This is because the price reached by the customer will affect the quantity of product to be purchased by the customer. The largest revenue stream is obtained through the sale of sweet potato chips that are the mainstay of MaUtik products. 85% of the revenue comes from sales of chips, while the other 15% comes from the sale of other processed products. The creation of shared values that are embedded in the customer relationship blocks and customization on the value proportion block can be a revenue stream by means of a license. The granting of permits for the use of halal certification and P-IRT can be used as a way to build income stream in MaUtik.

6. *Key Resources*

The main source of MaUtik is divided into four categories, namely the main resources in the form of physical, financial, intellectual, and human. The main physical resources consist of cilembu sweet potato, multicut sweet potato, spinning machine, stove, frying pan, sealer, and storefront. The main human resources of MaUtik are 7 workers consisting of 4 men and 3 women. In addition, MaUtik also has a Women Farmer Group named KWT Putri Kareumbi as human resources. The intellectual resources of MaUtik consist of trademarks or brands, knowledge, certification of HALAL MUI, and P-IRT.

7. *Key Activities*

MaUtik engages in activities such as production and marketing. These activities are carried out separately. The main focus of MaUtik's activities is production. Marketing that takes place in MaUtik is product distribution and sales. The production activities in making cilembu sweet potato chips as follows:

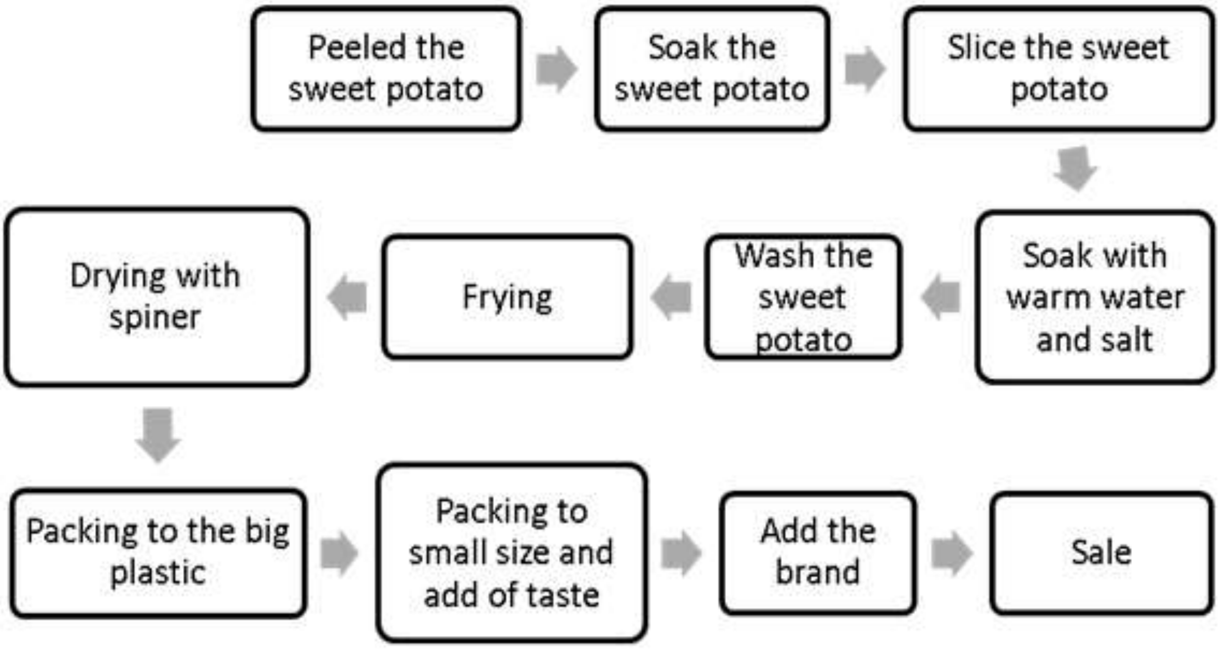

Fig. 2. Production Process Of Chops Sweet potatoes MaUtik

8. *Key Parthnership*

In business process, MaUtik cooperates with several partners. Resellers and dropshippers become agents as well as key partners that help distribute MaUtik products into the hands of consumers. In addition, MaUtik also cooperates with several cilembu yard as the main supplier of chips, chili peppers, orange leaves, and food agents also participate as partners in the fulfillment of complementary materials for making chips. The process of distributing unreachable products is done in cooperation with courier service providers. Currently, MaUtik has recently partnered with M.Irsyad as a kemplang supplier which is then packaged and distributed by MaUtik.

9. *Cost Structure*

Costs incurred by MaUtik include fixed costs, variable costs, economies of scale, and environmental scope. Most expenses are incurred for variable costs. Based on the findings of the field, is shows that the cost structure of cilembu sweet potato chips racing on the cost which is the business conditions by minimizing the cost.

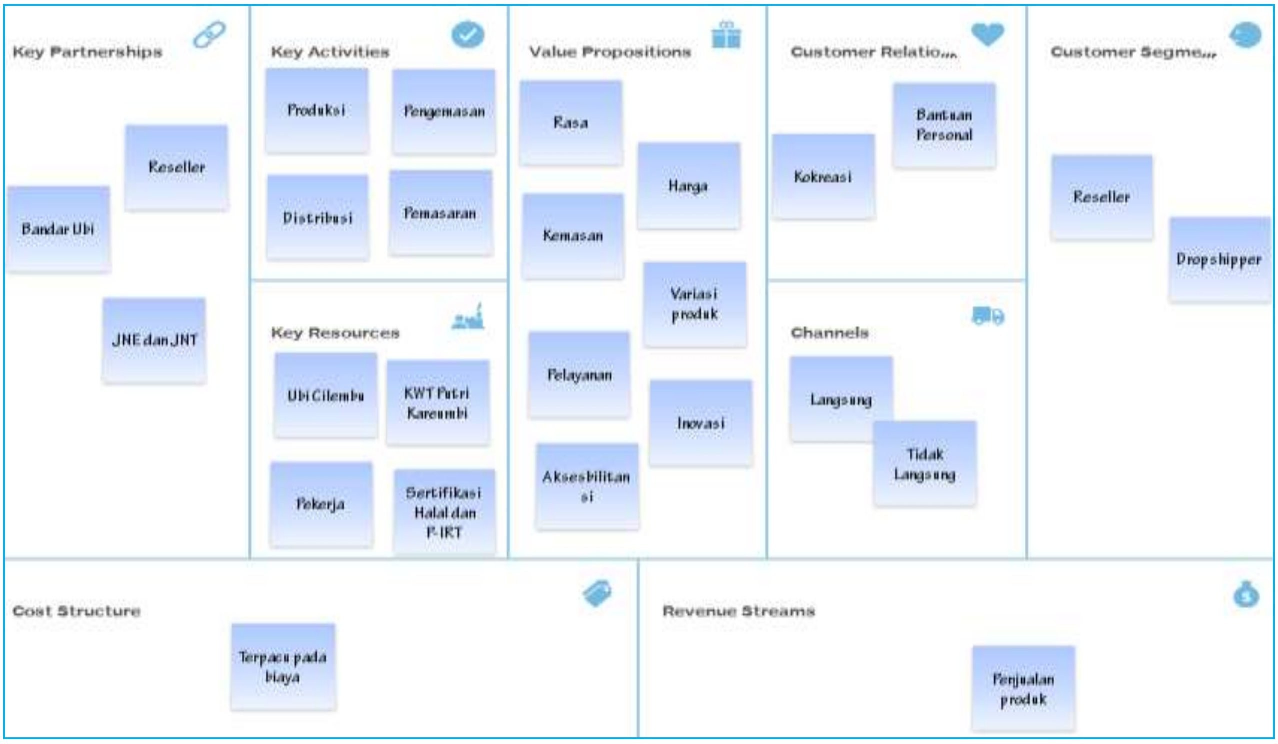

Fig. 3 Business Model Canvas Chips Sweet Potatoes MaUtik

C. SWOT Analysis and Repair of BMC Strategy

1. Customers Segment

The suitability between the product offered and the customer has been done well. However, the development of companies that produce similar products with tight price competition has the potential to become a threat to MaUtik. Therefore, it is necessary to increase the number of resellers and dropshipers by MaUtik. In addition, to anticipating the decrease in the number of customers due to competitor companies, the addition of the number of resellers and dropshipers can expand the scope of marketing MaUtik in the future. Recruitment either directly or indirectly becomes reseller and dropshiper should be done immediately to introduce the product to a wider area, so it can have positive impact also for other business block.

2. Value Proposition

The value delivered to the customer well can be an opportunity for repeat order. Therefore, MaUtik does not stop doing development on its products. Based on customer jurney and advice from some customers who met, that it would be better if MaUtik develops innovation on the variety of products and taste of chips owned. On the other hand MaUtik was trying to process the waste tuber of sweet potato into flour that can be processed into a variety of products. MAUtik can develop its products with sweet potato flour. Creating new products can create added value. One of the new products that can be created and developed is crackers. The way of making that is not difficult is also supported by the indulgence of most Indonesian people in eating a light snack of crackers. The development of this product was supported by experts available in Cilembu Village. In addition to the development of sweet potato products, in June 2017 MaUtik began to develop products by selling kemplang (processed cassava products) produced by Muhammad Irsyad Cilembu villagers.

3. Channels

The development of technology can help the marketing process that occurs in MaUtik. However, the use of technology has not been done massively to improve marketing and product sales. The existence of intensive, regular, and periodic management of the product can be optimized through a social media that has been owned. Attending exhibitions or opening booths in bazaar events can also be a means to introduce products to the broader arena.

Channel integration and channel adjustment with customer segments should be done to optimize the existing channel in MaUtik. The suitability of the channel with the customer segment will provide ease of access and can be a solution for accessing products that are difficult to reach by customers in the discussion of previous value proporsition blocks. Emerging technologies such as the Internet and intercell service providers can be an option in determining the channel that suits the customer. In addition, channel integration can help suppress existing costs in the cost structure block.

4. *Customer Relationship*

Customer relationships in MaUtik have been well established through established communication and mutual trust. But sometimes the trust is used by customers to take the goods in advance and pay over time to maturity until many times. It is potentially a threat to the relationship.

Good communication can be a means of improving or establishing a relationship. The addition of a customer can be created through a good relationship. Organizing a promotion is one technique that can be done to add or acquire customers and increase customer loyalty. During this time, MaUtik has applied promotion through bonus system and discounted price to its reseller. In addition, with the creation of value together either through social media or product customization will also enhance the customer relationship that is intertwined.

5. *Revenue Stream*

The delay in payment made by the customer is a threat to the business continuity of MaUtik. The decline in demand caused by switching customers in similar companies also became a big threat. In the block of revenue streams MaUtik has not been able to make many improvements that significantly affect the income stream. Improvements to this block can be done through the addition of product innovation through value proporsition block.

6. *Key Resources*

The main advantages MaUtik has not used optimally. Optimization can be done through development. The main human resource development is carried out through women farmer groups of kareumbi and conducting worker's regeneration. KWT Princess kareumbi has a great chance to expand its marketing reach. In addition, the need for regeneration by way of cadre to workers or other group members to the special skills that must be owned. The writers recommend that MaUtik begin to do cadre for successors of chistik, kiricok, and especially balado flavor chips. The process of managing sweet potatoes into chips was not all can do especially when frying. Employee cadre is necessary to maintain the existence of this business. In addition to the main human resources, MaUtik can improve this block by adding and completing tools that support the production process so as it can be increased the production.

7. *Key Activity*

Marketing activities conducted by MaUtik can be developed by optimizing social media accounts that have been owned. Growing online sales can be an opportunity in this business. Now, consumers prefer to shop online with the various conveniences offered. Instagram can be used as mass media and promotion. Updating photos becomes important in the activities of managing social media especially instagram. In addition, it needs to be done in order to recording reservations and purchases made by customers to facilitate the data collection of income streams,archiving data costumers and the number of requests well and neatly.

8. *Key Partnership*

The main partner of MaUtik consists of various circles. The cooperation is done also ranging from unrestricted sale to barter products. Dependence on partners was felt MaUtik when there is scarcity of raw materials either sweet potato, gas, or chili. Through partners working together now and adding MaUtik investors can expand the reach of future market share. However, the current conditions have not been possible to invite investors in cooperation. Limitations of facilities, infrastructure and production capabilities are the constraints. This is the reason behind the difficulty in the repair of this block in the near future.

9. Cost Structure

The cost structure adopted by MaUtik is in line with the condition of its business model. Improvements to the cost structure can be done with the emphasis of costs on some activities that occur. Emphasis on marketing costs and channel integration can help in reducing costs. In addition, production activities on a large scale can reduce costs because the process of product creation has an economic value of scale.

Based on SWOT analysis with business model approach canvas that has been done then obtained the following results on Fig. 4 and Fig. 5.

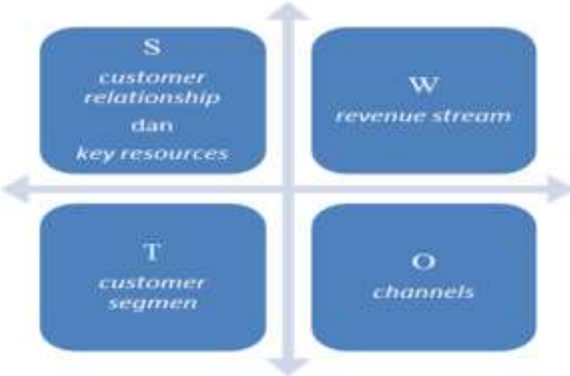

Fig. 4. SWOT Analysis of MaUtik

The result of SWOT analysis with business model approach canvas generates alternative strategy as follows:

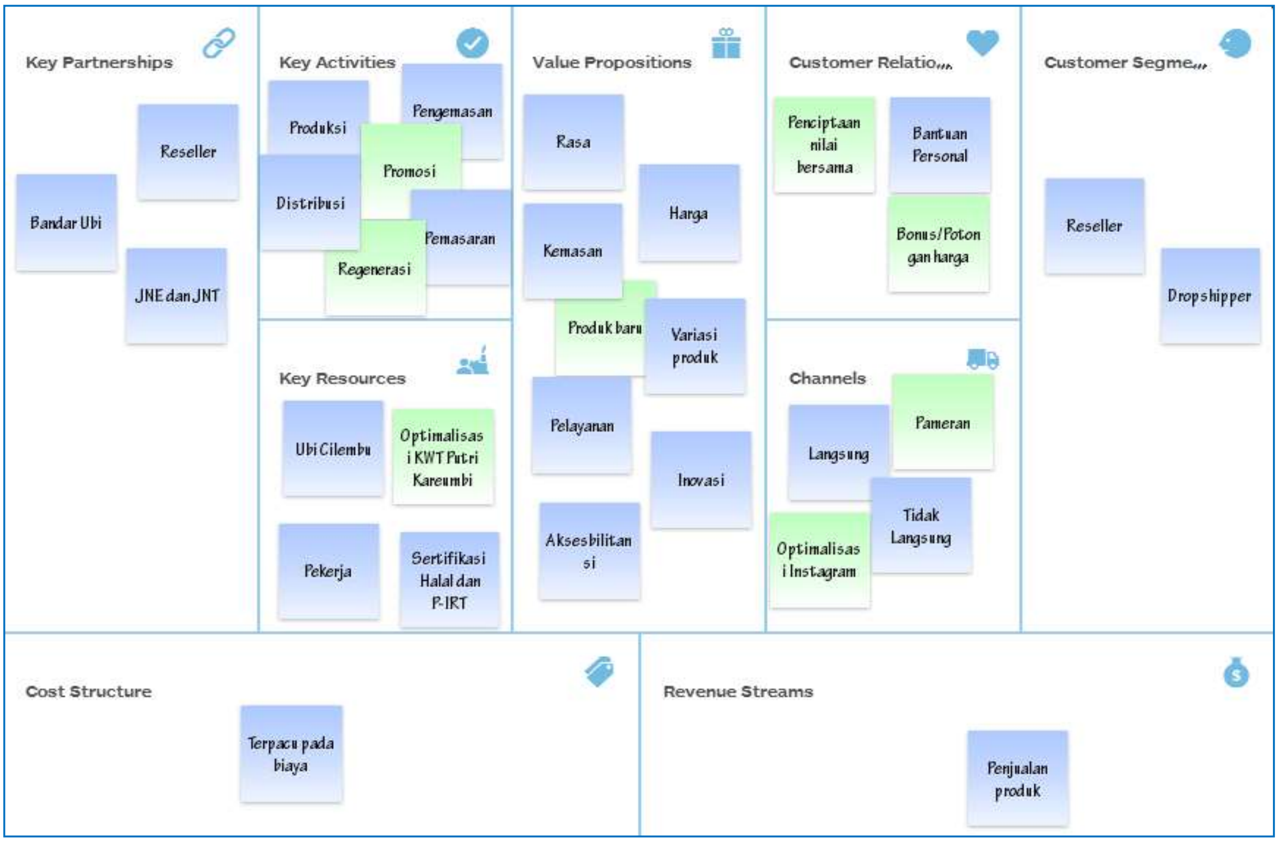

Fig. 5 Strategy of New Business Model Canvas Chips Sweet Potatoes MaUtik

IV. CONCLUSION

Based on the identification of problem and result of discussion about business strategy of sweet potato cilembu MaUtik and the concluded that key of MaUtik business model lies in main activity that is marketing approach to develop business done.

The Strange of MaUtik in the block of customer relationship and key resources, the weaknesses are in revenue stream, the threats is a customer segments and the opportunities is channel.

The effective strategy is to repair on the value proposition, channels, customer relationships, key resources, and key activities.

REFERENCES

Central Statistics Agency. 2015. Harvested Area, Production, and Productivity of Sweet Potato Indonesia Year 2014-2015. Ministry of Agriculture.

Central Bureau of Statistics Sumedang. 2015. Sumedang District In Figures 2015. BPS Sumedang.

Barnes J.G. 2003. Secrets Of Relationship. Andreas Winardi. Yogyakarta: Andi.

Gunawan, Imam. 2014. Qualitative Research Methods Theory and Practice. Jakarta: Earth Literacy.
Kotler, Phiip and Kevin Lane Kotler. 2009. Marketing Management Edition 13 volumes 1. Terj. Adi Maulana and Wibi Hardani (ed). Jakarta: Erland.
Osterwalder, Alexander and Yves Pigneur. 2015.Business Model Generation.Terj Natalia Ruth Sihandrini (ed). Jakarta: PT. Alex Media Komputindo.
Center for Agricultural Data and Information Systems. Food Consumption Statistics 2015. Ministry of Agriculture.
Center for Agricultural Data and Information Systems. 2015. Agriculture Statistics 2015. Ministry of Agriculture
Rangkuti, Freddy. 1997. SWOT Analysis: Technique of Dissecting Business Case, Reorientation Concept, Strategic Planning to Facing Abag 21. Jakarta: Main Gramedia Pustaka.
Sugiyono. 2011. Qualitative Research Methods, Quantitative and R & D. Bandung: Alvabeta, cv
Wida Fatonah. 2002. Optimizing Jam Production With Cilembu Sweet Potato Raw Material. Thesis. Faculty of Agricultural Technology. Bogor Agricultural University.

B.4

STUDY ON IMPLEMENTATION OF GOOD AGRICULTURAL PRACTICE (GAP) IN IMPROVING PRODUCTIVITY AND COCOA FARMERS INCOME (CASE STUDY OF NATURAL AULIA FARMERS GROUP, KORONG AMBUNG KAPUA, NAGARI SUNGAI SARIAK, VII KOTO SUBDISTRICT, PADANG PARIAMAN DISTRICT, WEST SUMATERA PROVINCE)

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ABSTRACT

The productivity of cocoa smallholder plantation is still cannot fulfill the expectation. The efforts to increase productivity of cocoa and income also increased by practice of cultivating accordance with the rules of Good Agriculture Practices (GAP). This study aimed to identify: (1) How much the extent for application of GAP that have been done correctly by farmer in Aulia Natural Group, (2) The problems which encountered by the Aulia Natural Group implementing GAP, and (3) Does the application of GAP can increase the productivity and income of cocoa farmers.

The research was conducted with qualitative design. The method used is a case study method. The data obtained by use purposive sampling. Analysis used is a descriptive analysis. The data used a primary data and secondary data. Primary data gathering techniques used through observation and interviews with some informans who were purposively selected and know the condition of the object of research. The application of GAP not yet fully done correctly by farmers. The components of GAP that have been implemented by farmers is just 48 %. Racebelity component by recording in the process of production to post-harvest handling of cocoa has not been noticed by the farmers. The problems faced in the case of implementing GAP extension is the lack of assistance, the difficulty of changing the mindset of farmers and no price guarantee. The members of group who already started implementing GAP has higher productivity and incomes more than the members of groups that have not implemented the GAP.

Keywords : Good Agricultural Practices (GAP), Productivity, Income, Cocoa, Smallholder Plantation

I. INTRODUCTION

Cocoa quality is an important factor in improving the competitiveness and added value of cocoa, especially in the face of free trade. The low production, productivity and quality of the product is due to the fact that farmers have not conducted good farming management, have not applied the technology as recommended. To be able to produce high production quantity and quality as well as environmentally friendly, farming should use advanced technology and managed professionally and effectively in line with Good Agriculture Practices (Indonesian Coffee and Cocoa Research Center, 2007).

Based on that, the implementation of Cocoa Gernas has been set in 2009 which is implemented in 40 districts in nine provinces of eastern Indonesia, namely: South Sulawesi, West Sulawesi, Southeast Sulawesi, Central Sulawesi, Bali, NTT, Maluku, West Papua and Papua. In addition to the Province implemented Gernas 2009, other provinces namely: South Sulawesi, West Sulawesi, Southeast Sulawesi, Central Sulawesi, Bali, NTT, Maluku, West Papua, and Papua. In addition to Gernas 2009, other provinces are West Sumetera, Bengkulu, Lampung, Gorontalo, North Sulawesi, North Maluku, East Kalimantan, West Kalimantan and NTB (http://jpnn.com/news.php?id=57811).

In West Sumatra, Padang Pariaman regency is one of the districts selected as cocoa plantation area, which has development opportunities because the cacao plants are cultivated in intercropping with coconut trees. This is because the cultivation of good cacao plants is the existence of a protective plant such as coconut trees, but in this region the production of coconut is very large. The area of coconut plant in Padang Pariaman district is big enough so that the opportunity of cocoa development with the support of 39,333 ha of land availability, and the cacao plant has been planted up to 2009 with 16,981 ha with production 6,992 tons and the productivity 976,53 ton / ha / year Agriculture Food crops, Horticulture, Plantation, and forestry, 2009, in Hanafia, 2011). The area of cocoa plantation in Padang Pariaman is higher than in other areas, but the productivity of cocoa in Padang Pariaman Regency in 2012 is still less than 900 kg / ha / year, and this figure is considered to be far from the production potential that can reach more than 2 Ton / ha / year.

Table 1. Area of Production and Productivity of Smallholder Cocoa Plantation in West Sumatera Province Year 2012

No	District	Wide Area (Ha)	Production (Ton)	Produktivity (Ton/Ha)
1	Kep. Mentawai	2.714	1.437	979
2	Pesisir Selatan	5.727	2.717	926
3	Solok	5.421	2.543	913
4	Sijunjung	5.349	2.154	844
5	Tanah Datar	6.903	3.269	897
6	Padang Pariaman	29.872	12.139	806
7	Agam	9.090	4.854	996
8	50 Kota	8.190	4.057	908
9	Pasaman	25.189	16.438	936
10	Solok Selatan	2.383	1.122	923
11	Dharmas Raya	3.849	1.969	924
12	Pasaman Barat	18.481	8.742	913
13	Kota Padang	1.742	782	818
14	Kota Solok	645	286	872
15	Kota Sawahlunto	4.768	1.967	857
16	Kota Padang Panjang	28	10	769
17	Kota Bukittinggi	59	14	534
18	Kota Payakumbuh	2.572	1.102	904
19	Kota Pariaman	2.067	941	857

Source : Dinas Perkebunan Provinsi Sumatera Barat (2013)

One of the factors causing the low productivity is the lack of crop maintenance due to the low knowledge of the farmers, besides that some of the seeds used by farmers are not superior seeds (sweep). Pruning is done only by some farmers, besides fertilization done not in accordance with the suggestion, as well as the attacks of squirrels, pests of PBK, and Helopelthis that have not known how to control it. The low quality of cocoa is due to the fact that most farmers do not know the fermentation technology of cocoa beans, and there is no price difference between the fermented cocoa beans and the unfermented (Hasan, et al., 2010).

After the launching of West Sumatera Province as the center of cocoa production by former Vice President Yusuf Kalla in August 2006, the area of cocoa field continues to increase, especially Padang Pariaman Regency. In an effort to improve the productivity and quality of cocoa, the government established a National Movement for the Increase of Cocoa Production and Quality (Cocoa Gernas). The goal of this program is the improvement of community cacao plants through rejuvenation, rehabilitation, intensification, farmers empowerment, pest and disease control, cocoa quality improvement, and provision of other supporting facilities.

Padang Pariaman District has several sub-districts producing cocoa, but not all sub-districts have large cocoa fields. Koto Sungai Sarik Sub-district VII is in the fourth position which has a cocoa land above 1,000 ha after Koto kampong Dalam Sub-district V, Sungai Geringging and Enam Lingkung. However, according to the staff of Agriculture, Livestock and Forestry Office of Padang Pariaman District, there are farmer groups that have started to orient to environmentally friendly farming, namely Aulia Natural farmer group in Korong Ambung Kapua. This farmer group is considered to have begun to apply the principles of Good Agricultural Practices (GAP) compared to other farmer groups.

To be able to penetrate the world market, then the quality of a product becomes a very urgent factor. Therefore, the application of GAP principles is a must for cocoa farmers so that the quality of their products can be competitive, thus increasing their income.

Table 2. Area of Land, Production and Productivity of Cocoa Plants by District of 2012.

No.	Sub-District	Productive lands (ha)	Area Total (ha)	Producvity (kg/ha)*
1	Batang Anai	314	775	1.000
2	Lubuk Alung	477	1.147	1.000
3	Sintuk Toboh Gadang	278	639	1.000
4	Ulakan Tapakis	99	499	1.050
5	Nan Sabaris	107	384	2.031
6	2 x 11 Enam Lingkung	183	587	1.000
7	Enam Lingkung	132	1.285	1.000
8	2 x 11 Kayu Tanam	225	892	1.000
9	VII Koto Sungai Sarik	363	1.274	1.000
10	Patamuan	609	1.050	1.000
11	Padang Sago	285	732	1.000
12	V Koto kampung Dalam	2.809	3.175	1.000
13	V Koto Timur	161	1.051	650
14	Sungai Limau	169	721	1.150
15	Batang Gasan	202	547	505
16	Sungai Geringging	632	2.411	1.000
17	IV Koto Aur Malintang	346	725	1.000

Source: Agriculture, Livestock and Forestry Office of Padang Pariaman District, 2013

Description: *) Estimated results from the Department of Agriculture, Livestock and Forestry of Padang Pariaman District.

II. MATERIALS AND METHODS

The design of this research is qualitative, while the research technique used is case study. Case study research technique is one kind of descriptive approach, research done intensive, detailed, and deeply against a certain organism (individual), institution or symptom with narrow area or subject (Arikunto, 2002). Information retrieval technique is done by purposive sampling technique. This technique is used with certain considerations, ie informant is the source who is considered most know about what is expected by the researcher, or maybe he as the ruler so that will facilitate the researchers explore the object / social situation under study (Sugiyono, 2012). In this research the selected informants were Agricultural Extension Farmers (PPL), Head of Farmer Group, Plantation Office staff of West Sumatera Province. Furthermore, the election of farmer group members selected as respondents is as much as 30 farmers who assist the authors in describing the size of farmers' expenses and income (15 people who have implemented GAP and 15 people who have not implemented GAP).

Secondary data mining is also done to complete the primary data, that is by collecting and studying written data in the form of documents or transcripts, newspapers, journals, bulletins, and open access through the internet looking for websites related to this research. Data and information obtained then analyzed by descriptive correlative.

The design of data analysis in qualitative research, according to Miles and Huberman (1984) in Sugiyono (2012) done interactively and lasted continuously until thoroughly, so the data is saturated. Activities in data analysis, namely: data reduction, display data, and conclusion drawing / verification. The steps can be described as follows on Fig. 1.

For revenue, acceptance and cost analysis, the following formula is used:

$$I = TR - TC \tag{1}$$

Note: I = Income (IDR/year)
TR= Total of Revenue (IDR/year)
TC= Total of Cost (IDR/year)

$$TR = Q.Py \tag{2}$$

Note: Q = output/yield (tone/year)
Py = Price of product (IDR/tone)

$$TC = TFC + TVC \quad (3)$$

Note: TFC = Total Fix Cost (IDR/year)
TVC = Total of Variable Cost (IDR/year)

Production costs are only calculated for cocoa plant maintenance costs. Furthermore, to calculate productivity, it is calculated using only one input resource ie the number of producing plants (trees). Productivity is calculated to see the difference in productivity between farmer group members who have implemented GAP and who have not yet implemented the GAP.

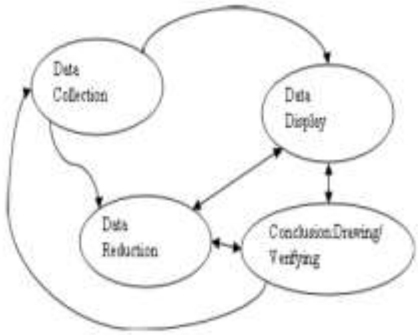

Fig. 1 Interactive Model

III. RESULTS AND DISCUSSION

A. Condition of Research Area and Characteristic of Cocoa Farmer

Nagari Sungai Sariak is one of the nagari located in District of VII Koto Padang Pariaman District West Sumatra Province, this area has a land area of 2796 ha, and is located above the altitude of 14 masl. The condition of the area in Nagari Sungai Sariak where the cultivation of cocoa planted by Aulia Natural Farmer Group has been in accordance with the requirement to grow for cocoa plants as disclosed by Agricultural Research and Development Agency (Year 2008) and RPJM Nagari Sungai Sariak (Year 2011-2016) .

When viewed from the experience of farmers in the cultivation of almost the majority of cocoa farmers (73.33 percent) has been in it for more than 5 years, and their age is mostly over 55 years (67 percent). Furthermore, the extent of cacao plantation exploitation from most farmers (71.43 percent) is under 1 ha and this land is a hereditary heritage. Cocoa farmers in this area are only a small part (25 people) who enter the Aulia Natural farmer group, and they have received seedlings from the government of 6000 trees in 2007. This seedlings are given to farmers whose crops need rejuvenation.

Intensification activities have been conducted on their cocoa crops, and even this farmer group has done rehabilitation, by side-grafting technique. Furthermore, to support the success of Gernas, the government has also provided assistance in the form of: fertilizers, pesticides, pruning shears, fermentation boxes, and para-para. But the fermentation box is used only by some farmers only, because not all farmers do fermentation, their reason is the absence of significant difference to the selling price.

When viewed from the income of cocoa farmers, is determined by the area of land, the number of trees owned by farmers, age of plants, and treatment of treatment by farmers. For example, the productivity of cacao crops aged 4 years and treated intensively (4.5 kg / tree / year) is higher than that of the 10 year old cocoa plant with the same treatment (0.72 kg / tree / year), and Who is 13 years old (0.36 kg / tree / year). Another factor determining the high income of farmers is the existence of julo-julo (mutual cooperation) which can reduce production costs by 38 percent. Their income could be even higher if the price of fermented cocoa beans is much higher than that which is not fermented.

B. Some Government Programs To Support Cocoa Plantation Development

1. MP3MI Program

MP3MI Program (Rural Agricultural Development Model Through Innovation) is a training program for cocoa farmers from the practice of cultivation to post-harvest. Aulia Natural Farmer Group, received this training in September 2011-2012. Through this training, the farmers' cocoa farm is used as a model cocoa farm that has implemented innovative technology.

2. Gernas Kakao Program

Gernas (Gerakan Nasional) cocoa program is a national program launched by the government as an effort to increase the production and quality of Indonesian cocoa. The movement began in 2009. The activities undertaken in Gernas are: intensification, rehabilitation and rejuvenation of cocoa plants.

Intensification is done for untreated cocoa plants or lack of maintenance, and these activities are conducted throughout the district in Padang Pariaman District. Intensification activities, carried out through pruning plants, and the target pruning of this plant is done in Padang Pariaman District of 125 ha and spread throughout the district. Furthermore, cocoa plant rehabilitation is done to improve the condition of the crop both in terms of growth and crop productivity. This activity can be done through side grafting techniques on their less productive cacao plants.

Cocoa plant rejuvenation activities is one of the efforts of replacing unproductive plants (old plants) with new plants as a whole or gradually. Rejuvenation is done for cocoa plants that are more than 20 years old. Rejuvenation activities are conducted in Kampung Dalam and Sungai Geringging.

3. Seed and Production Support Program

The Seed and Production Support Program is implemented once a year, and the farmer groups that receive this aid take turns and spread evenly throughout the district in Padang Pariaman District. Seedlings are provided for farmers whose cocoa plants need to be rejuvenated, or for farmer groups who want to cultivate cocoa. While the aid of production facilities, given in accordance with the needs and conditions of cocoa plants.

Aulia Natural Farmer Group received seed assistance in 2007 as many as 6000 cocoa seedlings, and production facilities such as fertilizers, pesticides, pruning shears, para-para and fermentation boxes. But for the fermentation box has not been fully used by farmer group members, this is because farmers have not yet fermented. The cause of farmers not fermenting is, because there is no difference in price for fermented and non fermented cocoa beans.

C. Implementation of GAP at Aulia Natural Farmer Group

Based on field observations and interviews, the implementation of GAP by Aulia Natural farmers group was 48% in accordance with recommendation, 25% not yet appropriate, and 27% did not match the recommendation. What have been done by cocoa farmers in applying GAP, can be seen from the following activities.

Table 3. Implementation of GAP at Aulia Natural Farmer Group

Activity	Unrecommended
Fertilization	Fertilization is not timely and dosage is not as recommended
Pesticide	Still using herbicides and synthetic pesticides
Use of protective equipment	There are still farmers who do not want to use a protective nose (mask) when doing pesticide applications
Availability of fisrt aid (*P3K)*	Not available
The use of natural enemies	Some farmers do not like to use natural enemies
Sanitation	There are still farmers who do not hide the fruit skin of pests
Recording	The absence of recording in farming

The number of Aulia Natural farmer group members who have implemented GAP is 13 people, while those who have not applied there are 2 people.

Use of environmentally friendly fertilizers has been done by farmers in this region, they use natural materials such as livestock manure and dried foliage as raw material for composting. This can reduce production costs and the impact of environmental pollution. Then, in an effort to cope with plant-disturbing organisms, farmers use natural enemies, namely by using black ants. The use of black ants can reduce fruit damage as a result of pest attacks.

To prevent erosion, this farmer group also utilizes the protective crops, namely banana and coconut trees. In addition to the protective plants, they also make a trench in every row of cocoa plants, called rorak.

The application of GAP in terms of health and welfare safeguards, farmers are still not in accordance with the principles contained in the GAP, for example, in the use of masks at the time of spraying pests, it is due to the difficulty of changing the habits of farmers, especially old aged farmers.

Traceability is a recording system that aims to track (trace) the origin (history), apalikasi or location of a product through the recording of identification (recording). In the GAP is very necessary, but in Aulia Natural farmer groups there is no record in the activities of farming, such as: the labeling on the packaging of cocoa beans to be sold. This is because, there is no demand and requirement from cocoa seed buyer to do so. Therefore, farmers mix all the cocoa beans they produce.

D. Problems Faced by Farmers in Application of GAP

Some of the problems faced by farmers when implementing the GAP are: a) a lack of continuous assistance from the government, as evidenced by the majority of farmers (72 percent) who state that counseling and guidance given by the government are rare; B) the difficulty of changing the mindset and habits of cocoa farmers, they usually cultivate coconut and banana plants that do not require intensive care, so when cultivating cocoa they do not do intensive care; And c) the absence of a price guarantee for the fermented cocoa beans (the price of the fermented cocoa beans is the same as the unfermented cocoa beans), this makes the farmers' weakness to ferment their cocoa beans.

IV. CONCLUSION

The implementation of GAP by Aulia Natural Farmers Group has not been fully implemented. GAP component that has been applied is the application of environmentally friendly technology by reducing the use of synthetic pesticides in pest control, but farmers have not used the mask when applying pesticides. In addition, farmers have not done traceability.

The problems faced by farmers in implementing GAP are: the lack of continuous guidance done by the government, it is difficult to change the mindset and habits of farmers, and there is no guarantee of price.

Farmers who have implemented GAP have higher productivity and income than farmers who have not implemented GAP. In order for farmers to fully implement the GAP then, need coaching and assistance intensively. Through intensive guidance and mentoring it can change the mindset and habits of farmers. In addition, there is a need for government regulation in terms of price for fermented cocoa.

REFERENCES

Damanik, Sabarman. 210." Prospek dan Strategi Pengembangan Perkebunan Kakao Berkelanjutan Di Sumatera Barat". Jurnal Perspektif, Vol. 9, No.2, Desember 2010.Hlm.940105

Departemen Pertanian 2008. Pedoman Budidaya Tanaman Biofarmaka yang baik (Good Agriculture Practices). Dirjen Hortikultura.

Departemen Pertanian 2005. Direktori dan Revitalisasi Agribisnis kakao dalam menghadapi Era Globalisasi. Komisi kakao Indonesia; Jakarta.

-------------------------- 2005. Prospek dan Arah Pengembangan Agribisnis Kakao Di Indonesia. Badan penelitian dan pengembangan Pertanian; Jakarta.

Dinas Perkebunan Provinsi Sumatera Barat. 2012. Sumatera Barat Dalam Angka. 2013

Forum Sertifikasi The Indonesia. 2010. "Good Agricultural Practices". Newslett Sustainable Tea. Edisi September-Oktober 2010.

Gerakan Tanam Kakao di 9 Provinsi (9 Februari 2010). Melalui http://m.jpnn. com/news.php?id=57811(27/01/2014

Hasan. Dkk.2010. Pengendalian Hama Utama Kakao Menggunakan Minyak Serei Wangi Di Perkebunan Rakyat Sumatera Barat. Laporan Hasil Pengkajian Kerjasama Balai Pengkajian Teknologi Pertanian Sumatera Barat dengan Menristek.

Malaysia Cocoa Board.2014. Official website Lembaga koko Malaysia. http://www.koko.gov.my/lkm/loader.cfm?page=Industry/SfGMCBeans.cfm

Muhfian Isnoor. Good Agricultul Practices (GAP) Pada Budidaya Perkebunan. http://cybex.deptan.go.id/lokalita/good-agricultur-practice-gap-pada-budidaya-perkebunan.

Pattiasina dan Alfah.2012. "Analisis Pendapatan Usahatani Kakao (Theobroma cacao L) Di Desa Latu".Jurnal Budidaya Pertanian. Vol.8 No.1 Juli 201

Poedjiwidodo. 1996. Sambung Samping Kakao. Trubus Agriwidya: Yogyakarta.

Pusat penelitian kopi dan Kakao Indonesia 2004. Panduan Lengkap Budidaya Kakao. Agromedia Pustaka.

Sugyono. 213. Metode Penelitian Kuantitatif dan Kualitatif. Alfabeta; Bandung

Sustainable Cocoa Production program (SCCP).2012. Penerapan Budidaya terbaik Tanaman Kakao.

USDA.2012. Good Agricutural Practices Good Handling Practices Audit Verification Checklist.

B.5

LOCAL PROCESSED FOOD INDUSTRY BASED CASSAVA IN IMPROVING RURAL ECONOMY

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ABSTRACT

Lampung's economic structure is predominantly sustained by agriculture, industry and trade. The contribution of agricultural sector reached ± 31%, Industry ± 19%, and trade ± 11%. Lampung's industrial and trading base has backward linkage support from the availability of adequate agricultural production. This situation should mean adding value to economic actors, especially people who depend on their agricultural sector. But the fact that the poor are still over 13% with HDI of 66.94 indicates that some people, especially in rural areas who's living on agricultural basis, are not prosperous. This study aims to (1) study the performance of cassava based food industry in production centers and (2) to analyze the potential of labor absorption and new sources of income through the development of local cassava based food processing industries. The field study was conducted in February until May 2017 at the center of cassava based processed food production in Pesawaran, Lampung Tengah, and Pringsewu Districts. Sampling method conducted by case study approach. Data analysis used descriptive statistical analysis and trend method. Based on the analysis result, it can be concluded that the cassava based food processing industry was characterized by the scale of production of micro/home industry and using the family and the family's worker on average <5 people. The most common types of foodstuffs are: cracker, klanting, chips, and opak. The analysis of revenue structure showed that cassava processing business was beneficial as a source of family income. Based on rural labor absorption analysis, the existence of local food processing industry has the potential to provide employment for rural labor force. However, the lack of competitive standards of rural wages was an issue that causes the lack of appeal of the processed food industry as a source of income. An opportunity is open to new entrepreneurs in prospective market line networks. The market of processed products of cassava food industry is still very wide open. The business activity of the cassava processed food industry produces an economic multiplier for the actors who are involved.

Keywords : cassava, processed food, local, rural

I. INTRODUCTION

Lampung's economic structure is predominantly sustained by agriculture, industry and trade. The contribution of agricultural sector reached ± 31%, Industry ± 19%, and trade ± 11% (Lampung Statistic Agency, 2016). Lampung's industrial and trading base has backward linkage support from the availability of adequate agricultural production. This situation should mean adding value to economic actors, especially people who depend on their agricultural sector. Lampung as an agribusiness earth provides more than 49% of employment in the agricultural sector. More than 80% of agricultural sector activity is done in rural areas. Based on the contribution of sub-sectors, food crops contribute almost 50% of agricultural sector contributions. With the average growth rate in the last three years reaching more than 3%/year, the food crops sub-sector can be one of the rational choices as a leading sector in increasing productivity, employment opportunities, income, and farmers' welfare.

Food and beverage agroindustry at Lampung's GRDP contributes 12.50%, with growth of 4.2% year-1. Manpower in large agroindustry enterprises reached 48,735 people in 2014 from 222 existing companies (Lampung BPS, 2015). Food agroindustry provides a multiplier effect on the local economy through increased value added, diversity of sources of income, availability of business, increasing income, and ensuring food security for households, as well as reducing rural poverty.

In the downstream line of foodstuff agroindustry, it is important to be directed to the growth of the people-scale processing industry through the empowerment of women farmers in the rural agro-industry chain. Chain of rural agroindustry becomes a necessity in an effort to increase the source of farmer's income. Promotion and incentives for the development of foodstuff processing businesses need to be continuously carried out by stakeholders. The price guarantee and market of household products mobilized communally through the women farmer group/Gapoktan/ cooperative / BUMP institutions become the embryo of the development of integrated rural bio industry chains and integrated into the larger agro-industry market network (Fitriani, Trisnanto, & Fatih, 2013)(Budi Trisnanto & Fatih, n.d.)(Fitriani, Ismono, & Rosanti, 2011) (Fitriani, 2015). Strengthening through ongoing capital, technology and market support to rural bio industry actors is a key to the growth of rural income sources. The growth of rural bio industry is a gateway to the availability of job opportunities for the rural labor force, thereby reducing unemployment and poverty (Fitriani, et.al., 2014).

But the fact, the condition becomes an irony, considering most of the rural agricultural community was still face poverty. Rural communities are undeniably often overlooked by relevant stakeholders. The poor are still over 13% with HDI of 66.94 indicates that some people, especially in rural areas who's living on agricultural basis, are not prosperous. The lack of budget allocation for agriculture sector development (> 2%) and investment, also the lack access of capital, no assistance from skilled trainers, as well as access to narrow land (smallholders and farm laborers) were as a part of the low income that welfare farmers couldn't reached yet (Fitriani, et.al., 2014).

The food agroindustry-based cassava faced the issue on business management and marketing because the business-oriented sustainable and market network has not been built yet. They has not been able to meet the market needs at the level of volume, quality, time, and place continuous (Novia, dkk, 2013; Pahlevi, dkk., 2014; Rangkuti, dkk., 2015). They also facing the limitations of modern production technology, the quality of human resources is not sufficient (Hidayat, 2016; Surfiana dkk., 2014; Caesarina dan Estiasih, 2016; Adicandra dan Estiasih, 2016). On the capital side, micro/household scale has not been touched by capital institution, so the business scale is not economical (Fitriani & Zaini, 2012); (Fitriani, Arifin, & Ismono, 2010); (Ismono, Arifin, & Fitriani, 2011); Indarwanta dan Pujiastuti, 2011).

This study aims to (1) study the performance of cassava based food industry in production centers and (2) to analyze the potential of labor absorption and new sources of income through the development of local cassava based food processing industries.

II. MATERIALS AND METHODS

The field study was conducted in February until May 2017 at the center of cassava based processed food production in Pesawaran, Lampung Tengah, Lampung Timur, and Pringsewu Districts. Sampling method conducted by case study approach. Data analysis used descriptive statistical analysis.

III. RESULT AND DISCUSSION

Agricultural development aims to improve the welfare of agricultural communities through improved production systems, infrastructure, innovation and technology adoption and solid agricultural institutions. Efforts to increase agricultural productivity with the principle of orientation on populist economy needs to be done. The ongoing economic activities involving the participation of all members of the community, the results for the communities and the implementation of economic activities under the leadership and supervision of the community are the prerequisites for the work of sustainable agriculture development programs. Based on these principles, the development of agriculture should continue to be developed with the aim to increase the income and welfare of the community through the creation of employment opportunities that involve the rural community as much as possible (Fitriani, Sutarni, Ismono, & Lestari, 2015).

Agroindustry plays an important role in increasing the utility, absorption and productivity of labor institutions, and expanding the reach of marketing institutions. Rural agro-industrial development requires traditional institutional transformation processes related to labor and marketing, especially in the application of postharvest innovative technology to realize agro-based agricultural products (Elizabeth, 2010). The description of technology application on processing cassava could see as Table 1. Table 1 presented the information about machinery equipment which was apply to enhance cassava proceed productivity. Dominantly (86%), application of mechanical equipment becomes developed at production center of cassava processed product (Table 2).

Table 1. Machinery equipment for cassava processed product

No.	Machinery		No.	Machinery		No.	Machinery
1.	Grinding Machine		4.	Press / jack tool		7.	Steamer
2.	Slicing Machine		5.	Stove			
3.	Mixer Machine		6.	Scales			

Table 2. Level of equipment technology adoption

Technology	Respondent	(%)
Traditional	7	14%
Semi modern	42	86%
Total	49	100

The technology level categorized as traditionally and semi modern. There was 14% producer still lack access of semi modern equipment. The main cause was limited in capital. Machinery investment is expensive for rural household. The allocation of machinery investment was in range IDR 1.3 – 5.1 million (Table 3).

Table 3. Machinery investment (IDR)

Varian product	Min	Max	Average
Crackers	125,000	6,670,000	2,995,560
Klanting	470,000	9,176,000	5,142,294
Chips	2,155,000	4,845,000	3,607,750
Opak	305,000	2,820,000	1,313,000

In average, cassava chips industries have been sufficient at equipment investment. The equipment investment expenditure range relative closed each within industries. The deep gap on equipment investment had been faced by crackers, klanting, and opak industries. There was no sufficient capital to enhance their equipment technology. Some of them just processed cassava product as side job. It was just a way to find income resource alternative in rural. Labor in rural had been facing problematic situation. The rural labor conditions of the informal sector treated more informally, including at rural agro industry.

As comparison, in 2015 the quantity of decent living needs in Lampung Province was IDR 1.442.898. The wage rate of informal agricultural workers is lower than the Lampung minimum decent living needs. Various districts in Lampung still provide a large amount of agricultural labor wage in the range of IDR 35,000 - 45.000 per day. When refer to with US $ exchange rate, it currently means that per capita income was less than 1 US $, or is classified under the UN poverty line.

Agricultural development means improvement in agricultural wage rates. The efforts to improve wage rates for agricultural sector workers also can be done through increased fiscal spending of the agricultural sector. Capital expenditure needs focus on improving the quality of peasant resources and the opening of new jobs in the agricultural sector, both labor-intensive and capital-intensive. On the other hand, the incentive stimulus for business actors in agriculture through ease of permit, tax incentives, easy access to credit from finance, and the expansion of domestic and international market networks will systematically increase investment in agriculture become an improvement (Fitriani et al., 2015).

There is opportunity for rural labor absorption on cassava processed product industry (Table4). The existence of local food processing industry has the potential to provide employment for rural labor force. Without a strategic effort to improve the level of wages in the agricultural sector, this condition will encourage urbanization to seek a better life. However, because the labor skill requirements of rural areas that do not meet the qualifications of urban migrant workers cause them to fill in the informal employment space that earns less. As a result, urban poverty increased, in other words, the city as the estuary of migration of the rural poor. This condition certainly cannot be allowed to find a solution by itself. Potential rural worker adsorption into small scale cassava proceed product (person) in production center could see at Table 4.

Table 4. Potential rural worker adsorption into small scale cassava proceed product (person) In production center

Cassava proceed production center	Food Home industry*)	Worker	Home industry (<5)	Small scale industries (5-19)
Pesawaran	328	656	1312	6232
Central of Lampung	89	178	356	1691
Pringsewu	42	84	168	798
East of Lampung region	85	170	340	1615
Total	544	1088	2176	10336

Sources: Statistic Agency at Pesawaran, Central of Lampung, Pringsewu, and East of Lampung region, 2016

Based on Table 4, home industries based on cassava involved 544 small enterprises at four regions. There were minimum 2 rural workers for their industries. The estimation of worker adsorption in rural count as two categorize: home industry with maximum worker 4 person, and Small enterprises with range 5-19 worker. Then the rural worker adsorption could be reach 10.336 worker.

The analysis of revenue structure showed that cassava processing business was beneficial as a source of family income. The processed food industry is one of a source of rural income. The net income was around IDR 1.3 million.month^{-1}. Cracker was the most profitable. Follow by cassava chips, klanting, dan opak (Table 5)

An opportunity is open to new entrepreneurs in prospective market line networks. The market of processed products of cassava food industry is still very wide open. The business activity of the cassava processed food industry produces an economic multiplier for the actors who are involved.

Government intervention required to meet with economic (private) actors. So far, the agricultural sector has received minimum attention, minus the development budget allocation, as well as the neglect and marginalization that caused the development and development of the agricultural sector stagnated if not to be said to resign. The policy of improving the fate of agricultural labor can be done by considering the value of labor multiplier in the regional economy. The value of multiplier factor of labor production can be the government base in increasing the fiscal expenditure of its development in agriculture sector. In addition, the basic investment stimulus strategy for domestic agricultural actors is a top priority for development policy (Fitriani et al., 2015).

Table 5. Net revenue of cassava processing business

Product	Net revenue/period (IDR)	Minimum 2 x/month (Net revenue/month) (IDR)
Crackers	826,875	1,653,750
Klanting	615,601	1,231,202
Chips	656,071	1,312,143
Opak	507,383	1,014,767
Average	651,483	1,302,965

IV. CONCLUSION

Based on the analysis result, it can be concluded that the cassava based food processing industry was characterized by the scale of production of micro/home industry and using the family and the family's worker on average <5 people. The most common types of foodstuffs are: cracker, klanting, chips, and opak. The analysis of revenue structure showed that cassava processing business was beneficial as a source of family income. Based on rural labor absorption analysis, the existence of local food processing industry has the potential to provide employment for rural labor force.

REFERENCES

Adicandra, R. M., & Estiasih, T. (2016). Beras Analog dari ubi kelapa putih: Kajian Pustaka. *Pangan Dan Agroindustri*, *4*(1), 383–390.

Budi Trisnanto, T., & Fatih, C. (n.d.). Membangun modal sosial pada gabungan kelompok tani Building social capital for farmer association. Retrieved from http://e-journal.unair.ac.id/index.php/MKP/article/viewFile/2621/2718

Caesarina, I., & Estiasih, T. (2016). Beras Analog dari Garut (Maranta arundinaceae): Kajian Pustaka. *Pangan Dan Industri*, *4*(2), 498–504.

Elizabeth, R. (2010). Pengembangan Agroindustri Bahan Pangan untuk Peningkatan Nilai Tambah melalui Transformasi Kelembagaan di Pedesaan, *5*(1), 102–112.

Fitriani. (2015). Penguatan kapasitas kelembagaan gapoktan melalui pembentukan koperasi pertanian Gapoktan capacity institutionalization through farmer cooperative (koperasi). *Jurnal Kebudayaan Masyarakat Dan Politik*, *28*(2), 63–69. https://doi.org/http://dx.doi.org/10.20473/mkp.V28I22015.65-71

Fitriani, Arifin, B., & Ismono, H. (2010). Analisis Skala Ekonomi Produksi Tebu di Propinsi Lampung. *PANGAN*, *19*(4), 303–315.

Fitriani, Ismono, H., & Rosanti, N. (2011). Produksi dan tataniaga beras di propinsi lampung. *J-SEP*, *5*(1), 1–11.

Fitriani, Sutarni, Ismono, H., & Haryono, D. (2014). Kinerja Sub Sektor Tanaman Pangan pada Sektor Pertanian Lampung. In J. H. M. S. Muslimin, T. A. D. Nugroho, G. W. F. Rohmah, L. F. L. P. H. Perwitasari, & Diterbitkan (Eds.), *Prosiding Seminar Nasional Kedaulatan Pangan dan Pertanian* (pp. 212–220). Yogyakarta: Jurusan Sosial Ekonomi Pertanian Faperta UGM.

Fitriani, Sutarni, Ismono, H., & Lestari, D. A. H. (2015). Masa Depan Tenaga Kerja Sektor Pertanian. In Yusnita, Asmiati, N. Sa'diyah, L. Hakim, G. N. Susanto, Mardiana, … J. F. Suwandi (Eds.), *INOVASI SAINS DAN TEKNOLOGI UNTUK KETAHANAN PANGAN DAN KEMANDIRIAN ENERGI* (Vol. 42, pp. 319–334). Bandar Lampung: LPPM Universitas Lampung.

Fitriani, Trisnanto, T. B., & Fatih, C. (2013). Membangun Modal Sosial Pada Gapoktan Sumber Makmur di Desa Adiluwih.

Fitriani, & Zaini, M. (2012). Efficiency of Economics of Catfish Growing Business. *Jurnal Ilmiah ESAI*, *6*(2).

Indarwanta, D., & Pujiastuti, E. E. (2011). Kajian Potensi (Study Kelayakan) Pengembangan Agroindustri di Desa Gondangan Kecamatan Jonalan Klaten. *Administasi Bisnis*, *8*(Januai), 1–13.

Ismatul Hakim, Setiasih Irawanti, Murniati dan Suharmani, Asmanah Widiarti, Rachman Effendi, M. M. dan S. R. (2010). *Menuju Restorasi Pembangunan Kehutanan Berkelanjutan*. (S. A. dan I. Hakim, Ed.). Pusat Penelitian dan Pengembangan Perubahan Iklim dan Kebijakan Kampus.

Ismono, H., Arifin, B., & Fitriani. (2011). Implikasi INPRES No. 1 Tahun 2006 tentang Bahan Bakar Nabati Terhadap Kondisi Bahan Baku Industri Gula di Propinsi Lampung. *PANGAN*, *20*(1), 163–175.

Novia, W., Wan Abbas Zakaria, & Lestari, D. A. H. (2013). JIIA, VOLUME 1 No. 3, JULI 2013. *Jurnal Ilmu-Ilmu Agribisnis*, *1*(3), 210–217.

Pahlevi, R., Zakaria, W. A., & Kalsum, U. (2014). Analisis Kelayakan Usaha agroindustri Kopi Luwak di Kecamatan Balik Bukit Kabulapen Lampung Barat. *Jurnal Ilmu-Ilmu Agribisnis*, *2*(1), 48–55.

Rangkuti, K., Mardhiyah, A., & Putr, A. D. (2015). Analisis Nilai Tambah Keripik Singkong pada Kelompok Usaha Keluarga (KUK) Desa Sipare-Pare. *Agrium*, *19*(2), 116–121.

Surfiana, Hidayat, B., & Akmal, S. (2014). Efektivitas Tansfer Teknologi Pengolhan Beras Sige Terhadap Peningkatan Produktivitas Usaha Beras Tiwul Tradisional. *Inovasi Dan Pembangunan*, *2*(3), 32–45.

B.6

COSTUMER SATISFACTION ON COFFEE OF CAFE'S MARKETING

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ABSTRACT

Coffee is ones of Indonesian favorite agriculture commodity. Beginning from Upper course to Lower course of anything about coffee, Indonesia make it special to handled. Cafe on Coffee shop is the part actors of lower course Indonesian agriculture and it being popping up for western culture affects for Indonesia people to enjoy coffee. Thus it can be seen from the sales data Café Armor fluctuating (ones of the biggest cafe in Bandung, West Java-Indonesia). It has a goal to know about connection between marketing mix with customer satisfaction at Café Armor. Analysis Methode of the datas that I used are the Importance Performance Analysis and Customer satisfaction Index to assess the level of customer satisfaction. The Attributes are: Product, Price, Place, Promotion of Marketing Mix. Based on the analysis that has been applied shows that : average of consumers who come are male & the male are aged around 21-30 years. They chose Café Armor because they like their service of coffee and also the social atmosphere at Café Armor. Attributes that consumers preferred are the products and places that have been presented by Café Armor. Consumers do not think too much about the promotion and the price that given by Café Armor. Café Armor already provide what consumers want to be able to enjoy the convenience. Variable media printing promotion is in quadrant I, which means the media printing promotions is important for customers but the performance of Café Armor is still said to be low. The level of the diversity of the menu, variety of coffee beans, methods of making coffee, coffee quality, strategic location, comfort, cleanliness of the place and facilities were located in quadrant II, which means consumers love the performance of Café Armor and it was already given the maximum performance. As for the price, the terms of payment, the social media promotion, and the relation through promotion was entered in quadrant III, which is to be considered less important than the customer, and indeed of the Café Armor is not too influential in serving customers.

Keywords : food, lower course commodity, coffee shop business, marketing method, customer satisfaction

I. INTRODUCTION

Indonesia is the patern of several countries who have many kind of special coffees. It happened because of coffees planting at every different area can produce difference tastes. That differences, happened because of difference geographical also in every region. Some Indonesian coffees are from Gayo coffee from Aceh, kintamani coffee from Kalimantan, mandaling coffee from North Sumatra, mangkuraja coffee from Bengkulu, Java preanger and Ciwidey coffee from West Java and another.

Indonesian consumption since 2010 until 2015 has gradually raising, it because of many factors happened, one of it is can changes the trend in society in actually more love single origin coffee and usually available single origin menu in coffee shop , so it can be build the new trend to turn up many coffee shops in big town, specially in Bandung city.

Many coffee shop in Bandung city has made consumer embittered to taste blend various of original coffee. Coffee shop set aside many kind of drinkin frickle coffee, some kind: espresso coffee, coffe latte, cappucino coffee and the others. In addition to the cunsumer's embittered, comfortable place and good facilities can make coffee shop better and can make consumers to extracted to enjoy the coffee from its shop.

Here these below of coffee shops in Bandung city that use manual brew that produce single coffee origin. One of that shop who make single coffee origin is Coffee Armor Shop.

Table 1. Coffee shop in Bandung city with manual brew process

No.	Name of Coffee Shop	Coffee shop address
1	Armor Kopi	Taman Hutan Raya Djuanda Dago
2	Two Hands Full	Jl. Sukajadi no.206
3	Lacamera Coffee	Jl. Naripan no.97
4	Jack Runner Roastery	Jl. Ciumbeulit no.42
5	Dreezel	Jl. Cisangkuy no.56
6	Blue Doors	Jl. Gandapura no. 61
7	Noah Barn	Jl. Dayang Sumbi no.2
8	Cultivar	Jl. Sultan Tirtayasa no.26

Coffee Armor Shop located at Taman Hutan Raya (Tahura) Djuanda region dago is conservative area in Bandung city. Now, Tahura was opened the opportunity for any one who want have to open the firm of coffee shops. Coofee shop Tahura has opened its exertion at Tahura in 2015. Misses's said (as the owners of Tahura coffee shop), she build armor coffee shops in Tahura because of good atmosphere and it can make enjoy consumers of coffees.

The unique of armor coffee shop is have many kind of variation bean, so it can make consumers have to choose about bean of their wanted to. The consumers are very happy to come to armor coffee shop because they can choose every coffee of their like and can enjoy at armor coffee shop. The varian beans in armor coffee shop is the mainstay of armor coffee shop. Lintong coffee and Toraja coffee that kind of arabica coffee are the model coffee in armor coffee shop. The other unique of armor coffee shops is the nice place that consumer can enjoy their drinking with good atmosphere condition. That uniqly, make consumer enjoy everything happened innthere, specially of it is good atmosphere. That condition showed by good raising in January until October 2016.

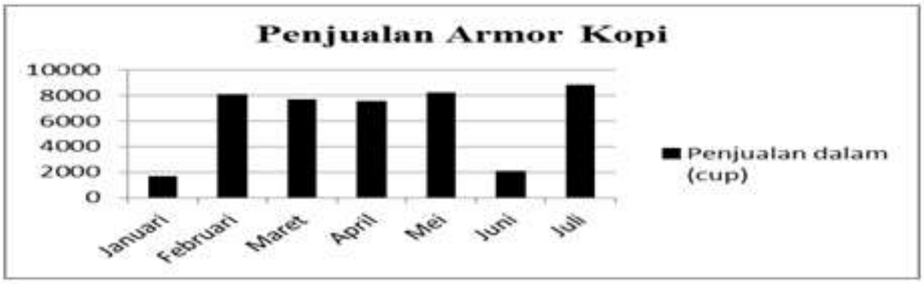

Fig. 1. Selling amor coffee in 2016 (Source : Armor coffee shop data 2016)

The luster of coffee shop business in Bandung city was made more rivalry for all coffee business. So, armor coffee shops should hold out on that competition of business. The manner of armor coffee shop's effort that used by armor coffee shop is to make available more variative kind of coffee because for consummers, it can be very important thing to make their loyality.

In this research, writers was used experiment of variables on product attribute that asking to consumers in armor coffee shop about consumer satisfaction. So, the impact of this research is can help armor coffee shop to have maximum income and knowing all about costumer satisfaction, specially on coffee of cafe's marketing.

1. How is consumer characteristic in armor coffee shop?
2. Which one dominate impact on consumers satisfaction? (4P; Product, Price, Place, Promotion)

II. MATERIALS AND METHODS

The placement of this research is Armor coffee shop. Armor coffee shop is in the parking area of the Tahura's tour garden (Taman Hutan Rakyat Djuanda), at Dago Atas street, Bandung city, West Java, Indonesia. The research's place was choosen by intentional choosing and considerate of many kind of beans that delivered by Armor coffee shop.

It is reseach case. Quantitative design is used on this desain research, at the time that technical survey description is used on this reseach also). The population has used by this research are all coffee shop's customers. Quantity of population definites by on the average of costumers who came to armor tahura coffee shop in every day in February 2015 until February 2016, amounting to 324 costumers. In that case, if we calculate in every week, all of costumers are 2.268 costumers, and continued by slovin methode so we have 96 respondens only.

To analize costumer's satisfaction can use 2 methodes; Costumer Satisfaction Index (CSI) and Important Performance Analysis (IPA)

1. Costumer Satisfaction Index (CSI)
2. Importance Performance Analysis (IPA)

The analisys data, we use:

1. Validity test
2. Reability test

III. RESULTS AND DISCUSSION

A. Costumer Characteristics

Nowadays, business of coffee on cafe in Bandung city is on the fire. Many business of them not only selling something like dringking only, but they sell all out of theirs power and all everything their capacities. Ones of the examples, their business have to do some thing special and unique to cacth as many as costumers they can get. The atmosphere and service can be the facilities to support goal of their business, it is to have so many costumers every day. So it is also for Armor coffee shop must do it. The competition of this business is very thigt competitiveness. The costumer satisfaction is very important thing to be have, because it is the key`s success of this business. The costumers characteristic in this research are explain by vary variables, they are: age, gender, job activity, and education.

B. Costumer characteristic on Age

Table 2. Costumer characteristic on Age

No.	Age (Years)	Frequency	Percentage (%)
1	<20	3	3.13
2	21-30	84	87.50
3	31-40	9	9.38
	Total	96	100

It is indicating that the consumers who came to the armor coffee shop are youth, between 21-30 years old. They come to armor coffee shop usually together with their friends and invite the other friends to come to armor coffee shop in another day to enjoy the taste of coffee with its comfortable atmosphere.

C. Consumer characteristics based on Gender

Result has shown, at Armor coffee is dominated by male than female.

Table 3. Gender in Armor Coffee Shop's Consumer

No.	Age (Year)	Frequency	Percentage (%)
1	Male	59	61.46
2	Female	37	38.54
	Total	96	100

D. Consumer characteristics based on occupation

Armor Coffee shop is various enough if it is watched from occupation kinds of. It is shown that consumers largely have own self income to be spent in according to desirability and need levels. Consumer occupation kinds of at Armor Coffee shop most dominant is students or university students. It can be seen on table at below:

Table 4. Consumer characteristics based on occupation at Armor Coffee Shop

No.	Occupation	Frequency	Persentase (%)
1	Pegawai Swasta	7	7.29
2	Pelajar/Mahasiswa	85	88.54
3	Wiraswasta	3	3.13
4	Wirausaha	1	1.04
	Total	96	100

E. Consumer characteristics based on Education Level

Following Engel, et.al (1994), education level differences would also be shaped different purchasing behavior. Consumers' education level of Armor Coffee shop is college that is 88,54%. That result has shown that consumer who have better education level is very selective to buy a product.

Table 5. Consumer characteristics based on education level at Armor coffee shop

No.	Occupation	Frequency	Persentase (%)
1	High school	11	11.46
2	Under graduate or graduate	85	88.54
	Total	96	100

F. Customer satisfy index

A measure toward customer satisfies are very needed to determine goals in the future to know satisfy level resulted by an attribute. For customer satisfies level is used Costumer Satisfaction Index (CSI) method. Customer satisfies level counting by use Costumer Satisfaction Index (CSI) is needed importance level average score and available attribute performance level average score.

It is obtained CSI as much as 73,49% then Armor coffee shop costumer satisfy included into "Cause for concern" (71 < X ≤ 76) or "Satisfy Less" (Table 6). It can be seen at above table that Armor coffee Shop performance is given satisfy less to its customers. So, Armor coffee shop is not carried out maximal performance at its have attributes in order to able to improve its customer satisfies. The factors are caused that things occure that is its capital resources limited, lack human resources quality and lack human resources numbers. By those conditions, Armor Coffee shop should be carried out some improvements to increase Customer satisfy level. CSI=73,49% so costumer satisfaction index point is below on satisfied for costumers.

Customer Satisfaction Index (CSI) in Kedai Kopi Armor by formula:

$$\mathrm{CSI} = \frac{\sum_{k=1}^{p} \mathrm{WS_k}}{\mathrm{HS}} \mathrm{x}100\% \tag{1}$$

$$\mathrm{CSI} = \frac{3{,}6745}{5} \mathrm{x}100\%$$

$$\mathrm{CSI} = 73{,}49\%$$

G. Attribute Improvement Priotities

Human resources limited make Armor Coffee Shop must be able to manage available human resources to improve attribute is priorited necessary in order to have bigger benefit toward customer. This folowing is analysis result of available attribute importance level at Armor Coffee Shop.

Table 7. Mean point depend on attribute importance level at Armor Coffee Shop in 2016.

No	Attribute	Importance level	Performance level
1	Menu Variety Level	4,09	3,82
2	Coffee Bean Variation	4,24	3,99
3	Coffee Processing Method	4,04	3,79
4	coffee quality	4,33	4,01
5	price	3,74	3,50
6	payment method	3,34	3,30
7	Location Strategy	4,09	3,94
8	Site Comfortableness	4,26	4,09
9	Site Cleanness	4,36	3,93
10	Facility	4,33	3,78
11	Promotion and social media	3,38	3,28
12	Promotion by relationship	3,28	3,13
13	print media promotion	3,29	3,14
	average	3,91	3,67

Both these value would be middle line on cartesius diagram that is Important Performance Analysis (IPA) so that cartesius diagram will be divided into four quadrants. Following is Important Performance Analysis (IPA) cartesius diagram:

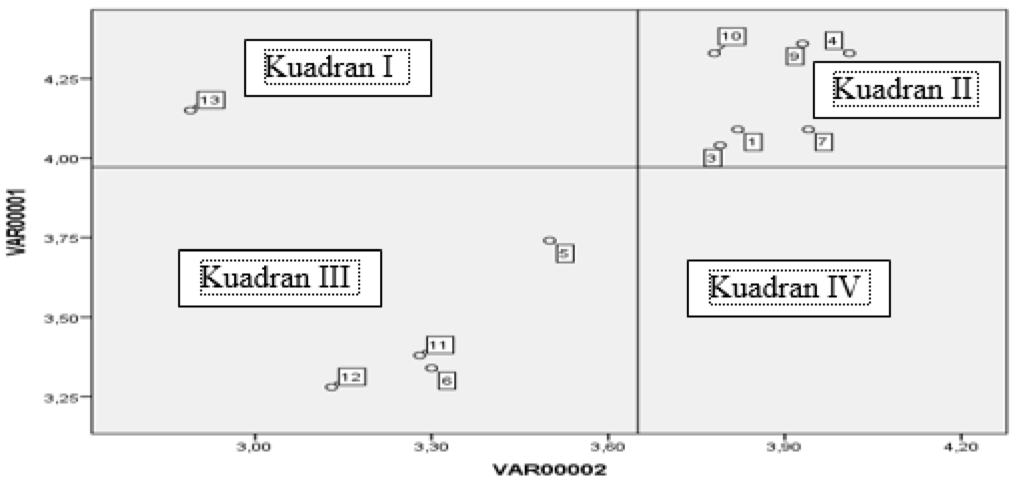

Fig 2. Cartesius Diagram Important Performance Analysis cafe Armor coffee

where :

1. Menu Variety Level
2. Coffee Bean Variation
3. Coffee Processing Method
4. Coffee Quality
5. Price
6. Payment method
7. Location Strategy
8. Site Comfortableness
9. Site Cleanness
10. Facility
11. Promotion and social media
12. Promotion by relationship
13. Print media promotion

A mapping at cartesius diagram based on this performance level and importance level is make possibility Armor Coffee Shop side to do attribute improvement which is assumed very important by consumers, either in shor-term or long-term. This attribute improvement has depended on each attributes position on four quadrants.

1. Quadrant I (Main Priority)

Quadrant I on IPA cartesous diagram has shown product attribute importance level is very importand assumed customer, but performace is shown by this attribute proposed still low or not maximal yet. Attribute at quadrant I should be main priority for Armor Coffee Shop to improve a performance so able to fulfill and to increase customer satisfies. It is based on field research, attribute at quadrant I is following :

a. Published Media Promotion

Armor Coffee Shop Promotion maight be said less. Promotion in social media or mouth to mouth shapes may be already good but for customers the published media promotion also importand then this variable has had 35,41% and doing performance is good enough with percentage 42,71%, saying that published media is important enough promotion to do.

Table 8. Importance level and working atribute level on media promotion

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	12	12.50	very good	5	5.20
important	23	23.96	good	27	28.13
quite important	34	35.41	quite good	41	42.71
not important	20	20.83	bad	20	20.83
very not important	7	7.30	very bad	3	3.13
total	96	100.00	total	96	100.00

2. Quadrant II (Performance Maintain)

Quadrant II at IPA Cartesius diagram has shown that akready carried out by Armor Coffee Shop has been maximal and it is enjoyed by customers. On this quadrant can also be said important attributes for customers and is already appriopriate to customers desired.

a. Menu Variety Level

Armor Coffee Shop has been had menu variety in according to what customes desired is. Menu including as an important attribute and Armor Coffee Shop side has been given maximally and it is enjoyed by customers. It can be seen from importance level percentage that is 47,92% meaning important and even customer having percentage for performance level as much as 38,5% meaning satisfy with given menu by Armor Coffee Shop.

Table 9. Menu Variety Level

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	32	33.33	very good	25	26.04
important	46	47.92	good	37	38.55
quite important	14	14.58	quite good	26	27.08
not important	3	3.13	bad	8	8.33
very not important	1	1.04	very bad	0	0.00
total	96	100.00	total	96	100.00

b. Coffee Bean Variation

Armor Coffee Shop including shop which is having various coffee bean variety kinds of. It is usually from Sabang u to Merauke served by Armor Coffee Shop. Because Armor Coffee Shop self vision and mission that is to introduce coffee from Indonesia then it importance level as much as 47,92% meaning very important. For customer even this coffee bean variation very important for them who want to know coffees from Indonesia, then, it performance level as much as 39,58% meaning satisfy with Armor Coffee Shop performance has been given.

Table 10. Level of importance and working atribute level on coffee bean

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	46	47.92	very good	30	31.25
important	32	33.33	good	38	39.58
quite important	15	15.63	quite good	25	26.04
not important	1	1.04	bad	3	3.13
very not important	2	2.08	very bad	0	0.00
total	96	100.00	total	96	100.00

c. Coffee Processing Method

Coffee processing methods are very various. Armor Coffee Shop is also serves some methods to process a coffee. It important level already at 39,58% meaning important for both customer and that shop. Performance level on this coffee processing method as much as 43,75% meaning good to do. This coffee processing method is also very influence customer satisfy, because every coffee bean would be outed different taste if it is processed with other method.

Table 11. Level of importance and working atribute level on cofffee processing methode

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	34	35.42	very good	21	21.88
important	38	39.58	good	42	43.75
quite important	20	20.83	quite good	25	26.04
not important	2	2.08	bad	8	8.33
very not important	2	2.08	very bad	0	0.00
total	96	100.00	total	96	100.00

d. Coffee Quality

Coffee quality is one consideration for coffee devotee mainly in this Bandung. It is caused coffee bean quality choosen by customers is determined customer satisfy. Based on Tabble 15, 53,13% for importance level of coffee quality attribute. Therefore, that coffee quality customer should be very paid attention so that able to enjoy coffee with their wants. Performance level having by coffee quality attribute as much as 38,54%.

Table 12. Level of importance and working atribute level on quality of coffee

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	51	53.13	very good	37	38.54
important	31	32.29	good	30	31.25
quite important	11	11.46	quite good	22	22.92
not important	1	1.04	bad	7	7.29
very not important	2	2.08	very bad	0	0.00
total	96	100.00	total	96	100.00

e. Location Strategy

Coffee shop location determination would be determined the customer number who coming to that coffee shop. Here, given evaluation by customer is choosen location by Armor Coffee Shop, include inside location easy to reach, see, and memorize.

It is based on table 12, can be seen that customer number is said that coffee shop location attribute is very important (38,55%). While Armor Coffee Shop performance level for this attribute, customer numbers who said that it performance is very good (36,46%).

Armor Coffee Shop location at Djuanda Great Forest Park, Dago, Bandung is become more value for this one coffee shop. This is meant that Dreezel Coffee must be maintained this attribute performance.

Table 13. Level of importance and working atribute level on location strategy

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	37	38.55	very good	35	36.46
important	36	37.50	good	33	34.38
quite important	20	20.83	quite good	16	16.67
not important	1	1.04	bad	11	11.45
very not important	2	2.08	very bad	1	1.04
total	96	100.00	total	96	100.00

f. Site Comfortableness

Customer is coming to enjoy a glass coffe will also be sure to choose comfort site, not noisy, can be enjoyed coffee in quiet. It is given site comfortableness by this Armor Coffee Shop having importance level as much as 47,92%, therefore, customer is also want to enjoy a glass coffee with supported atmosphere. Performance level at site comfortableness attribute having number as much as 40,63%. Customer is happied to enjoy a glass coffee at Armor Coffee Shop and this coffee shop is also already having location in appropriate to customer desirability.

Table 14. Level of importance and working atribute level on site comfortableness

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	46	47.92	very good	39	40.63
important	33	34.38	good	33	34.38
quite important	14	14.58	quite good	19	19.79
not important	2	2.08	bad	4	4.16
very not important	1	1.04	very bad	1	1.04
total	96	100.00	total	96	100.00

g. Site Cleanness

Someone is want to enjoy a glass coffee at quiet and clean sites. Although Armor Coffee Shop has been had site at Great Forest Park but Armor Coffee Shop is also paid attention site cleanness matter. It can be seen at Table 18. Importance level for site cleanness is very important having percentage 56.25% and performance level for site cleanness as much as 56,25% in good evaluation.

Table 15. Level of importance and working atribute level on site cleanness

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	54	56.25	very good	20	20.83
important	28	29.17	good	54	56.25
quite important	10	10.41	quite good	17	17.71
not important	3	3.13	bad	5	5.21
very not important	1	1.04	very bad	0	0.00
total	96	100.00	total	96	100.00

h. Facility

Beside Armor Coffee Shop has sited at Great Forset Park, this coffee shop is also pay attention to facility. Customer who came will also be sure felt quiet is prepared facilities are ordered and clean.

It can be seen at table 19 from facility attribute importance level (58,33%) that customer has felt very important for facility completeness available and can also be seen from this attribute performance level (32,29%) that given performance by this Armor Coffee Shop is very good.

Table 16. Level of importance and working atribute level on facilities

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	56	58.33	very good	31	32.29
important	21	21.88	good	27	28.13
quite important	16	16.67	quite good	24	25.00
not important	1	1.04	bad	14	14.58
very not important	2	2.08	very bad	0	0.00
total	96	100.00	total	96	100.00

3. Quadrant III (Low Priority)

Attribute at this Quadrant III should be concerned again about its situation. From customer side, this attribute including attribute has assumed less important and of course, even from Armor Coffee Shop including attribute is not much influenced for customer serve.

a. Price

In enjoy a glass coffee, a customer should also be pay what is ordered. Following customer this price attribute having very important importance level (32,29%) and good performance level (30,21%) but for customer this price attribute is less important to enjoy a glass coffee and given site comfortableness by Armor Coffee Shop.

Table 17. Level of importance and working atribute level on price

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	31	32.29	very good	21	21.88
important	26	27.09	good	29	30.21
quite important	24	25.00	quite good	28	29.16
not important	13	13.54	bad	13	13.54
very not important	2	2.08	very bad	5	5.21
total	96	100.00	total	96	100.00

b. Payment Method

Armor Coffee Shop is not having various payment method, it can be seen atv table 21, this attribute having important level as much as 30,20% meaning important enough and at performance level as much as 37,50% meaning also important enogh. For customer and Armor Coffee Shop alone this attribute is important less.

Table 18. Level of importance and working atribute level on payment method

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	22	22.92	very good	13	13.54
important	20	20.84	good	28	29.17
quite important	29	30.20	quite good	36	37.50
not important	19	19.79	bad	13	13.54
very not important	6	6.25	very bad	6	6.25
total	96	100.00	total	96	100.00

c. Social Media Promotion

In social media promotion attribute, Armor Coffee Shop is not very used that attribute. It can also be seen at Table 22, that this attribute importance level and performance level there is at important enough (26,04%) and good enough (27,08%). Therefore, promotion is not carried out by this coffee shop side. Even for customer as social media promotion is not very important.

Table 19. Level of importance and working atribute level on promotion social media

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	23	23.96	very good	18	18.75
important	22	22.92	good	25	26.05
quite important	25	26.04	quite good	26	27.08
not important	18	18.75	bad	20	20.83
very not important	8	8.33	very bad	7	7.29
total	96	100.00	total	96	100.00

d. Promotion through Family

Armor Coffee Shop is just carried out mouth by mouthpromotion only, on of them may be promotion through family a customer fellow or Armor Coffee Shop alone. This promotion activity can be said important because having big number as much as 34,38% and performance has been carried out also said good enough with percentage number as much as 28,12%. For customer this promotion can also be said important because just this promotion only carried out by Armor Coffee Shop alone.

Table 20. Level of importance and working atribute level on Promotion through Family

Importance level			Performance level		
assessment level	total Respondents	Presentase (%)	assessment level	total Respondents	Presentase (%)
very important	15	15.62	very good	17	17.71
important	33	34.38	good	22	22.92
quite important	27	28.13	quite good	27	28.12
not important	6	6.25	bad	16	16.67
very not important	15	15.62	very bad	14	14.58
total	96	100.00	total	96	100.00

IV. CONCLUSION

It is based on carried out research result, then it is obtained conclusion, that is:

1. Armor Coffee Shop consumer are male sex kind of, having age 21-30 years old in average, having education in college level, a student/university student. Consumer was coming to Armor Coffee Shop is young man who has aged 21-30 years old in average and is tsill become student/universiry student.
2. Customer sarisfy at Armor Coffee Shop is satisfy less in category. Factors is caused Armor Coffee Shop performance is not optimal yet that is performance quality, human resources number lacks and optimizing for small things. It is dominant influenced from product, site, promotion, and price toward customer satisfies are product and site existing at quadrant II, meaning product and site have maximally carried out by Armor Coffee Shop

REFERENCES

Ainsworth M, Smith, S. dan A. Millership. 2002. *Managing Performance People*. Terjemahan. Jakarta: PT. Bhuana Ilmu Populer.

Bygrave, William D. 1994. *The Portable MBA in Enterpreneurship.* New York: John Willey & Sonc, Inc.

Engel, J.F, Blackward, dan Miniard. 1994. *Consumer Behaviour*. (Perilaku Konsumen, alih bahasa: Budijanto). Ed ke-6 Jilid 1. Jakarta: Binarupa Aksara.

James D. Dana & Denis W Crlton. 2004. *Product Variety and Demand Uncertainly. Journal of Economic.*

Kasali, Rhenald. 2000. *Manajemen Public Relations*. Jakarta : PT. Temprint.

Kotler, Philip. 1997. *Marketing Management"Analysis, Planning, Implementation and Control"*(9ed.). New Jersey: Prentice Hall International,Inc.

Kotler, Philip., Keller. 2007. *Manajemen Pemasaran*. Jakarta: Erlangga.

Kotler, Philip., Keller. 2009. *Manajemen Pemasaran*. Jakarta: Erlangga.

Lupiyoadi , Rambat. 2001. *Manajemen Pemasaran Jasa*. Jakarta : PT. Salemba Empat.

Nazir, M. 2005. *Metode Penelitian.* Jakarta: Ghalia Indonesia.

Norvi Handayati, Novi. 2011. Analisis Proses Pengambilan Keputusan dan Preferensi Konsumen Rahat Cafe Bogor. Skripsi. Institut Pertanian Bogor

Pangabean , Edy. 2012. *The Secret of Barista*. Jakarta: PT. Wahyumedia

Rangkuti, Freddy. 2006. *Teknik Mengukur dan Strategi Meningkatkan Kepuasan Pelanggan*. Jakarta : Penerbit PT Gramedia Pustaka Utama.

Sugiyono. 2006. *Metode Penelitian Bisnis*. Cetakan IV. Bandung: Alphabeta

Sugiyono. 2011. *Metode Penelitian Pendidikan Pendekatan Kualitatif, Kuantitatif, dan R&D.* Bandung: Alfabeta.

Suliyanto. 2006. Metode Riset Bisnis. Yogyakarta: Andi.

Sumarwan, Ujang. 2004. Perilaku Konsumen dan Keputusan Pembelian Konsumen Produk Pertanian Sedgar di Ritel Modern. Skripsi Sarjana Pertanian Program Ekstensi Manajemen Agribisnis, Fakultas Pertanian Institut Pertanian Bogor.

Supranto. 2001. *Pengukuran Tingkat Kepuasan Pelanggan Untuk Menaikkan Pangsa Pasar*. Jakarta: Penerbit Rineka Cipta.

Umar Husein. 2003. *Riset Pemasaran dan Perilaku Konsumen*. Jakarta: Gramedia Pustaka Utama.

Rosselina Cindy Kautsar.2012. Analisis Preferensi Konsumen Yoghurt My Healthy di Dramaga Bogor. Skripsi. Institut Pertanian Bogor

B.7

SUPPLY CHAIN ANALYSIS OF CRYSTAL GUAVA IN THE DISTRICT OF CIMAUNG, REGENCY OF BANDUNG

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ABSTRACT

Crystal guava in Regency of Bandung is spread in three Districts, Cimaung, Arjasari, and Pasirjambu. Particularly in the District of Cimaung it has been developed since 2013 and the district is the first area that develop crystal guava in Regency of Bandung,

The research aims to investigate supply chain of Crystal guava at the District of Cimaung, Regency of Bandung.The research is implementing qualitative design with case study techniques and survey method to map the supply chain of crystal guava from producer to customer.

The result shows supply chain of crystal guava at the district of Cimaung, regency of Bandung consists of farmer, farmer community, supplier to traditional and modern market, exporter, agrotourism activities and consumer.

Keywords : Supply Chain, Crystal Guava, District of Cimaung, Regency of Bandung

I. INTRODUCTION

Crystal guava is one variant of guava with large berries and clean fruit flesh. The crunchy texture, with only few seeds contained is the main cause of its popularity. It was first developed in Indonesia, particularly West Java, where one of development area is in Regency of Bandung. There are three development centers for cristal guava in Regency of Bandung, they are District Cimaung, Arjasari and Pasirjambu. The pioneer of the development for crystal guava in Regency of Bandung is in District Cimaung by Tirta Mulya farmer group and then spread to several areas such as Arjasari and Pasirjambu.

The development of crystal guava is certainly not independent of consumer demand for the production of the comodity itself. Based on this situation, the authors are interested in conducting research on the supply chain analysis of crystal guava in District of Cimaung, Regency of Bandung.

II. MATERIALS AND METHODS

The research method is survey. While research technique is case study. The data are primary and secondary data. Data was analysed with supply chain analysis by describing supply chain of Crystal guava in District of CImaung, Regency of Bandung.

Respondents were chosen purposively which is the farmer group that is the pioneer in cultivating crystal guava.

III. RESULTS AND DISCUSSION

Crystal Guava in Regency of Bandung was first introduced and cultivated byTirta Mulya farmer group in 2009. The group is located in District of Cimaung, Regency of Bandung but began to be seriously cultivated in 2013. In addition to crystal guava, the group also cultivating regular guava, oranges, rice and vegetables. The 71 members who is cultivating crystal guava, as many as 12 people posses average land ownership of 500-1,000 m^2 with private ownership status.

The supply chain system in value chain is all the activities undertaken to produce goods and services. These activities form a chain that connect producers with consumers. The results of the carried-outsearch and mapping has identified actors in the distribution chain as described in following on Fig. 1.

Traditional market is still the main market of the farmer group to sell crystal guava through the role of intermediary traders around the production centers. Inadequate cultivation process (without standard operational procedure) resulted in high quality crystal guava can not be obtained consistently. The crystal guava standard is determined by weight, shape, defect, and maturity. So that even though they can penetrate the modern market but with a little volume. While Agrotourism activities do not have much effect on the sales of crystal guava.

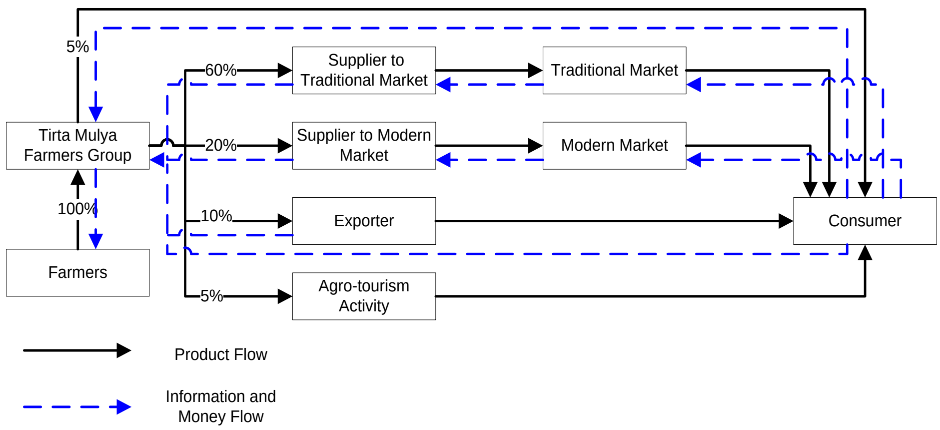

Fig. 1. Suplly Chain Cristal Guava

The development of crystal guava in District of Cimaung have various problem:

- Must compete with guava that has cultivated by community for long time and already have market.
- Community are not interested in using crystal guava as raw material of aroindustry processed products.
- Crystal guava more expensive than guava
- Crystal guava have limited consumer

This causes most people still survive cultivating guava in District Of Cimaung. Regardless of that problem, crystal guava usually bear fruit within 6 months after planting. After that period the crystal guava plant will continue to produce fruit until the age of 10 years (depends on the maintenance process).

The plant and fruits can grow optimally at a temperature of about 23-28° C during the daylight. Lack of sunlight can cause a decrease in yield or less than perfect (dwarf) fruit. The ideal season for flowering and ripening is during the dry season in around July – September. The fruit season occurs in November-February along side the wet season if properly maintained.

Regarding the harvest season, ever since the fertilization process can be done throughout the year. Hence the harvest time of crystal guava can basically be executed anytime when the fruit is ready to be harvested.
Usually the major harvest season occurs in January - March and will continue every four months. Market wise, the harvest season of crystal guava is usually done two times in a year.

IV. CONCLUSION

Limitations in abilities of upstream actors result in facing various business risks such as production risk, marketing risk, financial risk and institutional risk. These limitationsinhibit the development of enterprise, that led to stagnancy of operational economic scale, despite being run long enough.

REFERENCES

Abdullah, Thamrin dan Francis Tantri. 2012. *Manajemen Pemasaran*. Depok: PT Raja Grafindo Persada.
Badan Pusat Statistik 2013. Perkembangan buah-buahan di Jawa Barat.
C. Furqon. Analisis Manajemen dan Kinerja Rantai Pasokan Agribisnis Buah Stroberi di Kabupaten Bandung. IMAGE vol III no 2. 2014
Heizer, Jay, dan Render, Barry, 2014, *Operations Management: Sustainability and Supply Chain Management, 11thEdition,* Pearson Education, Inc
Hikmah, Nurchayati, A.T. Ratnawati. Pola Distribusi Buah Lokal Hasil Produksi di Kota Semarang. Prosiding Semnas hasil-hasil penelitian dan Pengabdian LPPM Universitas Muhamadiyah Purwokerto 2015.
Laporan Road map pengembangan Jambu Kristal 2014. Direktorat budiaday dan pasca panen buah Dirjen Hortikultura dengan LPPM Universitas Padjadjaran
Marimin, dkk 2013. Teknik dan analisis pengambilan keputusan Fussy dalam Manajemen Rantai Pasok. Bogor. IPB Press
N. Tamuntuan. Analisis Saluran Distribusi Rantai Pasokan Sayuran Wortel di Kelurahan Rurukan Kota Tomohon. Jurnal EMBA 2013. Vol 1 No 3
T.I Noor, P. Pardian, A. Nugraha. Analisis Rantai Nilai Bawang Merah Jawa Barat. Jurnal Agricore 2016 vol 1 no 1.
P. Pardian, T.I. Noor, A. Kusumah. Analisis Penawaran dan Permintaan Bawang Merah Jabar, Jurnal Agricore 2016 vol 1 no 2.
Ratnasari Rr. Analisis Rantai Manajemen Pasok Kopi Arabika pada PT. Indokom Citra Persada di Kabupaten Sidoarjo, Skripsi Fakultas Pertanian Universitas Jember 2014
S.A. Andayani, A. Sumarna, A. Ferdiana, Analisis Tataniaga dalam Usahatani Jambu Kristal Suatu Kasus di Desa Jayi Kecamtan Sukahaji Kabupaten Majalengka. Jurnal Ilmu Pertanian dan Peternakan 2014 vol 2 no 2.

B.8

RISK MANAGEMENT IN THE SUPPLY CHAIN OF MANGO EXPORT-ORIENTED IN SEDONG, CIREBON

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ABSTRACT

Samimulya is one of farmer groups in subdistric Sedong, Cirebon that has cooperated with the exporter (PT. SAE). But either way farmer, farmer groups and exporter in running their the business is encountered obstacles and barriers, so that in the long term would threaten the continuity of supply of mangoes and therefore there needs to be supply chain risk management. The method is used case study, with a qualitative design. The analytical reseach is used the analysis of House Of Risk (HOR). The results of the Hor-1 analysis showed there were six priority risks that must be handled at farmer level, 6 priority risks at the farmer groups level and 7 priority risks at exporters level. The result of Hor-2 analysis showed that the risk mitigation actions are most effective at the farm level is to increase role of Farmer groups; at Farmer Groups level are the training of SOP, GAP and GHP; as well as at the level of Exporters is to expand the domestic market outside of Java island. Therefore it is necessary role of extension workers to assist mango's farmer and farmer groups in the implementation of mango cultivation techniques in accordance with the SOP, GAP and GHP for mango production is maintained in terms of quantity, quality and continuity and in turn with mitigation risks, the banking is daring to provide financing to mango's farmers.

Keywords: Supply Chain, Risk management, House of risk.

I. INTRODUCTION

International market has known mangoes from Indonesia, even though for some target countries for export such as Saudi Arabia, Hong Kong, and the USA, the export volume tends to decrease. This is due to the standard of quality demanded by international market could not be fulfilled by Indonesian producer farmers. The inability of mango farmers to fulfill the demand of international market might be caused by several factors such as the inability of the farmers to guarantee the production continuity. This is because the harvest of mangoes is seasonal while the technology for the production increase of mangoes during the off-season is still lacking, and the off-season technology is quite expensive for farmers, which extends from IDR 300,000.00 to 500,000.00 per tree [1].

Another factor that has caused the instability of the export value of mangoes is the existence of risks faced by farmers, including production risks such as the emergence of pest attacks at mango trees such as the attacks of fruit flies, rice pests, and others. The other risks are price and financial risks.

In West Java, there are five main types of mangoes developed in centers of mango cultivation ranging from Indramayu Regency, Majalengka Regency, and Cirebon Regency, i.e., *harumanis*, *gedong*, *gedong gincu*, *dermayu*, and *golek*. Of the five types, *gedung gincu* variety of mangoes is the local superior type with competitive value.

Many obstacles faced by Indonesian mango farmers have made the export of mango relatively decrease from year to year, but the proportion is more than the export value of Indonesian mangoes. This condition shows that the price of Indonesian mangoes is high because they have delicious and special taste and aroma, interesting skin color, and high nutrition values, and that the harvest period in Indonesia does not coincide that of the other countries.

One of the obstacles faced by mango farmers to fulfill the structure of market demand is the limitation of the stock of mangoes with good and prevalent quality, and that farmers have not been able to provide mangoes continuously due to the risks they face. It seems that the understanding about the supply chain risks and the business process of mangoes in structured market is important, because they can increase trust and belief of the creditors, who are, so far, considered as the financing institutions that have high risk in financing the actors in the supply chain, so that with the ability to access capital farmers can perform their business all the year with off-season technology. Therefore, this research would focus on the risk analysis in the value chain of mangoes of *gedung gincu* variety as well as the risk mitigation actions.

A. Problem Formulation

The problems in this research were formulated as follows:

1. What types of risk faced by agribusiness actors of structured-market-oriented *gedung gincu* mangoes?
2. How is the strategy of risk mitigation in supply value of structured-market-oriented *gedung gincu* mangoes?

B. Literary Review

Types and Sources of the Risk in Agribusiness

Agriculture activities, particularly those related to the production process, are often posed with risks and uncertainties. Risk is a condition that makes possible the existence of various kinds of business results or various consequences of certain business. The risk shows the condition whose result and consequence can be possibly known before. It is different from uncertainty, i.e. something that cannot be predicted before, and hence the chance of experiencing loss has not been known before. The definition of the risk is in line with the opinion of [2], who defined risk as the chance of the unintended result to happen, so that risk is only linked to the situation that makes negative value possible to happen, and linked to the ability of predicting the negative result.

However, according to Kountur [3], the risk is related to uncertainty happening as the result of the lack and unavailability of information regarding what is going to happen. Then, [3] mentioned that there are three important elements of something considered as a risk as follows.

1. Being an event
2. The event is still a possibility, so that it is possible that it happens and does not happen.
3. If it happens, it will make loss.

The uncertainties that have an adverse or beneficial impact that are faced by companies. If the uncertainties faced have a beneficial effect, then it is called opportunity, while the uncertainty that has an adverse effect is called a risk. Therefore, risk is meant as an uncertain condition faced by a person or a company that can lead to possibility of loss in a decision-making [4] .

The main risks in supply chain, according to [5], are climate and weather, natural disaster, biological and environmental risk, market risk, logistic and infrastructure risk, and managerial and operational risk.

Other effects of this risk are the disruption of the flow of goods and services, increased demands for the procurement of inputs and other support services to producers (ability to repay loans), and the effect on the timeliness of goods movements throughout the supply chain.

C. Risk Management of the Supply Chain

Supply chain risk management has the role as a synergistic structure and process throughout the supply chain in order to optimize strategy, process, human resources, technology, and knowledge. The objective of Supply chain risk management is to oversee, monitor, and evaluate the risks that exist in the company's activities [6]. Supply chain risk management (SCRM) is the relationship between supply chain and risk management tools aimed at facing the risks that impact logistics activities or resources in the supply chain [7]. Supply chain risk management is a point of intersection between risk management and supply chain management.

The risk management in the supply chain should focus on preventive actions, i.e. by reducing the possibility of the occurrence of risk agents, thus preventing other risks from occurring. This is because one risk agent can encourage or cause other risks.

Among the risk analysis methods are the modification of the Failure Mode and Effects Analysis (FMEA) model for quantitative measurement of the risk and the House of Quality (HOQ) model, known later as HOR (House of Risk), for prioritizing the risk agents to be handled first and choosing the most effective actions to reduce the potential risks posed by the risk agents. In FMEA method, risk assessment is done by calculating Risk Priority Number (RPN) with three factors, i.e., risk probability, severity of the impact emerged, and risk detection. However, the HOR model only determines the probability of the risk agent and the level of difficulty arising from the risk, since one of the risk agents can induce a number of other risk events, so it is necessary to have the quantity of the potential aggregate risks of the risk agent.

The development of risk priority calculation (RPN) is assisted by ARP (Aggregate Risk Potential) method through FMEA method to conduct risk assessment in HOR. This HOR is also aided by the use of SCOR (Supply Chain Operations Reference Model) model that described on Table 1.

Supply Chain Risk Management (SCRM) is a tool to manage (in this case, to minimize) possibility of occurrence of the things that can cause failure in one of the aspects of supply chain (supply, operating, demand), so that the overall supply chain performance (overall chain performance) cannot function properly. And [9] said that the effective Supply Chain Risk Management has become the needs of current companies.

House of Risk model (HOR) is based on the idea of supply chain risk management that focuses on preventive actions, reducing the possibility of a risk agent to occur. Reducing the occurrence of risk agents usually prevents the occurrence of a risk event as well. Risk handling on HOR begins by identifying the risks to be addressed. In this stage, a risk list is generated from the identification of risk sources. These risks have an impact on the achievement of company goals and objectives.

Table 1. Five Main Proccesses of SCOR

SCOR Process	Definition
Plan	Complete supply and demand balancing processes aimed at developing optimal delivery, production and supply requirements
Source	Processes for purchasing goods and services aimed at meeting actual or planned demand
Make	The process of transforming the material into an end product to meet actual or planned demand
Deliver	Processes of providing finished products / services to meet actual or planned demand, including order management, transportation management and distribution
Return	Processes associated with returns and receipts of products with categories of return of products for various reasons. This process is extended to the service after delivery to the consumer

Source: Supply Chain Council in [8]

II. MATERIALS AND METHODS

The design used in this study was a qualitative research that describes the study to understand the phenomenon of the object of research as it is [10]. The research technique used was case study. The analysis technique used was House of risk (HOR) consisting of HOR 1 and HOR 2. HOR 1 was the first step to determine the risk agent that would be given priority for preventive action. The calculation of the value of risk priority index (Pj) or commonly known as ARP (Aggregate Risk Potential) was used as a consideration to determine priority of which risk agents need to design their mitigation strategy. Determining the value of the risk priority index (Pj) from the risk agent used the following formula.

ARP = RPN (Risk Priority Number) x the correlation weight between risk event agent j and causative agent i. Afterwards, HOR -2 was used to decide the strategy of risk mitigation by the formula :

$$TE = \Sigma j \times ARPj \times Ejk \times Ak \quad (1)$$

$$ETDk = TEk / Dk \quad (2)$$

Business processes	Risk event (E_i)	Risk agents (A_j) A_1	A_2	A_3	A_4	A_5	A_6	A_7	Severity of risk event i (S_i)
Plan	E_1	R_{11}	R_{12}	R_{13}					S_1
	E_2	R_{21}	R_{22}						S_2
Source	E_3	R_{31}							S_3
	E_4	R_{41}							S_4
Make	E_5								S_5
	E_6								S_6
Deliver	E_7								S_7
	E_8								S_8
Return	E_9								S_9
Occurrence of agent j		O_1	O_2	O_3	O_4	O_5	O_6	O_7	
Aggregate risk potential j		ARP_1	ARP_2	ARP_3	ARP_4	ARP_5	ARP_6	ARP_7	
Priority rank of agent j									

III. RESULTS AND DISCUSSION

A. *Mango Supply Chain System in Cirebon Regency*

Supply Chain Management is the coordination of materials, information, and money flows among participating companies. Supply chain management can also mean all types of commodity activities ranging from producers, intermediary traders to consumers. There are three streams contained in the supply chain system as follows:

- Material flow involves the flow of physical products from suppliers to consumers through the chain, as well as the backflow of product returns, services, recycling, and disposal.
- Information flow includes demand forecasts, order transmissions and order status reports; this current runs in two directions between the end consumer and the raw material provider.
- Flow of Money includes pricing information, credits, credit terms, payment schedules in determining ownership and delivery, etc. [11] .

B. Flow of Product/Material

Mango Supply Chain System in Cirebon district was as follows:

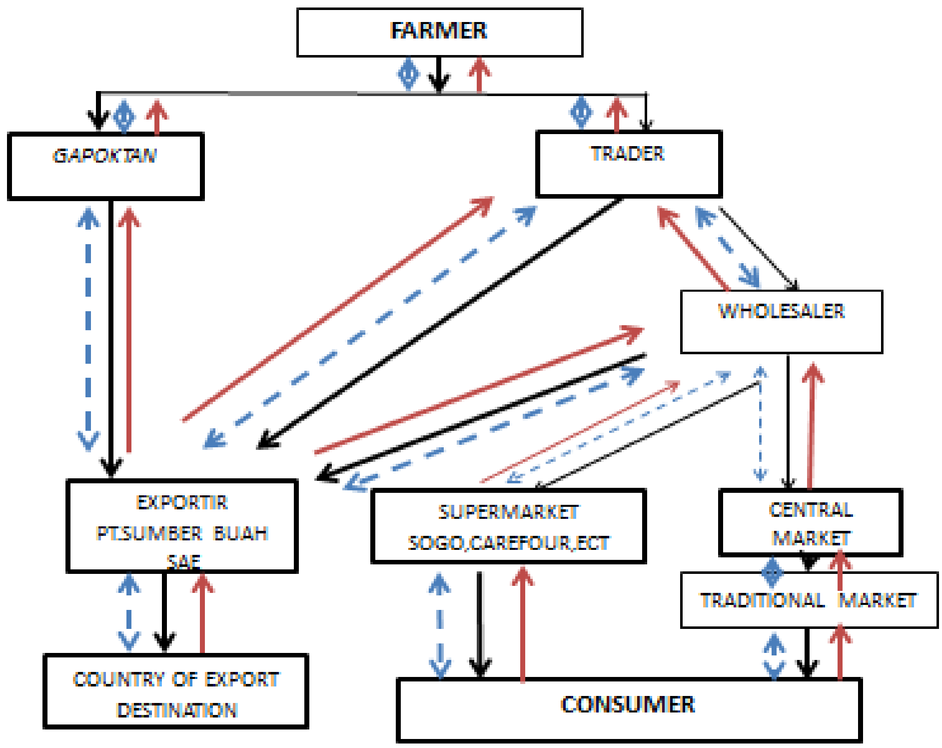

Fig 1. Supply Chain System of Mangoes in Cirebon Regency

where :

: Flow of Product
: Flow of Money
: Flow of Information

From the picture, it is shown that farmers` in Cirebon Regency marketed their mangoes to various marketing channels. Farmers assembled in the Farmers Group (*Gapoktan*) of Sami Mulya marketed their mangoes through *Gapoktan,* which then sent it directly to an exporter, where in this case who acted as the exporter was PT Sumber Buah SAE.

Beside through *Gapoktan*, some farmers marketed their mangoes through local traders or brokers. From local traders, some were directly sold to exporters (PT Sumber Buah SAE), while some others were through wholesalers. From these wholesalers, the sorting was performed based on the quality of the mangoes, with the Grade 1 class to be sent to the exporter (PT Sumber Buah Sae). As for Grade 2, it was distributed to the supermarkets such as SOGO, Carrefour, etc. The mangoes belonging to Grade 3 were marketed through the central markets in Jakarta, which was then sold to traditional markets, until finally to the last consumers.

When the harvest came, farmers with *Gapoktan* sorted the mangoes that would be shipped to exporters. The sorting was by shape, size, weight, graduation, and maturity. For Grade A and B, mangoes with good and smooth shape, and weight ranging from 200 to 250 g / fruit (4-5 pcs / kg) were selected. Whereas, if the weight 200 gr or less, they would be included into Grade C. If there was a little dirty because of mud or wet soil, simply wipe it with a dry cloth. The mangoes that had been selected based on their grades were packaged into plastic box with 50 kg/box, until they were ready to send to exporters.

The exporters then sent the mangoes to some of the marketing targets based on the orders, including to overseas such as Singapore, Dubai, Bahrain, Jeddah, Abu Dhabi, and Oman. As for domestic, PT. Sumber Buah SAE used to market mangoes to Carrefour of Surabaya. From interviews, it was mentioned that the standards set by domestic supermarkets were more stringent than foreign standards, especially the Middle East markets.

So far, PT. Sumber Buah SAE had tried to meet the coming demands of mangoes from both domestic and overseas markets. For the Middle East markets, some countries such as Oman requested to be sent mangoes with frequency 3 times per week, with each shipment of 1 ton. For the needs of the Middle East, from 1 ton it usually consisted of 80% Gedong Gincu mangoes, and 20% Arumanis mangoes. For Singapore, the requested orders were uncertain, depending on the needs, but it was usually send 500 kg to 1 ton with the percentage of 20% Arumanis, and 80% Gedong Gincu.

In the case of mangoes delivery for export, PT. Sumber Buah SAE usually used two different pricing systems, i.e., FOB and CIF systems. The FOB system is the pricing system in which the exporter is only responsible for the mangoes arrival in Jakarta, while the CIF system is the pricing system in which the exporter is responsible until the location in the destination countries. The choice between these systems is related to the risk determination of the mangoes during the shipments, and to those responsible for the transportation cost.

C. Flow of Information

The flow of information that had been happening was limited to information on the price and its changes, as well as the need for mango supply from time to time. Although exporters sometimes provided guidance on the quality specifications of mangoes required for export markets. Another information was usually about cultivation techniques, which usually came from the Local Government Office/Extension Worker.

D. Flow of Money

The flow of money starts from the consumer in the form of buy-and-sell transactions between traders and buyers, be it consumers in the country and abroad. Consumers in the country are consumers who get mango products from supermarkets and traditional markets. The payments made are usually in cash. As for the flow of money from supermarkets, the system of "counter bond" is usually applied, where the payment is suspended for a certain time limit, usually a week to two weeks.

The flow of money derived from consumer payments abroad usually also applies the system of "counter bond" or the postponement of payments in a period of 1 week to 1 month. Even from the interview, there are some newly paid after more than 1 month. This late payment resulted in the delay of payments to intermediary traders or *gapoktan* as exporter suppliers.

E. Supply Chain Risk Management of Mangoes

The dominant supply chain for export-oriented mangoes currently applied was as follows:

Fig. 2 Actors in the Supply Chain of Export-Oriented Mangoes in Sedong, Cirebon

SCOR model of supply chain activities that occur in the *Gapoktan* of Sami Mulya were plan (planning), source (procurement), make (production), delivery (distribution), and return (recurrence). Each activity was performed by the respective actors involved in the supply chain of mangoes, i.e., farmers, *gapoktan*, and exporters.

At farmer level, it was identified that the supply chain activity was performed by digging information from informant farmers, at *gapoktan* level the informant was the chief of the *gapoktan*, and at exporter level, the informant was the manager of production and marketing of PT SAE.

Table 2. SCOR activity on the level of farmers

SCOR	Process
Planning	Production planning Planning the capital Employment planning Planning the means of production
Procurement	Procurement of production means Procurement of capital Procurement of labors
Production	Needed seeds Utilization of the means of production and labors Maintenance of mangoes Harvest Post-harvest
Shipment	Transport from gardens to farmers' houses Transport to *gapoktan*
Return	Return of mangoes that do not meet the criteria of *gapoktan*

The planning undertaken by farmers included the expected mango production planning which was hoped to reach in that year. This production planning was of course related to the planning of production facilities and capitals needed for mango farming activities. Farmers who owned several mango trees and might not be able to procure the means of production and capitals rented some of the mango trees. Instead, for mango farmers who had sufficient capitals even planned to produce their mangoes at off-season. The availability of capitals both from individual source and from the loan became greatly important in the off-season, because the cost for the off-season was quite large, about IDR 300,000.00 to IDR 500,000.00 per tree. This cost was for production facilities and labors. In Sedong, besides those renting the mango trees, there were also those who established a *tebas* contract (the purchase transaction buying up the entire of what to be the agricultural products before harvest), or even an *ijon* contract. *Tebas* contract is usually chosen because farmers do not have the costs for the harvest and the post-harvest, in addition that there is certain urgent need for money.

For procurement at the farmer level, including the procurement of production facilities, mostly obtained from *Gapoktan*, as well as of the capitals. Farmers sometimes obtained loan capitals from banks through *gapoktan*, though farmers and *gapoktan* currently found it difficult to obtain capital from banks because the payment installment was monthly (*KUR*), whereas when the credit scheme was *KKPE*, the payment would be in *Yarnen* system. For farmers having not too many mango trees and the location close to home, more family labors were used, and if the mango gardens were wide, it would be needed labors from outside the family to help take care of the mango trees.

Gedong gincu mango farming in Sedong Subdistrict had been since 2000. Farmers cultivated *gedong gincu* mangoes with varied land width ranging from 0.25 hectare to 13 hectares. With a planting age of nearly 15 years, each mango tree produced on the average about 50 kg. In order to meet market demands, especially export markets, some of these farmers applied the technology of off-season mango fertilization. By using this technology, mango harvests that were usually done only in October to December could be done from April to December.

The off-season cultivation method performed includes the acceleration of pruning and maintenance. After each harvest, the plants are immediately pruned, the dry branches are removed, and the branches are reduced in number, for example, among four branches, one was removed. In this technology, manure becomes necessary. To apply this technology, farmers usually spend around 300 to 500 thousand rupiah per tree, depending on the weather. Therefore, not every farmer is able to apply this technology.

Most farmers of *gedong gincu* mangoes in Sedong Subdistrict performed intercropping plantation among mango trees to mango trees. There were some intercrops with rice plants as well as planting crops. Usually from 1 hectare of garden of *gedong gincu* mangoes planted with 100 mango trees and planted with rice produce about 5 tons of *gedong gincu* mangoes (about 50 kg / tree) and 1 ton of paddy (per season). This was done because they think it is impossible to rely solely on the living cost fulfillment from mango farming alone. Even if the plantation of mango trees is without using off-season technology, which usually harvest only during harvest time, mango price will fall. The main pests of mango are fruit flies and stem borers. If the trees encounter this pest, the production will decrease; even it can cause crop failure.

The next activity was the shipment of mangoes harvested from the gardens of *gapoktan* farmers. What became the problem was the condition of the narrow path towards the garden and that the means of transportation could not reach. This was felt by the farmers whose locations were far from *gapoktan*, so it sometimes made mangos damaged in the street.

The mangoes sent the by farmers to the warehouse of the *gapoktan* were then sorted and graded into 3 grades, i.e., grade A, B and C. Grade A and B were sent to PT Sumber buah SAE, while while the grade C (off grade) was sold to mango processors for mango purée. The return of off-grade mango was rarely done because *gapoktan* assisted to distribute them to the processors, unless the farmers wanted to sell them themselves.

F. Risk Types on Farmer Level

Furthermore, from the FGD results and interviews with several informant farmers, it was explored more deeply about the risk events occurring in mango farming and the severity of the impacts. The results were that there were 26 risk events and that, based on their severities, there were the following severities: the existence of fruit fly pests, the lack of use of production means, crop failure, the lack of capital, and the return of mangoes from high *gapoktan*.

G. Risk Agents and Their Priorities on Farmer Level

Risk events that affect mango farming of course have a certain cause. This cause can come from farmers, the internal as well as external environment. From the results of confirmation and interviews with farmers, the risk agents at farmer level were 12, among which the highest risks in occurrence probability were weather change, less intensive cultivation, limited capital and access to banking. Extreme weather change made it difficult for farmers to predict the need for production facilities. For example, when farmers already used ZPT or there was a sudden rain, the farmer should immediately repeat it again for the fear that the used means of production was not working.

Furthermore, from risk events and risk agents, a matrix was established to determine which risks should be prioritized and non-prioritized. The result as shown in the Table 4 shows that the highest ARP, AP7 risk agent, has the value of 5.778, which shows that the very limited source of capital was the problem of main priority to tackle, compared with the others. This is because the greater the value of ARP is directly proportional to the impact level to be generated in the business process at farmer level.

In handling the risks, not every risk agent got the handling. This was caused by several factors, i.e., in terms of cost, energy, and limited time. Therefore, it is necessary to select the priority risk agents. The determination of the category of priority risk agent was done by using Pareto or law of 80:20. The application of Pareto law at risk is that 80 percent of losses were caused by only 20% crucial risks (Kountur, 2008). If 20% of such crucial risks can be handled, then the company can already avoid 80% loss.

From the analysis result, it was found there were six risk agents that were included into priority category. Risk agents of priority category contributed 17.61% to 74.06% of the total risk impacts experienced by mango farmers. Therefore, risk mitigation was carried out on risk agents that fell into the priority category first, i.e., limited sources of capital, extreme weather change, intensive cultivation activities, lack of utilization of inputs, less skilled labors, and low access to banks.

Table 3. Pareto Calculation of risk agent on mango farmers

No.	Risk Agents	Information	ARP	% ARP	% Cumulative ARP	
1	AP7	Very limited source of capital	5778	17.61	17.61	Priority
2	AP1	Extreme weather change	5130	15.64	33.25	Priority
3	AP5	The cultivation not yet intensive	4167	12.70	45.95	Priority
4	AP3	Lack of the utilization of the means of production	3465	10.56	56.52	Priority
5	AP8	Less skilled labors	2919	8.90	65.41	Priority
6	AP11	Low access to banking	2835	8.64	74.06	Priority
7	AP9	Less utilization of post-harvest technology	2736	8.34	82.40	Not priority
8	AP2	Inadequate infrastructure	1476	4.50	86.90	Not priority
9	AP6	Harvest time	1470	4.48	91.38	Not priority
10	AP10	Less role of *gapoktan* in the cultivation	1359	4.14	95.52	Not priority
11	AP4	Remote shipping distance	1254	3.82	99.34	Not priority
12	AP12	High quality standard of export	216	0.66	100.00	Not priority
		Total	32805			

H. Risk Types at the Gapoktan Level

Business process of *gapoktan* was different from that of farmers. Of course, the risks faced might also be different. *Gapoktan* business processes include collecting mangoes from farmers, sorting, grading, packing, and delivering mangoes to exporters. Moreover, their activities which are related to farmers' needs include providing production facilities, capital assistance, guiding, and cooperating with other parties.

Here are 14 risk events occurring in *gapoktan* of mangoes of Sami Mulya. According to the opinion of the *gapoktan* chief, of the fourteen risks, the one with the most severe impact was when the procurement of the means of production was inadequate or too late, because when it happened, it would affect the other things such as that the quantity and quality of the mangoes that fit the exporter's standards became unfulfilled. In turn, the instability of the availability also would cause the price to fluctuate.

Risk events with severe impacts too include late or inadequate procurement of production facilities, unfulfilled standards regarding mangoes' quality and quantity, and high number of the mangoes returned by the exporter. However, according to the chief of *gapoktan*, regarding the events there had been the way out, i.e. in order that the mangoes are not returned by the exporter, the process of sorting and grading should be done more carefully, while the off-grade mangoes are to be marketed to the processor to be made as mango pure.

I. Risk Agents and Their Priorities at Gapoktan Level

From the result of HOR 1 analysis, it is known that there are 7 Priority Risk Agencies at Gapoktan level. Furthermore, each of these risk agents is confirmed again through FGD to Gapoktan to know the alternative risk mitigation action when the risk agent occurs. Here is a mitigation action undertaken by Gapoktan:

Table 4. Risk Agent and mitigation risk at gapoktan level

Risk Agent	Mitigation risk	Description
Lack of capital	MG1	Seek Loans to purchases of production facilities
lacks knowledge and skills of workers	MG2	Training and Assistance
Loans from banks take long time to liquid	MG3	Looking for sources other than bank loans
High quality standards	MG4	Training of SOP, GAP and GHP
Weather is unpredictable	MG5	Anticipation Procurement of input factors
Grace period of payment from exporter/supermarket is too long time	MG6	Negotiation and Applying DP to Exporter/supermarket

J. Risk Types at Exporter Level

Risk events also occurred in exporters, consisting of 13 risk events, of which the ones with the highest severity impact were when the mangoes were damaged during shipping due to the less storage capacity and when the payment from the importer was delayed. The delay of payment caused the company's cash flow to be disturbed and, in the end, the late payment to *gapoktan* and then to farmers (negative effect multiplier).

K. Risk Agents and Their Priorities at Exporter Level

Furthermore, when viewed from the risk agents (causes), at the exporter level, there were 12 risk agents, of which, based on the company's most frequent assessment, the most occurrences were the limited capital and the inaccurate logistics reports. Furthermore, the results of Pareto analysis showed that there were seven risk agents becoming priorities at the exporter level, which were as follows.

Table 5. Pareto Calculation of the risk agents at the exporter

No.	Risk Agent	ARP	%ARP	%cumu-lative ARP	Criteria
1	AE8	1824	13.66	13.66	Priority
2	AE9	1760	13.18	26.84	Priority
3	AE10	1656	12.40	39.25	Priority
4	AE1	1590	11.91	51.16	Priority
5	AE4	1332	9.98	61.13	Priority
6	AE3	1211	9.07	70.20	Priority
7	AE7	1167	8.74	78.95	Priority
8	AE6	796	5.96	84.91	Not Priority
9	AE2	780	5.84	90.75	Not Priority
10	AE5	568	4.25	95.00	Not Priority
11	AE11	567	4.25	99.25	Not Priority
12	AE12	100	0.75	100.00	Not Priority
	Total	13351			

L. Determination and Measurement of Risk Mitigation Action (HOR-2) in Mango Supply Chain

The determination and measurement of mitigation action was done by using House of Risk 2 (HOR2) method. The procurement of mitigation action based on risk agents was a priority. Determination of mitigation action was carried out to each actor in the mango supply chain. The goal was that every supply chain actor could handle the causes of priority risks, so that the risks could be suppressed and even eliminated, products were in good quality, and in turn, the expected financial institutions would feel secure to procure funds/credits to the supply chain actors.

M. Determination and Measurement of Risk Mitigation Action at Mango Farmer Level

Having known which risk agents were the priorities for mango farmers, the next step was to determine what mitigation actions would be appropriate to address these risk agents. Here are the mitigation actions that can be done by farmers.

Table 6. Risk Agents and risk mitigation actions at farmers level

Risk Agents	Risk Mitigation	Information
Limited source of capital	MP1	looking for loan in intermediaries/relatives/neighbors
Extreme weather change	MP2	counselling/assistance to follow GAP/SOP
The cultivation which had not been done yet	MP3	establishing the more intensive relationship with counselling agencies, research institutions, and colleges
Inadequate number of the utilization of the production means	MP4	enhancing role of *gapoktan*
Less skilled labors	MP5	farmers to send their labors to trainings
Low access to banking	MP6	enhancing the role of banking

After determining the degree of difficulty, then the next step was to calculate the total effectiveness (TE). After calculating the TE value, the next step was to calculate the effectiveness to difficulty (ETD) value. The ETD value is obtained by dividing the TE value by the degree of difficulty. Here are the TE values, Degree of difficulty, and ETD, based on the highest ETD value.

Table 7. Risk Mitigation Actions and their effectiveness at farmer level

Rank	Mitigation	TE	Degree of Difficulty	ETD
1	MP4	87.834	3	29.278
2	MP3	66.123	3	22.041
3	MP2	86.436	4	21.609
4	MP5	64.557	3	21.519
5	MP1	100.413	5	20.083
6	MP6	92.079	5	18.416

The mitigation action with the greatest ETD value means that mitigation action must be done first. Based on the calculation of mitigation action, it is described as follows:

1. *Increasing the Role of Gapoktan*

In structured market of mangoes, the role of *gapoktan* is strategic. *Gapoktan* plays the role of bridging farmers with input markets as well as output markets. In addition, it is also important to bridge the interests of farmers for capital with financial institutions, because banks prefer group approach. So far, in *gapoktan* of Sami Mulya, it had been implemented, but there was currently a scheme change provided by the banks. The scheme offered by them was KUR, whose payment system was monthly, including the loan principal. *Gapoktan* therefore had to find another solution, i.e., through the loan from the exporter and company of production means as the *gapoktan* business partners.

2. *Counseling/Assistance to Follow GAP/SOP*

To produce mangoes with optimum productivity, high quality, and maintained continuity, counseling and assistance are necessary for farmers to follow SOP (Standard Operational Procedure) and GAP (Good Agricultural Product).

3. *Establishing more intensive relationships with institutional agribusiness supporters*

Institutions supporting agribusiness activities include counselling agencies, research institutions, and universities. Through the group, farmers consult the counselling agencies and get counselling from them to look for solution techniques in the cultivation of *gedong gincu* mangoes, especially when facing extreme weather, and to enhance their ability in the business management. Research Institutions and universities can also be asked for guidance in applying new technologies to comply with the SOP.

4. *Farmers to send their labors to training many times*

Less skilled workers are improved in their knowledge and skills by sending them to training or counseling. Workers must be skilled in the maintenance during fertilizing, spraying, fruit-flies-pest trapping, harvest, and post-harvest.

5. *Looking for Loan in Intermediaries/Relatives/Neighbors*

To use the off-season technology well, it is required a considerable amount of funds ranging from IDR 300,000.00 to IDR 500,000.00 per tree per year. If the funds or the necessary production facilities are not available in *gapoktan*, farmers seek loans to other parties such as intermediaries, relatives, or neighbors. However, the fact is that farmers find it difficult to obtain the loan.

6. *Enhancing the Role of Banking*

Another problem concerning risk agents is low access to banking. Therefore, the mitigation is to perform self-introduction and convince banks that mango farming is profitable and able to repay the loan properly. From the side of the banking sector is to increase its role for the agricultural sector including mango farming. Banks prefer recognizing the business process of the mango farming in order that they will not hesitate to support mango farming because farmers will return the capital with its achievement counter.

N. *Determination and Measurement of Risk Mitigation Action (HOR-2) at Gapoktan Level*

From the result of HOR 1 analysis, it was known that there were seven priority risk agents at *gapoktan* level. Furthermore, each of these risk agents was reconfirmed through FGD to *gapoktan* to know the alternative risk mitigation action when the risk agent occurred. The mitigation actions undertaken by *gapoktan* described on Table 8 and the result of the risk mitigation actions was then further analyzed, and the result was shown in the Table 9.

Table 8. risk agents and risk mitigation actions at gapoktan level

Risk Agents	Risk Mitigation	Information
Insufficient amount of capital	MG1	looking for the loan in order to fulfill the need for production means
Human resources with less knowledge and skills	MG2	training and assistance
Loans from bank which is difficut in proccess	MG3	looking for loan providers outside banks
High quality standard	MG4	training of SOP, GAP and GHP
Unpredicted weather	MG5	anticipated procurement of production means
Too long payment deadlines from the exporter or supermarkets	MG6	negotiation and proposal of DP to the exporter

Table 9. Risk mitigation actions, degree of difficulty and effectiveness in Gapoktan

Rank	Mitigation Action	TE	Degree of Difficulty	ETD
1	MG4	29.028	3	9.676
2	MG2	20.584	3	6.861
3	MG6	25.251	4	6.312
4	MG3	27.867	5	5.573
5	MG1	21.339	5	4.268
6	MG5	12.033	3	4.011

The largest risk mitigation action means the easiest to do compared with other mitigation actions. For more details, concerning the risk mitigation actions based on the ratings is as follows:

1. *SOP (Standard Operational Procedure), GAP (Good Agriculture Product), and GHP (Good Handling Product) Trainings*

To meet the demand of exporters and/or modern retailers for good quality mangoes, *gapoktan* feels the need for knowledge and skills about SOP, GAP, and GHP that must be owned by its labors. This training is considered easy because the local government through its offices often facilitates it.

2. *Training and Assistance*

In addition to training, *gapoktan* also requires assistance, so that there will be no misinterpretation regarding what have been trained, and there will be no misunderstandings. In addition, assistance is necessary because without it they tend to return to the original habit.

3. *Negotiation and Applying Down Payment to Exporter*

Lack of capital is a condition that often occurs in *gapoktan* in the fulfillment of the needs for farming capital of its members. Due to payment by the exporter usually in 2 weeks or even 4 weeks, the gapoktan chief often make negotiations with the exporter to ask for partial payment in the beginning (Down Payment/DP). The maximum DP ever obtained by *gapoktan* was 50% of all sales value.

4. Looking for loans other than to the Banks

In general, mango farmers claimed that the problem was lack of capital, but they found it difficult and complicated to borrow to the banks, and the process was long. What was felt by *gapoktan* was similar, especially the current credit scheme provided was only KUR whose quantity is limited, and the payment must be monthly, including the principal installment. Therefore, *gapoktan* is looking for sources of loans other than banks, sometimes intermediaries were also visited, particularly for the purposes of the payment of labor cost and other purposes. It can be done easily for lending loans to farmers, as well as the payment can be done by cutting the amount paid by the exporter.

5. Seeking Loans to Meet the Need for Production Facilities

The problem of using the means of production becomes a very important thing for mango farmers, especially when they apply off-season technology, whose average cost was IDR 300,000.00 to IDR 500,000.00 per tree per year. If the DPs of the exporter were not sufficient to procure the means of production, *gapoktan* would seek other financial sources such as loan in kind to suppliers of production facilities, which were then distributed to farmers.

6. Anticipated Procurement of Production Facilities

Changes in the current weather often occur suddenly. Of course, it is very influential to the plants including mango. As a result, pests and plant diseases are also increasing. The mitigation action to overcome this problem is to make an anticipation by providing adequate production facilities.

O. Determination and Measurement of Risk Mitigation Action at Exporter Level

There were six priority risk agents in the exporter. After reconfirmation by the exporter to explore some alternative risk mitigation actions, it was then obtained 17 mitigation actions of the risks for the six risk agents at exporter level. Here are the risk mitigation actions at exporter level.

Table 10. Risk agent and risk mitigation action at mango exporter level

Risk Agent	Risk Mitigation	Description
Limited capital resource	ME1	looking for loan to certain banks
	ME2	borrowing from certain leasing agency
Inaccurate logistic report	ME3	control/monitoring
	ME4	daily recording
Rapidly perishable mangoes	ME5	setting the volume of the products
	ME6	monitoring the age of the mangoes
Complicated export procedure	ME7	studying importer countries with simple procedures
	ME8	extending national market outside Java
Remote shipping distance	ME9	careful and safe packaging for mangoes (crates/baskets/paper boxes)
	ME10	noticing the quality of the mangoes to prevent claim
Insufficient mangoes during off-season	ME11	looking for the mangoes in other suppliers
	ME12	the existence of small traders (*bakul*) offering the mangoes despite their demand for cash payment
	ME13	Informing forthright the buyers when the supply is lacking
Long duration of export shipment	ME14	looking for more durable packaging and mango preservation techniques
	ME15	replacing the mode of transportation e.g. using plane as long as the price is still profitable

The 17 risks mitigation actions, according to the results of HOR2 analysis after calculating the degree of difficulty in the implementation of mitigation action, the sequence change can be seen in Table 11.

Table 11. Risk mitigation action, degree of difficulty and effectiveness at exporter level

Rank	Mitigation Actions	TE	Degree of Difficulty	ETD
1	ME8	28251	3	9.417
2	ME6	27171	3	9.057
3	ME15	35883	4	8.971
4	ME14	39645	5	7.929
5	ME3	20808	3	6.936
6	ME2	20049	3	6.683
7	ME5	18714	3	6.238
8	ME10	22515	4	5.629
9	ME13	16179	3	5.393
10	ME1	20049	4	5.012
11	ME4	17172	4	4.293
12	ME9	15080	4	3.770
13	ME12	14483	4	3.620
14	ME11	18003	5	3.601
15	ME7	14310	4	3.578

The following is the explanation of each risk mitigation action at exporter level.

1. *Extending the national market outside Java*

The exporter felt that the export procedure so far had been quite complicated, so that not all mangoes could be marketed overseas. Therefore, in order to maintain its cash flow, the company believed that there is a great opportunity to expand its market even though it is still within the country but it is still very promising outside Java. The markets targeted outside Java include Batam, Medan, Banjarmasin, and others.

2. *Observing and sorting the mango fruit based on the age*

This mitigation was done to overcome the problem of rapidly damaged mango, which was by arranging the mango fruit to be sent by applying first-in-first-out method.

3. *Replacing the transport mode*

Replacement of transport mode was done when it was necessary to anticipate the long export delivery process. It was to reduce the cost of using ship, but if the mangoes were expected to be long to arrive, then the transport mode would be replaced by using the plane.

4. *Looking for more durable packaging and preservation techniques for mangoes*

To solve the problem of export delivery process, in addition to changing the mode of transport was by looking for the packaging and preservation techniques which are more durable but still safe for mangoes. So far, it had been done by looking for and asking for information as well as consulting the researchers.

5. *Control and monitoring*

There were often problems caused by inaccurate logistic reports, e.g. the reports about the quantity, quality of goods available. Therefore, risk mitigation action was done by controlling and monitoring the logistics system, which was by checking and re-checking the logistics in the company.

6. *Borrowing capital from leasing agency*

When the exporter were lack of funds for goods or transactions and other activities, the most considered as easy to get capital injections is to borrow from leasing agency, either through direct lease or sale and lease back. Therefore, the exporter' relationship with leasing agency had been quite good.

7. *Setting the volume of mangoes*

Mango is a perishable commodity. One of the technique for the risk mitigation action was that the exporter managed the volume of goods. The volume of the goods should not be too dense so that there would be space for the air between the mangoes.

8. *Noticing the mangoes' quality to prevent claim*

To overcome remote shipping distances, the exporter did the mitigation action by performing quality control (QC) to the mangoes sent. This session of QC is important to avoid claims.

9. *Informing the buyers forthright when the supply is lacking*

Because not all farmers employed off-season technology due to the lack of capital, sometimes the exporter could not meet the amount requested by the buyers. Its mitigation action steps were honestly and forthright inform the buyers that the mango stock was lacking at that time.

10. *Looking for loans to banks*

In facing the problem of limited capital resource, in addition to borrowing from leasing agency, the exporter also could try to get the loan from banks. The loan can be made if the exporter was able meet the requirements requested by the banks. Banks continue to apply prudential principles to secure their credits of Five Cs. (character, capital, capacity, collateral, and condition of economy).

11. *Daily recording*

In addition to monitoring and controlling the company's logistics, the other mitigation action was by making daily recording. It was recognized by the exporters that recording activities often get not much attention, so that it was often not accurate, then the recording was finally decided to be done every day. The record included traffic of goods, source of goods, payments, prices, packaging numbers, receipt, and so on.

12. *Packaging Mangoes Carefully and Safely (Crates / Baskets)*

Remote shipping distance such as to Middle East required careful and safe packaging for the mangoes. Usually the form of packaging was by using crates/baskets or paper boxes. The shipment to the Middle East costs quite a bit, so that it was by ship.

13. *Existence of Small Traders (Bakul) Offering Mangoes despite Their Demand for Cash Payment*

Apart from the exporting partners and other suppliers, to meet the supply for export, exporter also sometimes bought from *bakul*s who came directly to the exporter's warehouse. However, the exporter needed cash funds to buy from them, because they usually want to be paid in cash. The mangoes received from them of course had to be the qualified mangoes for export or modern retailers.

14. *Looking for mangoes in other suppliers*

To meet the demand for mangoes from overseas importers, exporters tried to find mangoes to other suppliers outside the partnership, if the supply of the partners could not meet the demand from the exporter. These suppliers could be from the intermediaries or large farmers who had many mango trees.

15. *Studying importer countries with simpler procedures*

The price of export mangoes is very attractive despite the procedures and requirements

IV. CONCLUSION

A. Conclusion

1. The actors involved in supply chain mango with structured market orientation were mango farmers, *gapoktan*, and an exporter. The farmers' business process was to plant and maintain mangoes until harvest. The business process of *gapoktan* included sorting, grading, packaging, and sending mangoes to the exporters. The business process of the exporter included sorting, repackaging, marketing, and sending mangoes abroad.
2. a) Risk events at the level of farmers were 26; Risk events at gapoktan level were 14, and the risk events at exporter level were 13. b). The risk agents at the level of farmers included limited capital resource, climate change, less intensive cultivation, lack of production means utilization, and low access to banks. As for risk agents at the level of *gapoktan*, they included inadequate amount of capital, no collateral when borrowing from banks, difficult administration in banks, less skilled human resources, and too long payment deadlines from the exporter or supermarkets. The priority risk agents at exporter level were as follows: limited capital sources, inaccurate logistic reports, rapidly perishable mangoes, complicated export marketing procedures, remote shipping distances, lack of mangoes during the off-season, and long export delivery process. c). There were risk mitigation actions for each of the mango supply chain actors based on the ease of implementation for the purpose of minimizing and/or eliminating the risks that would be faced in order to keep the financing of the mango supply chain running.

B. Recommendation

1. Every actor involved in the supply chain needs to pay attention to the risk events and prepare the risk mitigation actions when such risk events occur.
2. Counsellors play a role in assisting farmers in the implementation of mango cultivation techniques to fit the SOP, GAP, and GHP, so that mango production can be maintained in good production in terms of quantity, quality, and continuity.
3. With the risk mitigation, mangoes supply chain stakeholder more easily access to the bank.

4. The government should facilitate the existence of guarantor institutions that can give more security to the banks for the loans it distributes.

REFERENCES

[1] Tuti Karyani,dkk. 2015. Rancang Bangun Model Pembiayaan Rantai Pasok Agribisnis Mangga Berorientasi Pasar Terstruktur di Jawa Barat. Unpad. Bandung

[2] Basyaib, F. 2007. *Manajemen Risiko*. Jakarta: PT. Grasindo.

[3] Kountur, R. 2008. *Manajemen Risiko Operasional (Memahami Cara Mengelola Risiko Operasional) Perusahaan*. Jakarta: PPM.

[4] Harwood, J *et all.* 1999. *Managing Risk in Farming: Concepts, Research, and Analysis.* U.S: Economic Research Service

[5] Steven J.et.al .2010. *Rapid Agricultural Supply Chain Risk Assessment: A Conceptual Framework*. Agriculture and Rural Development. World Bank.

[6] Widyarini, R. 2008. Managing Supply Chain Risk in The Engineering to Order Manufacturer. Surabaya : Tugas Akhir Teknik Industri ITS, Institut Teknologi Sepuluh Nopember

[7] Briendly,2004 . *Supply Chain Risk*: A Reader. Hampshire: Ashgate Publishing Limited

[8] Juliana R. 2008. *Evaluasi Supply Chain Management dengan Pendekatan SCOR Model Versi 8.*0 (Studi Kasus di PT. XYZ). Tesis pada Sekolah Pasca Sarjana UI. Depok

[9] Tang, C.S. 2006. Perspectives in supply chain risk management." International Journal of Production Economics, 103(2): 451-488.

[10] Idrus. M,2007. *Metode Penelitian Ilmu-Ilmu Sosial* (Pendekatan Kualitatif dan Kuantitatif). UII Press. Jogjakarta

[11] Kalakota, R. and Robinson, M. "E-Business 2.0 - Looking Over the New Horizon," EAI Journal (2000:October), 2000, pp. 22-30.

B.9

FINANCIAL ANALYSIS OF TWO VARIETIES INPARI IN RICE FARM ENVIRONMENTLY FRIENDLY

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ABSTRACT

One of effort to increase rice production was using of new high yields varieties (VUB) like Inpari variety. The problem, what was as financially Inpari varieties feasible to develop. The aimed of the research was to find out the profit that obtained a farmer from rice farming of Inpari varieties on rice farm of environmentally friendly. The research carried out in Poncokresna village, District Negerikaton on dry season 2015, involved cooperator farmer of 16 people. The treatments tested were varieties of Inpari 10 and Inpari 30, Inpari 10 was as the control varieties. Environmentally friendly here were no waste (all rice straw be utilized for feed, fertilization based on nutrient of needed and nutrient available in the soil, and control of diseases pest with an approach of integrated diseases pest management). Data observed were rice and rice straw yield and input of production. The yield of rice and rice straw were tested with paired samples test. Financial analysis was conducted namely advantages per ha, R/C and breaks even point. The result indicated that rice and rice straw were yielded by Inpari 30 varieties higher than inpari 10 but statistically was not significantly different. The rice yield of Inpari 10 varieties 4,472 kg ha^{-1} and rice straw 11,692 kg ha^{-1}, while rice yield of Inpari 30 varieties 4,880 kg ha^{-1} and rice straw 12,086 kg ha^{-1}. Inpari varieties was feasible for developed that can be shown by R/C > 1, namely 1.49 for Inpari 10 varieties and 1.59 for Inpari 30 varieties.

Keywords : Rice, financial, Inpari.

I. INTRODUCTION

Rice is a major source of carbohydrate for Indonesian people because most of them to make rice as staple food. Rice consumption of Indonesia population was 139 kg capita^{-1} year^{-1} in 2011, be highest in South East Asia [8]. When Indonesia population in 2015 was projected 255,461,700 people so rice need was 35,509,176 ton equal to 59,181,961 ton unhulled rice. The need was not included needs for seed, industry, and stock. Indonesia rice production in 2015 was achieved 75,361,200 ton milled dried grain/MDG [1]. Based on the review of the need and rice production of Indonesia, so in 2015 rice needs could be fulfilled of domestic production. However increase rice production still needs be done so that all needs to a man include industry and stock for 3 – 6 month to front can be fulfilled from domestic production.

Lampung is one of an area that contributes to national rice production, after North Sumatera Province [1]. In 2015 rice production of Lampung Province was 3,641,895.49 ton MDG and in 2011 only 2,940,795 ton MDG or enhance 23.84% with an average of enhancement 5.96%. The increase was caused harvested area increasing 16.25% with an average of enhancement 4.13% per year, while productivity enhances only 6.27% with average enhancement 1.57% per year.

This increase of productivity was low that showed to be needed arrangement of production technology well. For that was developed integrated crops management (ICM). ICM is an approach that consideration suitability and synergism between production technology and local environmental resources. Thus, the prepared technology package is location-specific, which can generate synergism and high efficiency, as an effort crops management and local resource [3]. The selection of technological components in ICM is based on the identification of areas and problems in rice farming, and the technology is expected the opportunity to overcome the problem. The results of an assessment by [11] showed that the ICM approach increased rice productivity by 16.67 - 48.64%.

One of technology component of ICM is using new high yield varieties. According to [6] productivity of new high yields varieties (VUB) like Inpari 13, Ciherang, and Mekongga were affected by the productive tiller, the weight of 1000 grain, filled grains percentage. The high yield new varieties that were generated by Indonesian

Agency for Agricultural Research and Development, Ministry of Agriculture namely Inpari 1, Inpari 2, Inpari 3, Inpari 4, Inpari 5, Inpari 6 up Inpari 43. The Inpari 10 has high yield potential namely 7-ton MDG ha^{-1} with the moisture content of grain 14%, yield average 4.8-ton MDG ha^{-1} moisture content 14%, and Inpari 30 has yield potentials of 9.6-ton MDG ha^{-1} with yield average 7.2-ton MDG ha^{-1} [10]. Production of Inpari 10 in Sinar Bandung Village, Negerikaton District was lower than Inpari 7 and Inpari 13 [12]. Nevertheless, in other areas, Inpari 10 varieties gave good production [5]. To find out the profit that obtained by a farmer from rice farming of Inpari varieties in Pesawaran regency so was conducted an assessment with financial analysts to rice farming of Inpari varieties, specially Inpari 10 and Inpari 30.

II. MATERIALS AND METHODS

A. *Location and data source*

The assessment was conducted in Poncokresna Village, Negerikaton District, Pesawaran Regency, Lampung of Indonesia on Mei – September 2015. The farmers involves in the assessment are 16 persons, in cover area 8 ha, with treatment organic fertilizer and balanced fertilizer was applied by all farmer. Each farmer planted varieties of Inpari 10 on area 0.25 ha, Inpari 30 on area 0.25 ha. Varieties of Inpari 10 as control was caused the varieties had been released prior of Inpari 30 and can be developed in Lampung. Rice farming was carried out application farming system of environment-friendly. Environment-friendly is no waste (all of the rice straw used for feed, fertilizer based on nutrients need and nutrient available in the soil, and control disease pest with approach integrated disease pest management).

Data get of observed in paddy cultivation that conducted with integrated crops management (ICM). Technology that was be applied namely legowo planting system 4:1, organic fertilizer (2 ton ha^{-1}), balanced fertilizer (dosage based on yield of test by soil test equipment (STE) for wetland), 175 kg urea ha^{-1}, 250 kg phonska ha^{-1} and 15 kg KCl ha^{-1}) and usage of high yield new varieties (Inpari 10 and Inpari 30). Data observed were rice production, the input of production and price of input and output.

B. *Data Analysis*

The analysis used was paired sample test and analysis of financial for rice farming of varieties Inpari. Financial analysis consisted of revenue, cost, R/C, income of farmer (profit), break evens point for production and prices. Revenue of rice farming is production value in a season and explained in money. Farm cost is a value of cost incurred (fixed and variable cost) as long as a season. Farmer profit is the difference between acceptance and expenditure [13, 6]. Profit (income) of rice farming of varieties Inpari was accounted by the formula:

$$Л = TR - TC \quad (1)$$

$$TR = Y.Py \quad (2)$$

$$TC = \sum Xi.Pi \quad (3)$$

Л = Profit (income) of rice farming of varieties Inpari
TR = Total revenue of rice farming of varieties Inpari
TC = Total cost of rice farming of varieties Inpari
Y = Yield of rice of varieties Inpari
Py = Price of rice
Xi = using factor i
Pi = Price of factor i

Besides that, income analysis was conducted with compare income of rice farming of varieties Inpari with regional minimum wage (RMW) and minimal life needs of labor (MLN) [9].

The ratio of revenue and cost was used for to know efficiency level of rice farming of varieties Inpari. If R/C > 1, so rice farming of varieties Inpari that was carried out will give a profit or can be developed. If R/C < 1, so rice farming of varieties Inpari that was conducted will be a loss or can't be developed and if R/C = 1, so the farming activity achieves up to breaks even point.

Breaks even point (BEP) of production and price can be used to determine the target of production and lowest price must be achieved so rice farming of varieties Inpari was not be lost. Besides that BEP of price is utilized for to know the effect of the changes of price output, cost, and production on profit. BEP of production and BEP of price accounted by the formula:

$$\text{BEP of Production} = \frac{\text{Total of variable cost + fixed cost}}{\text{Price of output}} \quad (4)$$

$$\text{BEP of price} = \frac{\text{Total of variable cost + fixed cost}}{\text{Total of production}} \quad (5)$$

III. RESULTS AND DISCUSSION

A. Production of Rice and Rice Straw

The result indicated that was gotten the yield of Inpari 30 more high than Inpari 10 varieties, both yield of rice and rice straw (Table 1), but statistically was not significantly different (Table 2). This is in line with the results of studies at other villages in one sub-district with the same climatic conditions, where Inpari 10 production was lower than Inpari 13 and Inpari 7 [12]. Rice straw that yielded was utilized as feed. If a cow needs fermented rice straw was as much 8.67 kg tail^{-1} day^{-1} [4], so 12,086 kg ha^{-1} rice straw of Inpari 30 variety could be given to 1,394 tails cow and 11,692 kg ha^{-1} rice straw of Inpari 10 variety could be given to 1348 tails. This means that rice farming of varieties both Inpari 10 and Inpari 30 can be planted or developed in Poncokresna.

Table 1. Rice production of Inpari 10 varieties and Inpari 30 varieties

No.	Varieties	Yield (kg ha^{-1})	
		Rice	Rice straw
1.	Inpari 10	4,472	11,692
2	Inpari 30	4,880	12,086

Table 2. Statistic analysis of Inpari 10 varieties and Inpari 30 varieties

No.	Varieties	Mean	Db	t	sig
1.	Inpari 10 vs Inpari 30 (Rice) ^{ns}	-408	15	-1.94	0.07
2.	Inpari 10 vs Inpari 30 (Rice straw) ^{ns}	-394	15	-0.772	0.452

B. Financial Analysis

Rice production of Inpari 10 variety in 2015 dry season was 4,472 kg ha-1 of harvest dry grain (HDG) and rice straw 11,692 kg ha-1, while Inpari 30 variety gets yield 4,880 kg ha-1 of HDG and rice straw 12,086 kg ha-1. The financial analysis indicated that was Inpari varieties feasible for developed that can be shown by R/C > 1, namely 1.49 for Inpari 10 and 1.59 for Inpari 30 varieties. Rice Farming system of Inpari 10 variety got revenue Rp 20,124,000,- ha-1 season-1 with cost Rp 13,480,785,-ha -1 season-1 and rice farming of Inpari 30 obtained revenue Rp 21,960,000 with cost Rp 13,847,985,-. Profit accepted by farmer that planted Inpari 10 Rp 6,643,215,- per season or Rp 1,660,804,- per month. The farmer that planted Inpari 30 obtained profit Rp 8,112,015,- per season or Rp 2,028,004,- per month (Table 3). This means Inpari 30 was more feasible to develop in Poncokresna village.

Table 3. Rice farmer income of Inpari varieties

No	Variable	Value (Rp/month)
1.	Farmer income of Inpari 10	1.660.804
2.	Farmer income of Inpari 30	2.028.004
3.	Regional minimal wages	1.518.000
4.	Minimum live needs for worker	1.399.037

If profit of rice farming or income was compared with regional minimal wages (RMW) and minimum live needs (MLN) for worker, so profit of rice farming of Inpari varieties 9 – 25% above RMW and MLN in Pesawaran Regency. RMW in Pesawaran Regency on 2014 was Rp 1,518,000,- per month and MLN Rp 1,399,037 per month [2].

Table 4. Financial analysis of rice farming for Inpari 10 varieties and Inpari 30 varieties

No.	Description	value	
		Inpari 10	Inpari 30
1	Cost of production	3.198.667	3.198.667
2	Wages	7.974.800	8.342.000
3	Cost of others	2.307.318	2.307.318
4	Total cost	13.480.785	13.847.985
5	Production (kg ha^{-1})	4.472	4.880
6	Rice price (Rp kg^{-1})	4.500	4.500
7	Revenue (Rp)	20.124.000	21.960.000
8	Profit (income)	6.643.215	8.112.015
9	R/C	1,49	1,59
10	Breaks even point for price (Rp kg^{-1})	3.014,5	2.838
11	Breaks even point for production (kg ha^{-1})	2.996	3.077

Reviewed of Breaks even point (BEP) for production and for the price, rice farming of Inpari 10 had BEP of production 2,996 kg season-1 and BEP of price Rp 3,014,- kg-1. While Inpari 30 varieties had BEP of production 3,077 kg season-1 and BEP of price Rp 2,838,- kg-1 (Table 4). That means minimal production that must be achieved on rice farming of Inpari 10 variety as much 2,996 kg season-1 and sold price cheapest Rp 3,014,- kg-1 and Inpari 30 variety as much 3,077 kg season-1 and sold price cheapest Rp 2,838,- kg-1. If production was under minimal production and sold price was under minimal price, so rice farming will be no profit.

IV. CONCLUSION

Rice farming of Inpari varieties as financially was feasible to develop. Feasibility level of rice farming reviewed from production, R/C, and profit. Rice and straw production of Inpari 30 variety were high than Inpari 10 (control). Rice production of Inpari was 10 4,472 kg ha^{-1} and straw of 11,692 kg ha^{-1}, while rice production of Inpari 30 variety was 4,880 kg ha^{-1} and straw of 12,086 kg ha^{-1}. R/C of Inpari 10 variety was 1.49 with the profit of rice farming of Rp 6,643,215,- ha^{-1} and R/C of Inpari 30 variety was 1.59 with the profit of rice farming Rp 8,112,015,- ha^{-1}.

REFERENCES

[1] Badan Pusat Statistik [BPS]. 2016. Statistik Indonesia 2016. BPS, Jakarta. 720 hal.

[2] Badan Pusat Statistik [BPS] Kabupaten Pesawaran. 2015. Pesawaran dalam angka 2015. BPS Kabupaten Pesawaran, Gedung Tataan. 366 hal.

[3] Badan Penelitian dan Pengembangan Pertanian. 2007. Pengelolaan Tanaman Terpadu (PTT) padi sawah irigasi. Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian. 40 hal.

[4] Bulo D., Agustinus N., Kairupan, F. F. Munier, Trixa P. Rumayar dan Saidah. 2004. Integrasi sapi potong pada lahan sawah irigasi di Sulawesi Tengah. Prosiding Seminar Nasional Sistem Integrasi Tanaman-Ternak. Denpasar, 20-22 Juli 2004. Pusat Penelitian dan Pengembangan Peternakan. p.155-161.

[5] Ernawati, Rr. 2012. Keragaan beberapa vaietas unggul baru padi penangkaran sebagai benih sumber di Lampung. Prosiding Inovasi Hasil Penelitian dan Pengkajian Teknologi Pertanian. Balai Pengkajian Teknologi Pertanian Lampung, Balai Besar Pengkajian dan Pengembangan Teknologi Pertanian. Hal 29-35.

[6] Girei, A.A., I.S. Usman and E. G. Onuk. 2016. Profitability investigation of rice production in fufore local government area of Adamawa State, Nigeria. European Journal of Academic Essays 3(3): 137-140.

[7] Hambali, A and I. Lubis. 2015. Evaluasi Produktivitas Beberapa Varietas Padi. Bul. Agrohorti 3(2): 137-145.

[8] Hidayat. 2013. Kosumsi beras Indonesia tertinggi di Asia Tenggara. http://bisniskeuangan.kompas.com/read/2012/02/07/21065277/Konsumsi.Beras.Indonesia.Tertinggi.di.Asia.Tenggara [11 Maret 2013].

[9] Hendrik. 2011. Analisis pendapatan dan tingkat kesejahteraan Masyarakat nelayan danau pulau besar dan danau bawah di kecamatan dayun kabupaten siak, Propinsi Riau. Jurnal Perikanan dan Kelautan 16(1):21-32.

[10] Jamil, A., Satoto, P. Sasmita, A. Guswara dan Suharna. 2016. Deskripsi varietas unggul baru padi. Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian, Jakarta. 90 hal.

[11] Pujiharti, Y., Muchlas, Rr. Ernawati dan B. Wijayanto. 2008. Kajian penerapan pengelolaan tanaman terpadu (PTT) padi sawah di Lampung. Prosiding Seminar Penelitian dan Pengkajian Teknologi Pertanian Spesifik Lokasi. Balai Besar Pengkajian dan Pengembangan Teknologi Pertanian, Balai Pengkajian Teknologi Pertanian Lampung, Dinas Pertanian dan Ketahanan Pangan Provinsi Lampung, Perhimpunan Penyuluh Pertanian Provinsi Lampung. Hal 1-7.

[12] Rohayana, D dan R. Asnawi. 2012. Keragaan hasil varietas unggul Inpari -7, Inpari -10 dan Inpari -13 melalui pendekatan pengelolaan tanaman terpadu (PTT) di Kabupaten Pesawaran. Prosiding Inovasi Hasil Penelitian dan Pengkajian Teknologi Pertanian. Balai Pengkajian Teknologi Pertanian Lampung. Hal 119-128.

[13] Soekartawi. 1995. Soekartawi, A. 1999. Agribisnis, teori dan aplikasinya. PT. Raja Grafindo Persada, Jakarta.

B.10

MOTIVATION AND PARTICIPATION OF FOOD BARN MEMBERS IN LAMPUNG PROVINCE

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ABSTRACT

One of efforts in achieving food security is improving food production system focusing on local institution such as food barns. They function as community food stock for daily need or for emergency situation and they can achieve their goals through members' participation. In participating in the group activities, members need to have motivation. This paper attempts to analyse the level of members' participation, level of motivation, and correlation between motivation and participatin in food barns. The results revealed that members' motivation dan participation on food barns are both categorized in moderate level, and motivation has a significant correlation with participation.

Keywords : Food Barn, Motivation, Participation

I. INTRODUCTION

Food is a basic need of human. Therefore, fulfilment of food by a government, including Indonesia, is a must. One of the Indonesian policies on food, the Regulation number 18, 2012, states that food security is a condition of food fulfilment for people including individual, in terms of adequate, safe, various, nutritious, equal, affordable, and compatible with religion/faith, and culture for people to live healthy, active, and productive.

The Indonesian Government has implemented programs and activities to achieve food security. However, there are a lot of people who are living in condition of food insecurity or in energy consumption insecurity.

Lampung Province is one of food production central areas in Indonesia, especially rice production, as a staple food. In 2014 there was a surplus of rice production of 1,235,316 tons in Lampung (BPS, 2014). Nonetheless, at the same time, 21.38% Lampungnese lived in severe and 38.16% in moderate food insecurity. Research by Hilmiyati, Ismono, and Indriani (2014) found that malnutrition or undernutrition existed despite rice surplus. Prasmatiwi, Rosanti and Listiana (2013) also found that 15% rice farmers were in food susceptibility and insecurity condition. Therefore, achieving food security is absolutely needed.

An effort to achieve food security is developing food production system focusing on local culture and institutions, one of which is food barn or 'lumbung pangan'. Indonesian farmers used to manage their food production, especially rice, together as a community activity and save their harvested unhulled rice in food barns. Some food barns belong to community since they build them together and some are built as a funding program from the government. Based on the Ministry of Home Affairs # 30, 2008, food barns are managed by local/village government and function as community food reserves for consumption or for emergency cases such as crop failures, famine season, and price fluctuations.

Food barns existing in villages in Lampung Province are managed by community in the forms of farmer groups, neighborhood groups, and other social groups. However, the study showed that 15% rice farmers was in food susceptibility and insecurity. Farmers who are producers of rice sell their product in a relatively low price but they are also consumers by buying rice in a high price. The food barn institution is important in managing food stock of farmers (Rachmat *et al.*, 2010), resolving crop failure and making food available until the following harvest season (Witoro, Napili, and Sihaloho, 2006), saving food for social and spiritual activities (Nurgani, 2010).

In managing the food barns, farmers need to participate. According to Notoatmodjo (2007), in participation members are supposed to contribute not only financially but also in terms of power and ideas. Kholiq, Hardinsyah, and Djamaludin (2008) said that members of food barns participate in making use of the barns, meetings, and carrying out activities.

In participating in any activities, any one needs to have motivation. The two-factor theory of Herzberg (in Gibson, Ivancevich, and Donnelly, 1996) says that two factors influencing people's motivation in doing activities are intrinsic factor and extrinsic factor. Intrinsic factor in food barn activities consists of achievement, appreciation, responsibility, progress, self-esteem, hope, needs, and satisfaction. Extrinsic factor consists of compensation, status, supervision, competition, attractiveness, environmental situation, and other members.

Members' participation and motivation are important in the sustainability of food barns as a local institution in achieving farmers' food security. This study is to explore their participation and motivation in the food barn institution, and analyse correlation between motivation and participation.

II. MATERIALS AND METHODS

The study uses a survay method and was conducted in two districts, Pringsewu and Lampung Selatan where there are most active food barns. The total of respondents are 160 rice farmers, members of 45 food barns. Data were collected through group discussions and interviews using structured questionnaires in June 2017.

Motivation and participation variables are measured using Likert scales. Motivation variable is categorized into 5, i.e. very low, low, moderate, high, and very high. Participation variable is categorized into 3 categories, i.e. low, medium, and high.

Data are analyzed descriptively using frequency table, persentage, mean, and rank Spearman correlation test.

III.RESULTS AND DISCUSSION

A. Characteristics of Farmers

Farmers characteristics include age, education, farm size, and family size. Most farmers (56.88%) are in the productive age between 41-56 years old, and the rest are younger than 41 years (21.25%), and older than 72 years (21.87%).

In terms of formal education, from the most to the least, farmers have elementary school level (56.25%), middle school level (32.50%), high school level (10%), and no school (1.25%).

The average paddy land holding is 0.47 hectare that can be cultivated once or twice yearly. Farmers mostly (50%) have farming land less than 0.5 hectare, 44.38% farmers have between 0.5-1 hectare, and 5.62% have more than 1 hectare farming land. They mostly (59%) live with 1-2 other family members and the rest live with more than 2 in the family.

B. Level of Motivation

Motivation is the encouragement or the force of an individual to do activities. This comes from within/internal or from outside the person. In average, the levels of intrinsic and extrinsic motivation of members in doing or participating in food barn activities, as shown on Table 1, both are in moderate category (3.27 and 3.06 of 5). These results are different from research results by Hubeis (2007) saying that motivation of extension workers in Sukabumi are in good or high category.

Table 1. Average scores of members' motivation

Motivation		Average score	Category
Intrinsic Motivation	Achievement	2.21	low
	Appreciation	2.29	low
	Responsibility	2.96	moderate
	Progress	3.44	high
	Self-esteem	3.09	moderate
	Hope	3.91	high
	Needs	4.56	very high
	Satisfaction	3.21	moderate
	Total average score	3.27	moderate
Extrinsic Motivation	Compensation	2.79	moderate
	Status	2.51	low
	Supervision	2.33	low
	competition	2.26	low
	Attractiveness	3.73	high
	Environment	3.87	high
	Other members	3.91	high
	Total average score	3.06	moderate

In this study, from the most powerful to the lower forces of internal motivation are needs (very high category), hope, progress, and satisfaction (moderate). Levels of motivation driven by achievement and appreciation are in low category. This means that farmer members of food barn join the food barn activities because they want to fulfill their basic needs, as rice is their stapple food, regardless of achievement and appreciation they receive from being members of the food barn. The most important thing for them is that they can save their harvested rice and take it when they need it.

In terms of extrinsic motivation, members are driven by, from the highest to lowest levels, other members, environmental situation, attractiveness of food barn activities, compensation, status, supervision, and competition.

Food barn is a local wisdom that has been established since 1960. In the study area, in average, food barns has established for 23 years and farmers have become members for 18.8 years. They become members mostly because of other members. The spirit of mutual cooperation among members is the most dominant force in doing food barn activities. Some benefits farmer members get from food barn are the guarantied availability of rice to anticipate food scarcity, borrowing inputs and or money for their agriculture, illness compensation, death aid, and holiday allowance. They feel or perceive the benefits that motivates them in being members. This is in line with Suherdi, Amanah, and Muljono (2014) who stated that motivation has a positive correlation with farmers'perception on the benefits of forest.

C. Level of Participation

Participation is involvement of people in activities especially in a development program. It is important that intended people involve in all activities for the sustainability of the program. In the activities of food barns, members together with administrators are expected to involve in planning, carrying out, monitoring, and making use of food barn functions such as savings dan borrowing money or products. The research showed that the average members' participation on food barns isin moderate level with the score 2.04 of 3. This result is different from the research resulted by Suprayitno, Sumardjo, and Sugihen (2012) who says that participation of farmers in managing candlenut forest in Maros District is in low level.

The food barn member activities having scores from the highest to the lowest respectively are rice saving, planning, managing, monitoring, developing business/marketing, borrowing, and money saving (Table 2).

The main activity of food barn is rice saving. Members save unhulled rice right after harvested as a stock and they can take it any time they need for consuming or selling. Most members participate in the rice saving and not many in borrowing. Members also involve in planning and managing activities, together with barn administrators. They plan and manage where, how, and when to put as well as to take the rice. Since most food barns in the study area are self-help granary, they manage the activities together.

Table 2. Average scores of members' participation

Participation variable	Average score	Category
Planning	2.51	high
Managing	2.47	high
Monitoring	2.18	moderate
Money saving	1.28	low
Rice saving	2.66	high
Borrowing	1.40	low
Developing business	1.81	moderate
Total average score	2.04	moderate

D. Correlation between Motivation and Participation of Food Barn Members

Members' motivation is expected to correlate with their participation. The analysis showed that, overall, motivation has a significant correlation with participation, meaning that the higher the motivation the higher the participation (Table 3). This supports the result of study done by Suprayitno, Sumardjo, and Sugihen (2012) about motivation and participation in managing and utilizing candlenut forest in Maros.

Most factors of intrinsic and extrinsic motivation have a significant relationship with participation. In intrinsic motivation, factors related to participation, respectively from the most significant are: self esteem, hope, satisfaction, progress, appreciation and achievement. Farmer members participate in food barn activities driven by their pride of being members. They feel that by participating they have high pride and they are satisfied being members. Based on the study, the food, especially rice, availability of most farmers is categorized in 'continuous' meaning that they have enough food to consume, and they have direct access on food by being members of food barn. Farmers have become members for a relatively long time (18.8 years) and food barn functions as fulfillment of their hope by saving and borrowing food collectively. This condition is parallel with result of research by Kholid, Hardinsyah, and Djamaludin (2008) saying that one of factors contributing to community's participation in developing food barn activity is tradition to store food by the community.

The intrinsic factors that do not have a significant relationship are responsibility and needs. A relatively low land holding (average of 0.47 ha) forces farmers (almost 50% of farmers) to also work off-farm. Although most food barns are not formally structured organization, they have organizers such as a leader, a secretary, and a treasurer who manage the barn activities. This may cause most members do not feel responsible in participating in food barn activities. Based on the scores stated in Table 1, the motivation driven by needs is the highest and most farmers are this category so that the motivation driven by needs does not correlate to theit participation.

Extrinsic factors that significantly motivate members in participating respectively from the strongest are compensation, supervision, status, and competition. They experience the benefits and most members are motivated because of barn's attractiveness, good social environment and membership which scores shown in Table 1 as high.

Table 3. Correlation between motivation and participation of food barn members

Motivation Factors		Participation	
		Correlation Coefficient	P value
Intrinsic Factor	Achievement	0.180*	0.023
	Appreciation	0.182*	0.021
	Responsibility	0.125	0.115
	Progress	0.187*	0.018
	Self-esteem	0.342**	0.000
	Hope	0.258**	0.001
	Needs	0.098	0.218
	Satisfaction	0.206**	0.009
Extrinsic Factor	Compensation	0.261**	0.001
	Status	0.194*	0.028
	Supervision	0.196*	0.013
	Competition	0.174*	0.030
	Attractiveness	0.076	0.338
	Environment	0.146	0.065
	Other members	0.083	0.297
	Motivation	0.292**	0.000

IV. CONCLUSION

Food barn members' motivation and participation are in moderate category. Motivation has a significant correlation to participation of members in food barn activities. Intrinsic motivation factors related to participation are: self esteem, hope, satisfaction, progress, appreciation and achievement. Extrinsic factors significantly motivate members in participating are compensation, supervision, status, and competition.

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REFERENCES

[1] Hubeis, A.V.S. 2007. Motivasi, Kepuasan Kerja dan Produktivitas Penyuluh Pertanian Lapangan: Kasus Kabupaten Sukabumi. *Jurnal Penyuluhan,* 3(2):90-99.

[2] Kholid, Hardinsyah, dan Djamaludin. 2008. Persepsi dan Partisipasi Masyarakat dalam Pengembangan Lumbung Pangan di Kabupaten Lampung Barat. *Jurnal Gizi dan Pangan,* 3(3): 217-226.

[3] Prasmatiwi, F.E., N. Rosanti, dan I. Listiana. 2013. Kajian Cadangan Pangan Rumah Tangga Petani Padi di Provinsi Lampung. *Prosiding Seminar Nasional Sains & Teknologi V Satek & Indonesia Hijau.* Bandar Lampung 19-20 November 2013. Halaman 1.103-1.112.

[4] Suherdi, A. Siti, dan P. Muljono. 2014. Motivasi Petani dalam Pengelolaan Usaha Hutan Rakyat Desa Cingambul, Kecamatan Cingambul, Majalengka. *Jurnal Penyuluhan,* 10(1): 85-93.

[5] Suprayitno, A.R., Sumardjo, D. S. Gani, dan B. G. Sugihen. 2012. Motivasi dan Partisipasi Petani dalam Pengelolaan Hutan Kemiri di Kabupaten Maros Provinsi Sulawesi Selatan. *Jurnal Penyuluhan,* 9(2): 182-196.

[6] Hilmiyati, Ismono, and Indriani (2014). Faktor-faktor penentu kerentanan terhadap kerawanan pangan di Kbupten Lampung Selatan. *Prosiding Seminar Nasional Kedaulatan Pangan dan Pertanian*. UGM. Yogyakarta. 380-389.

[7] Gibson, Ivancevich, and Donnelly. 1996

[8] Organisasi: Perilaku, Struktur, Proses. Edisi kedelapan. Binarupa Aksara. Jakarta.

[9] Notoatmodjo. 2007. Promosi Kesehatan dan Ilmu Perilaku. Rineka Cipta. Jakarta.

[10] Nurgani, A. 2010. Tradisi Menyimpan Gabah dalam Lumbung : Studi Kasus Lembang Turunan Kecamatan Sangalla Kabupaten Tana Toraja. *Makalah Hasil Penelitian*. Pusta Penlitian Lingkungan Hidup. Universitas Hasanuddin. Ujung Pandang.

[11] Rachmat, M., B. Rachman, B. Kustiarti, Supriyati, G.S. Budi, K.S. Wahyuning, dan D. Hidayat. 2010. Kajian Sistem Cadangan Pangan Masyarakat Pedesaan untuk Mengurangi 25% Risiko Kerawanan Pangan.

[12] Witoro, Y. Napiri, M. Sihaloho. 2006. Lumbung Pangan : Jalan Menuju Ketersediaan Pangan. Koalisi Rakyat Untuk Kedaulatan Pangan (KRKP). Bogor.

B.11

FARMER READINESS FOR ADOPTING STEVIA CULTIVATION (A CASE STUDY AT DISTRICT OF PASIR JAMBU, REGENCY OF BANDUNG)

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ABSTRACT

Recognized as complement for conventional sugars made from cane, coconut, corn and palm, as well as substitute for synthetic sweetener, stevia has accepted significant attention in order to fulfil increasing demand to sweeteners in recent Indonesia. Stevia has several advantages, among other is having 200-300 times sweetness level compared to cane sugar with low calorie level. In Indonesia, stevia was introduced from Japan, Korea and China, and has been cultivated in several areas, among other is in West Java, particularly at District of Cikajang (Garut), District of Pangalengan (Bandung) and District of Ciwidey/Pasir Jambu (Bandung). Introducing new commodity and/or technology has usually faced constraints and sometimes rejection. However, consider potentials had by stevia and increasing demand to it, stevia cultivation widespread need to be stimulated. This paper describes several conditions of farmer community at District of Pasir Jambu in terms of their readiness to adopt stevia cultivation in their land. Community readiness model was used to guide the structure of thinking in data collection process at farmer level in order to compose possible best intervention based on farmer aspiration and condition. In addition, several references from previous research reports, journal articles as well as government annual reports were used to sharpen analysis of data and information collected from the field.

Keywords : stevia, community readiness, Bandung

I. INTRODUCTION

Demand towards natural sugars has increased in line with the growth of food and beverage industries and increasing household consumption. Even though Indonesian natural sugar production tends to increase in the period of 2012-2016 (Hairani et al, 2013), hitherto its availability has not been able to fulfil national sweetener needs. This situation fostered food and beverage industries to use synthetic sweetener, which is not only to meet the demand, but also in order to cut their cost of production.

People apprehension towards use of synthetic sweeteners, in addition to increasing cases of diseases caused by excessive sugar consumption have stimulated the search for low calorie natural sweetener sources. One of the sources is stevia. Stevia has potential to be a low calorie natural sweetener, a complement for sugar from cane, coconut, corn and palm, as well as substitute for synthetic sweeteners. It has 200-300 times sweetness level compared to cane sugar (Maudy, 1992). In addition, stevia has other advantages, such as strong root for protecting land from erosion and able to cope with drought. From health viewpoint, several benefits of consuming stevia are reducing hypertension, will not causing caries, rich with vitamins that are not available in synthetic sweeteners, contain antioxidants, reducing diabetes, and curing stomach ace (Donna, 2000).

In Regency of Bandung, a farmer group that constantly cultivates stevia since 2010 is Mulyasari Farmer Group, located in Village of Cibodas, District of Pasir Jambu. Recently about 2 hectares of farmers' land cultivated stevia, produced about 500-600 kg stevia leaves in every two weeks after 40 days planting time. Demand of stevia to this farmer group increased, but they could not fulfil. Farmer hesitancy to cultivate stevia is presumed as a main factor of this situation. Financial aspect is also a "classical" problem faced by farmers. In addition, less support from local government to develop this commodity worsen farmer (group) inability.

Notwithstanding, as the main actor in development of stevia, farmer is also having the most important role in the success of this process. This role must be started by farmer readiness to develop, which represents several aspects, from an ability to make decision, to cultivate on farm, to organize themselves in terms of farm management and marketing, and other capacities. Behar and Hydaker (2009) states that the concept of "community readiness" offers a vital influence to improve the planning and implementation process for communities. Knowing important factors to the successful implementation should "help communities assess their own strengths and weaknesses". Furthermore, they go on to say that this understanding could "support technical assistance efforts by helping to determine areas of focus and strengthen areas of weakness".

Considering the previous statements, inquiries toward farmer readiness are important prior to implement activities. High famer readiness level is expected to be more successful to achieve activity's goals. In this context, the goal is to cultivate stevia successfully at farmer level.

II. MATERIALS AND METHODS

Research conducted for this paper writing implemented descriptive qualitative design, used a case study at Mulyasari Farmer Group, which cultivate stevia, located at Vilage of Cibodas, District of Pasir Jambu, Regency of Bandung. Qualitative method is frequently an interpretative method, because the result data usually resulted from field data interpretation (Sugiyono, 2012), while case study is a descriptive technique, the object is now, only one case (community, family, or individual) and deep explorative in nature (Rusidi, 1993).

Primary and secondary data were used in this research. Primary data were obtained by interview with farmer group members and informants and through observations. Purposive sampling to group patron, management and members was implemented. Secondary data were obtained from report documentations, journals, and related government institutions. Descriptive analysis data was used; refer to identification of characteristics of human groups, things or events. In short, qualitative descriptive involves conceptualization process and results in formation of classification schemes (Silalahi, 2012).

In order to conceptualize and guide structure of thinking in data collection, community readiness model was used. Community readiness model integrates communities' culture, resources and level of readiness to address the issues more effectively (Plested et al., 2006); developed to provide communities with a theoretical framework, a process, and specific tools to facilitate readiness (Behar and Hydaker, 2009); it also can be used for specific and certain situations of a community (Trautman et al, 2012).

The process of community readiness model development is (1) identify the issue, (2) define the community, (3) conduct key respondent interviews, (4) score interviews to determine level of readiness and (5) develop strategies based on level of readiness and conduct workshops or trainings (National Institute on Drug Abuse, 1997). Moreover, Plested et al (2006) categorized stage of community readiness (from low to high) into (1) No Awareness, (2) Denial/Resistance, (3) Vague Awareness, (4) Preplanning, (5) Preparation, (6) Initiation, (7) Stabilization, (8) Confirmation/Expansion, and (9) High Level of Community Ownership. In order to assess farmer readiness, four deep interviews with farmer group leader, a farmer group member, a cooperative management, and a local government leader have been conducted.

III. RESULTS AND DISCUSSION

Several following situations can be stated in order to describe stevia development in District of Pasir Jambu Regency of Bandung.

A. Stevia Cultivation in Regency of Bandung

Stevia was introduced in Regency of Bandung in 2005. It used stevia seeds originated from Vietnam, involving four demonstration plots at Districts of Pasir Jambu, Pangalengan, Banjaran and Cikalong. Since 2010, stevia has been developed intensively at District of Pasir Jambu, particularly at Village of Cibodas. Initially it was planted in 15-hectares of land, with hundreds of farmers involved. However, it decreased significantly into only two hectares, which is used for plasma stock, and only 25 farmers involved. According to farmer group leader, this plasma stock is different from its first introduced. It is new variety of stevia seed, developed independently by farmers. They named the variety "Cibodas Manis 3" (CM3), named after the village.

At District of Pasir Jambu, development of stevia is facing several obstacles, among others ***first***, hitherto stevia development has not been received sufficient attentions and responses from policy makers. It is indicated by a very limited amount of governmental based research and budget on stevia development. Even, at national level, only due to demands from large industries, such as Sidomuncul, Martha Tilaar and Jamu Jago, stevia has been cultivated in several places in Java. ***Second,*** in Regency of Bandung, particularly at District of Pasir Jambu, stevia was developed in communities that familiar with and common to tea plantation. Without intensive and serious approaches and assistances, this could result in a difficulty to disseminate technology and to raise culture for stevia cultivation. ***Third***, as large industries processing stevia do not exist, stevia cultivation will face challenging situation. Hitherto, stevia produced by Pasir Jambu farmers has only been sold to certain communities (herbal and organic consumers), even though so far "local" demand always exceed supply, and to a cooperative that processed it into several processed foods. Developing new consumers has also faced challenges as stevia taste is different from other sweeteners such as cane sugar or palm sugar. Hence, for several reasons, stevia has been mixed with other synthetic sweetener such as xylitol, which is actually unhealthy to consume. With several potential processed product diversifications in further industries, such as for food, cosmetics and pharmacy, so far farmers still only produced stevia-based food raw materials. ***Fourth,*** at farmer level cultivating stevia actually requires large amount of money, in particular for seed provision. Therefore, existing stevia farmers saw this situation as opportunity and recently they also started to produce stevia seeds instead of final stevia products.

Since 2016, Indonesian government released a regulation stating stevia can be used for food. Since then, demand towards stevia increased, it is even getting stronger since a commercial sweetener product has been released a sweetener with stevia on national television. In addition, increasing demand of stevia overseas, such as from Japan, the US and European Union (EUFIC, 2009) also plays an important role of farmer attractiveness to cultivate stevia. Further information stated that next year, the Regency of Bandung administration through Office of Agriculture, Plantation, and Food Plant promotes development of stevia in broader Regency of Bandung areas, in particular at Districts of Kertasari and Ciparay.

Further development of stevia in Pasir Jambu will require several requirements, namely ***first,*** processed industries based on stevia product must be available and ready for accepting stevia produced by farmers. So far, only one cooperative received stevia and processed it into sweet tea products with several tastes. ***Second,*** in order to keep stevia plasma for next cultivation, the government should help farmer to register farmer stevia variety for intellectual property rights (IPRs) and plant variety protection. This breeding process could be served as a type of participation plant breeding (PPB). ***Third,*** the government should provide regulation and support stevia to develop. Dominance of other sources of sugar, such as cane, coconut and palm should be complemented by "new" other sources such as stevia. It is political in addition to technical and economic considerations. Hence, government is indeed plays a very important role.

B. Farmer Readiness to Cultivate Stevia

Since has been introduced at District of Pasir Jambu, stevia cultivation never been refused and rejected by farmers. Almost all members of farmer groups located at District of Pasir Jambu recognize stevia and have ability to cultivate. However, at location, from about 600 members of farmer groups, only about 25 farmers cultivating stevia and coffee, the others cultivate coffee and other commodities. Decreasing cultivated land and production in the past were mainly resulted from disability of market to absorb production as well as high cost needed to cultivate.

Recently, there is a plan from Regency of Bandung administration to develop District of Pasir Jambu, particularly in Village of Cibodas into a tourist destination. It is planned to develop forestry educational tourism. The government has improved several infrastructures such as road, accommodation and sanitation facilities, as well as supports from certain offices in Regency of Bandung. Moreover, this district is going to be developed as a centre for several community-based agriculture developments in Regency of Bandung, which will conduct trainings, provide apprenticeship and carry out researches, which are not only for farmers from Bandung, but also opened for farmers from all over Indonesia. Among several commodities to be developed, stevia is one of the advantage commodities which receives special attention.

Based on community readiness assessment to adopt stevia cultivation at District of Pasir Jambu, Regency of Bandung, overall farmer readiness score is 6.46. This score shows that community is on "initiation" stage, which means that "enough information is available to justify efforts, activities are underway".

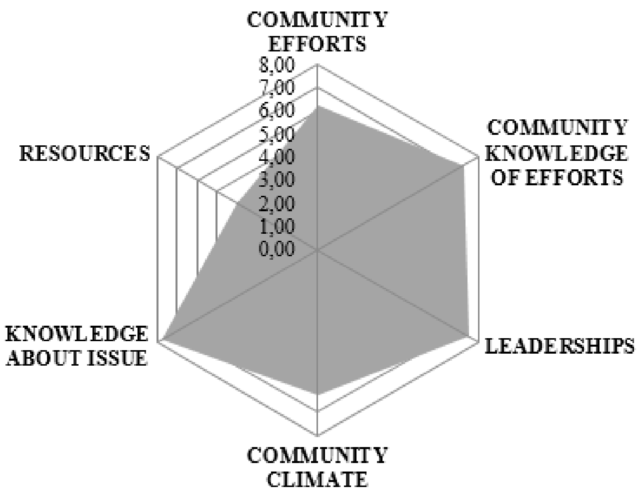

Fig. 8. Farmer Readiness Assessment Results to Adopt Stevia Cultivation at District of Pasir Jambu

Moreover, based on model developed by Plested et al (2006) detail score of every assessment component can be depicted on the following table 1.

Table 1 shows that farmer knowledge about issue is the highest score in this assessment. This score supports the issue that actually, stevia has been recognized and pretty familiar with farmer in the location. It is also supported by a local leader who give serious attention to cultivate stevia, which is indicated by a high score as well. Farmers also identified that several efforts have been conducted. Even though still at a very beginning involvement, farmers put stevia development as an important part in their life. Due to small development of stevia, so far only small amount of resources has been used to cultivate stevia. However, farmer is actually willing to provide their resources if stevia development will be extended.

Table 1. Farmer Readiness Assessment Components to Adopt Stevia Cultivation at District of Pasir Jambu

No	Components	Score	Definition
1	Community Efforts	6.25	Efforts (programs/activities) have been implemented
2	Community Knowledge of Efforts	7.25	There is evidence that the community has specific knowledge of local efforts, including contact persons, clients involved, etc.
3	Leaderships	7.25	Leaders are supportive of continuing basic efforts and are considering resources available for self-sufficiency
4	Community Climate	6.25	The attitude in the community is “this is our responsibility” and is now beginning to reflect modest involvement in efforts
5	Knowledge about Issue	7.75	Community members have knowledge of, and access to, detailed information about local prevalence
6	Resources	4.00	The community has individuals, organizations, and/or space available that could be used as resources
	Average	6.46	Enough information is available to justify efforts. Activities are underway

C. Development Strategies

Based on community readiness assessment to adopt stevia cultivation at District of Pasir Jambu Regency of Bandung, three weaknesses components identified, namely resources, community efforts and community climate. Hence, importunate strategies to implement are to increase quality and quantity of these three components. Several strategies to overcome these weaknesses can be formulated as can be seen in the following table 2.

Table 2. Development Strategies to Cultivate Stevia at District of Pasir Jambu

No	Components	Stevia Cultivation	
		Score	Strategies
1	Goals of Community Development	6.46	Provide community-specific information
2	Corrective Actions		• Plan publicity efforts associated with start-up development of stevia cultivation in community • Attend meetings to provide updates on progress of the potential and development of stevia in community • Search for additional resources and potential funding to develop stevia in location • Begin some basic evaluation efforts, in particular related to farmer involvement in developing stevia • Insist government (local, regional) to give further attentions and responses related to stevia development in the location • Collect information related to the gap between farmer and buyer expectation related to stevia (processed) products

Table 2 shows that actually, development stevia at District of Pasir Jambu has significant potential to deliver. Internally, farmer’s community is adequately ready to adopt stevia development. Better organization and management will easily attract farmers to involve. Government attentions and responses (at local as well as regional/national) through supportive policies (including financial source provisions) will help the development rate very much. Politically, the government should encourage alternative sweetener sources development, in addition to “conventional” sources. Similarly, certain industries involvement and collaboration with farmers will also increase the adoption process significantly.

IV. CONCLUSION

Farmer readiness to cultivate stevia at District of Pasir Jambu, Regency of Bandung is at “initiation” stage, which is actually having sufficient information to be further developed. In order to increase farmer (group) capacity (quantity and quality), several strategies can be implemented, in particular related to management and organization of farmers, government policy supports and involvement of related industries.

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REFERENCES

[1] Hairani R.I., Aji, J.M.M., and Januar, J., "Analisis Trend Produksi dan Impor Gula serta Faktor-Faktor yang Mempengaruhi Impor Gula Indonesia". *Berkala Ilmiah Pertanian* 1(1): 77-85, 2013

[2] Maudy E. "Peluang Bisnis Stevia". No. 274 Tahun XXIII. 1992 (18-19)

[3] Donna, G., Bonvie, B., Bonvie, L.: "The Stevia Story: A Tale of Incredible Sweetness & Intrigue", B.E.D. Publications. 2000

[4] Silalahi, U. "Metode Penelitian Sosial". PT Rafika Aditama. Bandung. 2012

[5] Sugiyono, "Metode Penelitian Kualitatif dan Kuantitatif dan R&D". Alfabeta Bandung. 2012

[6] Rusidi, "Metode Ilmiah". Laboratorium Sosiologi Penyuluhan Fakultas Pertanian Unpad. 1983

[7] Plested, B.A., Edwards, R.W., and Jumper-Thurman, P. "Community Readiness: A handbook for successful change". Fort Collins, CO: Tri-Ethnic Center for Prevention Research, (2006, April)

[8] Behar, L.B. and Hydaker, W.M., "Defining Community Readiness for the Implementation of a System of Care". Adm Policy Ment Health (2009) 36:381–392

[9] Trautman, K., Burkhart-Kriesel, C., and Rice, T., "Accessing a Community Readiness". University of Nebraska-Lincoln Extension, Institute of Agriculture and Natural Resources, 2012

[10] National Institute on Drug Abuse (1997). Community readiness for drug abuse prevention: Issues, tips and tools. Rockville, MD: National Institute on Drug Abuse

[11] Plested, B.A.; Jumper-Thurman, P.; and Edwards, R.W., "Community Readiness: Advancing Suicide Prevention in Native Communities (Community Readiness Model Handbook)". Center for Applied Studies in American Ethnicity, Colorado State University, Fort Collins, CO., (2006, September).

[12] EUFIC (European Food Information Council) "Stevia: a natural sweetener with potential". 2009: http://www.eufic.org/article/en/nutrition/Sweeteners/artid/stevia-natural-sweetener-with-potential.

B.12

ANALYSIS OF BUSINESS MODEL FOR POPULACE TEA PRODUCTION ENTERPISE ON *CAP DUA PETANI* GREEN TEA BAG PRODUCTS (CASE STUDY *GAPOKTAN KARYA MANDIRI SEJAHTERA*, CIBODAS VILLAGE, PASIR JAMBU SUBDISTRICT, BANDUNG REGENCY, WEST JAVA PROVINCE)

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ABSTRACT

Tea is a commodity which excessively developed both in small industry or huge industry. *Gapoktan Karya Mandiri Sejahtera* is a one of *Gapoktan* which creates the green tea bag products with *Cap Dua Petani* brand and has obtained IPR (Intellectual Property Rights), halal certificate, also P-IRT certificate. The less demand becomes obstacle for this business, so the production of green tea bag enterprise with *Cap Dua Petani* brand is being not optimal. The research purposes to know business model of *Gapoktan Karya Mandiri Sejahtera* by using Business Model Canvas. Data used in this research are primary and secondary data. Respondents in this research are the core organizers of *Gapoktan Karya Mandiri Sejahtera,* farmers, distributors, and consumers. The research result shows description about nine segments of Business Model Canvas, there are customers segment, it belongs to type of industry market. Value proposition segment, the products with best quality and affordable prices. Channel segment, here is applied indirect distribution such as traditional retail and direct distribution such as via exhibition. Customers relationship segment, fulfill the orders on time, return system, and discount. Revenue streams segment, obtained of selling products and donation. Key resources segment contained of physical, human, intellectual, and financial resources. Key activities segment contained of production, marketing, distribution, and administration activities. Key partnership segment covers the farmers as suppliers and distributors as partner, also there is company that cooperate for packaging. Cost structure segment, it is included to type of driven value by expenditure costs are divided into fixed cost and variable cost. Based on Business Model Canvas, there are obstacles on key activity block on marketing section that has not been widespread, administration is still undertaken manually in journal book, also the less promotion activity makes products are not well-known to wide community.

Keywords : tea industry, over production, Business Model Canvas

I. INTRODUCTION

West java province is a biggest tea producer area in Indonesia. Based on the table, from 2011-2015 year, national tea plantation area width, included to people tea plantation, country size, and privates size also be a first rank of widest tea plantation area in Indonesia than other provinces which also have tea plantation.

Table 1. Tea production in Indonesia

Province	Tea production (ton)				
	2011	2012	2013	2014	2015
West Java	95.571	95.253	95.361	94.086	93.697
Central Java	10.039	9.578	10.375	10.051	9.604
West Sumatera	4.924	4.981	4.999	5.060	4.916
North Sumatera	4.320	4.321	4.321	4.732	4.266
Jambi	2.625	2.625	2.625	2.625	2.625

Source: The Directorate General of Plantation, 2016

West Java province have suitable climate to plant the tea. The province succesfully receive Geographical Indication Certificate from The Directorate General of Intellectual Property (DGIP) Ministry of Law & Human Rights Republic of Indonesia for its featured product, Java Preanger Tea brand, it signifies that area can produce tea with the best quality (Plantation Service of West Java Province, 2014). Tea production centre in West Java spread in 5 regencies by the biggest production in Bandung Regency about 31.691 ton or 30,78% of tea total production in West Java Province. Beside become the biggest tea production centre in West Java Province, tea plantation in Bandung Regency is considered to meet Geographical Indication Terms of Java Preanger Tea. Natural resources pelf had by Indonesia especially Bandung Regency is one of factors that must be used by the entrepreneurs to develop their businesses. One of entrepreneurs of tea industry in Bandung Regency *Gapoktan Karya Mandiri Sejahtera* (KMS) located in RT 02 RW 02, Cibodas Village, Pasirjambu Subdistrict, Bandung Regency, West Java Province. Plantation area of all *Gapoktan Karya Mandiri Sejahtera* members that composed of 13 farmer group members with total plantation area width 427 Ha, all areas have obtained Geographical Indication Certificates " Java Preanger Tea Gambung Highland".

Gapoktan Karya Mandiri Sejahtera have built tea production entreprises since 2014, it's the only one *Gapoktan* in Bandung Regency which produce processed tea, market their own product with *Cap Dua Petani* brand, and obtain Intellectual Property Rights (IPR) via Protector Communities of Geographical Indications (PCGI), it shows origin area where the products come from. In the other hand, processed tea product of *Gapoktan Karya Mandiri Sejahtera* also have obtained halal certificate from Indonesian Ulema Council in West Java Province and P-IRT certificate from Bandung Regency Health Office.

Featured product of *Gapoktan Karya Mandiri Sejahtera* is green tea bag. It's caused since in early production until to distributor hands, the main ingredients and products came and made of *Gapoktan Karya Mandiri Sejahtera* themselves. It's always on control before the picking undertaken to ensure having P+2 or P+3 top tea leaves quality. *Gapoktan Karya Mandiri* receive wetly top tea leaves harvests from their members by total 100 kg/month, they can produce 600 boxes of green tea bag. Nevertheless, in reality, all *Cap Dua Petani* green tea bag products are not sold out in once production process, it makes such over production and also indicates the lack demand of *Cap Dua Petani* green tea bag products.

Based on these conditions, *Gapoktan Karya Mandiri Sejahtera* must be able to map the problems that occur in the running business, so it can be searched the way to make all products sold out steadily and deal with the competitors. A way that can make easier in mapping the business problems by analyzing its business model with business model canvas (BMC) approach.

The purpose of the research to know business model applied by *Gapoktan Karya Mandiri* in running populace tea production enterprise on *Cap Dua Petani* green tea bag products.

II. MATERIALS AND METHODS

The location selection is undertaken intentionally with consideration the *Gapoktan* already have entreprise to process wet tea and dried tea to be green tea bag and Intellectul Property Rights (IPR) for their products. In the other hand, the potency of *Gapoktan Karya Mandiri* plantation area which has had geographical indications (GI) certificate being the endorser in this tea production activity because it means the tea has best quality.

The research is a type of descriptive study with qualitative approach and case study method. Informant determination method is undertaken by using snowball sampling method. Data sources type used in this study are primary and secondary data. Primary data directly obtained form the ground both by observation or interview with informant. Meanwhile secondary data is from literatures of The Directorate General of Plantation, Plantation Service of West Java Province, Indonesia Tea Board, journals, and also internet.

Researchist uses Business Model Canvas explanation by several techniques of business design to analyze business model for populace tea production entreprise of *Gapoktan Karya Mandiri Sejahtera.* Business design is technique used as aids to answer the questions in the research. There are six techniques of business design such as consumers insight, idea formation, visual thinking, prototyping, story telling, and the scenario.

Data analysis is undertaken simultaneously with data collection process and continued after all data have already collected. The research uses qualitative data analysis process by compiling the sequence of discussion and interview results with entrepreneurs of *Gapoktan Karya Mandiri Sejahtera* tea production to determine contains of each business model canvas block by using by using story tellig technique and visual thinking technique. After that, data provided in short essay which contains the information for each Business Model Canvas element of *Gapoktan Karya Mandiri Sejahtera.* Furthermore, conclusion withdrawal made by taking the essence of research result series based on observation and discussion

III. RESULTS AND DISCUSSION

Bussiness Model Canvas (BMC) is a method used to map the problems on populace tea production enterprise run by *Gapoktan Karya Mandiri Sejahtera* for *Cap Dua Petani* green tea bag products. Business model explained below obtained by Business Design technique. There are nine blocks on Business Model Canvas which passed by different Business Design techniques. For Consumers Segment, Customers Relationship Segment, Income Streams Segment, Major Resources Segment, Main Partnership Segment, Cost Structure Segment obtained of story telling method. Meanwhile, for the Distribution Block and Major Activities Segment obtained of visual thinking.

A. Customer Segments

Market segment of *Gapoktan Karya Mandiri Sejahtera* is industrial market where *Gapoktan Karya Mandiri Sejahtera* buy needed goods ad services to produce the other goods and services in purpose to earn profits or/and other targets. *Gapoktan Karya Mandiri Sejahtera* produce green tea bags with main ingredients obtained of their own members, the green tea bag products only sold to distributors in the box packages contained of 25 bags. Meanwhile, consumers segment of *Cap Dua Petani* green tea bag products are all populace and tourists who live and come to Bandung Regency, precisely, in Pasirjambu Subdistrict and Ciwidey Subdistrict. *Gapoktan Karya Mandiri Sejahtera* have not marketed their products to wider place because *Gapoktan Karya Mandiri Sejahtera* want to focuse distributing their products in their own area first.

B. Value Proposition

Gapoktan Karya Mandiri Sejahtera sell the green tea bag products with *Cap Dua Petani* brand, yet, the ones listed on packages are the name of its product producers in order to make *Gapoktan Karya Mandiri Sejahtera* is more well-known in inhabitant especially who live in Bandung Regency. Packages of *Cap Dua Petani* gree tea bag products designed by *Gapoktan Karya Mandiri* themselves by putting Self Help Group (SHG) name as producer of the products. SHG is a name of *Gapoktan* which has been replaced to be *Gapoktan Karya Mandiri Sejahtera*. Their party intentionally put SHG name in order to introduce *Gapoktan Karya Mandiri Sejahtera* first as entrepreneurs of tea industry in Bandung Regency. In the packages also listed halal certificates, P-IRT number, information of nutritional value, expired dates, composition, serving way, and also contain quantity on each package.

Gapoktan Karya Mandiri Sejahtera obtain halal certificate, P-IRT, and IPR on *Cap Dua Petani* green tea bag products. Beside the best quality tea, *Cap Dua Petani* green tea bag products sold with very affordable prices, it is Rp 8.000/box. Furthermore, the workers used by *Gapoktan Karya Mandiri Sejahtera* are four people of *gapoktan* members.

Gapoktan Karya Mandiri Sejahtera also permit the returns of sent goods if there are fatal breakages on their selling products. For example: broken box seal plastic. The breakage happened because there are not *Standard Operating Procedures* (SOP) in *Cap Dua Petani* green tea bag production as reference of production activity. *Cap Dua Petani* green tea bag production is undertaken correspondingly with description on the machines but for the packaging process is still undertaken manually.

Performance given towards customers is a guaranteed product from main ingredients selection unti packaging process which uses alumunium foil plastic. *Gapoktan Karya Mandiri Sejahtera* also offer performance in customer services by amiability, politeness, and also giving festive allowance every eid al-fitr day such presents for shop owners.

Seen from accessibility, *Cap Dua Petani* green tea bag products are undertaken on several stores in Traditional Market of Ciwidey and Pasirjambu, it makes easier inhabitants around Ciwidey Subdistrict and Pairjambu Subdistrict to meet the products.

C. Channel

Channel used in *Gapoktan Karya Mandiri Sejahtera* customers, it uses indirect distribution type via partnership by entrusting the products on several stores in Traditional Market of Ciwidey and one store in Pasirjambu. Meanwhile, to reach *Gapoktan Karya Mandiri Sejahtera* customers with direct distribution by following exhibitions or government special occasion of Plantation Services of West Java Province, Cooperation and Small & Medium Entreprises Services of West Java, and also Agricultural Services of Bandung Regency.

D. Customer Relationships

The customer relationships type which interwined on *Gapoktan Karya Mandiri Sejahtera* entreprise included to personal assistance, it based on the interaction among people. Customers can communicate with the officers to get assistance due selling process or after finished the purchase. *Gapoktan Karya Mandiri Sejahtera* customers relationship which driven by customer acquisition strategy, by searching searching new customers with hold exhibition. *Gapoktan Karya Mandiri Sejahtera* also undertake some efforts in order to keep the customers

(customers retention), by keep the good relation with them when interacts directly, and also giving the discount to customers if they buy at least one cartoon.

E. Revenue Streams

Revenue streams on *Gapoktan Karya Mandiri Sejahtera* earned from asset sales of goods and services, and also from donation. Revenue streams which earned from asset sales in goods such selling the tea bags with Rp7.000/box, and Rp6.500/box if buy 1 cartoon, and from services in *maklun* (partnership with other parties to make products) with cost about Rp 250/tea bag. Meanwhile, for donation earned from administrators who deliberately give cash as capital to produce the green tea bag products. The turnover which earned by *Gapoktan Karya Mandiri Sejahtera* is still uncertain every month due to fluctuating sales.

F. Key Resources

Physical resources which owned are small place for production activity (mini factory), factory facilities (computer periphery, printer, chair, table, electricity), tea bag production machine (mini rotary dryer, meat grinder machine (for chopping tea), tea bag machine, plastic seal). *Gapoktan Karya Mandiri Sejahtera* also have one pick-up car to facilitate operational activities.

The intellectual resources which owned by *Gapoktan Karya Mandiri Sejahtera* are ready to drink tea products with *Cap Dua Petani* brand have claimed Intellectual Property Rights (IPR) through CPIG (Community Protectors for Geographical Indication). It such a petron for the brand and product originality. In addition, green tea bag products of *Gapoktan Karya Mandiri Sejahtera* also have obtained halal certificate from Indonesia Ulema Council of West Java Province, and also have had P-IRT certificate from Health Services of Bandung Subdistrict.

The human resources owned by *Gapoktan Karya Mandiri Sejahtera* are all members of *Gapoktan Karya Mandiri Sejahtera.* But, for core administrators are 8 people. All *Gapoktan Karya Mandiri* members have comprehension about tea plants which is very wide, it can keep the quality of the tea top leaves. Core administrators of *Gapoktan Karya Mandiri* are willing to help the capitals by donating personal fund to additional capital voluntarily.

The financial resources of *Gapoktan Karya Mandiri Sejahtera* are donation earned from The Directorate General of Plantation of West Java Province and used to buy tea production machine as much as 300 millions rupiah. The core administrators also donate voluntary funds about 100 millions rupiah and donation from *Gapoktan Karya Mandiri Sejahtera*'s petty cash, the total funds being Rp. 400,000,000.00.

G. Key Activities

Production activities at *Gapoktan Karya Mandiri Sejahtera* start from dry the wet tea top leaves up to the packaging process. In once production, it takes about 10 hours for once production. Packaging is undertaken manually and needs two days.

Gapoktan Karya Mandiri Sejahtera activity is undertaken around Pasirjambu Subdistrict and Ciwidey Subdistrict, there are four traditional retails of Ciwidey Market and one store in Cisondari Pasirjambu. Distribution activity undertaken by *Gapoktan Karya Mandiri Sejahtera* is distributing *Cap Dua Petani* green tea bag product directly and indirectly.

Administration activity covers accounting and notation any kind of transaction due the business run. Accounting and notaio activity are undertaken every production activity.

H. Key Partnership

Gapoktan Karya Mandiri Sejahtera helped by The Directorate General of Plantation of West Java Province to earn capital to buy the production machines and obtain media for marketing the products by exhibition held by West Java Province included Plantation Services of West Java Province, Cooperation and SME Servicesof West Java Services and Agriculture Services of Bandung Regency.

Gapoktan Karya Mandiri Sejahtera join with their farmers as main ingredients supplier to produce *Cap Dua Petani* green tea bag. The profit which earned by the farmer group by tagging higher price than in big factory for top tea leaves.

Gapoktan Karya Mandiri Sejahtera also join with Argapura Co and Kurnia Co that come from Karawang to fulfill green tea bag needs. Argapura Co have used modern technology in papers making system to make the tea bags such for its thread and papers on *Cap Dua Petani* green tea bag products.

In marketing their products, *Gapoktan Karya Mandiri Sejahtera* join with the distributors. The given price to distributors is Rp6.500/box. Nevertheless, until today, *Gapoktan Karya Mandiri Sejahtera* only cooperate with five stores and order quantity for each store is 1 cartoon in each month. It causes *Cap Dua Petani* green tea products endured a lot in the factory because the less market to sell those products.

I. Cost Structure

Gapoktan Karya Mandiri Sejahtera included to type of value-driven, it prioritize consumers satisfication by giving good quality products and cheap prices, also give return system if there are broken stuffs even have been on consumer hands. In the other hand, expenditure costs cover company fixed costs such for rent, wages, and electricity. Meanwhile variable costs cover production needs such for main ingredients (top tea leaves), packaging materials, fuel, and other unexpectable costs.

IV. CONCLUSION

Based on Business Model Canvas analysis, Cap Dua Petani green tea bag products have several matters on key activity block. The product marketing of Cap Dua Petani green tea bag products not distributed extensively yet and make it not well-known in populace, the conservative administration that causes they can't back up the data if the books are lost, and have no fixed format that causes the officers will be hard to detect errors. After that, the less promotion also make the products being not well-known in populace.

In the running, *Gapoktan Karya Mandiri Sejahtera* also make the *Cap Dua Petani* green tea bag as media to enhance their existence as the only one producer of processed tea products in Bandung Regency. It can be seen from the value proposition where the brand is not put in the packages but put the Self Help Group (SHG) instead as its producer.

REFERENCES

Arikunto, Suharsimi. 2006. Research Procedures A Practice Method. Jakarta: Rineka Cipta.

Indonesia Tea Board. 2016. Area of Tea Production. By (http://indonesiateaboard.org/, 12 January 2017)

Plantation Service of West Java Province. 2016. Statistical Data of Tea Production Area. By http://disbun.jabarprov.go.id/, 12 January 2017)

Directorate General of Plantation. 2015. Plantation Role in National Economy. By (http://ditjenbun.pertanian.go.id/, 21 January 2017)

Fandy Tjiptono & Gregorius Chandra. 2012. Strategic Marketing Edition 2. Yogyakarta: Andi.

Ministry of Agriculture. 2016. Strategy Plan of Ministry of Agriculture 2015-2019 Period. By (http://www.pertanian.go.id/, 2 February 2017)

Kotler dan Keller. 2009. Marketing Management. Translation Edition 12. Jakarta: ERLANGGA.

Osterwalder, Alexander dan Pigneur, Yves. Translation 2012. Business Model Generation: Guidelines for The Visionarist, Agent of Change, and Initiator. Jakarta: Elex Media Komputindo

Sugiyono. 2012. Quantitaive Qualitative Research Method and R&D. Yogyakarta. Alfabeta Publisher.

Setyamidjaja, Djoehana. 2000. Cultivated Tea and Post-Harvest Processing. Kanisius, Yogyakarta.

Syamsulbahri. 1996. Farming The Annual Plantation Crops. Yogyakarta. UGM Press.

Tjitradi, Elizabeth Cindy. 2015. Evaluation and Busines Model Designation Based On Business Model Canvas. Agora Journal Vol. 3, No. 1. Publisher: Busines Managament of Kristen Petra University, Surabaya.

B.13

THE ROLE OF EXTENSION WORKER IN DEVELOPING URBAN FARMING IN CISARANTEN KIDUL BANDUNG CITY

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ABSTRACT

The decline of agricultural land in urban areas has encouraged the local government of Bandung City to develop urban farming. Urban farming is expected to be a solution to farming in a narrow area, and also to improve food security of its citizens. Cisaranten Kidul is one of the urban villages that are active in developing urban farming in Bandung City. Extension activities are absolutely necessary to encourage people in Bandung City to involve in this activity. This study aimed at analyzing the roles of extension workers in developing urban farming in Cisaranten Kidul Urban Village and preparing technical recommendations to improve the role of counselors in urban farming activities. This research was conducted in Cisaranten Kidul Urban Village of Bandung City. The design of this study was qualitative, and the data were analyzed descriptively. Respondents of this research were 42 people who participated in urban farming activities in Cisaranten Kidul Urban Village. The results showed that the roles of extension workers, including the roles as a motivator, mediator, supervisor, and facilitator, were considered as quite good, although most people felt that the perceived frequency of the extension activities were still insufficient. To enhance people's participation in urban farming activities, the roles of extension workers were very important in encouraging people. Competence and motivation of extension workers needed to be improved with a variety of training, and it was necessary to provide facilities for extension workers to support their jobs.

Keywords: role, extension, worker, urban farming.

I. INTRODUCTION

Food security issue is one of global issues, because the fulfillment of the need for food is one of the important parts of human rights. National food security can be accomplished by both the availability of nationally or regionally sufficient food as well as the fulfilled food need at household level [9] [11]. One of the attempts at increasing household food security can be done by utilizing the house yards which are managed by households. The role and utilization of the yards are highly influenced by the need level, socio-culture, community education level, as well as physical and ecological condition of the local regions[8].

In urban areas, the limitation of yards has become one of the obstacles for some citizens in accomplishing agricultural activities. To get around the limitation in the areas, urban farming activities has recently emerged as a solution of the utilization of lands (including house yards) for agricultural activities. Urban farming is one of the attempts at utilizing urban lands, so that they can give benefit value such as increasing environment health, extending economic opportunities, social improvement, energy efficiency, and increasing availability and quality of food[12] .

Bandung City is one of the big cities in Indonesia that are actively encouraging urban farming movement. In the Mid-Term Development Plan (*RPJMD*) of Bandung City, year 2013-2018[1] , it is explained that urban farming is a breakthrough in the attempts at providing food independently and sustainably. Urban farming is developed from the concept of gardening in house yards or the utilization of wastelands to be planted by productive plants, land intensification, and planting the plants that have high economic value. In addition, what should be taken into account are about the foods which are varied, nutritious, balanced and secure, and the fulfilled food supply in Bandung City.

Urban farming program in Bandung City has been being accomplished since 2014 and has been one of the superior programs of Bandung City government. Since its first launch, there have been 151 urban villages participating in the program accomplishment.

One of the subdistricts whose all of the urban villages have begun the urban farming program is Gedebage Subdistrict. Gedebage Subdistrict consists of four urban villages, all of which have performed the urban farming program well. However, it was not in every urban villages where the urban farming was working well. Based on an interview with *Kasi Ekbang* (Head of Division of Economy and Development) of Gedebage Subdistrict, at that time, among four urban villages, there were only two of them that were actively performing the urban farming program (Table 1).

Table 1. The data of the urban villages that perform urban farming program in Gedebage Subdistrict

No.	Urban Village	Status
1.	Rancabolang	Active
2.	Cisaranten Kidul	Active
3.	Cimencrang	Inactive
4.	Ranca Numpang	Inactive

Source: Gedebage Subdistrict Data, 2017

The urban village that was actively performing urban farming program was Cisaranten Kidul Urban Village. Urban farming activity in Cisaranten Kidul Urban Village was performed in one hectare wasteland that was planned to be used as a new urban-village office. Besides, each *RW* (Community Association) in Cisaranten Kidul Urban Village was also actively performing the urban farming activity. Citizens in Cisaranten Kidul Urban Village actively planted vegetables, fruits, decorative plants, as well as medicinal plants. The cultivation techniques employed not only were not only the use of soil medium, but also the implementation of hydroponic technique for vegetable plantation. Moreover, in the land managed by the citizens, they attempted to distribute the seeds to every *RW* in Cisaranten Kidul Urban Village.

In 2015, Cisaranten Kidul Urban Village was made as a gardening model in Bandung City, based on the achievement by this urban village in performing urban farming program. The success of Cisaranten Kidul Urban Village in performing the program was, of course, because of the active role of its citizens as the main actors in the accomplishment of the program.

Extension activity was one of the methods in encouraging the active role of the citizens in urban farming activity. According to Law of the Republic of Indonesia Number 16 of 2006, agricultural extension is a learning process for the main actors and entrepreneurs in order that they have willingness and are able to help and organize themselves. The importance of extension activity was begun at raising community's awareness and participation in the development process in order that they are able to help themselves[4]. Local Governmental Agency of Agriculture and Food Security of Bandung City is one of the institutions which are given authorities to escort the urban farming program, including the extension and dissemination of information about the selection of agricultural commodities that have high productivity, high economic value, as well as open market opportunity, and are able to be developed in narrow areas.

Agricultural extension worker is one of professional workers who attempt to influence or to direct decision of innovation in order to be appropriate with the goal of the extension agencies. Extension agents are the agents of renewal of institutions, local government offices, or organizations who aim at making changes in society for the better[10].

Based on the above explanation, the objective of this research was to find out the role of extension workers in the development of urban farming activity in Cisaranten Kidul Urban Village of Gedebage Subdistrict of Banding City.

II. MATERIALS AND METHODS

A. Research Design

This research employed quantitative design with descriptive survey technique.

B. Data Classification and Source

The data in this research consisted of primary and secondary data. The secondary data was obtained from various agencies, such as Finance Investigator Institute, local government service of Agriculture and Food Security of Bandung City. The primary data was obtained from interview and directive group discussion with respondents. The population in this research was the citizens consisting of 54 persons who were involved in urban farming activity in Cisaranten Kidul Urban Village of Bandung City, and all them were made as the respondents in this research.

C. Data Analysis

The analysis on the role of extension workers in the development of urban farming activities in Cisaranten Kidul Urban Village of Bandung City was conducted descriptively by analyzing the informants' answers on the role of extension workers by categories: very low, low, enough, very high, and high. Descriptive analysis aimed at describing phenomena in depth and objectively.

III. RESULTS AND DISCUSSION

A. The Implementation of Urban Farming in Cisaranten Kidul Urban Village

In Cisaranten Kidul, Urban Farming program had been implemented in 2013. Initially, urban farming activities were only done in *RW* 12 by using wasteland with an area of 1 ha. One of the factors that had become the reason for some citizens to do urban farming was because they wanted to take advantage of wasteland which were abandoned and full of cogon grass. The urban village supported this activity by providing outsourcing workers with the background as farmers to help maintain the urban farming gardens. This increased the enthusiasm of citizens to develop Urban Farming in Cisaranten Kidul Urban Village. After the introduction of urban farming program from Local Government Office of Agriculture and Food Security of Bandung City in 2015, Cisaranten Kidul Urban Village got assistance in the form of seeds, seedlings, soil, as well as the tools and cultivation machines using hydroponics system.

The success of Cisaranten Kidul Urban Village in carrying out urban farming activities have encouraged outsiders to visit urban farming gardens, starting from PAUD (early childhood education program) children, Bandung City government, and visitation from Sukamiskin Penitentiary. It has made urban farming gardens of Cisaranten Kidul Urban Village as a demonstration gardens. Urban Farming activities in this village have been widely reported in cyberspace as in the pages of *Republika*, the website of the Local Government Office of Agriculture and Food Security of West Java Province and of Bandung City.

In 2016, to support the sustainability of the urban farming program in Cisaranten Kidul Urban Village, the Cisaranten Kidul Urban Village instructed all *RW* heads to run this program in every *RW* (Community Association) and form a gardening group. At that time, the program had been almost completely implemented. Of 15 RWs in Cisaranten Kidul, 9 RWs of the urban district had implemented this program. This was because of the high enthusiasm of Cisaranten Kidul citizens to this program. Some *RW*s that had not implemented this program had some limited constraints of land used for urban farming sites and lack of enthusiasm for the program.

Urban farming activities were partly implemented in the open green lands owned by the government and the community. Cultivated commodities included herbs such as ginger, turmeric, and celery; vegetable crops such as kale (*kangkung*), red spinach, *caesim*, Chinese cabbage, and cayenne pepper. In addition, non-rice food crops such as sweet potatoes, cassava, and corn were also cultivated. This was a support to one of Bandung City government programs, that is, *one day no rice*, where in Bandung City it is recommended that one day in one week people do not eat rice.

The cultivation method used by the majority of the community was the use of conventional cultivation techniques (using soil planting media in open field). However, there were some people who had used hydroponic cultivation techniques in *RW* 12 garden, and verticulture techniques in *RW* 09 garden. The differences in cultivation techniques was due to lack of understanding of the community about aesthetic-based cultivation. An agricultural extension worker of Bandung City who served in this area said that the people in this village were still lack of understanding about the meaning of urban farming. They thought that urban farming means just doing planting activities in fields, but actually the expected urban farming activities are different from the agricultural activities in villages where agriculture in cities are more concerned about the aesthetic element.

The completeness of supporting facilities and infrastructure in each *RW* varied, in *RW* 11, which was one of the *RW*s that were good enough in the management of this program, there had been an irrigation well, a screen house, and a wooden shed (*bedengan*). According to the observation result, among 9 RWs implementing this program, there were only 3 RWs (RW 09, 11, and 12) which had been good in the implementation of this program. This was due to limited funds in the development of urban farming program. So far, the funds used were from *PIPPK* funds and the community self-help, so the program was implemented based on the ability of the community.

In 2016, PT PERTAMINA through CSR program helped Cisaranten Kidul Urban Village in the development of health program of Toddler Food Taxi bike (Ojek Makanan Balita), which was the nutrition fulfillment of children under five with poor nutrition and malnutrition. This year PT PERTAMINA assisted Cisaranten Kidul Urban Village in developing urban farming program under the name of Nutrition Garden (*Kebun Gizi*) program. Unfortunately, this aid was not comprehensive in all RWs. There are only two RWs that received assistance, i.e., RW 04 and RW 14. This was because the potentials of the program development were not the same between the condition of the land and available human resources (HR). These two RWs were chosen because the potential of land used for the development of this program was still abundant, and the level of community participation in the development of this program was quite good, which was evident in the presence of FGD activities (focus group discussion) organized by PT PERTAMINA and attended by the government of the urban village, Agriculture extension workers of Bandung City, and the community managing urban farming.

B. Urban-Farming Activities in Cisaranten Kidul Urban Village

Urban Farming extension program in Bandung City was performed by the Local Government Office of Agriculture and Food Security of Bandung City. One extension worker served in three districts. The material presented in the extension activities was about technical cultivation of plants. Extension activities are usually conducted at the village office by inviting representatives from each RW.

C. The Role of Extension Workers in Urban-Farming Development in Cisaranten Kidul Urban Village

In Law No. 16 of 2006 on Extension System of Agriculture, Fisheries and Forestry, it is mentioned that counseling is a part of an effort to educate the life of the nation and promote general welfare. Agricultural extension workers play an important role in realizing the mandate of the law[7]. The role of extension workers according to the Agency for Agricultural Human Resources Development[3] are the initiators, facilitators, motivators, connectors, teachers, organizers, dynamists, analyzers, and agents of change. Based on the roles, there are four main roles of agricultural extension, i.e., as communicators, consultants, motivators and facilitators[2] .

In the development of urban farming program in Bandung City, especially in Cisaranten Kidul Urban Village, the roles of the extension workers were to motivate people to participate in urban farming activities, and to assist the community in the technical aspect of the cultivation, so that the community can run the urban farming activities independently and sustainably. People living in urban areas generally do not have knowledge and skills about cultivation techniques, because the educational background or occupation of people, including the citizens living in the Cisaranten Kidul Urban Village, is not agriculture. Gardening or farming for most people is a hobby or leisure activity. For that, training and assistance is needed for urban farming development. Extension workers as the spearheads of extension activities have a very important role in changing the behavior of the community.

In Cisaranten Kidul Urban Village, there was one permanent extension worker who routinely gives extension activities to the community. According to most respondents, as a communicator or messenger, the extension worker in Cisaranten Kidul Urban Village had good communication skill (Table 2). Extension materials and other information could be received well by the public. According to most respondents, in addition to the good way of delivering the materials, the extension worker mastered the materials presented and was also close to the citizens, so that they felt easy to communicate with him, and this is in line with, that to be a good communicator someone must have good faith, be trustworthy, and have good communication skill[5] .

Table 2. Respondents' opinion about the roles of extension workers in Cisaranten Kidul Urban Village

No.	Roles of Extension Workers	Category	f (person)	%
1	Communicator	Very Low	-	-
		Low	-	-
		Enough	-	-
		High	43	79.63
		Very High	11	20.37
2	Consultant	Very Low	-	-
		Low	-	-
		Enough	19	35.19
		High	24	44.44
		Very High	11	20.37
3	Motivator	Very Low	-	-
		Low	-	-
		Enough	17	31.48
		High	31	57.41
		Very High	6	11.11
4	Facilitator	Very Low	-	-
		Low	-	-
		Enough	27	50.00
		High	13	24.07
		Very High	14	25.93

As consultants, the role of extension workers is to provide guidance, consideration, and input to farmers[2]. In solving the problems faced in the implementation of urban farming, extension workers invite citizens to analyze and solve the problems they face. The problem that often arises is about technicality of cultivation and pest control. Most citizens still found it difficult to deal with technical problems of cultivation, because their backgrounds were not from agriculture. According to some respondents, the presence of extension workers helped them solve the problems they faced (Table 1), but according to some other citizens, the intensity of the extension workshops was still perceived to be insufficient, so that they found it difficult to consult the extension workers. The schedule of extension activities in Cisaranten Kidul Urban Village ranged from once a month to once every 2 months, and it was only held at the urban-village office, due to the dense schedule of extension workers who served in 3 subdistricts. Citizens hoped that extension workers can come directly to the location of the gardens in each RW, so that they can see directly the problems they face.

As motivators, the role of extension workers is to provide encouragement and motivation to the citizens in order that they have willingness and are able to carry out urban farming activities. The urban farming activities in

Cisaranten Kidul Urban Village was begun in 2012, and at that time the activities only focused on wastelands in RW 12. After the commencement of urban farming extension activities by Local Government Office of Agriculture and Food Security of Bandung City in 2015 until now, there have been 9 of 15 RWs in Cisaranten Kidul Urban Village running urban farming program. The success of the urban farming program in Cisaranten Kidul Urban Village could not be realized without the participation of the citizens. The growth and development of community participation in development are determined by opportunity to participate, as well as ability and willingness to participate[6] . Therefore, a counselor should be able to generate and encourage the desire of citizens to engage in urban farming activities. Most respondents considered that the extension workers were able to persuade and encourage citizens in urban farming activities through extension and training activities (Table 1). While most of the drivers of urban farming activities in Cisaranten Kidul Urban Village were mothers, because most of the women who were active in urban farming activities were housewives who had relatively free time to maintain the gardens.

Extension workers as facilitators plays a role in providing solutions or facilities in the extension process, or facilitating farmers or citizens in terms of business partnerships, access to markets or capital institutions and so forth[3]. According to most of the respondents, the role of extension workers as facilitators was felt as quite good; the extension workers were considered as capable of connecting citizens with various communities of urban farming observers like Bandung Gardening community. The products of the cultivated gardens were mostly consumed by the citizens themselves, and were not sold to markets. Some citizens hoped to make urban farming an income generating effort, so it needs support and facilitations to market the products of the citizens' gardens.

IV. CONCLUSION

The roles of extension workers as communicators, consultants, motivators, and facilitators were considered as good enough by the citizens. However, they expect the intensity of extension activities to be increased, so that more and more citizens will be encouraged, and understand the benefits of urban farming activities, not only for themselves but also for the environment around them. It was expected that with urban farming activities, food security and sustainability of the environment can be enhanced.

REFERENCES

[1] -----. *Rencana Pembangunan Jangka Menengah Daerah (RPJMD) Kota Bandung Tahun 2013–2018.* 2013

[2] Azhari, Rafnel. "Pengaruh karakteristik individu dan peran penyuluh terhadap peningkatan diversifikasi pangan rumah tangga". Bogor: Graduate School of Bogor Agricultural University. 2013

[3] Badan Penyuluhan dan Pengembangan SDM Pertanian [Online]. Avaialable at: cybex.deptan.go.id. 2010

[4] Bahua, Mohamad Ikbal. *Kinerja Penyuluh Pertanian*. Yogyakarta: Deepublish. 2016

[5] *Effendy*, Onong Uchjana. *Ilmu Komunikasi (teori dan Praktek)*. Bandung: PT. Remaja Rosdakarya. 2007

[6] Mardikanto, Totok dan Poerwoko Soebiato. *Pemberdayaan Masyarakat dalam Perspektif Kebijakan Publik*. Bandung: Alfabeta. 2013

[7] Narso, Amiruddin Saleh, Pang S Asngari, Pudji Muljono. "Persepsi penyuluh pertanian lapang tentang perannya dalam penyuluhan pertanian padi di Provinsi Banten". Jurnal Penyuluhan Vol 8 No 1 Maret 2012. 2012

[8] Rahayu, M, S. Prawiroatmodjo. "Keanekaragaman tanaman pekarangan dan pemanfaatannya di Desa Lampeapi Pulau Wawoni Sulawesi Tenggara". Jurnal Tek.Ling. P3TL-BPPT, 6 (2). 2005

[9] Rachman, Handewi .P.S. dan M. Ariani. 2007. *Penganekaragaman Konsumsi Pangan di Indonesia: Permasalahan dan Implikasi untuk Kebijakan dan Program*. Paper in Workshop "Koordinasi Kebijakan Solusi Sistemik Masalah Ketahanan Pangan Dalam Upaya Perumusan Kebijakan Pengembangan Penganekaragaman Pangan", Hotel Bidakara, Jakarta, 28 November Kementrian Koordinator Bidang Perekonomian Republik Indonesia. 2007

[10] Rogers, Everett M. *Diffusions of Innovations, Forth Edition*. New York: Tree Press. 1995

[11] Saliem, Handewi Purwati. *Kawasan Rumah Pangan Lestari (KPRL) : Sebagai Solusi Pemantapan Ketahanan Pangan*. Paper in congress of Ilmu Pengetahuan Nasional (KIPNAS) Jakarta 8-10 November 2011

[12] Widyawati, Nugraheni. *Urban Farming Gaya Bertani Spesifik Kota.* Yogyakarta: Lily Publisher. 2013

B.14

ANALYSIS OF THE INFLUENCE OF INDEPENDENT VARIABLES FOR INDONESIAN ROBUSTA COFFEE BEANS

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ABSTRACT

One of the agricultural commodities that have quite spacious planting area and become the strength of Indonesian export commodities are coffee, and in terms of quantity, robusta coffee is superior than other coffee, and more contribute to Indonesia's export activities. This study aims to: (1) Determine the influence of the world's total robusta coffee bean exported production, the export volume of Indonesian robusta coffee beans, the international prices of robusta coffee beans, and the economic crisis of 1998 affecting the value of Indonesian robusta coffee beans export. (2) Knowing what is the most influential variable that determine the export value of Indonesian robusta coffee beans. This study aims to look at how the world's robusta coffee bean exported total production, the export volume of Indonesian robusta coffee beans, the international prices of robusta coffee beans, and the economic crisis of 1998 affecting the export value of Indonesian robusta coffee beans. This study design are using a quantitative research with 'a case' technique. Time series data as much as 30 years which includes the value of exports of robusta coffee beans Indonesia, the world's total production is exported, the export volume of Indonesian robusta coffee beans, the international prices of robusta coffee beans, and the economic crisis in 1998 are necessary in this analysis. The analysis tool in this research are multiple regression analysis with five variables. The results showed that variables that affecting the value of Indonesian robusta coffee beans export the most in a row is the 1998 economic crisis, the international price of robusta coffee beans, Indonesian robusta coffee beans export volume, and the world's robusta coffee beans export.

Keywords : robusta coffee bean, independent variables, influence, export

I. INTRODUCTION

An international trading is important aspect for a country development. International trading is happened because there is human resources, natural resources differences, like as climate and geography site, and also social and economic differences available on countries. Every country has been done international trading because two main reasons, that each to be sources for trading advantage available for that country. Firstly, countries have traded among them because they are different one another. Secondly, countries have been done trading activity purposing to reach what can be called as economic of scale in production (Krugman and Obstefeld, 2004).

Indonesia is existed on third position in coffee productivity and export volume after Brazil and Vietnam. In 2012, Indonesia coffee production is reached 684.076 tons and it export volume is reached 432.781 tons. Coffee can be became very prominent product and is became Indonesia identity at international eyes because its special tastes. Coffee can be said as a part of life style for population largely in various world hemispheres.

All this time, Indonesia has been exported coffee for various countries like as United State, Germany, Italy, and Japan. Data is shown, last six years some countries have shown positive trends for Indonesia coffee exporting. Nevertheless, some countries are also shown export quantity decreasing toward coffee from Indonesia.

All this time, Indonesia has known as a Robusta coffee producer country with market share as much as 20 % from world robusta coffee exports. Indonesia coffee triangle zone including Lampung, South Sumatera and Bengkulu provinces are main robusta coffee producer areas in Indonesia. Robusta coffee acreage has spreaded in almost all of Indonesia archipelagos with acreage position and percentage as follows: Sumatera (66 %), Java (12 %), Bali and Nusa Tenggara (8 %), Sulawesi (7%), Kalimantan (4%), and also Maluku and Papua (1%). Main Arabica coffee producer area in Indonesia is Aceh and South Sumatera. Following is arabica coffee area position and percentage: Sumatra (56 %), Sulawesi (22 %), Bali and Nusa Tenggara (10 %), Java (8 %), and Papua (4 %). (Ditjenbun, 2013)

Following data from Directorate General of Plantation, Indonesia is noted as biggest exporter country of robusta coffee kind of in the world. It is almost all of Indonesia coffee export in dry bean shape and in small part only (less than 0,5%) in process product shape. By consider available data. This research specialized at influence factor on robusta coffe export value from Indonesia in dry bean shape or it is usually called green bean.

Other influence factor is Indonesia robusta coffee bean export volume has influenced directly Indonesia coffee bean export value. As we known, export value is multification result among export volume and export price. So, it is higher export volume then, it would also be higher Indonesia coffee export value. Soekartawi (2005), in her book has explained that international price is also influence export, its meant that in this case an international robusta coffee bean price influenced coffee export value from Indonesia. If international price is higher than domestic price then, international trade is starting to do and export value is added.

In 1998, Indonesia and some East and Sout East Asian have experienced economic crisis caused by some factors either external or internal factors in nature. It is suddenly fund withdrawing in big numbers by foreign investors encouraged by regional economy prospect pessimism was directly weakening rupiah currency dramatically. It weaken rupiah value through various transmission has increased less advantaged impact for economy sectors with different seriously level. It cannot be disowned that economic crisis has been encourage social political crisis intensities faster and it has caused apparently Indonesia real sector performance more downed (BI). It is based on that reasons, economic crisis in 1998 has also presumed influence Indonesia coffee export value.

This research would be analyzed how and how far is world robusta coffee bean production export number, international robusta coffee bean price, Indonesia robusta coffee bean export volume, and economic crisis in 1998 have influenced toward Indonesia robusta coffee bean export value.

1. How much world robusta coffee bean production export number influence, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 Indonesia robusta coffee bean export value?
2. Where variable most roled in export robusta coffee bean emerging between world robusta coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998?

II. MATERIALS AND METHODS

A. Research Technique and Design

It is used design research that is research with quantitative design. Research has carried out with technique a case using data sample and time series in nature.

For test this research data is used data regression method. For general form of analysis model equation is following as:

$$\hat{Y} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + DX_4 + e \quad (1)$$

where :

$\hat{Y}$ = Indonesia robusta coffee bean export value; thousand ton
X_1 = world robusta coffee bean production export number ; thousand ton
X_2 = Indonesia robusta coffee bean export volume; thousand ton
X_3 = International robusta coffee bean price; US Dollar
X_4 = Economic crisis in 1998
D = Dummy Variable
1 = after economic crisis
0 = before economic crisis
β_0 = Regression costante
$\beta_1, \beta_2, \beta_3$= regression coefficient
e = intruder error

B. Data Analysis Plan

This research has used econometric model to reflect discussion result is explained by number. Analysis technique has used for this research is multiregression and used method is Ordinary Least Square (OLS) method. Data processing operational is carried out by Microsoft Excel 2007 and SPSS (Statistic Package for Social Science) versi 19.0 softwares. OLS method is having some superiority that is very easy technically to interpretation drawing and counting, BLUE (Best Linier Unbiased Estimator) estimation, as well as.

C. Statistic Test Analysis

1. Determination Coefficient Test (R^2)

R^2 is used as a criteria for mesurement regression model n suitable or not to estimate dependend variable. (Verena, 2013)

2. *Statistic-F Test*

Statistic-F test has used to test simultaneously all independent variables significance toward dependent variables. To do statistic-F test, firstly, it is determined hypothesis and then is determined its significance level that is as much as 0,05.

3. *Statistic-T Test*

T test (partial) is to see partially independent variable influence toward its dependent variables. It is carried out world robusta coffee bean production export number influence test (X_1), Indonesia robusta coffee bean export volume (X_2), International robusta coffee bean price, (X_3), and economic crisis in 1998 (X_4) toward Indonesia robusta coffee bean export value ($\hat{Y}$).

D. *Classic Assumption Test Analysis*

1. *Normality Test*

Test normality is to see what normal or not distributed residual value is. Good regression model is having normal distributed residual value. So, normality test is not carried aout for each variable but for their residual value.

2. *Multicolinierity Test*

Multicolinier is obtained perfect or high correlations among dependent variables, multicolinier problem at regression model gerally is marked by high R^2 value but statistic-t test result at is dependent variables are not significant at all. If there is high correlation between their independent variables, then correlation among independent variable toward its dependent variable to be disturbed.

3. *Autocorrelation Test (Durbin Watson)*

Autocorrelation test is to see what correlation among period (t) with former period (t -1) occurred is. Simply that regression analysis is to see influence among independent variable toward dependent variables, so there cannot be obtained correlation among observation with former observation data.

4. *Heteroscedasticity Test*

Heteroscedasticity is residual variant unsimilarity existence for all observations on regression model. Heteroscedasticity test has carried out is aimed to know deviation exixtence from classic assumption terms on regression model, where in regression model must be fulfilled terms that there is not heteroscedasticity exixtence. Heteroscedasticity test has carried out using Glejser test, that it is carried out by make regression residual absolute value obtained from regression model as dependent variable toward all of independent variables in regression model. (Sumodiningrat.2001:271)

III. RESULTS AND DISCUSSION

A. *General illustration of Indonesia Robusta Coffee export*

An average Indonesia coffee export volume is about 350 thousands to per year including robusta coffee (85%) and Arabica coffee (15%). Tehere is more than 50 counties Indonesia coffee export destination with main destination is USA, Japan, Germany, Italy, and England. Indonesia robusta coffee demand is continuing increase over time remembered that Indonesia robusta coffee is having superiority because containing body strong enough and it viscosity level good enouh. (AEKI, 2011).

B. *Classic Assumption Test*

Some classic assumptions have carried out necessary in research to know how good resulted regression function is in research. Most this research data is time series data and in general, it could be some infractions occurered like as autocorrection and multicolonierity. Classic assumption test should be fulfilled to obtain equation in BLUE (Best Linear Unbiased Estimator) nature.

C. *Normality Test*

Normality test result with Kolmogorov Smirnov method can be seen at appendix. That analysis result data can be seen at Asymp.Sig. (2-tailed) part has shown value 0,568 that is bigger than 0,05. It is meant that resulted residual already normal distributed. Normality a data can also be seen from P-Plot normal test graphic. P-Plot graphic is resulted in this analysis can be seen on following picture.

From that graphic, it is seen that biggest data as long as diagonal line toward its dependent variable (Indonesia Robusta Coffee Bean Export value). Then, it can be conluded that used data in this research has fulfilled normality assumpsion, data has spreaded normally.

D. Multicolinearity Test

Table 2. SPSS 20,0 output result for multicolinearity analysis (VIF)

	Variable	VIF
X_1	World coffee bean production export number	4,524
X_3	Indonesia robusta coffee bean export volume	1,373
X_4	International robusta coffee bean price	1,180
X_5	Economic crisis in 1998	4,553

On carried out multicolinearity test result base for data at table has obtained that all of independent variables that are world coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 have not shown multicolinearity symptoms or correlation among same variables.

E. Autocorrelation Test

Autocorrelation test result with Durbin Watson test method has resulted value 1,886. dL dan dU values based Durbin Watson test table with n number as much as 30 and significance level 0,05 is 1.143 and 1.738. It is based Durbin Watson test certainty obtained at previously discussion, it is explained that there is no autocorrelation occurred among residuals on every observation because dL value bigger than upper limit (dU) that is 1,866 and less than 4-dU that is 2,262 so that it can be concluded that there is no autocorrelation at data.

Based on heteroscedasticity test on above graphic is resulted that regression has no heteroscedasticity sympthom because there is no certaion patterns on scatter plot diagram. On scatter plot diagram is seen that dots pattern scatter at all diagram areas. It is based on Glejser test can be seen at appendix is also obtained significance value from each variables has valued more than 0,05. This Glejser test result is also shown that regression model is not shown heteroscedasticity sympthom.

F. Partial and Simultaneous Statistic Tests (F and T Tests)

Statistic test analysis is carried out to know in more far way what variables in data influenced significantly are. Through sstatistic test can be known variables signifince either individually (partial) or groupely (simultaneously). T test is used to examine independent variables influence (world coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998) toward dependent variable (Indonesia robusta coffee bean value) partially while f test is used to examine independent variables influence (world coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998) toward dependent variable (Indonesia robusta coffee bean value) simultaneously. It is carried out statistic test analysis including determination coefficient test, statistic f test, and tatistic t test.

G. Determination Coefficient Test (R^2)

From above regression result can be seen that R^2 value (Adjusted R Square) is 0.948. So it can be concluded that independent variables influence contribution (X_1, X_2, X_3, and X_4) are as much as 94,8% toward its dependent variable (Y). While its remaining as much as 5,2% influenced by unreserached other factor. It is shown very good value because that determination coefficient value close to value 1.

H. Statistic-F Test

It based on regression analysis result can be seen above table and also it is obtained at appendix than is obtained F count value as much as 134,312. While critical f value or f table with significance level 0,05 and df1 and df2 as much as 4 and 25, is resulted f table value as much as 2,76. Therefore f count value bigger than f critical or f table, it can be said that H_0 hypothesis is rejected. It can be concluded that world coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 simultaneously have influenced Indonesia robusta coffee bean export value significantly.

I. Statistic-T Test

It is used df value that is 25 with significance level as much as 0,05 than it is obtained t table value as much as 2,06. T test analysisi result in above has shown that world coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 are having bigger value than t table or t count > t table. Beside it, each world coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 significance value are smaller than 0,05. It is meant H_0 hypothesis rejected at all independent variables. From t test analysis result can be concluded that all independent variables have influenced partially toward Indonesia robusta coffee bean export value.

J. Multiregression Analysis Result

Based on regression output result is obtained at above table, it is obtained following regression function:

$$\hat{Y} = -989517{,}015 + 0{,}421X_1 + 1{,}481X_2 + 264{,}623X_3 - 122411{,}284X_4 + e \quad (2)$$

Based on that function, some can be interpretated either related to previous analysis or regression analysis together with its theory are:

1. That constante value having value as much as -989517,015. It is meant that if world robusta coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 have considered fixed, than Indonesia robusta coffee bean export value would be decreased as much as 989517,015 in its unit (000 $).
2. It is resulted that world coffee bean production export number coeffiecien is as much as 0,421 and positive valued. Itsmeant that, world robusta coffee bean production export number is having liniar proportioned toward correlation Indonesia robusta coffee bean export value. If Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998 variables have considered fixed, the every 1 ton increment in world coffee bean production export number would be added Indonesia robusta coffee bean export value as much as 0,421 in its unit (000 $).
3. It is resulted Indonesia robusta coffee bean export volume is as much as 1,481 and positive valued. Itsmeant that, it is resulted world robusta coffee bean export volume more increase, than it would also be much more Indonesia robusta coffee bean export value is obtained. If world robusta coffee bean production export number more much is obtained, than it would also be much more Indonesia robusta coffee bean export value is obtained. If world coffee bean production export number, International robusta coffee bean price, and economic crisis in 1998 variables have considered fixed, then every 1 ton increment in Indonesia robusta coffee bean export value, then it would be resulted Indonesia robusta coffee bean export value as much as 1,481 in its unit ($0.000). It is more much resulted Indonesia robusta coffee bean export volume. It would also be obtained much more Indonesia robusta coffee bean export value.
4. It is resulted Indonesia robusta coffee bean international price is as much as 264,623 and positive valued. Itsmeant that, it is resulted world robusta coffee bean international price more increase, than it would also be much more Indonesia robusta coffee bean export value is obtained. If world coffee bean production export number, Indonesia robusta coffee bean export volume, and economic crisis in 1998 variables have considered fixed, then every increasing 1 unit International robusta coffee bean price ($/Ton), then it would be resulted Indonesia robusta coffee bean export value as much as 264,623 in its unit ($0.000). It is occurred International robusta coffee bean export value higher then, it would also be obtained Indonesia robusta coffee bean export value higher.
5. It is resulted crisis economic in 1998 coefficient is as much as -122411,284 and negative valued. Itsmeant that, crisis economic in 1998 has decreased Indonesia robusta coffee bean export value is obtained. If world coffee bean production export number, Indonesia robusta coffee bean export volume, and International robusta coffee bean price variables have considered fixed, then every increasing 1 unit in dummy variable of economic crisis in 1998, then it would be decreased Indonesia robusta coffee bean export value as much as 122411,284 in its unit (000 $).

K. Analysis toward Testing Result

Based on test using partial and simulataneous tests are obtained simultaneous test result all independent variables have significant influenced toward Indonesia robusta coffee bean export value. While on partial test has shown that independent variables having significant influence toward Indonesia robusta coffee bean export value is world robusta coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and economic crisis in 1998. While as rupiah nominal value exchange toward dollar has not significant influenced toward Indonesia robusta coffee bean export value, partially.

L. World Robusta Coffee Bean Production Export Number Influence (X_1) toward Indonesia robusta coffee bean export value

Production is every activity in creating and increase service and goods useful which is need production factors. Production number is related to domestic needs a state and export. Coffee, especially robusta coffee in bean form is trading commodity with high value. There are much countries have race to export their production product into other country for emerged various profits. World export number, of course influenced a state export number in this robusta coffee bean commodity.

Krugman and Obstfeld (2003), in their book explained that economy productive capacity can be presented through production possibility limits and difference in production possibility limits that further it will be opened an international trading opportunity is occurred.

Regression analysis at appendix has shown world robusta coffee bean production export number coefficient value at that regression model as much as 0,421. It is menat that, every 1 ton increasing world robusta coffee bean production export number then, Indonesia robusta coffee bean export value would be increased as much as 0,421 tons. On f test or simultaneous or t test or partial test, world robusta coffee bean production export number variable having significant influence toward Indonesia robusta coffee bean export value.

It is seen from resulted regression model, world robusta coffee bean production export number variable having significant influence toward Indonesia robusta coffee bean export value. It has shown that regression analysis result at world production number variable unsuitable with beginning hypotheis which is mentioned that world robusta coffee bean production export number has negative influenced toward Indonesia robusta coffee bean export value, because this variable having positive and significant influences toward Indonesia robusta coffee bean export value .

World robusta coffee bean production export number is having positive influence toward Indonesia robusta coffee bean export value. It is meant that, when world robusta coffee bean production export number has increased then Indonesia robusta coffee bean export value would be increased, so in other way. When world robusta coffee bean export is increased then, it could be said demand and world market in robusta coffee commodity is increasing and it is also automatically to increase Indonesia robusta coffee bean export value. But, world robusta coffee bean production export number has decreased, it caould be said that world robusta coffee bean marker is weakening and it has impacted to Indonesia robusta coffee bean export value.

M. Indonesia Robusta Coffee Bean Export Volume Influence (X_3) toward Indonesia robusta coffee bean export value

A commodity export volume from certain state to other state is difference among domestic supply and domestic demand has called supply excess. On other hand, supply excess from that state is import supply for other state or it is demand excess. In other word, Indonesia robusta coffee bean export volume can be determined from difference among domestic robusta coffee bean suplly and domestic robusta coffee bean demand. When supply about domestic robusta coffee bean, it would be opened robusta coffee bean export gate to other state having supply excess condition in its state. Indonesia robusta coffee bean export volume has influenced toward Indonesia robusta coffee bean export value significantly because as it has been known, that export value is multification result among export volume and export price.

In this analysis, it is obtained Indonesia robusta coffee bean export volume coeefiecient value as much as 1,481 meaning that every Indonesia robusta coffee bean export volume is increasing 1 ton then it would be increased export valuas as musch as 1,481 from its unit valuas (000 $).

Indonesia robusta coffee bean export volume and Indonesia robusta coffee bean export value. Are having positive relation. It is meant tha, if Indonesia robusta coffee bean export volume is increased, then it automatically to increase Indonesia robusta coffee bean export value. It is also caused export value is multification result among export volume and export price, so that automatic by increase of export volume has contributed to cause Indonesia robusta coffee bean export value increasing.

Indonesia robusta coffee bean export volume and Indonesia robusta coffee bean export value influences are showing significant and positive value and it is also proven that previous proposed hypotheis is true, that Indonesia robusta coffee bean export volume has positive influenced toward Indonesia robusta coffee bean export value.

Indonesia robusta coffee bean export volume shoul be more increased for increase a export value. Indonesia is necessary to increase product quality and quantity in order to not lose in international coffee market competition. Follow Arief as a PT.Coffindo marketing, Indonesia is need more use technology and resources, in orderto able produce constant and sustaibability production quantity. Indonesia is still relative doing coffee harvest for four times per year. It is different wit Brazil by using both technology and resources. They can be carried out continuous coffee harvest throughout year. It was made Brazil coffee export value is very high.

N. International Robusta Coffee Bean Price Influence (X_4) toward Indonesia Robusta Coffee Bean Export Value

International price is valid good price in wolrd market. It is valid price in international price constitute equilibrium among world supply and demand. Product difference is also influence for world supply and finally it would also be international price. A state will be tended to export goods if that goods price higher at international market than domestic market. Commodity price is also related to supply law, that is lower a goods price, then more much goods demand. It is also in turn, higher goods price, then lower that goods demand. It is also valid at international market. If valid price on international price robusta coffee bean is increased, then demand for Indonesia robusta coffee bean has increased because it is exixiting in under international price.

Regression analysis result is obtained at appendix has shown international price coefficient value at that regression model as much as 264,623. It is meant that, every international robusta coffee bean price is increased as much as one USD per ton then, Indonesia robusta coffee bean export value would be increased as much as 264,623 from its unit value (000 $). Robusta coffee bean international price is having significant influence on partial and simultaneous tests.

To see as obtained regression model, international robusta coffee bean price vatiable is having positive influence toward Indonesia robusta coffee bean export value. It is explained that regression analysisi result on international robusta coffee bean price variable is appropriated with hypothesis because this variable having significant and positive influences toward Indonesia robusta coffee bean export value.

Such as mentioned above, robusta coffee bean price in international market is very related with robusta coffee bean supply and demand in international market. Robusta coffee bean price is high at international market usually caused by less supplay number from some robusta coffee bean producer states.

O. Economic Crisis in 1998 Dummy Variable influence toward Indonesia robusta coffee bean export value

Economic crisis in 1998 as we are known is most bad economic crisis in Indonesia in some last decades. Monetary crisis in 1998 is crisis occurred because rupah exchange value is sharply falled toward US dollar, that caused Indonesia economic decreased on large scale at various secrtor including real sector inside. Exchang value alone is very important aspect for trading activity. Exchange value difference toward foreign currencies can be influenced price at world trading where it is finally determined the number export supply and demand. If rupiah exchange value depreciation is occurred toward foreign currency, then Indonesia goods would be valued lower relatively so that Indonesia product competitive ability would be increased and it could be increased Indonesia product export demand. Real exchange rate is very related to trading balance sheet or net to export (export less import). It can be said that, economic crisis in 1998 has contributed in real sector trading and performance influenced in Indonesia, one of them agriculture sector.

It is following available data regression result, in 1998 economic crisis dummy variable is having negative correlation toward Indonesia robusta coffee bean export value. Regression result analysis has shown in 1998 economic crisis variable coefficient value is marked min that is -122411,284. It can be meant that, every 1 % economic crisis increasing can be decreased Indonesia robusta coffee bean export value as much as 122411,284 unit (000 $). Regression result data is also shown its significance level is under 0,05, it is explained that, in 1998 economic crisis has influenced Indonesia robusta coffee bean export value significantly. This expression is also powered by Indonesia robusta coffee bean export value data has shown significant enough reduction at 1999 up to 2002. This analysis result is also proven all at once as proposed hypothesis in according to data analysis result, that is in 1998 economic crisis has negative influence toward Indonesia robusta coffee bean export value.

IV. CONCLUSION

It is based on data analysis result using multi liniar regression and Ordinary Least Square method can be concluded that:

1. Overally, all independent variables that are world robusta coffee bean production export number, Indonesia robusta coffee bean export volume, International robusta coffee bean price, and in 1998 economic crisis simultaneously or partially have significant influenced toward Indonesia robusta coffee bean export value development.
2. Factors have influenced Indonesia robusta coffee bean export value from most strong up to most weaken are economic crisis in 1998, robusta coffee bean international price, Indonesia robusta coffee bean export volume, and then world robusta coffee bean production export number. It is seen from occurred regression coefficient absolute number. Crisis economic in 1998 able to decrease export value as much as 122411,284 in its unit ($0.000). Robusta coffee bean international able to increase export value as much as 264,623 in its unit. Indonesia robusta coffee bean export volume variable able to increase Indonesia robusta coffee bean export value as much as 1,481 in its unit. Last, world robusta coffee bean production export number able to increase Indonesia robusta coffee bean export value as much as 0,421 in its unit.

C

AGRICULTURAL TECHNOLOGY

C.1

SIMULTANEOUS DETERMINATION OF L-ASCORBIC ACID AND GLUCOSE IN MIXTURE SOLUTION USING FTIR-ATR TERAHERTZ SPECTROSCOPY COMBINED WITH PLS2 REGRESSION

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ABSTRACT

This study deals with the simultaneous determination of L-ascorbic acid (L-AA) and glucose in mixture solution samples, by using terahertz (THz) spectroscopy and partial least squares regression technique. A calibration set consisting of 34 binary mixture solutions was applied for the construction of PLS model. The proposed procedure was successfully applied for the simultaneous determination of L-AA and glucose with acceptable result. The root mean square error of prediction (RMSEP) of 16 prediction samples was determined to be 2.55% and 1.92% for L-AA and glucose, respectively. SDR_{pred} of 2.880 and 4.730 could be obtained for L-AA and glucose, respectively.

Keywords *:* THz spectroscopy; PLS2 regression; L-ascorbic acid; glucose; mixture solution.

I. INTRODUCTION

L-ascorbic acid (L-AA), or vitamin C, is one of the water-soluble vitamins. It can be extracted widely in many biomaterials, such as fruit and vegetables. Recently, many food products, such as juices or sports drinks, are fortified with L-AA. During long storage and transportation, the quality of fruit juice is possible to change. Reference [1] reported that vitamin C concentration of orange, lemon, grapefruit and tangerine decreased after eight weeks of storage. It was also reported that at high temperature of storage (45°C), degree of vitamin C loss is higher than that at low temperature of storage (28°C). Reference [2] reported that content of ascorbic acid in orange juice from PET and glass bottles stored at 4°C and 25°C decreased after several days of storage. For this reason, it is very important to develop a new bio-sensing method which can be able to identify the concentration of vitamin C or L-ascorbic acid (L-AA) and other component of juices nondestructively without opening the packaging material of juice. This kind of sensor is important to establish a total quality management system for food quality and safety which can benefit both producers and customers. For this reason, it is highly desirable to be able to quantify L-AA in foods, especially in juices or sports drinks, for quality control purposes.

Many papers have established non-spectroscopic methods for L-AA determination. These conventional methods include titrimetry, chemiluminescence, fluorometric, chromatographic and electrochemical methods [3], [4]. Each method though has its limitations. For example, while the titrimetry method using dichlorophenolidophenol as the titrant is rapid, the titrant itself is unstable and must be standardized before use. In the case of the chromatographic method, while it is accurate, it is expensive and time consuming.

Of the spectroscopic methods, reference [5] reports using near infrared (NIR) spectroscopy coupled with step-wise multiple linear regression (SMLR) and partial least squares (PLS) regression to determine L-AA in pharmaceutical products at concentrations of 16.67%, 22.88% and 40% . In this analysis relative standard error (RSE) was used to assess the quality of the calibration and validation model, both for the SMLR and PLS regression. The RSE for the SML regression was 0.59-1.82% (calibration), and 0.72-2.34% (validation); and 0.69-2.46% (calibration), 0.89-2.85% (validation) for PLS regression. Spectroscopic methods using NIR, Mid Infrared (MIR) and Raman spectroscopy for determination of L-AA in powder and liquid samples has been reported [6]. In these measurements, coefficients of determination (R^2) for L-AA were 0.966-0.999, 0.973-0.980, and 0.941 for MIR, NIR and Raman spectroscopy, respectively.

In the recent report, the possibility of using THz spectroscopy with ATR method for L-AA quantification in L-AA solution has been investigated [7]. The result was acceptable with the lowest root mean square error of prediction (RMSEP) = 2.791%. A ratio of standard deviation to prediction error (RPD) value of 4.48 was obtained

[7]. In recent report, the improvement of L-AA determination using THz spectroscopy by applying iPLS regression has been published [8]. This result may lead to a new application of THz spectroscopy for L-AA determination in juice samples especially for juice inside packing material in which THz waves have ability to penetrate the packing materials with low photon energy (safe for biological sensing). However, since that in real juice samples there are many kind of substances inside the juice solution, therefore to realize inspection system using THz spectroscopy for juice samples, it is desired to investigate the ability of measure L-AA in more complex solution (not only in pure L-AA solution). In the present study, first attempt to measure L-AA in mixture solution using THz spectroscopy was investigated by using binary mixture of L-AA and glucose solution. The present study highly contributed to open the development of using THz spectroscopy as new sensor in biological solution in more complex solution.

II. MATERIALS AND METHODS

A. Samples

Fifty samples of binary mixture solution of L-ascorbic acid (L-AA) and glucose were used as samples. The binary mixture solutions were prepared by dissolving appropriate amounts of L-AA powder (Wako Pure Chemical Industries, Ltd., Japan) and glucose powder (Grade: Guaranteed Reagent (GR); Nacalai Tesque, Inc., Kyoto, Japan) in distilled water. The ranges of concentrations were from 2.6446 to 26.4709% (mass percent, w/w) for L-AA and from 2.1660 to 33.3605% (mass percent, w/w) for glucose. For each sample, 300 μL of mixture solution were used for spectral acquisition.

B. Devices for FTIR-THz-ATR spectroscopy

THz spectra of mixture solutions were acquired using a Fourier-transform infrared (FTIR) based spectrometer (FARIS-1S, JASCO Corp., Japan). This system is based on a FTIR spectrometer (range of measurement: 20-450 cm^{-1} or 0.6-13.5 THz) with a special light source made from a high pressure mercury lamp as a THz generating device. (See reference [7] for detail explanation of the system).

C. FTIR-THz-ATR spectroscopy

FTIR-ATR-THz spectra of the mixture solutions were acquired in the range 20-450 cm^{-1}, using a 16 cm^{-1} of resolution. Each spectrum contains on average 200 scanning spectra. The reference for air was measured every 5 samples. The spectra intensity of samples and reference were obtained in single beam (SB) unit. During THz spectral measurement, the laboratory temperature and relative humidity were maintained at around 25°C and 65-70%, respectively. For each samples, the spectral measurement was conducted at constant temperatures of 24°C. To obtain this sample temperature, the temperature of silicon prism was controlled at 24°C. The absorbance value of the sample was calculated using equation 1 [7].

$$A(\nu) = -\log_{10}\frac{S(\nu)}{R(\nu)} \tag{1}$$

where:

$A(\nu)$ is absorbance at wavenumber ν

$S(\nu)$ is intensity of sample at wavenumber? ν

$R(\nu)$ is intensity of air reference at wavenumber ν

The calculated absorbance value was corrected using the ATR correction function provided in the software (JASCO Spectral Manager, JASCO Corp., Tokyo, Japan). The corrected values were used for further analysis.

D. Selection of the calibration sample set

Table 1. Characteristics of the L-AA and glucose in mixture solution

L-AA concentration	Calibration set	Prediction set
Number of samples	34	16
Mean	13.886	13.879
Standard deviation	7.342	7.124
Glucose concentration	Calibration set	Prediction set
Number of samples	34	16
Mean	11.784	12.770
Standard deviation	7.931	9.090

L-AA and glucose are expressed as % (mass/mass or w/w).

The samples (50 samples) were divided in two different sets: (i) calibration, and (ii) prediction. The first sample set was used to develop calibration and performing full-cross validation test. The prediction sample set was used to evaluate the performance of the develop calibration model. The way to select the calibration and prediction sample set was as followed: first all samples were sorted based on L-AA values from the highest to the lowest. Then, from the highest L-AA we pick up 2 samples for calibration and 1 sample for prediction and repeat the process until the lowest L-AA. For this we selected 34 samples for calibration set and 16 samples for prediction sample set. Table 1 shows the composition of the different sets of the samples, including the maximum, minimum and average value of the L-AA and glucose.

E. Chemometric analysis

Chemometric analysis, including quantification analysis was carried out using The Unscrambler v. 9.2 software packages from Camo (Camo Process AS, Oslo, Norway). Quantification of L-AA and glucose in mixture solution were done simultaneously by partial least squares (PLS) regression analysis using the broad region (20-450 cm^{-1}).

F. Model evaluation

Performance of the calibration model and cross-validation was evaluated using the following statistical parameters; coefficient of determination between predicted and measured L-AA and glucose concentration (R^2_{cal}), root mean square error of calibration (RMSEC), root mean square error of cross-validation (RMSECV) and the standard deviation ratio (SDR) of calibration (SDRcv) which can be calculated as follow [9]:

Low RMSECV and a high R^2_{cal} and SDR_{cv} were desirable. SDR_{cv} above 3.0 is considered to be acceptable for practical spectroscopy applications [10].

To evaluate the prediction performance of the developed calibration model, the following parameters were used: the coefficient of determination in prediction (R^2_{pred}), the root mean square error of prediction (RMSEP), bias between the actual and predicted value, the bias-corrected standard error of prediction (SEP) and the standard deviation ratio (SDR) of prediction (SDR_{pred}). The RMSEP is an estimate of total prediction errors for an independent data set. The sources of error in the RMSEP value are including bias and SEP which can be mathematically expressed as follow [11]:

$$\mathrm{RMSEP}^2 \approx \mathrm{SEP}^2 + \mathrm{bias}^2 \tag{2}$$

Good prediction resulted in low RMSEP, bias and SEP and high SDR_{pred} value. The SDR_{pred} more than 3 was considered to be sufficient. The SDR_{pred} can be calculated as follow [9], [12], [13]:

$$\mathrm{SDR}_{pred} = \frac{\mathrm{S.D}_{predictionset}}{\mathrm{RMSECV}} \tag{3}$$

III. RESULTS AND DISCUSSIONS

A. Typical spectra of L-AA and glucose in mixture solution

Fig. 1 shows the two typical spectra of L-AA and glucose in mixture solution with different concentration. We can see that the in the spectral shape, the spectra of mixture solution of L-AA and glucose is similar with the spectra of water. Mixture2 with higher concentration of L-AA and glucose in total has lower absorbance comparing to Mixture1. This is because the amount of free water in Mixture2 is lower than that of Mixture1.

B. Developing calibration model for L-AA and glucose determination

Calibration model for L-AA and glucose were developed simultaneously by using PLS2 regression using original and some pre-processing method. Savitzky-Golay (SG) smoothing was found to be the best pre-processing method for L-AA and glucose determination (result of pre-processing evaluation was not shown here). The optimum number of PLS factors was determined by the full-cross-validation procedure by plotting the root mean square error of cross-validation (RMSECV) against the number of factors and searching for the minimum error (results not shown).

Fig. 2 and 3 show the scatter plot of actual and predicted L-AA for the best calibration and validation using SG smoothing spectra, respectively. The calibration model has 5 PLS factors with R^2_{cal}=0.963 and the root mean square error of calibration (RMSEC) = 1.386558% (w/w). The validation of L-AA resulted in the root mean square error of cross-validation (RMSECV) = 1.660468% (w/w). It can be seen that the differences between the RMSEC and RMSECV of the developed model was small. It can be said that there is no potential for over fitting case of the L-AA determination using this model. Fig. 4 and 5 show the scatter plot of actual and predicted glucose for the best calibration and validation using SG smoothing spectra, respectively. The calibration model has 4 PLS factor (lower than L-AA model) with R^2_{cal}= 0.960 and RMSEC = 1.567653% (w/w). The validation of glucose resulted in RMSECV = 1.880194% (w/w). It can be seen also that the differences between the RMSEC and RMSECV of the developed model for glucose was small. It can be said that there is no potential for over fitting case of the glucose determination using this model.

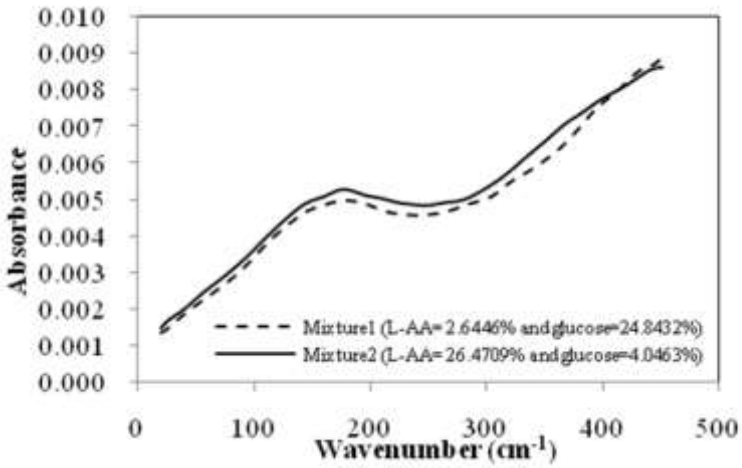

Fig. 1. Typical spectra of mixture solution of L-AA and glucose in range 20-450 cm^{-1}.

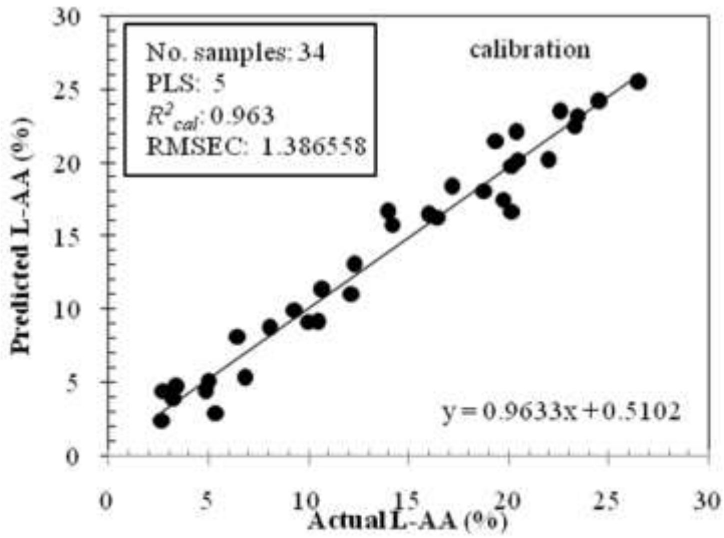

Fig. 2. Scatter plot between actual and predicted L-AA for calibration using PLS2 regression method

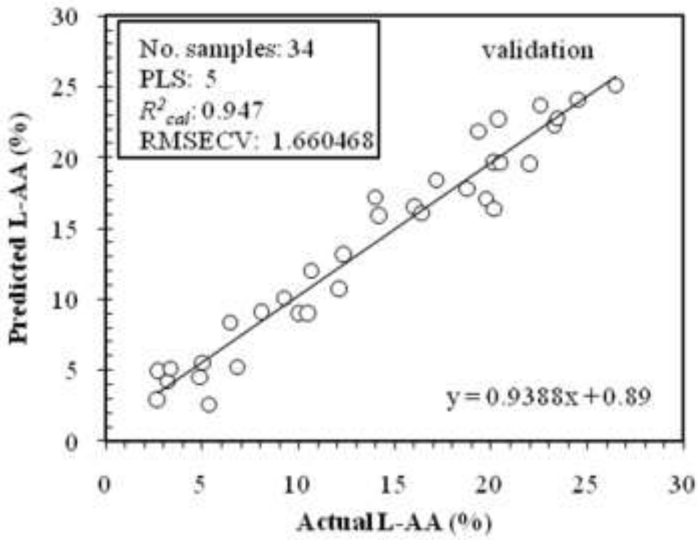

Fig. 3. Scatter plot between actual and predicted L-AA for validation using PLS2 regression method

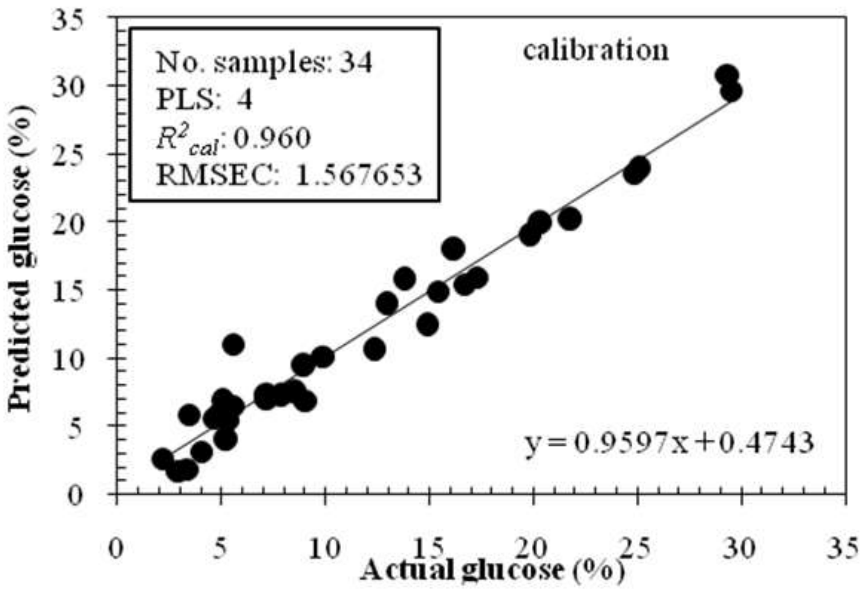

Fig. 4. Scatter plot between actual and predicted glucose for calibration using PLS2 regression method.

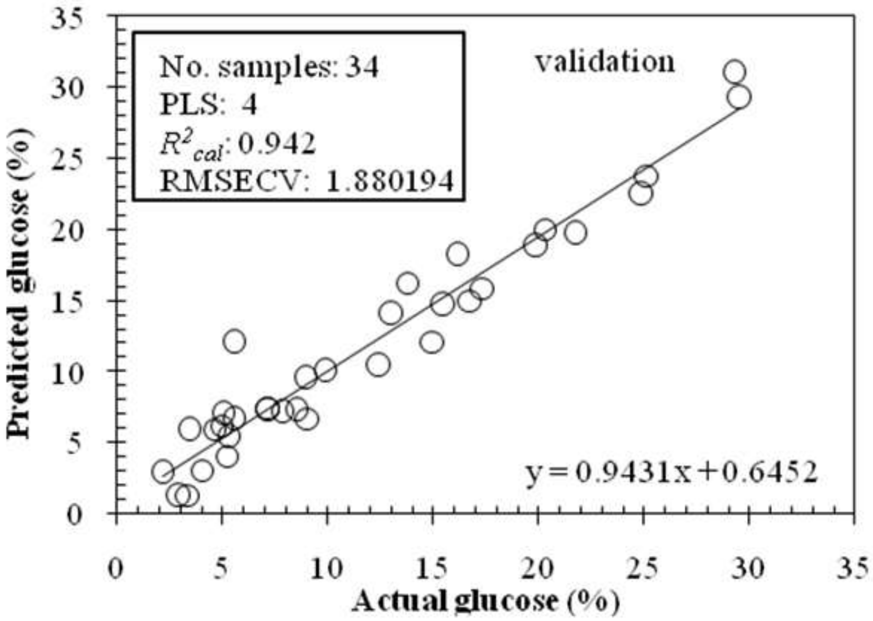

Fig. 5. Scatter plot between actual and predicted glucose for validation using PLS2 regression method

C. Prediction for L-AA and glucose in mixture solution

Using prediction sample set (n= 16), an evaluation on the performance of the developed calibration was investigated both for L-AA and glucose determination. Prediction for L-AA resulted in RMSEP= 2.473348% (w/w). With this RMSEP, SDR_{pred} of 2.880 could be obtained. Bias prediction was very close to 0.

As seen in Fig. 6, the regression between values found by the two-equation ATR-THz method (Y) and those obtained by the reference procedure (X) for L-AA provided a regression equation of Y = 0.8075X + 2.6711 (n = 16) which means that the developed ATR-THz method is not so accurate, it still requires a blank correction (the intercept is not almost zero) and presents constant relative errors (the slope is not very close to 1). However, the ATR-THz method shows possibility on L-AA determination in mixture solution and opens a practical application of using ATR-THz method for L-AA determination in more complex solution such as in juice samples.

For glucose, prediction resulted in RMSEP= 1.921876% (w/w). With this RMSEP, SDRpred of 4.730 could be obtained. This SDR_{pred} is higher comparing to SDR_{pred} for L-AA. Bias prediction was also close to 0.

As seen in Fig. 7, the regression between values found by the two-equation ATR-THz method (Y) and those obtained by the reference procedure (X) for L-AA provided a regression equation of Y = 1.0696X - 0.9742 (n = 16) which means that the developed ATR-THz method is better accuracy than L-AA with the intercept is closer to zero and the slope is also closer to 1.

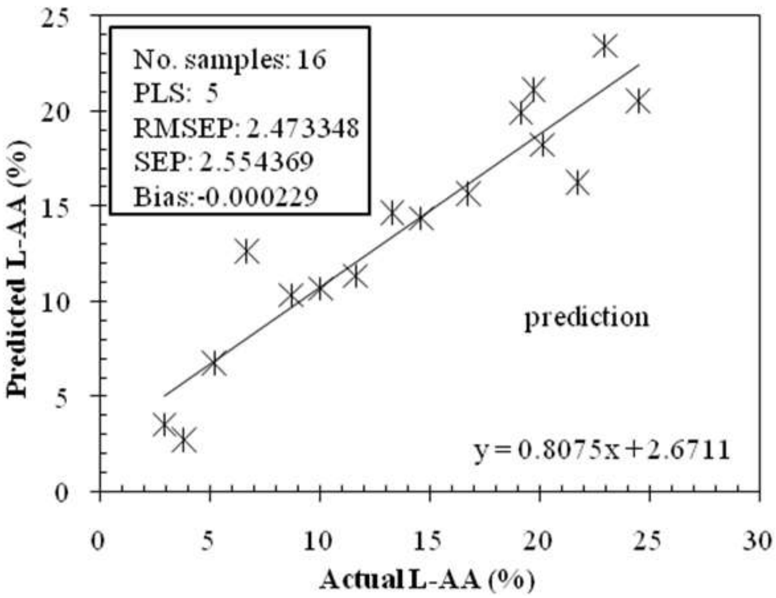

Fig. 6. Scatter plot between actual and predicted L-AA for prediction using PLS2 regression method.

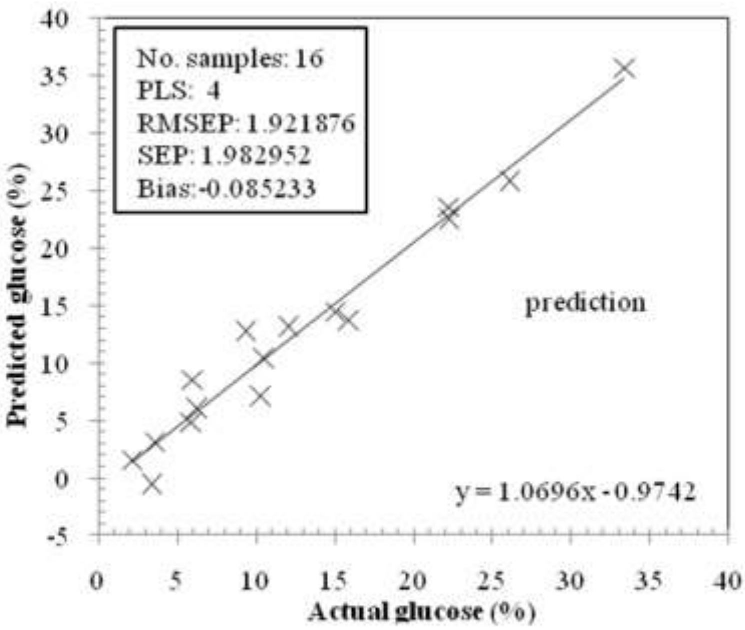

Fig. 7. Scatter plot between actual and predicted glucose for prediction using PLS2 regression method

D. Evaluation of structure of calibration model

In order to evaluate the structure of the calibration model for L-AA and glucose determination, a plot between regression coefficient and wavelength was constructed. As seen in Fig. 8, for L-AA determination there are several observed peaks. They are at 96 cm^{-1}, 173 cm^{-1}, 215 cm^{-1}, 273 cm^{-1}, and 358 cm^{-1}. These peaks may directly correspond with L-AA determination at mixture solution. It can be seen that the contribution of high frequency is higher comparing to that of lower frequency. It seems that L-AA determination of mixture solution was mainly determined by intramolecular vibration mode at higher frequency. For glucose the peaks of regression coefficient were much similar to the L-AA with different in magnitude sign. For example, the peak of L-AA at 358 cm^{-1} has a magnitude of regression coefficient 7823 while for glucose at the peak of 358 cm^{-1} the value of regression coefficient was -7823.

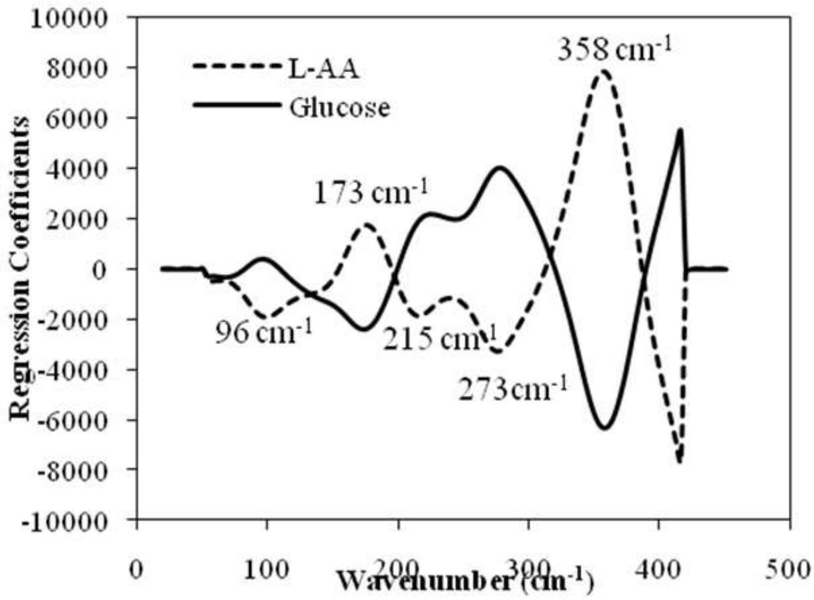

Fig. 8. Scatter plot between wavenumber and regression coefficient for L-AA and glucose determination using PLS2 regression method

IV. CONCLUSION

To summarize, we have measured simultaneously the L-AA and glucose spectral data in broad range of THz region in mixture L-AA and glucose solution. The validation of L-AA resulted in the root mean square error of cross-validation (RMSECV) = 1.660468% (w/w). The validation of glucose resulted in RMSECV = 1.880194% (w/w). The developed calibration model has high SDR_{cv} for both with SDR_{cv}= 4.421 and SDR_{cv}= 4.218 for L-AA and glucose, respectively. Prediction for L-AA resulted in RMSEP= 2.473348% (w/w). With this RMSEP, SDR_{pred} of 2.880 could be obtained. Bias prediction was very close to 0. This result showed a potential use of THz spectroscopy for L-AA determination in mixture solution.

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REFERENCES

[1] H.S. Burdurlu, N. Koca., and F. Karadeniz, "Degradation of vitamin C in citrus juice concentration during storage," *J. Food Eng*., vol. 74, pp. 211–216, 2006.
[2] M. Ros-Chumillas, Y. Belissario, A. Iguaz, and A. López, "Quality and shelf life of orange juice aseptically packaged in PET bottles," *J. Food Eng*., vol. 79, pp. 234–242, 2007.
[3] S. Arya, P. M. Mahajan, and P. Jain, "Photometric methods for the determination of Vitamin C," *Anal. Sci.*, vol. 14, pp. 889–895, 1998.
[4] S. Arya, P. M. Mahajan, and P. Jain, "Non-spectrophotometric methods for the determination of Vitamin C," *Anal. Chim. Acta*, vol. 417, pp. 1–14, 2000.
[5] M. Blanco, J. Coello, H. Iturriaga, S. Maspoch, and C. Pezuela, "Determination of ascorbic-acid in pharmaceutical preparations by near-infrared reflectance spectroscopy," *Talanta*, vol. 40, pp. 1671–1676, 1993.
[6] H. Yang, and J. Irudayaraj, "Rapid determination of vitamin C by NIR, MIR and FT Raman techniques," *J. Pharm. Pharmacol.*, vol. 54, pp. 1247–1255, 2002.
[7] D. Suhandy, M. Yulia, Y. Ogawa, and N. Kondo, "L-ascorbic acid prediction in aqueous solution based on FTIR-ATR terahertz spectroscopy," *Engineering in Agriculture, Environment, and Food*, vol. 5, pp.152–158, 2012.
[8] D. Suhandy, M. Yulia, Y. Ogawa, and N. Kondo, "Prediction of L-ascorbic acid using FTIR-ATR terahertz spectroscopy combined with interval partial least squares (iPLS) regression," *Engineering in Agriculture, Environment, and Food*, vol. 6, pp.111–117, 2013.
[9] M. Golic, and K. B. Walsh, "Robustness of calibration models based on near infrared spectroscopy for the in-line grading of stone fruit for total soluble solids content," *Anal. Chim. Acta*, vol. 555, pp.286–291, 2006.
[10] A. Clement, M. Dorais, and M. Vernon, "Nondestructive measurement of fresh tomato lycopene content and other physicochemical characteristics using Visible-NIR spectroscopy," *J. Agric. Food Chem.*, vol. 56, pp.9813–9818, 2008.
[11] L.K. Sørensen, and S. Dalsgaard, "Determination of clay and other soil properties by near infrared spectroscopy," *Soil. Sci. Soc. Am. J.*, vol. 69, pp. 159–167, 2005.

[12] M. Valente, R. Leardi, G. Self, G. Luciano, and J. P. Pain, "Multivariate calibration of mango firmness using vis/NIR spectroscopy and acoustic impulse method," *J. Food Eng.*, vol. 94, pp.7–13, 2009.

[13] Y. Liu, X. Sun, J. Zhou, H. Zhang, and C. Yang, "Linear and nonlinear multivariate regressions for determination sugar content of intact Gannan navel orange by Vis-NIR diffuse reflectance spectroscopy," *Math. Comput. Model.*, vol. 51, pp.1438–1443, 2010.

C.2

NIR SPECTROSCOPY APPLICATION FOR DETERMINATION OF TRIGONELLINE AND CHLOROGENIC ACID (CGA) CONCENTRATION IN COFFEE BEANS

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ABSTRACT

Trigonelline and chlorogenic acid (CGA) are several of the important indicators of coffee quality. Commonly, trigonelline and CGA concentration are determined using chemical method. This method is time consuming and destructive so it is not suitable for a real time sortation and grading system of coffee. The objective of this study was to investigate the ability of NIR spectroscopy in predicting trigonelline and CGA concentration in green coffee beans. Coffee beans samples (96 g) were placed in petri dish. The reflectance of samples was measured by near infrared reflectance (NIR) spectrometer in wavelengths of 1000-2500 nm, and then the trigonelline and CGA content of samples were determined by chemical method using liquid chromatography mass spectrometry (LCMS). Spectra data processing such as first and second derivative, multiple scatter correction (MSC), and combination of two data processing were applied before the calibration of NIR spectra and chemical data using partial least square (PLS) and combined with some factors of PLS method to obtain the best prediction model of trigonelline and CGA concentration using near infrared reflectance spectroscopy (NIRS). The NIR data processing and PLS model selected can be used to determine the concentration of trigonelline and CGA in coffee beans ($R > 0.93$ %, $CV < 2.8$ %, $RPD > 2$ %) using 4 factors of PLS with the data processing of the spectra by second derivative and combination of second derivative and MSC in building CGA and trigonelline prediction model, respectively.

Keywords : trigonelline, CGA, coffee bean, NIRS, PLS.

I. INTRODUCTION

In coffee market, ensuring good quality and customer satisfaction are the most important things for the coffee bussiness continuation. There are some functional quality characteristic of coffee which effect on its flavour, they are trigonelline, caffeine and CGA. Trigonelline and caffeine are alkaloid compound present in coffee. In fact, during thermal degradations while roasting process, trigonelline generates the non-volatile alkylpiridiniums which contributes to antioxidative activity in coffee beans. Beside having effect on coffee flavour, trigonelline have more medical properties such as antimigraine (Abe and Kaneda 1975), anticarcinogenic (Anthoni et al 1991) and antidiabetic activities (Yoshinari et al 2009). In addition, in coffee bean CGA contributes to the acidity and determines quality and acceptance of final cup coffee, CGA also play an important role in preventing various disease such as cancer, aging and cardiovascular (Belay and Gholap 2009).

At present, LCMS is used for quantification of coffee concentration such as caffeine, trigonelline and CGA, as well as in green bean or roasted bean. However, this LCMS method has number of limitations such as the requirement of complex sample preparation, destructive, high cost, time consuming and difficult to set up for online detection.

Therefore, the needs of another method to quantify the coffee concentration with little sample preparation, less measurement time, non-destructive, fast and accurate have increased. NIRS is a method that record informations about sample characteristics, such as molecular bonds of chemical components that consist of C, H, O and N elements. NIRS utilizes the spectral range from 780 – 2500 nm (12500 – 4000 cm^{-1}) and provides complex structural informations related to the behaviour of vibration of bonds' combination (Cen 2007).

To date, NIRS has been used in evaluating the green coffee beans quality (Santos et al 2012), predicting the concentration of caffeine, theobromine and theophylline in ground green coffee bean (Huck et al 2005), Predicting caffeine concentration in ground roasted coffee (Zhang et al 2013) and predicting caffeine in Aceh Gayo green coffee bean (Rosita et al 2016). In addition, NIRS has already used in quantifying chlorogenic acid (CGA) concentration in ground roasted coffee beans (Shan et al 2014), in line monitoring of the coffee roasting process (Santos et al 2016), and coffee roasting degrees prediction (Shan et al 2015). However, to date, there is no research that was using NIR spectroscopy for prediction of trigonelline and CGA concentration in green coffee beans. In fact, most of coffee are exported in bean form, that prediction of green coffee bean concentration is required for coffee exporter to guarantee coffee quality that will be exported rapidly. So the objective of this research was to investigate the ability of NIR spectroscopy in predicting trigonelline and CGA concentration in green coffee beans.

II. MATERIALS AND METHODS

A. *Sample preparation*

A batch of Arabica Java preanger green coffee bean (water content 11 – 12%) was obtained from Indonesian Coffee and Cocoa Research Institute (ICCRI). Samples of green coffee bean were weighed about 96 grams and poured into petri dish for each NIR reflectance measurment using NIR spectroscopy. Subsequently, 15 grams of each samples was grounded using grinder for the chemical analysis using LCMS.

B. *NIRS*

Samples were divided into 67 samples and 33 samples for calibration (2/3) and validation (1/3) sample respectively. Subsequently, 96 grams of samples in each petri dish organized into 4 layers of green coffee beans based on Rosita (2016). The NIR spectra were recorded by a NIR Spectrometer type NIRFlex N-500 (BUCHI Labortechnic AG Switzerland). Each spectra was acquired in diffuse reflectance mode with a 4 cm^{-1} interval using wavenumber from 10000 cm^{-1} to 4000 cm^{-1} and a scan speed of 3 scans/s. NIR spectra measurement was conducted at temperature around 22 – 25 ^oC.

C. *Chemical analysis*

After diffuse reflectance spectra of NIR were obtained, the reference concentrations of trigonelline and CGA in the coffee beans were measured using liquid chromatography mass spectrometry (LCMS) procedure. The LCMS system which used was Shimadzu LC-MS 2020. First, 2 ppm of trigonelline and CGA standard, respectively was injected into the LCMS. The condition in the LCMS were: C-18 waters as column (T 40^{o}C), mobile phase were divided into two, that was 40% water/formic acid 0.1% and 60% acetonitril, as mobile phase A and B respectively, and the flow rate was 0.2 mL/min. Subsequently, the peak of each concentration was obtained at any given time. After that, 0.2 gram of each coffee sample was injected into LCMS in the same condition. After the similar time with the standard was obtained, the peak of each concentration will be obtained. The concentration of each component can be counted from the area and the height peak, using below equation :

$$Concentration\ (\%) = C_s \times \frac{100}{1000} \times \frac{100}{W_s} \times C_f \quad (1)$$

$$C_f = \frac{100}{100 - water\ content} \quad (2)$$

where :

C_s = Concentration of component in sample (ppm)

W_s = Weight of sample injected (mg)

C_f = Corection factor

D. *Data analysis*

The whole spectra data, trigonelline and CGA concentration variables were entered into the Unscramble software v10.3 (CAMO, Norway) to treated using mathematic equation sequentially and analyzed statistically. Several data processing method such as first and second derivative (dg1 and dg2), multiple scatter correction (MSC), standard normal variate (SNV) and combination of two data processing were conducted to develop the best calibration model for trigonelline and CGA. Subsequently, partial least square (PLS) method was used to build model calibration using 2/3 data and cross validation was used to test the calibration model's performance.

III. RESULTS AND DISCUSSIONS

A. *Chemical concentration analysis*

Trigonelline and CGA concentration in Java Preanger green bean coffee were around 1.1 % and 6 %, respectively, this is appropriate with Clarke and Macrae (1985), concentration of trigonelline and CGA in Arabica green bean coffee are around 1 – 1.2% and 5.5-8% respectively. The chemical concentration range of the green coffee samples is shown in Table 1.

Table 1. Chemical concentration of coffee beans sample

Parameter	Concentration (%)	Mean (%)	Standard Deviation
Trigonelline	0,87 - 1,14	0,96	0,059
CGA	5,42 - 6,89	6,04	0,403

B. NIR spectra

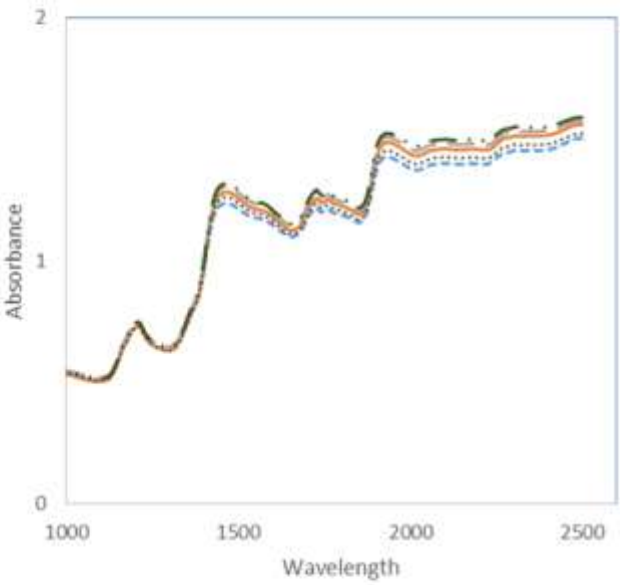

Fig. 1. NIR absorbance spectra of Intact Java Preanger coffee

Fig. 1 shows the original absorbance spectra of Arabica Java preanger green coffee bean. The spectra shape was influenced by particle size and chemical component concentration, however in this research coffee samples that being used was in green bean form (water content 12 – 14%), thus the data processing such as derivative may required. In fact, derivative processing data can isolate the influence of another concentration, for instance water in coffee bean to sharpen the peak and separate the components absorption that the peak of caffeine and CGA would be appear.

C. Result of calibration and validation

The best calibration and validation result of CGA and trigonelline cocentration is shown in Table 2 and 3. In CGA the best calibration model was found by only using 2nd derivative as data processing and 4 factors of PLS indicated by the high correlation coefficient (0.94), high RPD (2.27) and the low coefficient of variation (2.75 %). Furthermore, in trigonelline the best calibration model was found in combination of 2nd derivative and MSC as data processing and 4 factors of PLS indicated by the high correlation of coefficient (0.98), high RPD (2.98) and the low coefficient of variation (1.63 %). Moreover, the precision of model is shown by consistency of model, that is the difference of SEC and SEP in percent (William and Norris 1990).

In addition, to obtain the most reliable CGA calibration model, second derivative processing method was applied. As shown in table 2, the combination of 2nd derivative and MSC doesn't give a better model than the single processing data (2nd derivative) indicated by the decreased of R and RPD, this was caused by the concentration of CGA is large enough and the spectra didn't affected by scatter interference. In contrary, in Shan et al (2014), NIRS was used to determine CGA in roasted coffee beans in powder form (600 μm), and the best data processing was the combination of MSC and SNV. This caused by the sample was in powder form, that the water influence was relieved, so derivative data processing did not required. But, the bigger particle size then the highest absorbance will obtained. That is the reason in this research, MSC as processing data did not required.

Consequently, in trigonelline, combination of second derivative and MSC as data processing was used because the concentration of trigonelline in green coffee bean is small, so that by using 2nd derivative, it will enhance the spectra resolution (Stuart 2004) and bring out caffeine's peak. Moreover, MSC method being applied in order to remove baseline shift and scatter effect in data spectra until the best calibration model was obtained. In table 3, processing data number 4 and number 5 is having the same R value, but after MSC applied the RPD of number five increase and the CV decreased, this caused by the NIR spectra was obtained from coffee bean and having various particle size, that is the reason that the obtained spectra is affected by scatter. The more data processing applied then number of PLS factors that required will decrease and give effect on R value. If more PLS factors being applied, model will be overfitting, this is in accordance with Chen et al (2013), selecting number of PLS factors is important to remove noise and obtained model is affected by number of PLS factors, whether it be ideal, underfitting or overfitting.

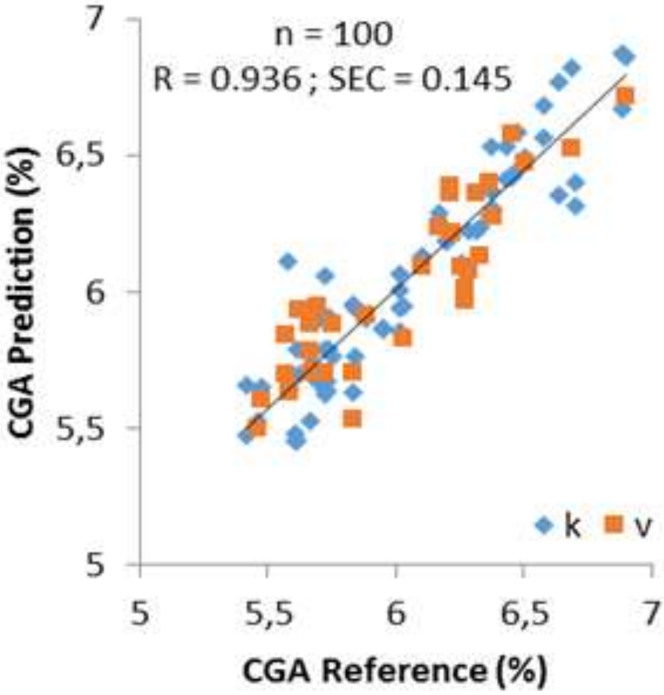

Fig. 2. Plots of CGA reference vs. prediction

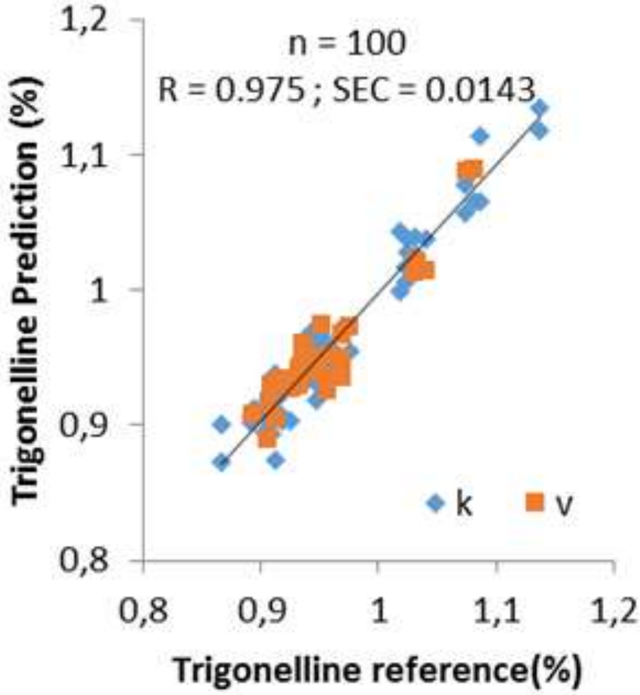

Fig. 3. Plots of trigonelline reference vs. prediction

Fig. 2 shows the scatter plot of reference vs. prediction values of CGA concentration obtained from the best PLS model using 2nd derivative. Value of r was 0.94, CV was 2.75 % and RPD was 2.27. Fig. 3 shows the scatter plot of reference vs. prediction values of trigonelline concentration from the best PLS model in combination with 2nd derivative and MSC processing data. Value of r was 0.98, CV was 1.63 % and RPD was 2.98. From the result indicates the calibration model that obtained can predict trigonelline and CGA concentration in green coffee beans accurately. Therefore, NIR spectroscopy is a suitable method to determine concentration of trigonelline and CGA in green coffee-beans.

IV. CONCLUSION

In this study, NIRS data processing and PLS selected model can determine the concentration of trigonelline and CGA in coffee beans (R>0.93 ; CV<2.75 ; RPD>2). In both analysis, the best model obtained by using derivative processing data since this method could bring out the spesific peak of each concentration by isolating the influence of another concentration, for instance water, lipid, carbohydrate in coffee bean. In addition, MSC method could increase the accuracy of NIRS method for predicting trigonelline. NIR spectroscopy can be used to determine the chemical concentration of coffee beans.

Table 2. Results of Calibration and Validation in CGA Concentration

No	Processing	Number of PLS Factors	R	SEC (%)	SEP (%)	CV (%)	RPD	Consistency (%)
1	Original	7	0.70	0.2935	0.3182	5.28	1.18	92.23
2	1st Derivative	5	0.90	0.1823	0.1847	3.06	2.04	98.70
3	2nd Derivative	4	0.94	0.1454	0.1660	2.75	2.27	87.59
4	2nd Derivative, MSC	3	0.92	0.1649	0.1762	2.92	2.13	93.59
5	MSC, 1st Derivative	3	0.82	0.2373	0.2260	3.75	1.66	105
6	MSC, 2nd Derivative	3	0.92	0.1599	0.1748	2.90	2.15	91.48

Table 3. Results of Calibration and Validation in Trigonelline Concentration

No	Processing	Number of PLS Factors	r	SEC (%)	SEP (%)	CV	RPD	Consistency (%)
1	Original	7	0.63	0.0496	0.0504	5.25	0.92	98.41
2	1st Derivative	6	0.96	0.0171	0.0175	1.82	2.66	97.71
3	2nd Derivative	4	0.98	0.0142	0.0185	1.93	2.51	76.76
4	2nd Derivative, MSC	4	0.98	0.0143	0.0156	1.63	2.98	91.67
5	MSC, 1st Derivative	6	0.97	0.0156	0.0171	1.78	2.72	91.23
6	MSC, 2nd Derivative	4	0.98	0.0141	0.0162	1.69	2.87	87.04

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REFERENCES

[1] A. Belay and A.V. Gholap, "Characterization and determination of chlorogenic acids (CGA) in coffee beans by UV-Vis spectroscopy," African Journal of Pure and Applied Chemistry Vol. 3 (11), pp. 234-240. 2009.

[2] H. Cen and Y. He, "Theory and application of near infrared reflectance spectroscopy in determination of food quality Theory and application of near infrared reflectance spectroscopy in determination of food quality," Food Science & Technology 18 (2007) 72-83.

[3] H. Chen, Q. Song, G. Ytang, Q. Feng and K. Lin, "The combined optimization of savitzky-golay smoothing and multiplicative scatter correction for FT-NIR PLS models," ISRN Spectroscopy; 1-9. 2013.

[4] R.J. Clarke and R. Macrae, *Coffee Volume 1 : Chemistry*. Elsevier Science Publishing CO, INC, USA, 1985.

[5] G. del Campo, I. Berregi, R. Caracena and J. Zuriarrain, "Quantitativedetermination of caffeine, formic acid, trigonelline and 5(hydroxymethil) furfural in soluble coffees by 1H NMR spectroscopy," Talanta 81 (2010) 367-371.

[6] C.W. Huck, W. Guggenbichler and G.K. Bonn, "Analysis of caffein, theobromin,theophylline in coffee by near infrared spectroscopy (NIRS) compared to high performance liquid chromatography (HPLC) coupled to mass spectrometry," Analytica Chimica Acta 538 (2005) 195-203.

[7] R. Rosita, I.W. Budiastra and Sutrisno, "Prediction of caffeine content of arabica coffee bean by Near Infrared Spectroscopy," JTEP Jurnal Keteknikan Pertanian. Vol. 4 N0. 2, p 179-186. 2016.

[8] J.R.M.C. Santos, A.O.S.S. Sarraguca, Rangel and J.A. Lopes, "Evaluation of green coffee beans using near infrared spectroscopy : A quantitative approach," Foodchem.2012.06.059.

[9] J.R. Santos, O. Viegas, R.N.M.J. Pascoa, I.M.P.L.V.O. Ferreira, A.O.S.S. Rangel and J.A. Lopes, "In-line monitoring of the coffee roasting process with near infrared spectroscopy : Measurement of sucrose and colour," Food Chemistry 208 (2016) 103-110.

[10] J. Shan, T. Suzuki, D. Suhandy, Y. Ogaw and N. Kondo, “Chlorogenic acid (CGA) determination in roasted coffee beans by near infrared (NIR) sperctroscopy,” Engineering in Agriculture, Environment and Food 7 (2014) 139-142.

[11] J. Shan, T. Suzuki, Y. Ogawa and N. Kondo, “Coffee roasting degrees prediction in terms of weight loss with selected wavebands based on near infrared spectroscopy,” Engineering in Agriculture, Environment and Food 8 (2015) 195-199.

[12] B. Stuart, *Infrared Spectroscopy; Fundamentals and Applications*. John Wiley & Sons, Ltd. 2004.

[13] P. Williams and K. Norris, “Near-infrared technology in the agricultural and food industries,” American As-sociation of cereal chemical, Inc. St. Paul. USA[US]: 146. 1990.

[14] X. Zhang, W. Li, B. Yin, W. Chen, D.P. Kelly, X. Wang, K. Zheng and Y. Du, “Improcement of near infrared spectroscopic (NIRS) analysis of caffeine in roasted Arabica coffee by variable selection method of stabilitty competitive adaptive reweighted sampling (SCARS),” Molecular and Biomolecular Spectroscopy 114 (2013) 350-356

C.3

DETECTION OF RIDGE GOURD *(Luffa acutangula)* FRUIT QUALITY DURING STORAGE USING NEAR-INFRARED SPECTROMETER

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ABSTRACT

Fruit quality detection using near-infraread spectrometer is fast and it does not damage the fruit, hence the fruit is still marketable. The aim of this research focused on analyzing quality component of ridge gourd during storage using near-infrared spectrometer. The research was conducted on March to July 2017 at the Laboratory Plant Production Technology of Horticulture Division of Agriculture Faculty of Padjadjaran University, Jatinangor. Ridge gourds were harvested at the same maturity stage from the orchad, then stored at 5 and 10 days. The method used in this research was multivariate data analysis using Unscrambler software (version 7.51, CAMO, Oslo, Norway). The data acquisition was taken using portable near-infrared (NIR) spectrometer (NirVana AG410, Integrated Spectronics Pty, Ltd, Australia) with wavelength range of 600-1100 nm and stored as absorbance spectra and pretreated by second-derivatives spectra using ISIS software (Integrated Spectronics Pty, Ltd, Australia). The results showed that non-destrucive method using near-infrared spectrometer was able to measure ridge gourd fruit quality component such as, total dissolved solid, moisture content, firmness and color values.

Keywords : calibration, loofah, validation

I. INTRODUCTION

Ridge gourd (*Luffa acutangula*) is a cucurbitaceous vegetable crop grown in some tropical countries of asia including Indonesia. Indonesia is a country that has fertile land which various types of plants grow well, especially horticultural crops such as vegetables and fruits. Food demand is expected to increase due to the population growth. Moreover, some crops also have good benefits for health.

Quality of fruit is generally determined only based on visual estimation, such as size, skin color, and weight. Besides, it requires laboratory analysis to obtain the information about internal quality. In conventional analysis, the samples have to be destructed and homogenized. Complex procedures and some hazardous chemicals are also needed. This method is considered to be time and cost consuming, requiring materials and manual work (Gómez et al., 2006; Nicolaï et al., 2007).

Since 1990s, near infrared spectroscopy has been used to predict fruit quality (Kawano, 1998). This technique is time and labor reducing alternatives. Near infrared spectroscopy (NIRS) provides a rapid, accurate, and enviromental friendly method for measurement fresh commodities (Blanco and Villarroya, 2002). Spectrometer records spectrum consist of physical and chemical information of radiated samples such as soluble solids content (SSC), firmness, and internal defect (McGlone et al., 2002; Sun et al., 2010). This technique has been previously used to predict fruit quality of prune (Slaughter et al., 2003), mango (Saranwong et al., 2004), apricot (Chen et al., 2006), apple (Lieu et al., 2007; Bobelyn et al., 2010), Jujube (Wang et al., 2011), and Fuji apple (Liu and Ying, 2005) with reliable accuracy. Near-infra red spectrometer is also used for detecting some fruit-vegetable commodities, such as tomato (Kusumiyati et al., 2007, Kusumiyati et al., 2008), bitter gourd (Kusumiyati et al., 2008), and cucumber.Once separated from the plant, as living organism fruits keep on respiration until senescence (Ranganna, 2008). The harvested fruit can not obtain water and nutrient from the plant anymore for it's ripening processes. The respiration determines potential shelf life (Varoquaux and Ozdemir, 2005). Therefore, this work aims to focus on analyzing quality component of ridge gourd during storage using near-infrared spectrometer.

II. MATERIALS AND METHODS

Ridge gourds were harvested at the same maturity stage from the field experiment, then stored indoors at room temperature. Then all the fruits that have been harvested, one-third part are directly tested (Ho), another third stored for five days then tested on the fifth day (H_5), then other third stored for ten days and tested on day 10 (H_{10}). The ridge gourd samples used in this study were 300 each for storage treatment. Each time the test is conducted on 50 samples. Prior to test the fruit was treated with pre-cooling for 2 hours.

The tools used in this research were tension gauge (AND Model AD-4932A-50 N, Taiwan) was used to the center of the fruit until punture to measure fruit firmness, in addition Texture analyzer (TA XT Express Enhanced Stable Micro system, Germany) is also used to measure the value of fruit firmness.

Measurement of moisture content by gravimetric method, Sliced fruit and then put in cup aluminum foil, dried in oven (Jouan EB.100, Germany) at 80^{o}C until its weight constant. Before and after inserted into the oven, weighed to determine the fresh water content of the fruit using the digital scales (ACIS, MN Series). Measurements of water content of the fruit were measured at the top, middle and bottom of the ridge gourd fruit.

The color of fruit is measured by using chroma meter to obtained the value of L^*, a^*, b^*. The L^* value describes the brightness of the color, where 0 is for black and 100 white. The value of a* indicates the type of green - red, where negative a* is green, whereas positive a* is a red color. The b* denotes the blue-yellow type, where the negative b* is blue, while the positive b* is yellow. Fruit color measurements were taken from two different sides of the fruit, in each side measured at the top, middle and bottom of the ridge gourd fruit. The upper part is the part attached to the stem of the fruit.

The total soluble solids measurements used a refractrometer (PR1 Atago, Japan) taken from extract of the top, middle and bottom of the ridge gourd fruit. All of the measurements were done at laboratory.

The method used in this research was multivariate data analysis using Unscrambler software (version 7.51, CAMO, Oslo, Norway). The data acquisition was taken using portable near-infrared (NIR) spectrometer (NirVana AG410, Integrated Spectronics Pty, Ltd, Australia) with wavelength range of 600-1100 nm and stored as absorbance spectra and pretreated by second-derivatives spectra using ISIS software (Integrated Spectronics Pty, Ltd, Australia).

III. RESULTS AND DISCUSSION

A. Destructive Data Analysis on Ridge Gourd

Measurement of ridge gourd composition by destructive method is used as reference data in the development of calibration model. These data determine the success of estimating value of quality components using NIR. All measurement processes will surely produce errors, including destructive measurements. Therefore, to reduce the occurrence of errors it is done special handling to the sample. Ridge gourd sample that has been radiated by NIR Spectrometer, then as soon as possible should be directly analyzed of it's chemical composition in the laboratory. This is needed to prevent the changes of chemical characteristics of ridge gourd. Data analysis of 300 ridge gourd samples can be seen on Table 1.

Ridge gourd fruit after harvest continues to respire resulting in some physical changes and chemical content in ridge gourd. The most common changes during ripening are color change, texture and total dissolved solids (O'brien et al, 1983 in Alfansuri, 2012). Ridge gourd fruit samples used in this research were taken from the same maturity stage, then stored for 0, 5 and 10 days.

The average value of ridge gourd moisture content by destructive method is 90.89%. The value of moisture content affects the durability and freshness of ridge gourd fruit during storage. The standard deviation for moisture content is 0,02314. This value indicates that the water content dataset is considerable diverse.

Firmness is form of physical changes in the maturity stage of ridge gourd fruit. Immature fruit is considered to have higher firmness value, in the other hand full mature fruit is considered to have lower firmness value.

Total dissolved solids (TDS) is soluble solids contained on ridge gourd as measured by using refractometer. The amount of measured soluble solid content on the ridge gourd is a measurable portion of TDS. The average value of TDS on 300 ridge gourd samples were 3.52% Brix. TDS measurements were performed on the upper, middle and lower of ridge gourd samples so as to obtain the value of TDS thoroughly.

Color assessment by destructive method is determined by measuring the amount of reflected light from the surface of ridge gourd fruit. Color notation system is characterized by 5 parameters such as L^*, a^*, b^*, ^{0}hue and chroma. In the table can be seen that average value of L^* is 41,84, the higher value of L^* means the color of ridge gourd is brighter. Average value of a^* is -9,71 indicating that the color of fruit is getting green. Then the average value of b* is 17,91 which states that the color of ridge gourd fruit leads to the yellow color due to some samples of ridge gourd stored for 5 and 10 days. Average of ^{0}hue value is -60,93 which indicates greed ridge gourds lead to yellow. While the average value of chroma is 20,44 which means the level of color content from immature to full mature. The higher the value of chroma indicates the color of ridge gourd fruit is getting matured.

Standard deviation (SD) describe the diversity of single set of data being analyzed. Largest statistical data variation is found in ^{0}hue value as 4,84 and the lowest variation in total dissolved solids value as 0.52. Maximum and minimum statistic data of 300 fruit samples show the high range. The table presented below is a summary of ridge gourd analysis result by destructive method.

Table 1. Statistic Data Analysis of 300 Ridge Gourd Samples By Destructive Method

Composition		Ave	SD	Min	Max
Moisture Content		0,9089	0,023	0,729	0,998
Firmness (N)		16,205	3,855	4,11	35,58
TDS (%)		3,5279	0,525	1,2	6,9
Color	L^*	41,840	4,158	0,95	54,18
	a^*	-9,717	1,579	-21,3	-3,44
	b^*	17,915	3,966	4,73	30,02
	Hue^0	-60,93	4,844	-79,17	-41,489
	Chroma	20,448	3,932	5,8486	33,929

B. Near-Infrared Data Analysis of Ridge Gourd

Data analysis on moisture content, firmness, total dissolved solids and color were measured by reflectant data and NIR absorbance data using multivariate calibration method as partial least square (PLS). Partial least square (PLS) was developed by Herman Wold (1982). PLS was used to estimate a series of bound variables from a large number of independent variables, which has linear or nonlinear systematic structure, with or without missing data and high collinearity. PLS is a widely used bilinier modeling to connect physical properties and content of a material to its spectral data. This method establishes the estimation model from estimating a set of non-free and independent variables, thus forming a linear or non-linear systematic structure with or without missing data and can set aside the multi-cholinearity problem in the spectrum of reflectant and absorbant data (Lindblom, 2004 in Gabbie, 2011).

C. Ridge Gourd Data

Absorbance data is obtained from the process of absorption of ridge gourd fruit sample. Absorbance data is feasible to analyze thin-skinned commodities and directly attached to the pulp such as ridge gourd, sapodilla, squash, etc. The amount of samples used is 300 samples. The sample used for calibration phase are different from the sample used for the validation phase.

D. Moisture Content Assessment

At calibration phase the assessment of moisture content used 627 samples of reflectant data and 601 samples for validation phase with wavelength 312- 1050 nm. The calibration Fig. of moisture content is presented on Fig. 1. Data analysis of calibration and validation phase of moisture content assessment using reflectant data with PLS method is presented on Table 2.

Table 2. Data analysis of calibration and validation phase of moisture content assessment based on absorbant data with *partial least square* method

	n	R	Min	Max	Ave	SD	SE
Calibration	627	0,702	84%	93%	91%	0.01883	0,01
Validation	601	0,586	83%	93%	90%	0.0166	0.10

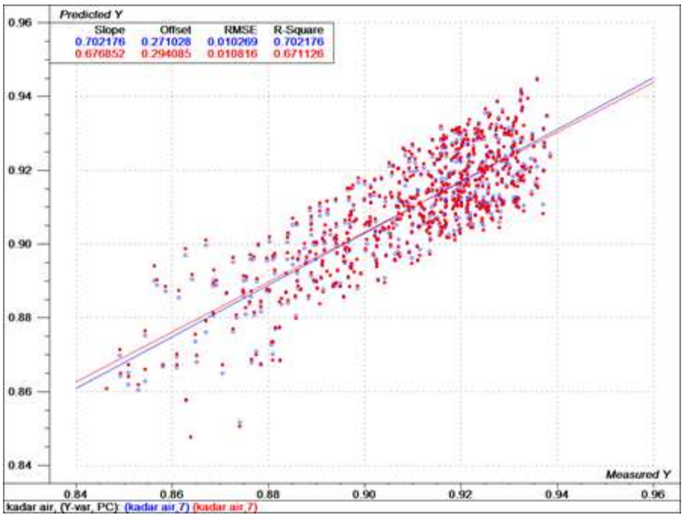

Fig. 1. Calibration of Moisture Content on Ridge Gourd

Correlation coefficient (R) for assessment of moisture content value of ridge gourd is 0,70 means high (closed to 1). This shows that the NIR prediction is close to the measurement value by using destructive method. At the calibration phase, the standar error of calibration (SEC) is 0,01. Considering the standard error value at calibration phase, it can be assumed that the calibration regression has been built well because the default error value near to zero (0). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of moisture content assessment of ridge gourd fruit used different samples from calibration which 601 samples from NIR absorbance data and destructive method measurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 0,10. Standard error prediction is acceptable due to close to zero. The validation Fig. of moisture content is presented on Fig. 2. The combination of calibration and validation of moisture coontent is presented on Fig. 3.

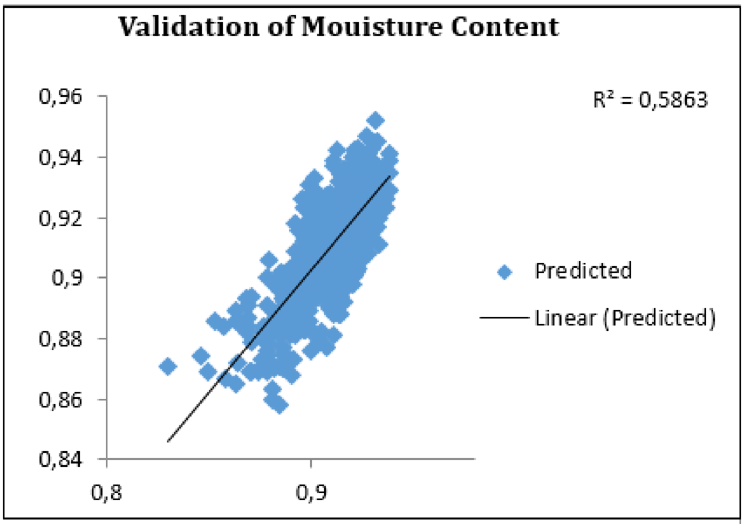

Fig. 2. Validation of Moisture Content on Ridge Gourd

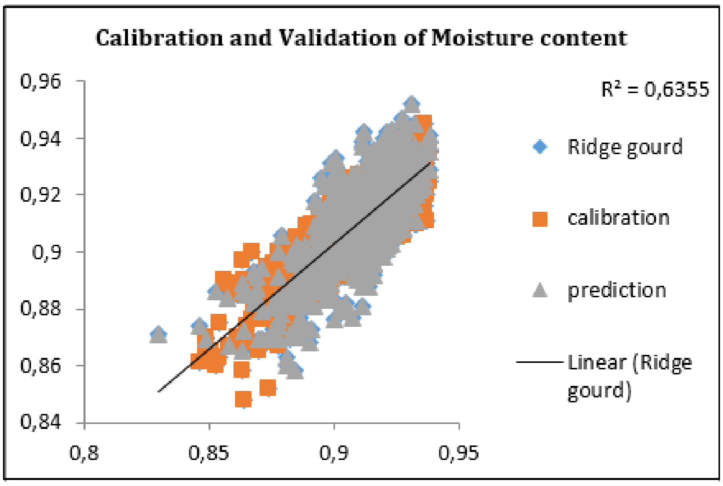

Fig. 3. Calibration and Prediction of Moisture Content on Ridge Gourd

E. Firmness Assessment

At calibration phase the assessment of firmness used 616 samples of reflectant data and 603 samples for validation phase with wavelength 312- 1050 nm. Data analysis of calibration and validation phase of firmness assessment using reflectant data with PLS method is presented on Table 3.

Table 3. Data analysis of calibration and validation phase of firmness assessment based on absorbant data with *partial least square* method

	n	R	Min	Max	Ave	SD	SE
Calibration	616	0,526	4.11	30.25	15.949	3.834	2,63
Validation	603	0,490	4.73	30.25	16.365	3.131	1,77

Correlation coefficient (R) for firmness assessment of ridge gourd is 0,526 means high (closed to 1). This shows that the NIR prediction is close to the measurement value by using destructive method. The calibration Fig. of firmness is presented on Fig. 4.

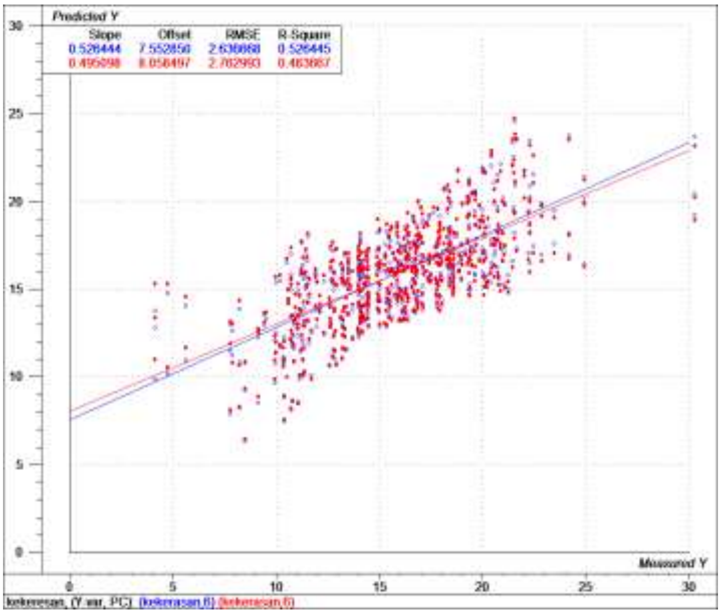

Fig. 4. Calibration of Firmness on Ridge Gourd

At calibration phase, the standard error of calibration (SEC) is 2.63%. Considering the standard error values at the calibration phase, it can be assumed that the calibration regression that has been built is not good due to the default error value exceeds one (1). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of firmness assessment of ridge gourd fruit used different samples from calibration which 603 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 1,77. Standard error validation is not good because the value exceeds one (1). The validation Fig. of firmness is presented on Fig. 5. The combination of calibration and validation of firmness is presented on Fig. 6.

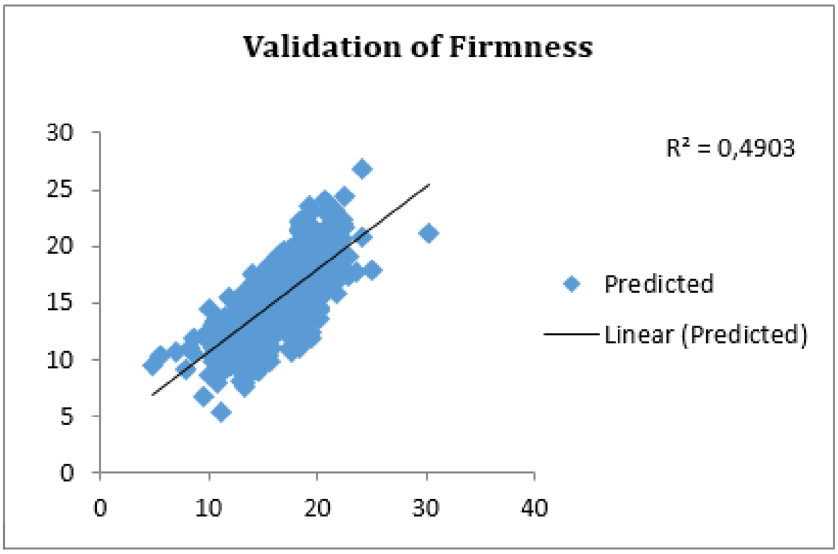

Fig. 5. Validation of Firmness on Ridge Gourd

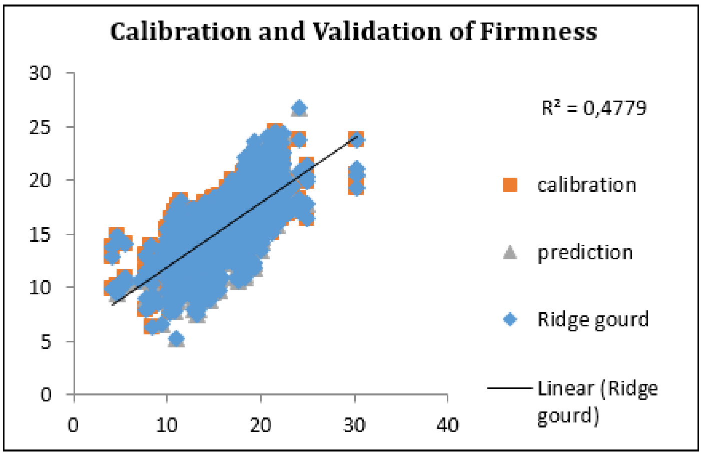

Fig. 6. Calibration and Validation of Firmness on Ridge Gourd

F. Total Dissolved Solids Assessment

At calibration phase the assessment of TDS used 610 samples of reflectant data and 615 samples for validation phase with wavelength 312- 1050 nm. Data analysis of calibration and validation phase of TDS assessment using reflectant data with PLS method is presented on Table 4.

Table 4. Data analysis of calibration and validation phase of total dissolved solids assessment based on absorbant data with *partial least square* method

	n	R	Min	Max	Ave	SD	SE
Calibration	610	0,484	1.2	6.9	3.520	0.643	0,46
Validation	615	0,450	2.3	5.5	3.479	0.395	0,82

Correlation coefficient (R) for TDS assessment of ridge gourd is 0,48 means high (closed to 1). This shows that the NIR prediction is close to the measurement value by using destructive method. The calibration Fig. of TDS is presented on Fig. 7.

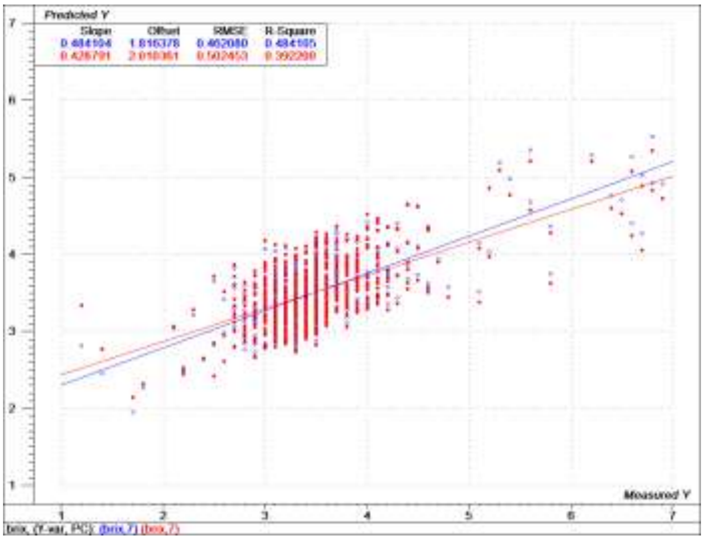

Fig. 7. Calibration of TDS on Ridge Gourd

At the calibration phase, the standar error of calibration (SEC) is 0,46. Considering the standard error value at calibration phase, it can be assumed that the calibration regression has been built well because the default error value is close to zero (0). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of TDS assessment of ridge gourd fruit used different samples from calibration which 615 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 0,82. Standard error prediction is acceptable due to close to zero. The validation Fig. of TDS is presented on Fig. 8. The combination of calibration and validation of TDS is presented on Fig. 9.

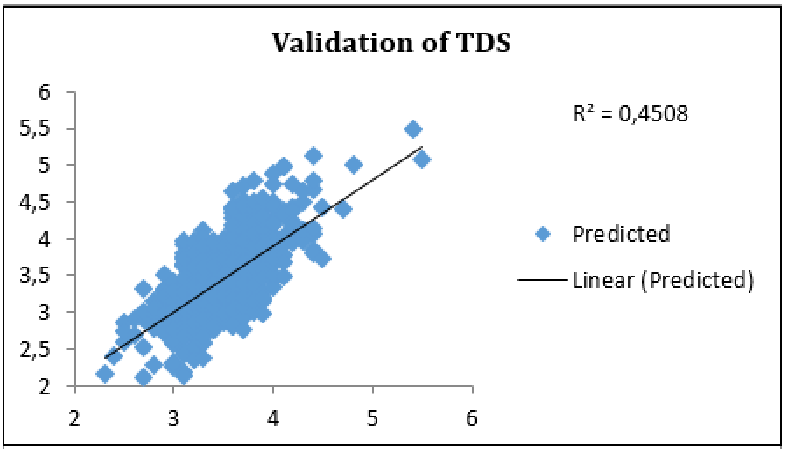

Fig. 8. Validation of TDS on Ridge Gourd

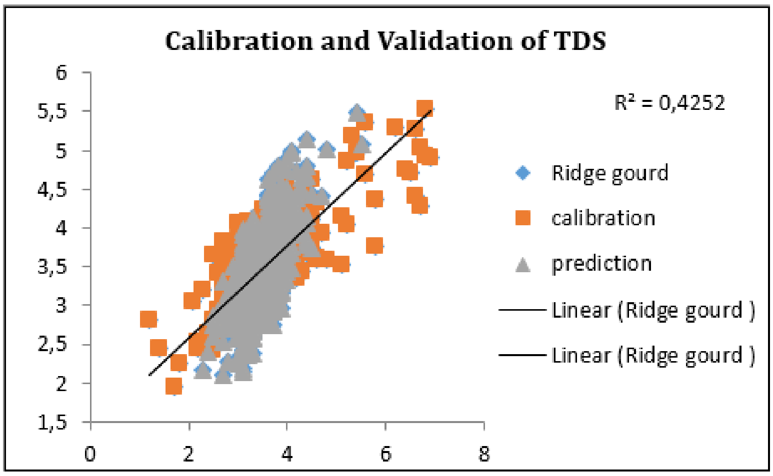

Fig. 9. Calibration and Validation of TDS on Ridge Gourd

G. Color Assessment

Color measurement is one of the methods used in assessing the appearance quality (visual) of fresh horticultural products. Color measurements using numerical color codes are L* a* b* or often referred as "Hunter" notation. The L* notation denotes reflected light that produces white, gray and black acromatic color (0: black, 100: white). Value of a* denotes the gree red blended chromatic color with a+ from 0 to 100 for red and -a from 0 to -80 for green. Value of b* represents blue yellow blended chromatic color with +b from 0 to +70 for the yellow and 0 to -70 for blue. According to Mohsein (1984), Munsell's method based on three Munsell notes: Hue⁰ (green, red, blue, yellow), Value (brightness or L or darkness to light/bright) and Chroma colors that move from light to dark).

At the calibration phase of color assessment including L*, a*, b*. Hue⁰ and Chroma used different reflectant data on each measurement for calibration and validation stages with wavelength 312-1050 nm. Data analysis of calibration and validation phase of color assessment using reflectant data with PLS method is presented on Table 5.

Table 5. Data analysis of calibration and validation phase of color assessment based on absorbant data with *partial least square* method

		n	R	Min	Max	Ave	SD	SE
L*	Cal	600	0,80	28.1	52.0	42.21	3.733	1,66
	Val	612	0,77	32.3	50.9	42.06	3.338	1,33
a*	Cal	627	0,62	-14.2	-4.34	-9.86	1.471	0,90
	Val	600	0,57	-13.5	-5.41	-9.86	1.354	1,12
b*	Cal	600	0,86	7.31	29.9	18.00	4.118	1,48
	Val	608	0,84	4.75	28.0	18.04	3.969	1.55
Hue⁰	Cal	615	0,86	-72.9	-48.7	-60.7	4.493	1,67
	Val	618	0,83	-75.3	-49.6	-60.4	4.150	1,38
Chrom	Cal	627	0,82	5.84	33.9	20.60	4.317	1,82
a	Val	620	0,81	8.90	30.8	20.50	3.821	1,73

Correlation coefficient (R) for the color assessment of L*, a*, b*. Hue⁰ and Chroma values on ridge gourd are high (closed to 1). This shows that the NIR prediction is close to the measurement value by using destructive method. The calibration Fig. of L* is presented on Fig. 10.

H. L Value*

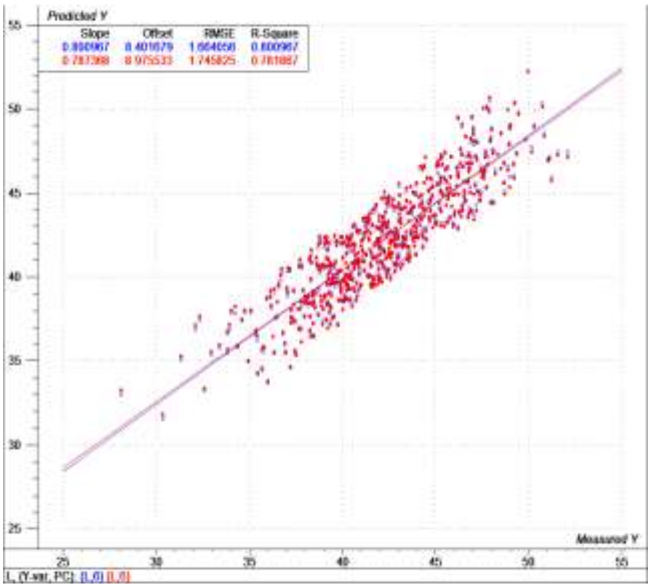

Fig. 10. Calibration of L* on Ridge Gourd

At calibration phase, the standard error of calibration (SEC) is 1,66 considering the standard error values at the calibration phase, it can be assumed that the calibration regression that has been built is not good due to the default error value exceeds one (1). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of L* assessment of ridge gourd fruit used different samples from calibration which 612 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 1,33. Standard error validation is not good because the value exceeds one (1). The validation Fig. of L* is presented on Fig. 11. The combination of calibration and validation of L* is presented on Fig. 12.

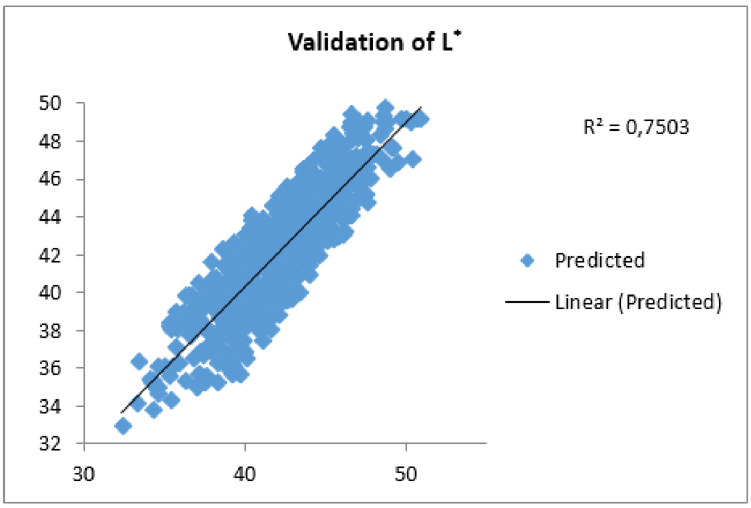

Fig. 11. Validation of L* on Ridge Gourd

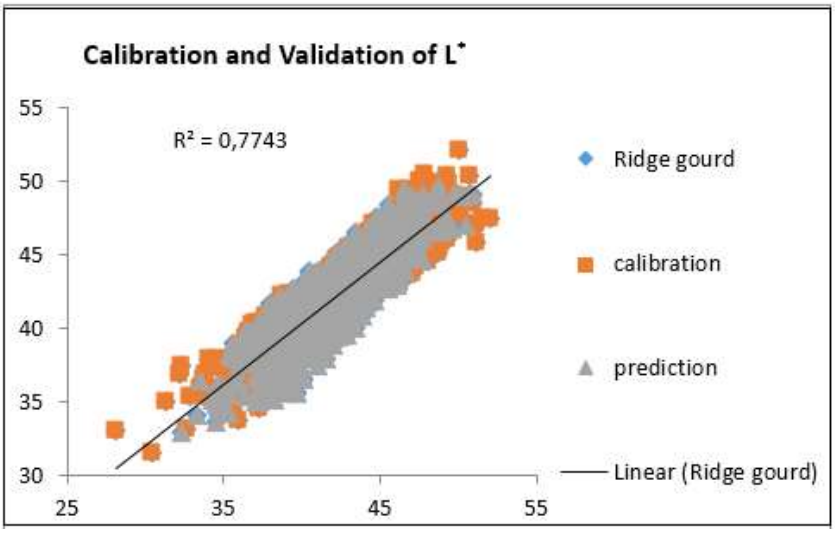

Fig. 12. Calibration and Validation of L* on Ridge Gourd

I. a Value*

At calibration phase the assessment of a* used 627 samples of reflectant data and 600 samples for validation phase with wavelength 312- 1050 nm. The calibration Fig. of a* is presented on Fig. 13.

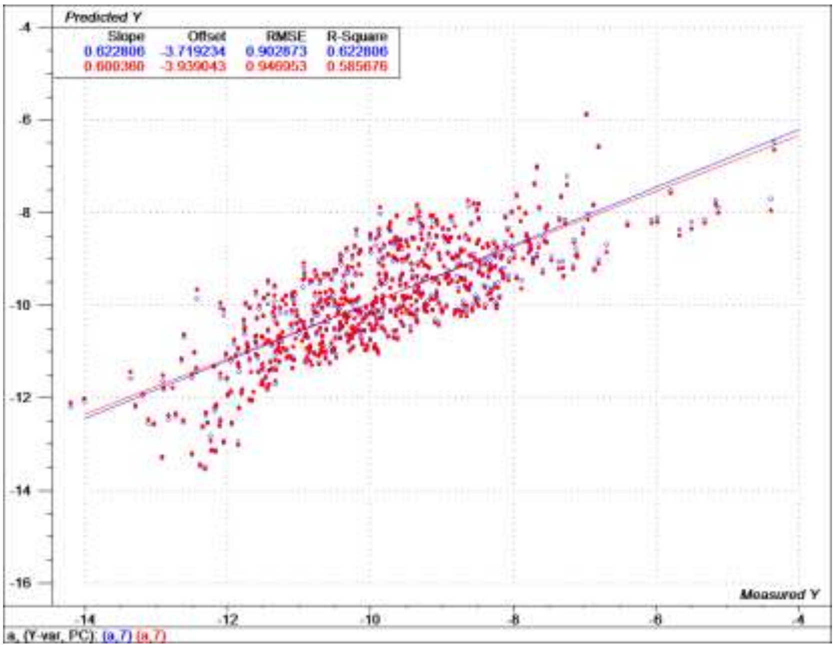

Fig. 13. Calibration of a* on Ridge Gourd

At calibration phase, the standard error of calibration (SEC) is 0,90. Considering the standard error values at the calibration phase, it can be assumed that the calibration regression that has been built is acceptable due to the default error value close to zero (0). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of a* assessment of ridge gourd fruit used different samples from calibration which 600 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 1,12. Standard error validation is not good because the value exceeds one (1). The validation Fig. of a* is presented on Fig. 14. The combination of calibration and validation of a* is presented on Fig. 15.

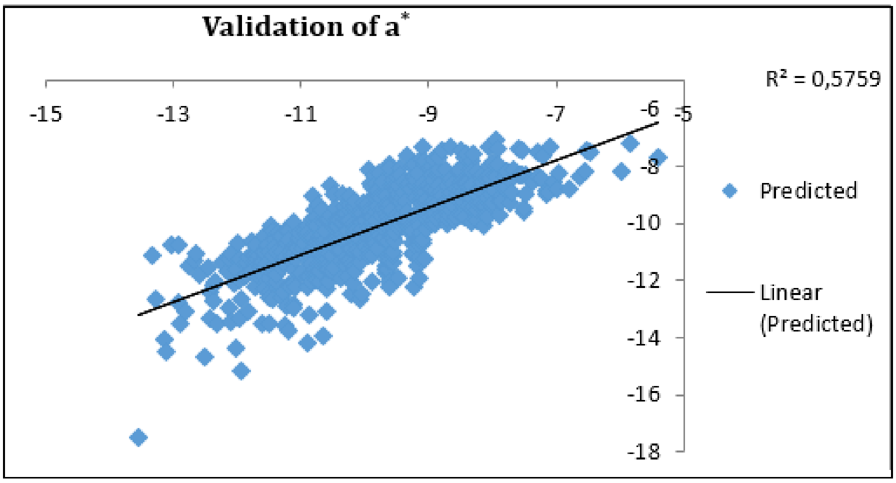

Fig. 14. Validation of a* on Ridge Gourd

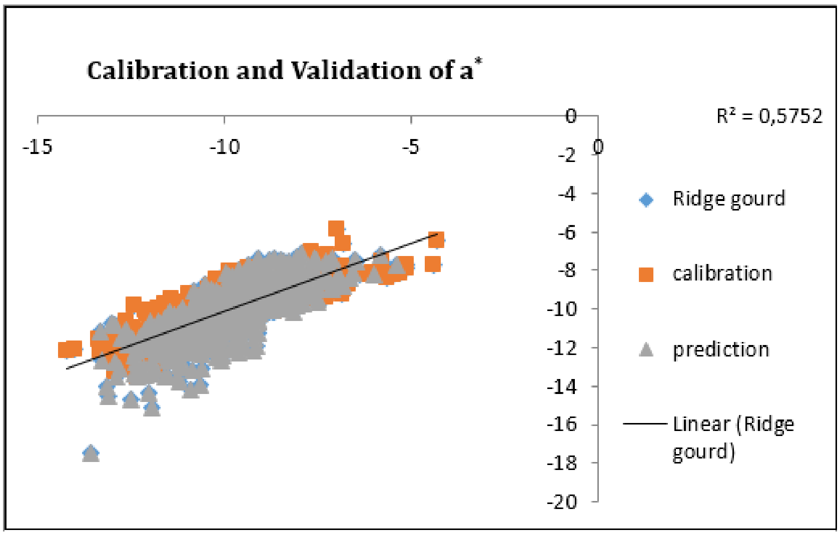

Fig. 15. Calibration and Validation of a* on Ridge Gourd

J. b Value*

At calibration phase the assessment of b* used 600 samples of reflectant data and 608 samples for validation phase with wavelength 312- 1050 nm. The calibration Fig. of b* is presented on Fig. 16.

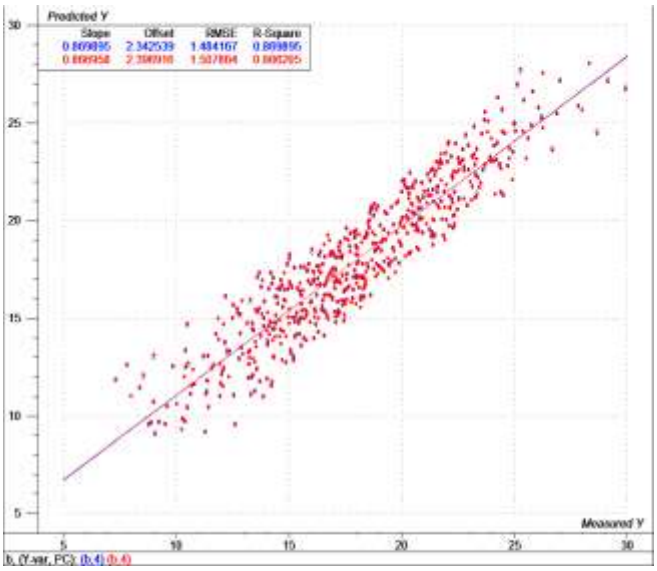

Fig. 16. Calibration of b* on Ridge Gourd

At calibration phase, the standard error of calibration (SEC) is 1,48. Considering the standard error values at the calibration phase, it can be assumed that the calibration regression that has been built is not good due to the default error value exceeds one (1). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of b^* assessment of ridge gourd fruit used different samples from calibration which 608 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 1,55. Standard error validation is not good because the value exceeds one (1). The validation Fig. of b^* is presented on Fig. 17. The combination of calibration and validation of b^* is presented on Fig. 18.

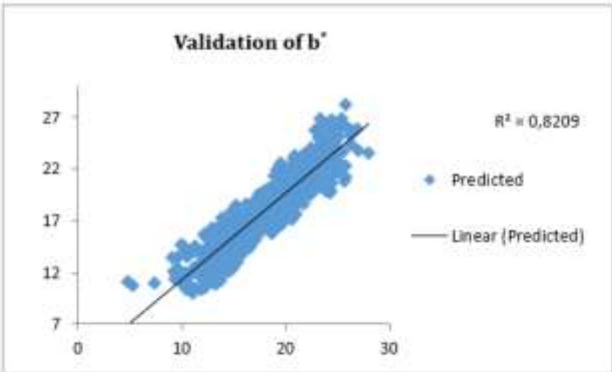

Fig. 17. Validation of b^* on Ridge Gourd

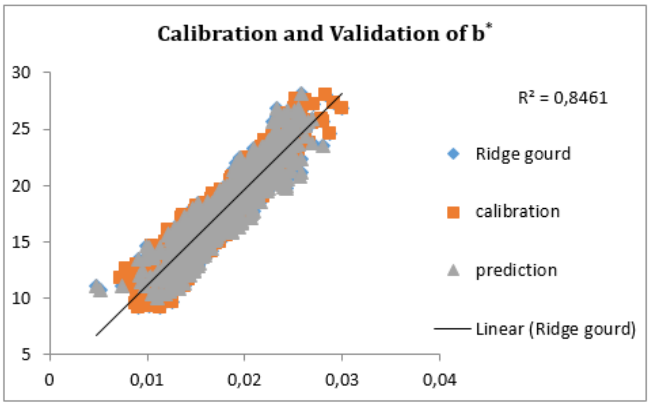

Fig. 18. Calibration and Validation of b^* on Ridge Gourd

K. Hue⁰ Value

At calibration phase the assessment of hue^0 used 615 samples of reflectant data and 618 samples for validation phase with wavelength 312- 1050 nm. The calibration Fig. of hue^0 is presented on Fig. 19.

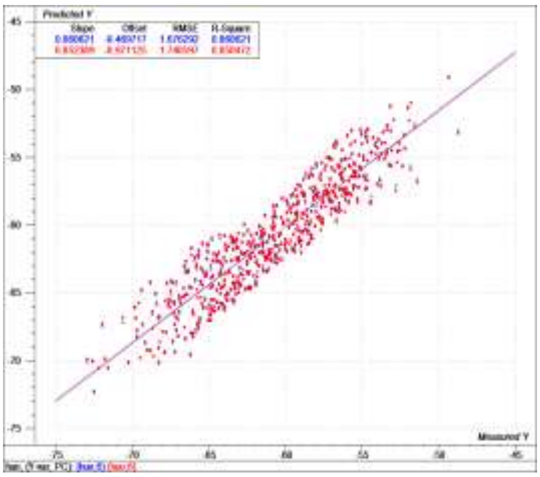

Fig. 19. Calibration of Hue^0 on Ridge Gourd

At calibration phase, the standard error of calibration (SEC) is 1,67. Considering the standard error values at the calibration phase, it can be assumed that the calibration regression that has been built is not good due to the default error value exceeds one (1). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of hue^0 assessment of ridge gourd fruit used different samples from calibration which 618 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 1,38. Standard error validation is not good because the value exceeds one (1). The validation Fig. of hue^0 is presented on Fig. 20. The combination of calibration and validation of hue^0 is presented on Fig. 21.

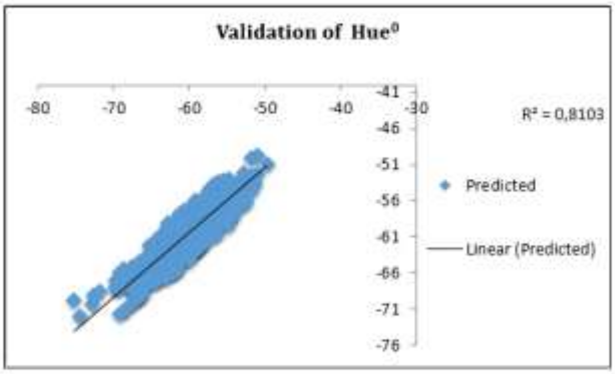

Fig. 20. Validation of Hue^0

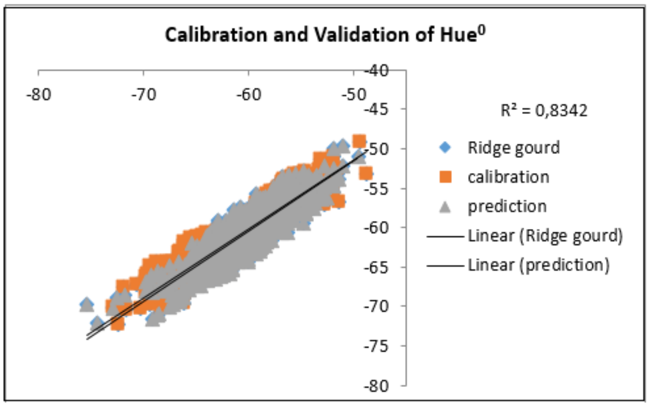

Fig. 21. Calibration and Validation of Hue^0

L. Chroma value

At calibration phase the assessment of chroma used 627 samples of reflectant data and 620 samples for validation phase with wavelength 312- 1050 nm. The calibration Fig. of hue^0 is presented on Fig. 22.

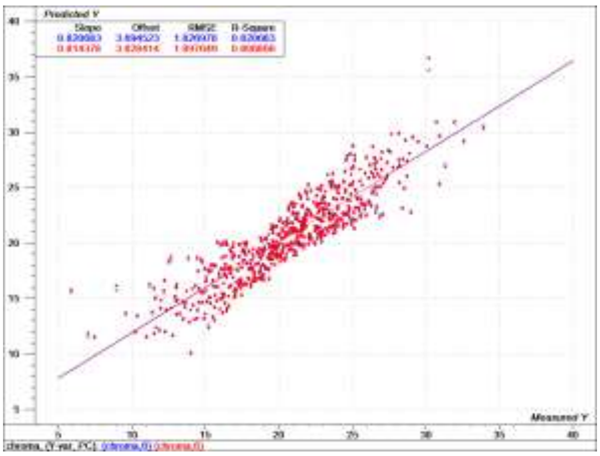

Fig. 22. Calibration of Chroma

At calibration phase, the standard error of calibration (SEC) is 1,827. Considering the standard error values at the calibration phase, it can be assumed that the calibration regression that has been built is not good due to the default error value exceeds one (1). To analyze the accuracy of regression equation of calibration it is necessary to perform the validation phase.

The validation phase of chroma assessment of ridge gourd fruit used different samples from calibration which 620 samples from NIR absorbance data and destructive method mesurement. The level of accuracy in the validation phase based on the form and model of calibration largely determined by the standard error of prediction (SEP). Based on the result of the validation phase obtained, it can be examined that the standard error prediction (SEP) generated is 1,73. Standard error validation is not good because the value exceeds one (1). The validation Fig. of chroma is presented on Fig. 23. The combination of calibration and validation of chroma is presented on Fig. 24.

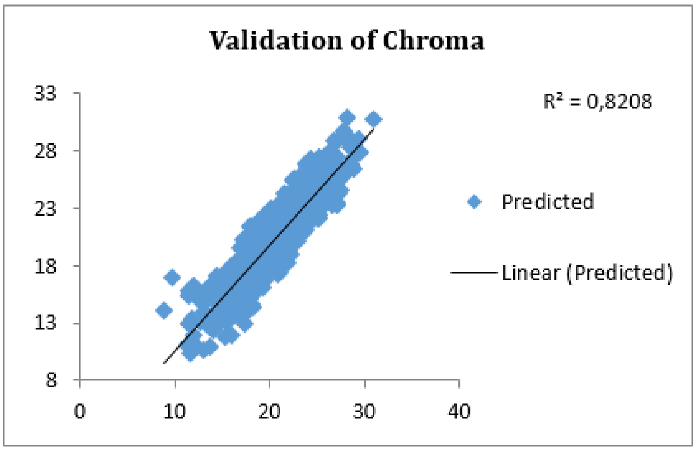

Fig. 23. Validation of Chroma

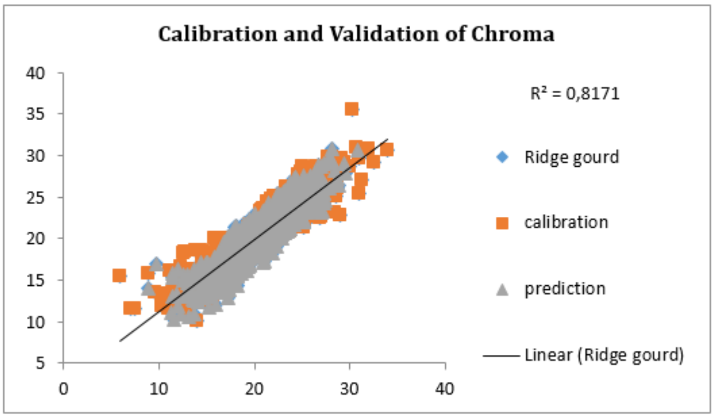

Fig. 24. Calibration and Validation of Chroma

IV. CONCLUSION

Detection of ridge gourd was able to measure dissolved solids, moisture content, firmness and color values during storage using near-infrared spectrometer.

REFERENCES

[1] Blanco, M., Villarroya, I., 2002. NIR spectroscopy: a rapid-response analytical tool. Trends Anal. Chem. 21, 240–250.

[2] Bobelyn, E., Serban, A., Nicu, M., Lammertyn, J., Nicolaï, B.M., Saeys, W., 2010. Postharvest quality of apple predicted by NIR-spectroscopy: study of the effect of biological variability on spectra and model performance. Postharvest Biol. Technol. 55, 133–143.

[3] Chen, J.Y., Zhang, H., Matsunaga, R., 2006. Rapid determination of the main organic acid composition of raw Japanese apricot fruit juices using near-infrared spectroscopy. J. Agric. Food Chem. 54, 9652–9657.

[4] Gómez, A.H., He, Y., Pereira, G., 2006. Non-destructive measurement of acidity, soluble solids and firmness of Satsuma mandarin using Vis/NIR-spectroscopy techniques. J. Food Eng. 77, 313–319.

[5] Kawano, S., 1998. New application of nondestructive methods for quality evaluation of fruit and vegetables in Japan. J. Jpn. Soc. Horticult. Sci. 67, 1176–1179.

[6] Kusumiyati, T. Akinaga, S. Yonemori, T. Shikanai, H. Okamoto, T. Tanabe, S. Kawasaki. 2008. Internal quality sensor of fruit jagged surface: preliminary study of bitter gourd (*Momordica charantia* Linn). Acta Horticulturae Vol.768 p.391-398.

[7] Kusumiyati, T. Akinaga, S. Yonemori, S. Kawasaki, T. Tanabe. 2007. Evaluation of Tomato Quality on Tree and after Harvesting using portable NIR Spectroscopy. Journal of the society of agricultural structures, Japan (Nogyo Shisetsu) Vol 38 No.2 pp.117-126

[8] Kusumiyati, T. Akinaga, M. Tanaka, S. Kawasaki. On tree and after harvesting evaluation of firmness, color, and lycopene content of tomato fruit using portable NIR spectroscopy. 2008. Journal of food, agriculture and environment Vol.6 No.2 pp.132-137.

[9] Liu, Y., Ying, Y., 2005. Use of FT-NIR spectrometry in non-invasive measurements of internal quality of 'Fuji' apples. Postharvest Biol. Technol. 37, 65–71.

[10] Liu, Y., Ying, A., Fu, X., Lu, H., 2007. Experiments on predicting sugar content in apples by FT-NIR Technique. J. Food Eng. 80, 986–989.

[11] McGlone, V.A., Jordan, R.B., Martinsen, P.J., 2002. Vis/NIR estimation at harvest of pre- and post-storage quality indices for 'Royal Gala' apple. Postharvest Biol. Technol. 25, 135–144.

[12] Nicolaï, B.M., Beullens, K., Bobelyn, E., Peirs, A., Saeys, W., Theron, K.I., Lammertyna, J., 2007. Nondestructive measurement of fruit and vegetable quality by means of NIR spectroscopy: a review. Postharvest Biol. Technol. 46, 99–118.

[13] Ranganna, S., 2008. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. McGraw-Hill Publishing Company Limited, New Delhi, pp. 444.

[14] Saranwong, S., Sornsrivichai, J., Kawano, S., 2004. Prediction of ripe-stage eating quality of mango fruit from its harvest quality measured nondestructively by near infrared spectroscopy. Postharvest Biol. Technol. 31, 137–145.

[15] Slaughter, D.C., Thompson, J.F., Tan, E.F., 2003. Nondestructive determination of total soluble solids in fresh prune using near infrared spectroscopy. Postharvest Biol. Technol. 28, 437–444.

[16] Sun, T., Huang, K., Xu, H., Ying, Y., 2010. Research advances in nondestructive determination of internal quality in watermelon/melon: a review. J. Food Eng. 100, 569–577.

[17] Varoquaux, P., Sani Ozdemir, I., 2005. Packaging and produce degradation. In: Lamikanra, O., Imam, S., Ukuku, D. (Eds.), Produce Degradation: Pathways and Prevention. CRC Press, pp. 117–153.

[18] Wang, J., Nakano, K., Ohashi, S., 2011a. Nondestructive evaluation of jujube quality by visible and near-infrared spectroscopy. LWT-Food Sci. Technol. 44, 1119–1125.

[19] Wang, J., Nakano, K., Ohashi, S., 2011b. Nondestructive detection of internal insect infestation in jujubes using visible and near-infrared spectroscopy. Postharvest Biol. Technol. 59, 272–279.

C.4

RIGHT-ANGLE FLUORESCENCE SPECTROSCOPY COUPLED WITH PLS-DA FOR DISCRIMINATION OF INDONESIAN PALM CIVET COFFEE

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ABSTRACT

Indonesian palm civet coffee is regarded as one the most expensive and rarest coffee in the world. Authentication of civet coffee is recently becoming important due to high potential of adulteration and mislabelling of Indonesian palm civet coffee with cheaper non-civet coffee. In the present study, right-angle fluorescence spectroscopy coupled with partial least squares discriminant analysis (PLS-DA) were used for discrimination of Indonesian palm civet coffee. Total 60 samples were used (30 samples for civet and non-civet coffee, respectively). All coffee samples were ground using a home-coffee-grinder. Since particle size in coffee powder has a significant influence on the spectra obtained, we sieved all coffee samples through a nest of U. S. standard sieves (mesh number of 40) on a Meinzer II sieve shaker for 10 minutes to obtain a particle size of 420 μm. The experiments were carried out at room temperature (around 27-29°C). All samples were extracted with distilled water and then filtered. For each samples, 3 mL of extracted sample then was pipetted into 10 mm cuvettes for spectral data acquisition. Excitation emission spectra were obtained for civet and non-civet coffee samples by acquiring emission spectra from 210 to 750 nm (interval 1 nm) with excitation in the range of 200-550 nm (interval 5 nm) using JASCO FP-8300 Fluorescence Spectrometer. The result showed that the discrimination model was successfully developed by PLS-DA and resulted in high performance of discrimination between civet and non-civet coffee with 100% of discrimination rate. The study demonstrated that the right-angle fluorescence spectroscopy technique combined with PLS-DA method has high potential in rapid and accurate qualitative analysis of Indonesian palm civet coffee discrimination

Keywords : Fluorescence spectroscopy; PLS-DA; Civet coffee; Discrimination; Authentication.

I. INTRODUCTION

Civet coffee is one of the most expensive coffees in the world due to its unique taste and rare production [1]. Most of the commercially available civet coffees are ground roasted civet coffee. On account of the high price of civet coffee as compared to non-civet coffee, undeclared additions of cheaper non-civet coffee (mislabelling) is commonly practiced for purposes of economy, which makes civet coffee fraud a real problem in Indonesia. For this reason, maintaining high production standards of civet coffee may enhance fair trading competition in the civet coffee industry as well as satisfaction of consumers. Therefore, there is need for developing analytical techniques to control authenticity of civet coffee samples.

Several analytical methods have been established to develop coffee authentication system and detect the level of adulteration. In general, the techniques most widely used are classified into two groups: based on spectroscopic and chromatographic methods: UV-Vis spectroscopy [1–4], NIR spectroscopy [5–7], gas chromatography (GC) [8], [9] and high performance of liquid chromatography (HPLC) [10]. Chromatographic methods are accurate but relatively expensive, time consuming and require highly skilled operators [11].

In the previous reports, several studies have been published on the authentication of civet coffees quantitatively and qualitatively using UV-vis spectroscopy and NIR spectroscopy [1], [12]. Recently, UV-Vis spectroscopy shows a great potential for civet authentication with acceptable result [1], [13], [14]. UV-Vis spectroscopy is simpler, less expensive and quicker than other widely used methods (NIR spectroscopy, HPLC and others). However, this method is less sensitive and its spectra are more overlapped compared to fluorescence spectroscopy.

So far the use of fluorescence spectroscopy for civet coffee authentication has not received sufficient attention. Therefore, the objective of this research was to investigate the application of fluorescence spectroscopy and partial least squares-discriminant analysis (PLS-DA) method for the discrimination between pure civet and pure non-civet coffees.

II. MATERIALS AND METHODS

A. Samples

Roasted coffee samples (civet and non-civet) were purchased at local farmers at Liwa, Lampung province, Indonesia. A number of 30 samples of civet coffee and 30 samples of non-civet coffee were used as samples. Each samples has 1 gram weight. An aqueous extraction procedure of the coffee samples was performed based on the previous reported studies [1], [2]. For PLS-DA, the samples were divided randomly into two groups: calibration sample set (50 samples) and prediction sample set (10 samples).

B. Fluorescence spectral data acquisition

The EEM (excitation-emission matrix) spectral data of coffee samples were obtained using a spectrofluorometer (JASCO model FP-8300, Tokyo, Japan) by dropping 3 mL of samples into 10 mm cuvettes in the excitation range from 200 nm to 500 nm (5 nm steps) and the emission range from 210 nm to 750 nm (1 nm steps). The excitation and emission bandwidth were both 5.0 nm. The software of Spectra Manager (JASCO Co., Tokyo, Japan) was performed to manage the EEM spectral data acquisition. This software was also used for spectral data pre-treatment such as fluorescence correction and finding peak for high intensity of EEM spectral data.

C. Data analysis using PLS-DA method

PLS-DA is working based on a PLS regression algorithm. PLS-DA attempts to build models that can maximize the separation among the classes of objects. For more detailed theory about the PLS-DA algorithm can be found in the literatures [15–17]. In this study, for developing a PLS-DA model, each sample in the calibration set was assigned a dummy variable as a reference value (variable *y*), which is an arbitrary number designating whether the sample belongs to a particular class or not [18] (1 = civet coffee; 2 = non-civet coffee). The PLS-DA calibration model was developed using the calibration sample set and the optimal number of PLS factors was determined using the lowest RMSECV value.

The PLS-DA calibration model was evaluated based on the following parameter: number of PLS factors, coefficient of determination (R^2_{cal}), and the RMSECV. The performance of the PLS-DA model was evaluated using the prediction sample set using ±0.5 as a threshold value to delimit the classes. In this study, a coffee sample was classified as civet coffee if its value was below 1.5 and classified as non-civet coffee if the value was above 1.5.

III. RESULTS AND DISCUSSION

A. Fluorescent spectra of civet and non-civet coffee.

The measurement of the excitation-emission matrix (EEM) for different coffee samples: civet and non-civet coffee, are shown in Fig. 1 and Fig. 2. It is seen that a peak at around excitation of 370 nm and emission of 453 was observed at both civet and non-civet coffee sample. This peak may be related to the typical emission spectra of flavonoid content in coffee.

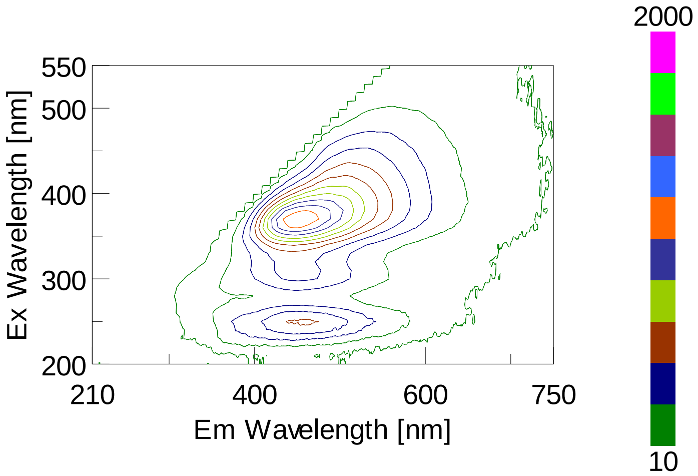

Fig. 1. Excitation-emission spectra of non-civet coffee

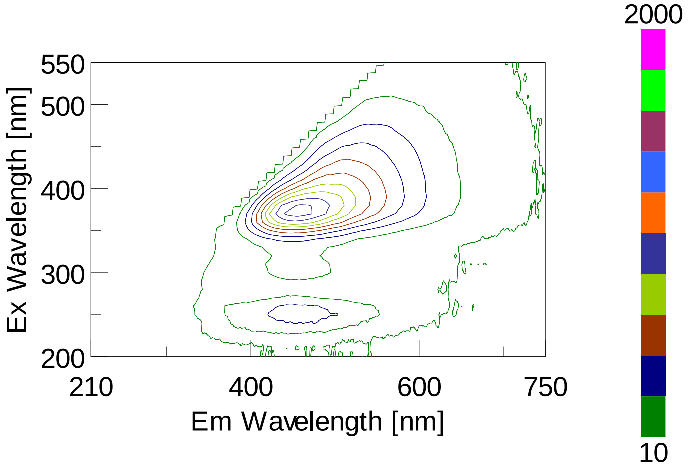

Fig. 2. Excitation-emission spectra of of civet coffee

B. Principal component analysis of all samples.

PCA is applied for all samples (30 civet and 30 non-civet) using emission spectra at 370 nm of excitation wavelength. Fig. 3 shows the score of PC1 and PC2 of the result of PCA on spectra dataset. Here, PC1 and PC2 in total could be able to explain 99% of the variation on the coffees spectral data. From Fig. 3, it can be seen that civet and non-civet coffee could be well separated. The civet coffee samples was located on the left quadrant and non-civet coffee samples was on the right one.

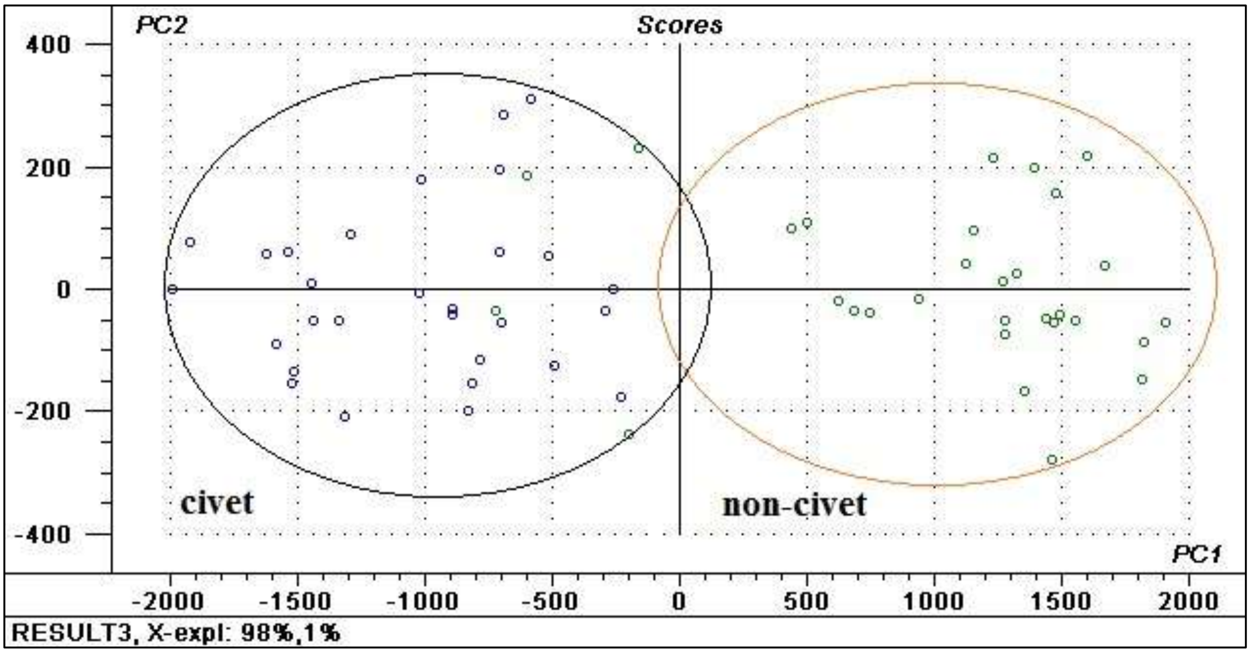

Fig. 3. PCA score plot for civet and non-civet coffees.

C. Developing PLS-DA calibration model

Using PLS regression algorithm, a PLS-DA model for discrimination between civet and non-civet coffee was developed on original spectra. The optimal number of PLS factors included in model was selected using the lowest root mean square error of cross validation (RMSCV). Fig. 4 shows the relationship between PLS factors and RMSECV. The lowest RMSECV was obtained at 9 PLS factors.

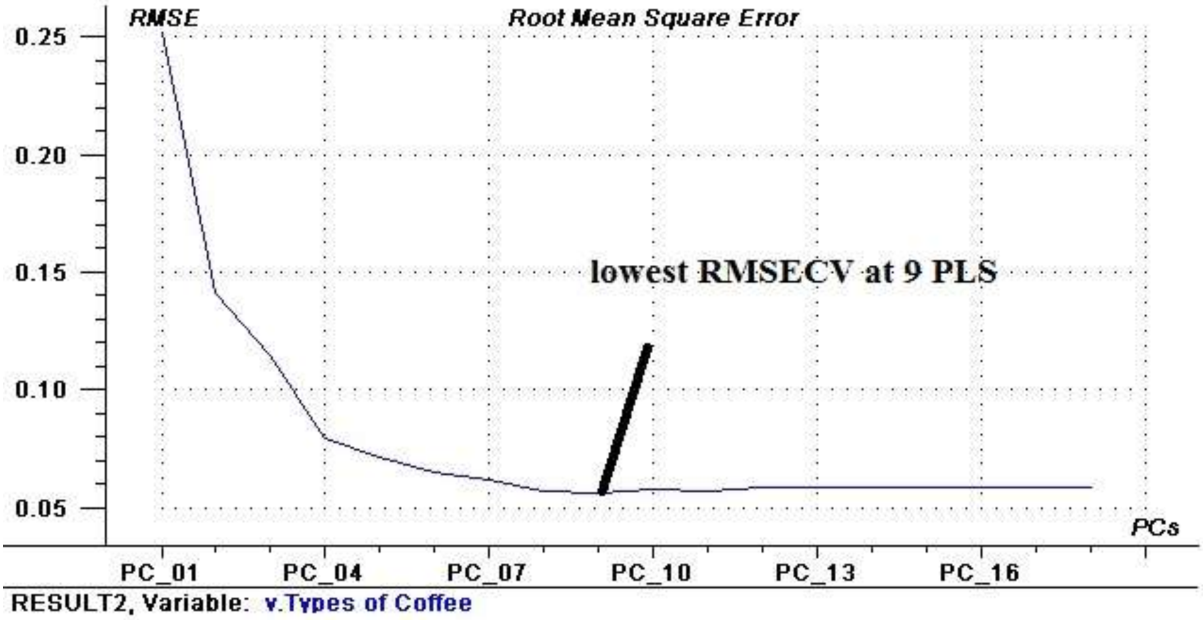

Fig. 4. Plot of PLS factors versus RMSECV for determination of type of coffee samples.

Fig. 5 shows the scatter plot of actual and predicted values of type of coffees using 9 PLS factor for calibration and validation, respectively. The calibration resulted in high coefficient of determination (R^2_{cal}=0.99). Low RMSECV could be obtained (RMSECV= 0.057). This PLS-DA model is used to predict the type of coffee (civet or non-civet coffee) in the prediction sample set.

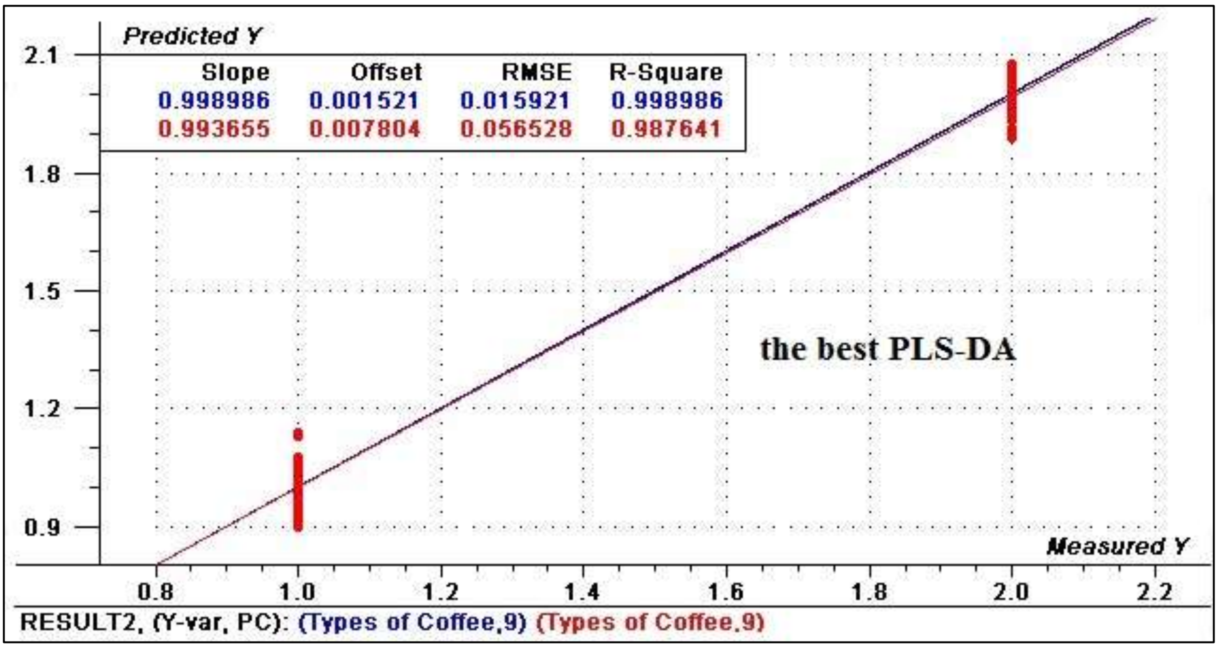

Fig. 5. Scatter plot between actual and predicted type of coffees for calibration and validation using PLS regression method

D. Prediction of type of coffee using PLS-DA model

Using the developed calibration model, a prediction for type of coffee was done using prediction sample set (10 samples). Tabel 1 shows the prediction result. We can see here that actual values are very close similar to that of predicted values.

Using student *paired t-test*, there is no any significant differences between the actual and predicted values. All prediction samples classify properly into its correspondence class (100% discrimination rate).

Table 1. The result of prediction using developed PLS-DA model for discrimination between civet and non-civet coffees.

Sample	Predicted values	Deviation	Reference/Actual values
Civet	1.065	0.071	1.000
Civet	1.029	0.071	1.000
Civet	1.053	0.063	1.000
Civet	1.042	0.066	1.000
Civet	1.026	0.076	1.000
Non-civet	2.072	0.091	2.000
Non-civet	2.025	0.063	2.000
Non-civet	2.100	0.076	2.000
Non-civet	2.073	0.067	2.000
Non-civet	2.057	0.075	2.000

IV. CONCLUSION

This study demonstrated the potential application of using fluorescence spectral data in the authentication of civet coffee samples. The right-angle fluorescence measurement was successfully applied to identify civet and non-civet coffee samples. In conclusion, this present study achieved the discrimination of civet and non-civet coffee. The combination of fluorescence spectroscopy and PLS-DA method for civet and non-civet coffee resulted in good prediction with 100% rate of discrimination. The right-angle fluorescence method can be used as a sensitive screening tool for the authentication of Indonesian civet coffee samples.

ACKNOWLEDGEMENT

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REFERENCES

[1] D. Suhandy, and M. Yulia, "The use of partial least square (PLS) regression and spectral data in UV-visible region for quantification of adulteration in Indonesian palm civet coffee," *Int. J. Food Sci*., 2017 (*accepted manuscript*).

[2] D. Suhandy, and M. Yulia, "Peaberry coffee discrimination using UV-visible spectroscopy combined with SIMCA and PLS-DA. *Int. J. Food Prop*., 2017 (*accepted manuscript*).

[3] U.T.C.P. Souto, M.J.C. Pontes, E.C. Silva, R.K.H. Galvão, M.C.U. Araújo, F.A.C. Sanches, F.A.S. Cunha, and M.S.R. Oliveira, "UV-Vis spectrometric classification of coffees by SPA-LDA, " *Food Chem*., vol. 119, pp. 368–371, 2010.

[4] U.T.C.P. Souto, M.F. Barbosa, H.V. Dantas, A.S. Pontes, W. Lyra, P.H.G.D. Diniz, M.C.U. Araújo, and E.C. Silva, "Identification of adulteration in ground roasted coffees using UV-Vis spectroscopy and SPA-LDA", *Food Sci. Technol.,* vol. 63, pp. 1037–1041, 2015.

[5] C. Pizzaro, I. Esteban-Díez, and J.M. González-Sáiz, "Mixture resolution according to the percentage of robusta variety in order to detect adulteration in roasted coffee by near infrared spectroscopy", *Anal. Chim. Acta*, vol. 585, pp. 266–276, 2007.

[6] J.R. Santos, M. Lopo, A. Rangel, and J.A. Lopes, "Exploiting near infrared spectroscopy as an analytical tool for on-line monitoring of acidity during coffee roasting," *Food Control*, vol. 60, pp. 408–415, 2016.

[7] R. Calvini, A. Ulrici, and J.M. Amigo, "Practical comparison of sparse methods for classification of Arabica and Robusta coffee species using near infrared hyperspectral imaging, " *Chem. Intell. Lab. Syst*., vol. 146, pp. 503–511, 2015.

[8] F. Carrera, M. León-Camacho, F. Pablos, and A.G. González, "Authentication of green coffee varieties according to their sterolic profile," *Anal. Chim. Acta*, vol. 370, pp. 131–139, 1998.

[9] M.J. Martin, F. Pablos, A.G. González, M.S. Valdenebro, M.L. Carnacho, "Fatty acid profiles as discriminant parameters for coffee varieties differentiation, " *Talanta*, vol. 54, pp. 291–297, 2001.

[10] E.D. Pauli, F. Barbieri, P.S. Garcia, T.B. Madeira, V.R. Acquaro Junior, I.S. Scarminio, C.A.P. Camara, and S.L. Nixdorf, "Detection of ground roasted coffee adulteration with roasted soybean and wheat, " *Food Res. Int.*, vol. 61, pp. 112–119, 2014.

[11] P. Satora, M. Kostrz, P. Sroka, and T. Tarko, "Chemical profile of spirits obtained by spontaneous fermentation of different varieties of plum fruits, *"Eur. Food Res. Technol.*, vol. 243, pp. 489–499, 2017.

[12] D. Suhandy, and M. Yulia, "A method to compensate the influence of different particle size of coffee powder in NIR calibration model performance", In proceedings of AESAP, pp. 6-10, 2016.

[13] D. Suhandy, M. Yulia, S. Waluyo, N. Sugianti, R. Iriani, F.N. Handayani, and N. Apratiwi, "The Potential use of ultraviolet-visible spectroscopy and soft independent modelling of class analogies (SIMCA) for classification of Indonesian palm civet coffee (kopi luwak)", In proceeding of The USR International Seminar on Food Security (UISFS), pp.245-253, 2016.

[14] M. Yulia, D. Suhandy, S. Waluyo, and C. Sugianti, "Detection and quantification of adulteration in luwak coffee through ultraviolet-visible spectroscopy combined with chemometrics method", In proceeding of The USR International Seminar on Food Security (UISFS), pp.254-261, 2016.
[15] S. Wold, M. Sjostrom, and L. Eriksson, "PLS-regression: a basic tool of chemometrics", *Chem. Intell. Lab. Syst.*, vol. 58, pp. 109–130, 2001.
[16] M. Barker, and W.S. Rayens, "Partial least squares for discrimination", *J. Chemom.*, vol.17, pp. 166–173, 2003.
[17] L. Xie, Y. Ying, and T. Ying, "Combination and comparison of chemometrics methods for identification of transgenic tomatoes using visible and near-infrared diffuse transmittance technique", *J. Food Eng.*, vol. 82, pp. 395–401, 2007.
[18] D. Ballabio, and V. Consonni, "Classification tools in chemistry. Part 1: linear models. PLS-DA", *Anal. Methods*, vol. 5, pp. 3790–3798, 2013.

C.5

RAPID AND NON-DESTRUCTIVE QUANTIFICATION OF CHLOROGENIC ACID IN INTACT COFFEE BEANS BY DIFFUSE REFLECTANCE SPECTROSCOPY

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ABSTRACT

To quantify chlorogenic acid (CGA) content of intact coffee beans, several methods were employed. Yet, most of them are based on solvent extraction followed by complicated and time consuming procedures. Thus, rapid and non-destructive methods are required to evaluate and quantify CGA content of coffee beans and other agricultural products. Diffuse reflectance based on near infrared spectroscopy (DRIFT), is one of the most promising and non-destructive method that has been currently used in many industries. This present study aimed to apply DRIFT in quantifying CGA content of intact coffee beans. Infrared spectra data, in wavelength range from 1000 to 2500 nm were acquired for a total of 30 bulk intact coffee beans amounted 25 g for each bulk samples. Multiplicative scatter correction (MSC) was employed as spectra data correction method while partial least square regression (PLSR) was used to establish CGA prediction models. The result showed that DRIFT can predict CGA content instantly correlation coefficient (r) of 0.71 and residual predictive deviation (RPD) of 1.44 for raw uncorrected spectrum. Further, spectra correction, using MSC method did not achieved significant impact on prediction accuracy and robustness. It yields same r coefficient = 0.71; RPD = 1.46. Based on obtained results, it may conclude that DRIFT can be used as a rapid and non-destructive method to quantify CGA content of intact coffee beans with sufficient accuracy and robustness.

Keywords : DRIFT, spectroscopy, coffee, quality, chlorogenic acid.

I. INTRODUCTION

Coffee known as famous beverages for people around the worlds due to its taste, flavour and some nutrient content. Interest in coffee quality assessment is impelled by the need to supply the consumer with a consistently high quality product at an affordable price. Indeed, quality is a major aspect for the modern coffee industry because a high quality product is the basis for success in today's particularly competitive market [1].

Arabica and Robusta are globally well known and the most traded among those species. Generally, Arabica has gained greater popularity than Robusta. A greater quantity of Arabica is traded and fetches a higher price than Robusta. Differences in prices are also determined by geographical origin. Among the several species of the genus coffee identified so far, two of these varieties are economically and commercially important.

Food quality encompasses sensory properties, nutritive values, mechanical properties, functional properties and presence of defects. The majority of traditional techniques used for quality assurance are costly, labour intensive and time consuming, an example being sensory panel evaluation that, to this date, is the ultimate tool to assess coffee quality. Besides being costly and time consuming, sensory panels are inadequate for employment in routine analysis in food processing facilities. In this scenario, infrared spectroscopy is gaining attention since it has been demonstrated capable of solving some of the problems presented by traditional techniques [2].

Moreover, chemical compositions in green coffee beans can be used to differentiate between species. Sucrose and trigonelline in Arabica have higher levels than Robusta. Conversely, caffeine and chlorogenic acid in Arabica are lower than in Robusta [3].

These chemical compositions (caffeine, chlorogenic acid sucrose, trigoneline) are commonly measured by the high-performance liquid chromatography (HPLC). This method has the advantage of being accurate, but, on the other hand, it is time-consuming and needs extensive sample preparation. An alternative to the HPLC therefore is required which provides simplified measurement procedures, specifically for caffeine and chlorogenic acid contents in green coffee beans [2, 3].

In particular, much attention has been given to FTIR and NIR spectroscopy. The FTIR spectrum detects fundamental vibrations in the mid-infrared region (4000– 400 cm 1) whereas the NIR spectrum (2500–800 nm) arises from the molecular absorptions of overtones and combinations of fundamental vibrational bands in the mid-infrared region. These techniques are rapid, non-destructive and require minimum sample preparation [4].

During last few decades, infrared (IR) spectroscopy has been widely employed as an effective tool for the analysis of soil properties. Compared with traditional wet chemistry analysis, IR analysis is rapid, cost effective, non-destructive, requires minimal sample preparation and can be used in situ. More importantly, it permits a quantitative assessment of several properties from a single measure- ment. This technique mainly measures overtones and combinations of fundamental vibrational bands for O-H, N-H and C-H bonds from the mid-infrared region [5].

The feasibility of using infrared spectroscopy in combination with multivariate statistics has been examined with notable success in coffee quality evaluation, with applications including discrimination and quantification of Robusta and Arabica blend, coffee adulteration, and prediction coffee sensory properties [6, 7].

Therefore, the main purpose of this study is to use infrared technology in form of diffuse reflectance spectroscopy for coffee quality evaluation in term of chlorogenic acid (CGA) content.

II. MATERIALS AND METHODS

A. *Coffee bean samples*

Green Arabica coffee bean samples were collected mainly from Gayo, Aceh Province and some of them were collected from different geographical origins around Indonesia.

B. *Diffuse reflectance infrared spectra acquisition*

In this study, infrared spectra data of all coffee bean samples were acquired in form of diffuse reflectance spectral data. Background spectra correction was performed every hour automatically. Diffuse reflectance spectra in wavelength range of 1000 – 2500 nm with the increment of 0.2 nm resolution were acquired 32 times, averaged and recorded in SPA and CSV extension files format.

C. *Chlorogenic acid (CGA) content measurement*

Once spectra acquisitions were completed, CGA content for all coffee bean samples were measured using standard laboratory method (HPLC). These data were used as data validation.

D. *Spectra data correction*

To enhance and improve prediction performance, spectra correction was employed to all spectra data of coffee bean samples. Multiplicative scatter correction (MSC) was chosen as spectra data correction method [8].

E. *CGA content prediction and validation*

Diffuse reflectance spectra data of all coffee bean samples were used to predict CGA content using partial least square regression (PLSR) method. To validate the prediction result, full cross validation was applied during prediction model development. Model performance was quantified using statistical indicators: coefficient determination (R^2), coefficient correlation (r), the root mean square error (RMSE) and residual predictive deviation (RPD) index. It is obvious that good model should have higher R^2 and r coefficient, lower RMSE and RPD above 1.5 [3, 4].

III.RESULTS AND DISCUSSION

Diffuse reflectance spectrum of coffee bean samples in NIR wavelength region range of 1000-2500 nm corresponds to hydrogen bonds (C-H, N-H, O-H and S-H) and can be used to analyze the chemical composition of organic matter. Additionally, NIR spectra detect the presence of chemical contents that contain hydrogen bonds [9, 10].

Calibration was attempted to predict CGA content using partial least square regression (PLSR) with co added of full cross validation. Raw untreated spectra data was firstly employed to predict CGA content. Obtained result shows that CGA content can be predicted using raw spectra data with correlation coefficient of 0.71 and RPD index of 1.44. Based on literatures, it inferred as coarse and sufficient prediction model performance. Scatter plot drawn for this result is shown in Fig.1.

Moreover, CGA content was also to be predicted using MSC corrected spectra data. As a result, the correlation coefficient was not improved. It yields same as raw spectra data (r = 0.71). Yet, RPD index is slightly increased to 1.46. Nevertheless, it still coarse and sufficient prediction model performance. Comparison result between raw and MSC spectra data in predicting CGA content is shown in Table 1.

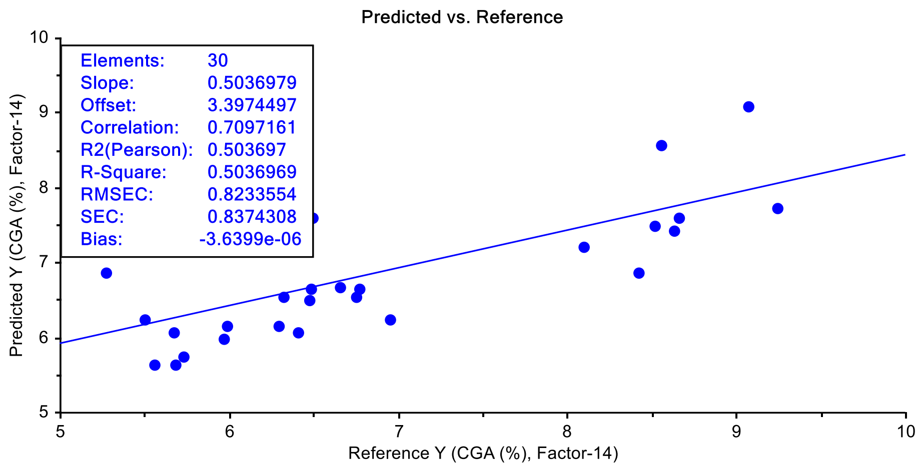

Fig.1. Scatter plot between predicted and actual CGA content of green coffee bean samples using raw uncorrected spectra data.

Table 1. CGA prediction result using raw and MSC corrected spectra data.

Accuracy indicators	Raw spectra data	MSC spectra data
R^2	0.5034	0.5034
r	0.7097	0.7097
RMSE	0.8233	0.8231
RPD	1.4416	1.4602

Scatter plot of actual and predicted CGA content using MSC spectra data is presented in Fig. 2.

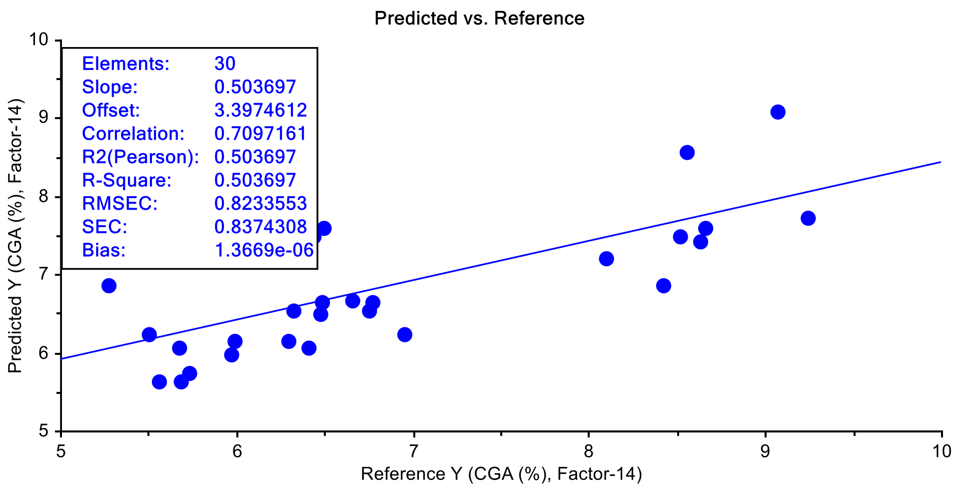

Fig. 2. Scatter plot between predicted and actual CGA content of green coffee bean samples using MSC corrected spectra data.

In addition, both spectra data, raw and MSC spectra requires maximum 14 latent variables to obtain achieved prediction results. This is commonly un-efficient for PLSR from which more than 10 latent variables involved. Nonetheless, these obtained models need to be enhanced probably by applying non-linier regression approach such as support vector regression or artificial neural networks.

IV. CONCLUSION

We attempted to apply diffuse reflectance infrared spectroscopy as a rapid and non-destructive method in determining CGA content of intact green coffee beans samples. MSC corrected spectra data and raw un-corrected spectra were used in tandem with partial least square regression method.

Achieved results, shows that CGA content can be predicted sufficiently and coarsely using both spectra data with maximum correlation coefficient of 0.71 and residual predictive deviation index of 1.46. Further spectra data analysis and non-linier regression approach may be applied to enhance accuracy and prediction robustness.

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REFERENCES

[1] D. Perrone, Donangelo, C. M., & Farah, A., 2008. Fast simultaneous analysis of caffeine, trigonelline, nicotinic acid and sucrose in coffee by liquid chromatography–mass spectrometry. Food Chemistry, 110, 1030–1035.

[2] A Myles, A. J., Zimmerman, T. A., & Brown, S. D., 2006. Transfer of multivariate classification models between laboratory and process near-infrared spectrometers for the discrimination of green Arabica and Robusta coffee beans. Applied Spectroscopy, 60(10), 246A–272A (1097–1216. 1198-1203(6)).

[3] B. M. Nicolai, Beullens, K., Bobelyn, E., Peirs, A., Saeys, W., Theron, K. I., & Lamertyn, J. (2007). Nondestructive measurement of fruit and vegetable quality by means of NIR spectroscopy: a review. Postharvest Biology and Technology, 46, 99-118.

[4] H.W Siesler, Ozaki, Y., Kawata, S., & Heise, H. M. (2002). Near Infrared Reflectance Spectroscopy: Principles, Instrument and Application. Wiley VHC Verlag, GmbH, Weinheim.

[5] A.A. Munawar, Hoersten, D.v., Pawelzik, E., Wegener, J.K & Moerlein, D. (2016). Rapid and non-destructive prediction of inner quality attributes of intact mango using Fourier-transform infrared and chemometrics. J. Engineering in Agriculture, Environment and Food, 9 (1): 208 – 215.

[6] M.Y, Choi, W., Park, J.H., Lim, J., Kwon, S.W., 2010. Determination of coffee origins by integrated metabolomic approach of combining multiple analytical data. Food Chem. 121, 1260–1268.

[7] P. Parras, Martineztome, M., Jimenez, A., Murcia, M., 2007. Antioxidant capacity of coffees of several origins brewed following three different procedures. Food Chem. 102, 582–592.

[8] W. S. Sepúlveda, Chekmam, L., Maza, M.T., Mancilla, N.O., 2016. Consumers' preference for the origin and quality attributes associated with production of specialty coffees: Results from a cross-cultural study. Food Res. Int. 89, 997–1003.

[9] A.M. Feria-Morales, 2002. Examining the case of green coffee to illustrate the limitations of grading systems/expert tasters in sensory evaluation for quality control. Food Qual. Prefer. 13, 355–367.

[10] Barbin, D.F., Felicio, A.L. de S.M., Sun, D.-W., Nixdorf, S.L., Hirooka, E.Y., 2014. Application of infrared spectral techniques on quality and compositional attributes of coffee: An overview. Food Res. Int. 61, 23–32

C.6

NON-DESTRUCTIVE DETERMINATION OF SWEETNESS AND FIRMNESS LEVEL FOR PAPAYA CALINA (*Carica papaya L.*) USING ULTRASONIC METHOD

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ABSTRACT

Sweetness and firmness are important quality criteria for papaya according to SNI 4320:2009. This quality parameters are still evaluated visually, so that the result of evaluation is very diverse. Therefore, a non-destructive method for determination of sweetness and firmness is required. The objectives of this study was to assess ultrasonic method to determine quality (sweetness and firmness) of papaya calina nondestructively. Papaya calina used for experiment consisted of three levels of harvesting time (1^{st}, 2^{nd}, 3^{rd} tinge). The samples were measured by ultrasonic apparatus at frequency of 50 kHz and followed by physicochemical measurement (firmness, total soluble solids, and density). The results showed that the velocity of ultrasonic waves ranged between 166,79 to 219,41 m/s. While the attenuation coefficient ranged from 18,96 to 29,23 dB/m. The firmness, total soluble solid and density of papaya calina were 20,96 to 68,10 N, 4,23 to 9,26 °Brix, 901,56 to 982,69 kg/m^3, respectively. As papaya calina matured, ultrasonic velocity decreased as attenuation coefficient increased. The sweetness and firmness level of pepaya calina can be classified accurately with percentage of accuracy 100% using linear regression equations based on ultrasonic wave velocity parameter.

Keywords : attenuation coefficient, linear regression, papaya calina, ultrasonic, velocity.

I. INTRODUCTION

Papaya calina (*Carica papaya L.*) is the result of breeding varieties of Tropical Horticulture Research Center (PKHT) IPB which have thick flesh, sweet and high productivity. Papaya calina is a climacteric fruit types that the respiration rate increases abruptly before entering the ripening process[*1*]. Papaya calina have flowering date 114 days after planting, bright green fruit skin color, reddish orange flesh color, angular, the shape of fruit base slightly inward, intermediate texture rind, weight per piece 1.24 kg and TSS 11°Brix[*2*].

One of the problems in the postharvest handling of papaya calina is the accurate determination of the internal quality (sweetness and firmness level) of the fruits by a non-destrucitve method. Commonly, the sweetness and firmness level of papaya calina has to be assesed by extracting the juice from papaya or hit a plunger to papaya, which belong to destructive method. An alternative by judging the color of the skin has been proved to be unreliable. It is frequently found by the consumer, that a fruit with a good color and appearance does not necessarily give a good taste and texture[*3*]. So, the external quality of papaya calina can not guarantee the internal one. Therefore, it is necessary to find a method for determining the internal quality of papaya calina non-destructively. The important internal qualities of papaya calina are texture and flavor.

The main research objective was to develop a non-destrucitve method to evaluate the internal quality of papaya calina by using the ultrasonic method. The specific objetives of the research were a) to determine the velocity and the attenuation coefficient of ultrasonic wave in papaya calina, 2) to examine the relationships between characteristics of ultrasonic wave transmission with physico-chemical properties of papaya calina and 3) to classify papaya into three categories according to sweetness and firmness level using ultrasonic waves parameters and linear regression model.

II. MATERIALS AND METHODS

A. Materials

Papaya calina were harvested at three levels harvesting time (1st, 2nd, 3rd tinge) from the farmers at Jasinga, Bogor Regency, West Java. Total samples used for experiment is 90 papayas, separated randomly for calibration (60 samples) and for validation (30 samples).

B. Experimental Apparatus

The experimental apparatus for measuring the transmission of the ultrasonic wave is set up as described in Fig. 1 and 2. The apparatus includes a transmitter transducer and receiver transducer made from a piezoelectric material, transducers bench include sample thickness gauges, ultrasonic tester, digital oscilloscope, and personal computer. The transducer is tubular type with taper-shaped tip, the tube diameter of 2.95 cm, 7.05 cm in length, and frequency of 50 kHz. The transducer holder can be positioned, so it is easy to measure the thickness of papaya calina through which ultrasonic waves pass.

Other equipment used is *Rheometer CR 500-DX* models used to measure the firmness of papaya calina. The total soluble solids or sweetness levels was measured by a digital portable refractometer (*Atago PR 201)* at room temperature. Caliper is used as dimensional measurement device and digital scales as a measure of weight, knives, and distilled water.

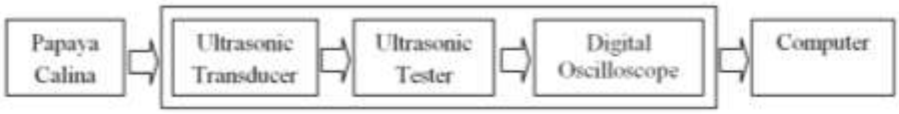

Fig. 1. Block diagram of Ultrasonic Apparatus[*4*].

Fig. 2. Measurement system of ultrasonic wave transmission[*4*]

C. Ultrasonic Wave Velocity Measurement

Ultasonic wave velocity measurements on air and papaya calina as a medium is determined by calculating the travel time (t) of the electric pulse from transmitter to the receiver. Sampling rate used is 400 microsecond.. The calculation of ultrasonic wave velocity can be calculated by equations 1 and 2.

$$V = \frac{s}{t} \tag{1}$$

$$V = v.c \tag{2}$$

D. Attenuation Coefficient Measurement

The wave attenuation is measured by observing the decreasing amplitude of the ultrasonic wave after passing the medium (Papaya Calina). Attenuation coefficient can be calculated using the equation 3.[*5*].

$$\alpha = \frac{1}{x}\left[ln\frac{A_0}{A_x}\right] \tag{3}$$

E. Density Measurement

Density was calculated by dividing mass with volume. using equation 4. Volume of papaya was determined by water displacement method, as mass of papaya was measured by digital balance.

$$\rho = m / v \tag{4}$$

F. Firmness Measurement

Firmness of papaya was measured by rheometer using a plunger or probe of diameter of 5 mm in 3 points of measurement (base, middle, end).

G. Total Soluble Solids Measurement

Total soluble solid was measured by a portable digital refractometer. The juice was extracted from flesh of papaya and then dropped it into refractometer sensor. TSS measurements were taken at three different points with three repetitions at each point.

H. Data Analysis

Ultrasonic and physicochemical parameters measured on papaya calina were analyzed by analysis of variance (ANOVA), honestly significant difference test (HSD) at level 5% test using *SPSS 22.* Correlation regression analysis was carried out using scatter plot of linear regression graph and equations in *Microsoft Excel 2016.*

III. RESULTS AND DISCUSSION

A. Physico-chemical Properties for Papaya Calina at Three Levels of Harvesting Time

Table 1. Physico-chemical Properties for Papaya Calina at Three Levels of Harvesting Time

Physico-chemical properties	1^{st} harvesting time	2^{nd} harvesting time	3^{rd} harvesting time
Firmness (N)	68,10 ± 4,7^{a}	57,51 ± 9,81^{b}	20,96 ± 12,88^{c}
Density(kg/m^3)	901,56±22,97^{a}	982,69±51,88^{a}	950,04 ± 47,12^{a}
TSS (^{0}Brix)	4,23 ± 0,66^{a}	6,93 ± 0,50^{b}	9,26 ± 0,77^{c}

1. Firmness

The firmness of papaya calina in three different harvesting time is significantly different (Table 1) and decreased with increasing age of harvest. Decrease in firmness of papaya calina caused by respiration and transpiration effect that continuesly occurred, also due to other physiological activities that occur in papaya calina such as protopectin and hemicellulose changes during the process of fruit ripening. The decrease in fruit firmness has a closely linked with pectin enzymes that relation to ethylene[*6*]. Softening process that happened is caused by pectin's hydrolysis process into water-soluble components, so that the pectin total affecting the papaya calina's firmness decreases and make the fruit malleable[*7*],[*8*]. Beside that, based on harvesting time and papaya's quality shows the firmness will decreased as the harvesting time increased while meat, fruit color and total soluble solids will increased[*9*].

2. Density

The papaya calina's density at three levels of harvesting age were not significantly different (Table 1). Density increased from 1^{st} harvesting time to 2^{nd} harvesting time and decreased at the 3^{rd} harvesting time. The decrease in density for 3^{rd} harvesting time is caused by two days storage before measurement. Papaya calina stored will decrease the weight with shrinkage about 4,30%[*10*]. This is caused by respiration and transpiration processes during the fruit ripening process [*11*], [*12*].

3. Total Soluble Solids (TSS)

The total soluble solids of papaya calina at the three levels of harvesting time showed significantly different (Table 1). The increase of total soluble solids values on papaya calina due to the increasing of total sugar content caused by carbohydrate (starch) reversal into simple sugars. When the starch content decreases, the content of sucrose will increase and be broken down into glucose and fructose. This simple sugar is a total soluble solids when detected by a refractometer that represents the degree of papaya calina's sweetness level.

B. Ultrasonic Wave Transmission for Papaya Calina at Three Levels of Harvesting Time

Table 2. Average values of Ultrasonic Wave Transmission for Papaya Calina at Three Levels of Harvesting Time

Physico-chemical properties	1^{st} harvesting time	2^{nd} harvesting time	3^{rd} harvesting time
Velocity (m/s)	215,00 ± 4,00^{a}	196,13 ± 6,37^{b}	178,27 ± 5,56^{c}
Attenuation (dB/m)	21,53 ± 1,60^{a}	23,85 ± 2,23^{b}	25,35 ± 2,40^{c}

1. Velocity

Ultrasonic wave velocity of papaya calina decrease as the harvesting time increase. Ultrasonic wave velocity is strongly influenced by the firmness and density of a medium. The decrease in ultrasonic wave velocity as the harvesting time increase, which means that the maturity of fruit can be explained by the more softening of fruit flesh, the ingredients in the compartment are no longer compact. In ripe fruit, the solid composition has decreased while the water content composition in the flesh increases, so that the ultrasonic wave energy transmitted through the flesh decreases. Theoretically, ultrasonic wave velocity is influenced by the fruits physical characteristics, such as density and Young Modulus (firmness)[*13*]. In addition, the water content of fruit flesh also greatly affect ultrasonic wave velocity, The higher water content then the turgor cell pressure is also getting higher, which will affect the ultrasonic waves velocity that are transmitted also higher. This is because ultrasonic wave velocity depends on the elastic properties of the medium it passes through[*14*].

2. Attenuation Coefficient

Attenuation coefficient of papaya calina increase as the harvesting time increase. The attenuation coefficient is a quantity that describes the loss of an energy because the waves pass through a certain medium, so that the wave energy will decrease. The attenuation coefficient is influenced by the concentration of the medium through which it passes. At the fruits which have a gas composition or cavity and the higher water content, then the average attenuation coefficient value will be higher as well. Increasing the fruit harvesting time, the formation of fruit components will be more complex so that more wave incidents occur such as refraction and reflection at the boundary between different mediums, thus the more energy that can not be continued so that the attenuation coefficient will increase. In addition, the amplitude of ultrasonic waves increases with the change of skin color of the fruits from green to yellow, indicating a correlation between the age level of fruit harvest with attenuation coefficient[*15*].

C. The Relationship Between Ultrasonic Wave Transmission and Physhico-chemical properties of Papaya Calina.

1. The relationship between ultrasonic wave velocity and papaya calina's firmness

The ultrasonic wave velocity is strongly correlated with firmness, from the regression of linear equations with correlation coefficient r = 0.8246 obtained from 60 ultrasonic wave velocity measurement data (Fig. 3)

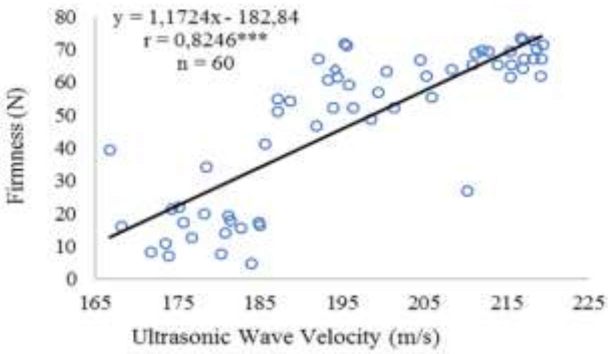

Fig. 3. The relationship between ultrasonic wave velocity and papaya calina's firmness

2. The relationship between ultrasonic wave velocity and total soluble solids of papaya calina

The relationship of ultrasonic wave velocity and total soluble solids yields a first-order negative linear regression equation with a correlation coefficient r = 0.9163 which means there is a very strong or reliable relationship between the factors (Fig. 4)

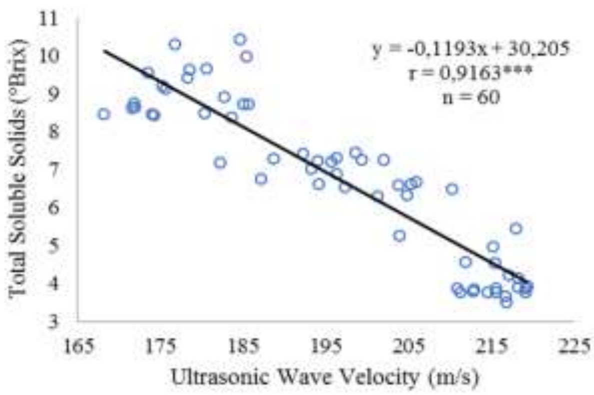

Fig. 4 The relationship between ultrasonic wave velocity and total soluble solid of papaya calina

D. Papaya Calina's Sweetness and Firmness Level Classification Based On Ultrasonic Wave Transmission Characteristics.

The sweetness and firmness level classificiation of papaya calina based on ultrasonic wave characteristis was performed using regression linear equations. Correlation coefficient (r) of linear regression showed that ultrasonic wave velocity have a higher correlation with sweetness and firmness level of papaya calina than attenuation coefficient, so that ultrasonic wave velocity has been selected as a parameter for classification process. This classification produced two linear regression equations (y_1 and y_2)

$$y_1 = -0{,}1193x + 30{,}205 \tag{6}$$

$$y_2 = 1{,}1724x - 182{,}84 \tag{7}$$

These two linear functions (y_1 and y_2) is sweetness and firmness level's classification functions based on 60 calibration data which selected randomly. The range of sweetness and firmness level of papaya calina shows in Table 3.

Table 3. The value ranges of sweetness and firmness level for papaya calina

Sweetness and Firmness Level	Sweetness value (°Brix)	Firmness value (N)
1st	< 6	> 54
2nd	6 - 8	34 - 54
3rd	> 8	< 34

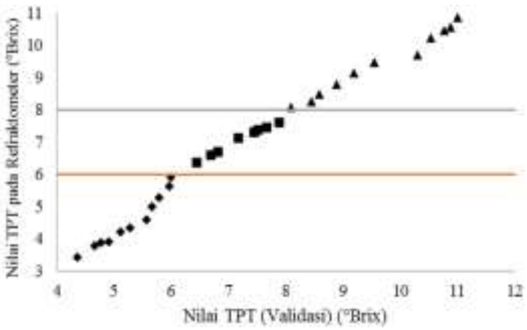

Fig. 5. The sweetness level's classification graph of papaya calina

Table 4. Validation results of papaya calina for three sweetness level

Sweetness level	1st	2nd	3rd	Total	%Accuration
1st	11	0	0	11	100,00%
2nd	0	8	0	8	100,00%
3rd	0	0	11	11	100,00%
Total	11	8	11	30	100,00%

The classification results using regression linear equation with 30 validation samples which selected randomly (Fig. 5) showed that classification for 1st, 2nd and 3rd for sweetness and firmness level can be classified accurately with average percentages 100% (Table 4), (Fig. 6 and Table 5). So that the function (y_1 and y_2) are very good for sweetness and firmness level's classification process, respectively.

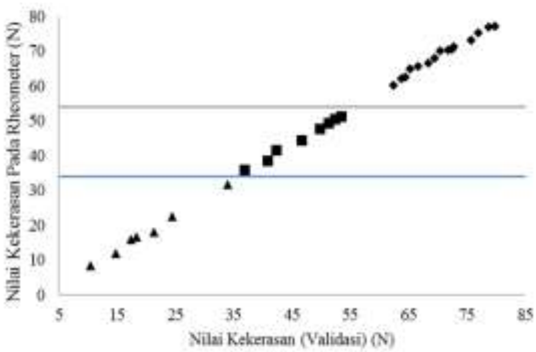

Fig. 6 The firmness level's classification graph of papaya calina

Table 5. validation results of papaya calina for three firmness level

Firmness level	1st	2nd	3rd	Total	%Accuration
1st	15	0	0	15	100,00%
2nd	0	8	0	8	100,00%
3rd	0	0	7	7	100,00%
Total	15	8	7	30	100,00%

IV. CONCLUSION

Ultrasonic wave velocity for papaya calina at three level harvesting time ranged from 166,79 to 219,41 m/s, whereas the attenuation coefficient ranged from 18,96 t0 29,23 dB/m. As papaya calina matured, ultrasonic velocity decreased as attenuation coefficient increased. Papaya calina's firmness decreased as the level of harvesting time increased, the value ranged from 68,10 to 20,96 N and otherwise for total soluble solids which have value ranged from 4,23 to 9,26 °Brix. Density increased from 1st harvesting time to 2nd harvesting time with value 901,56 kg/m^3 982, 69 kg/m^3, respectively and decreased at the 3rd harvesting time with value 950,04 kg/m^3. Ultrasonic wave velocity of papaya calina have a very significant linear correlation with firmness and total soluble solids with correlation coefficient r values respectively 0,8047 and 0,9078.

The sweetness and firmness level of pepaya calina can be classified accurately with percentage of accuracy 100% using linear regression equations based on ultrasonic wave velocity parameter.

NOMENCLATURE

V ultrasonic wave velocity (m/s)
s fruit diameter (the length between transmitter and receiver) (m)
t time (s)
v ultrasonic wave on fruit (m/s)
c constants
X fruit diameter (the length between transmitter and receiver) (m)
A_0 initial Amplitude (volt)
A_X final Amplitude (volt)
ρ fruit density (kg/m^3)
m fruit mass (kg)
v ftuit volume (m^3)
y_1 linear classification functions for sweetness level (°Brix)
y_2 linear classification functions for firmness level (N)
x ultrasonic wave velocity (m/s)

Greek letters
 Attenuation coefficient (dB/m)

REFERENCES

[1] Ahmad U. 2013. Teknologi Penanganan Pascapanen Buahan dan Sayuran. Yogyakarta (ID): Graha Ilmu.
[2] Suketi K, Poerwanto R, Sujiprihati S, Sobir, Widodo WD. (2010). Studi Karakter Mutu Buah Pepaya IPB. Jurnal Hort. Indonesia. 1(1):17-26
[3] Budiastra, IW. Trisnobudi A, Purwadaria HK. 1999. Ultrasonic System for Automation of Internal Quality Evaluation of Durian. The 14th IFAC Triennial World Congress.1(1):469
[4] Juansah J, Budiastra IW, Suroso. 2005. Pengembangan Sistem Pengukuran Gelombang Ultrasonik Untuk Penentuan Kualitas Buah Manggis (*Gracinia Mangostana L.*). Jurnal Keteknikan Pertanian. 20(2): 167-178.
[5] Mirzach A. 2000. Determination of Avocado and Mango Fruit Properties by Ultasonic Technique. *Institute of Agricultural Engineering.* Ultrasonic 38(2000):717-722
[6] Jeong, J., D. J. Huber and S. A. Sargent. (2002). Influence of 1- methylcyclopropene (1-MCP) on ripening and cell-wall matrix polysaccharides of avocado (Persea americana) fruit. Phostharvest Biology Technology 25: 241- 256.
[7] Muchtadi, T. R. dan Sugiyono. 1992. Ilmu Pengetahuan Bahan Pangan. Departemen Pendidikan dan Kebudayaan. Direktorat Jenderal Pendidikan Tinggi. Pusat Antar Universitas Pangan dan Gizi. IPB. 412 hal
[8] Widyastuti, W. (2009). Kajian Kualitas Buah Delapan Genotipe Pepaya Koleksi PKBT pada Dua Stadia Kematanngan. [Skripsi]. Departemen Agronomi dan Hortikultura. Fakultas Pertanian. Institut Pertanian Bogor, Bogor.
[9] Rafikasari, I. 2006. Umur Petik dan Kualitas Buah Pepaya. Skripsi: Program Studi Hortikultura. Fakultas Pertanian. Institut Pertanian Bogor.
[10] Taris ML. 2016. Kriteria Kematangan Pascapanen Buah Pepaya (*Carica papaya* l.) Calina dari Beberapa Umur Panen. [Skripsi]. Bogor (ID): Institut Pertanian Bogor.
[11] Adriana. 1996. Pengaruh pemberian putresin pada berbagai konsentrasi terhadap perubahan kualitas buah pepaya (*Carica papaya* L.) varietas Dampit. [Skripsi]. Bogor (ID): Institut Pertanian Bogor
[12] Zulkarnain. 2009. *Dasar-dasar Hortikultura.* Jakarta (ID) : Bumi Aksara.
[13] Garret RE dan Furry RB. 1992. Velocity of Sonic Pulses in Apples. *ASAE* :15(4):770-774.
[14] Blitz J. 1963. Ultrasonics : Methods and Application. Butterworths, London (UK).
[15] Mizrach A, Flitsanov U, Fuchs Y. 1997. An Ultrasonic Non Destructive Method For Measuring Maturity of Manggo Fruit. *Trans ASAE 40(40: 1107-1111*

C.7

A STUDY OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF VARIOUS SWEET POTATO CLONES (*Ipomoea batatas* L.)

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ABSTRACT

Marketable sweet potato production should meet consumer preferences of size, shape, and colour. This study is aimed at investigating physical and chemical characteristics of various clones of sweet potato taken from CIP-SEA Bogor and Aceh local clones. The research was conducted at Plant Physiology Laboratory and Animal Fodder Laboratory of the Faculty of Agriculture, Syiah Kuala University. The study took place from September to October 2014. The clones used in this study were 19 sweet potato clones obtained from Center of International Potato-South East Asia (CIP-SEA) Bogor and 4 local clones from Saree and 1 from Bener Meriah, The Province of Aceh. The study used Completely Randomized Design of non-factorial, where clones were treated with 3 replications. Data were analyzed using F Test and Duncan's Multiple Range Test at a confidential level of 0.05. Observation on sweet potato tubers included physical properties (tuber diameter, length and colour) and chemical properties (dry matter content). Colour was measured by digital camera with intensity levels of red, green and blue light. The results showed that the largest diameter and tuber length were found in CIP-513, CIP-B9, SARI and CIP-W. The highest dry matter content was found in CIP-CER (69.10%). The highest *L* (brightness) values was on CIP-204 and Saree yellow, and the *a* (red) values were found in CIP-1945, CIP-513, CIP-440137, CIP-286, CIP-287, CIP-W, CIP-W104, Saree Cream, while *b* (yellow) values were found on CIP-LSQ and Saree yellow.

Key words: clones, colour, brightness, red, yellow, dry matter

I. INTRODUCTION

Diversification of food can be enriched by utilizing sweet potatoes to reduce dependence on rice. Sweet potatoes are rich in carbohydrates, vitamins and minerals. It is also a storehouse of many important pigments like β-carotene, anthocyanin, which act as antioxidants [1]. Dry matter is an important feature of good sweet potato varieties, as represented by 70% of starch [2]. In Indonesia, 89% of sweet potato production is consumed as food with consumption level of 7.9 kg/capita/year [3]. The rest are used as raw materials of food industry and as animal fodder.

Sweet potatoes are varied in physical properties such as shape, colour of skin and flash, and its texture according to their varieties. The shape and tuber size are among the main quality criteria that influence its price. Oval tuber shape without many bumps will ease the process of peeling and minimize scraps. Tubers at average weight of 200-250 g and uniform takes relatively faster peeling time than small or large tuber [4]. The chemical properties of sweet potato are influenced by its varieties and seasons. In dry season, the same varieties may produce a higher starch properties than in rainy season [5].

The basic economic value of sweet potato products for farmers and industries is the dry matter content which is the chemical potential of the crop and reflects its true biological yield. Since most processed products are sold on dry matter basis, it is important that as much dry matter as possible is recovered from a given quantity of fresh tubers. Dry matter contents are the widely accepted measurements of potato quality, and these may be affected by genotype, season, tuber size, planting density and location [6], [7].

Therefore, information on physical and chemical characteristics in a variety of sweet potato clones need to be studied and used as a baseline of post-harvest development of sweet potatoes, considering sweet potatoes as an alternative source of food commodities. Sweet potatoes that are acceptable by consumers can be developed to facilitate its development and marketability.

This study is aimed at studying physical and chemical characteristics of various sweet potato clones taken from CIP-SEA Bogor and Aceh's local clones.

II. MATERIALS AND METHODS

This study was conducted at Plant Physiology and Animal Fodder Laboratory of Faculty Agriculture, Syiah Kuala University which took place from September to October 2014.

In this study, tools such as analytical scales, ovens, petridish, ruler, slide, plate, spoon, camera, and others were used, 19 clones of sweet potato clones were derived from Center of International Potato - South East Asia (CIP-SEA) in Bogor, 4 Aceh's local clones from Saree and Bener Meriah (Table 1). Those sweet potatoes were cultivated in the District of Bukit, Municipal of Bener Meriah, at the altitude of 1400 meters above sea level, during dry season from April to August 2014.

The experimental design used in this study was Completely Randomized Design with non-factorial pattern. Treatment of the study consisted of 24 levels of clonal species, with 3 replications. The arrangement of sweet potato tuber treatment is presented in Table 1. The data were analyzed by F test. If the F test result showed a real effect, then the analysis was continued with Duncan's Multiple Range Test (DMRT) test at confidential level of 5%.

Table 1. Types of sweet potato clones used in the study

Clone Code (Clone Types)	Origin	Flash Colour	Skin Colour
K_1 (CIP-LSQ)	Local Bogor	Cream	Yellow
K_2 (CIP-1945)	Breeding CIP ESEAP	A little Orange	Purple
K_3 (CIP-MAN)	Local Kuningan, North Java	Cream	Cream
K_4 (CIP-513)	Breeding CIP-Lima, Peru	White	Purple
K_5 (CIP-CER)	Local Bogor, North Java	Orange	Purple
K_6 (CIP-BDG)	Local Bandung	Dark Purple	Dark Purple
K_7 (CIP-WHI-5)	Breeding CIP ESEAP	White	Rather Yellow
K_8 (CIP-W86P)	Breeding CIP ESEAP	Orange	Purple
K_9 (CIP-B9)	Local Kuningan	Cream	Rather Yellow
K_{10} (CIP-204)	Breeding CIP ESEAP	White	Rather Yellow
K_{11} (CIP-440137)	Breeding CIP-Lima, Peru	White	Purple
K_{12} (CIP-AC)	Local Kuningan, Jawa Barat	Orange	Purple
K_{13} (CIP-B19)	Breeding CIP ESEAP	White	Purple
K_{14} (CIP-286)	Breeding CIP-Lima, Peru	Orange	Purple
K_{15} (CIP-287)	Breeding CIP-Lima, Peru	A little Yellow	Purple
K_{16} (CIP-GA)	Local Bogor	Orange	Purple
K_{17} (SARI)	Breeding BALITKABI	A little Yellow	Purple
K_{18} (CIP-W)	Breeding CIP ESEAP	Dark Purple	Dark Purple
K_{19} (CIPW104)	Breeding CIP ESEAP	Yellow	Purple
K_{20} (Saree Cream)	Local Saree	Cream	Purple
K_{21} (Saree Orange)	Local Saree	Orange	Yellow
K_{22} (Saree Purple)	Local Saree	Purple	Cream
K_{23} (Saree Yellow)	Local Saree	Yellow	Rather Orange
K_{24} (Bener Meriah Yellow)	Local Bener Meriah	Yellow	Rather Orange

Sweet potatoes harvested when the plants were 5 months old. Harvesting done when the plant leaves have started to yellow and tubers were enlarged.

Research observation on sweet potato tubers consist of physical properties (tuber diameter, length, and colour) and chemical properties (dry matter content). Colour measurement is determined based on digital camera with the intensity of red, green, and blue (RGB) taken with Exilim Casio camera. The RGB values of the sweet potato clones were then converted to the values of L, a, and b, by the equation:

$$X = 0{,}607R + 0{,}174G + 0{,}201B \quad (1)$$

$$Y = 0{,}299R + 0{,}587G + 0{,}114B \quad (2)$$

$$Z = 0{,}066G + 1{,}117B \quad (3)$$

The conversion equation used to determine L, a, and b values are as follows:

$$L = 25\left[\frac{100Y}{Y_0}\right]^{\frac{1}{3}} - 16 \quad (4)$$

$$a = 500\left[\left(\frac{X}{X_0}\right)^{\frac{1}{3}} - \left(\frac{Y}{Y_0}\right)^{\frac{1}{3}}\right] \quad (5)$$

$$b = 200\left[\left(\frac{Y}{Y_0}\right)^{\frac{1}{3}} - \left(\frac{Z}{z_0}\right)^{\frac{1}{3}}\right] \quad (6)$$

where :
X_0 = 98,071
Y_0 = 100
Z_0 118,225

In conversion equation, the value of L denotes the brightness [L = 100 (white) and L = 0 (black)], the value of a denotes red when it was positive, gray when it was 0, and green when it was negative. While the value of b denotes yellow when the value was positive, the gray when it was 0, and blue when it was negative [8].

III. RESULTS AND DISCUSSION

The result of F test showed that variations in sweet potato clones have a highly significant effects on diameter, length, dry matter, L (brightness), a (red), b (yellow) values of sweet potato tuber. Average diameter and length of sweet potato tubers, and dry matter content are presented in Table 2, while L (brightness), a (red), and b (yellow) values due to clonal type treatment are presented in Table 3.

The largest diameter of sweet potato tubers was found in clone K_{18} (CIP-W) which is not significantly different from K_1 (CIP-LSQ), K_4 (CIP-513), K_7 (CIP-WHI-5), K_9 (CIP-B9), K_{14} (CIP-286), K_{17} (SARI), and K_{19} (CIP-W104). While the smallest diameter of sweet potato tuber was found in clone K_{10} (CIP-204) which is not significantly different from K_2 (CIP-1945), K_3 (CIP-MAN), K_5 (CIP-CER), K_8 (CIP-W86P), K_{11} (CIP-440137), K_{12} (CIP-AC), K_{13} (CIP-B19), K_{15} (CIP-287), K_{16} (CIP-GA), K_{20} (Saree Cream), K_{21} (Saree Orange), K_{23} (Saree Yellow), and K_{24} (Bener Meriah Yellow).

Table 2. Average diameter and length of sweet potato tuber (cm) and dry matter content (%) according to clone type treatment

Clones	Tuber Diameter (cm)	Tuber Length (cm)	Dry matter (%)
K_1 (CIP-LSQ)	7.30 (2.70) e-g	11.60 (3.40) a-c	51.35 l
K_2 (CIP-1945)	4.83 (2.20) a-d	12.70 (3.56) a-d	28.10 d-f
K_3 (CIP-MAN)	5.43 (2.32) a-e	12.93 (3.58) a-e	34.80 i
K_4 (CIP-513)	8.67 (2,91) g	20.33 (4.51) f	26.45 d
K_5 (CIP-CER)	4.30 (2.07) a-d	10.73 (3.25) ab	69.10 m
K_6 (CIP-BDG)	5.80 (2.39) b-e	13.60 (3.68) a-e	26.90 de
K_7 (CIP-WHI5)	8.20 (2.86) fg	9.83 (3.13) a	22.10 bc
K_8 (CIP-W86P)	4.10 (2.01) ab	16.93 (4.10) c-f	28.00 d-f
K_9 (CIP-B9)	8.10 (2.84) fg	17.73 (4.21) d-f	28.55 e-g
K_{10} (CIP-204)	3.50 (1.87) a	14.07 (3.75) a-e	23.65 c
K_{11} (CIP-440137)	4.57 (2.14) a-d	16.97 (4.10) c-f	32.55 h
K_{12} (CIP-AC)	5.23 (2.29) a-e	12.77(3.57) a-d	30.20 g
K_{13} (CIP-B19)	4.90 (2.21) a-d	15.73 (3.96) b-f	52.60 l
K_{14} (CIP-286)	6.27 (2.50) c-g	10.73 (3.24) ab	37.95 j
K_{15} (CIP-287)	5.37 (2.28) a-e	15.17 (3.88) b-f	38.65 j
K_{16} (CIP-GA)	5.20 (2.28) a-e	21.3 (4.57) f	30.25 g
K_{17} (SARI)	8.30 (2.87) g	15.40 (3.89) b-f	21.55 b
K_{18} (CIP-W)	8.73 (2.95) g	15.97 (3.99) c-f	30.50 g
K_{19} (CIP-W104)	6.50 (2.54) d-g	9.73 (3.11) a	41.65 k
K_{20} (Saree Cream)	4.20 (2.04) a-c	17.83 (4.21) d-f	17.00 a
K_{21} (Saree Orange)	5.33 (2.30) a-e	18.33 (4.28) d-f	27.50 d-f
K_{22} (Saree Purple)	5.87 (2.42) b-f	21.20 (4.60) f	29.15 fg
K_{23} (Saree Yellow)	5.03 (2.24) a-e	17.47 (4.18) d-f	18.10 a
K_{24} (Bener Meriah Yellow)	4.57 (2.12) a-d	19.00 (4.33) ef	39.80 j

Description: The number followed by the same letter in the same column is not significantly different at 5% confidential level of the DMRT test. The number (...) transformation value $\sqrt{x}$

The longest sweet potato tuber was found in clone K_{22} (Saree Purple) which is not significantly different from clones K_4 (CIP-513), K_8 (CIP-W86P), K_9 (CIP-B9), K_{11} (CIP-440137), K_{13} (CIP- B21), K_{15} (CIP-287), K_{16} (CIP-GA), K_{17} (SARI), K_{18} (CIP-W), K_{20} (Saree Cream), K_{21} (Saree Orange), K_{23} (Saree Yellow), and K_{24} (Bener Meriah Yellow). While the shortest sweet potato tuber was found in clones K_{19} (CIP-W104) which is not significantly different from clones K_1 (CIP-LSQ), K_2 (CIP-1945), K_3 (CIP-MAN), K_5 (CIP-CER), K_6 (CIP-BDG), K_7 (CIP-WHI-5), K_{10} (CIP-204), K_{12} (CIP-AC), and K_{14} (CIP-286). The largest and longest tubers were K_4 (CIP-513), K_9 (CIP-B9) and K_{17} (SARI) clusters with average diameter of 83.6 mm and tuber length of 178.2 mm. According to United States Department of Agricultural (USDA), this clone similar to U.S. No 1 grade and considered as an excellent class, with its desirable size for processing. The average diameter and length of tubers of these clones were also higher than the results obtained in previous study [9] presented measurements of agricultural products and reported bulk density of 1.12 g cm-3 for potato the graded potato between 57 and 69 mm. While the shortest and smallest tubers were K_2 (CIP-1945), K_3 (CIP-MAN) and K_5 (CIP-CER) with average diameter of 48.5 mm and length of 121.2 mm.

The diameter, length, and thickness of the tubers are among important physical characters of sweet potato. This is a very important parameter in the agronomy production in terms of grading, handling, processing and packaging systems, in addition to the size and weight of the production volume [10], [11]. The variation among the cultivars can be attributed to variation in size, shape, difference in agro - climatic conditions and difference in rate of absorption of nutrients that affects the growth of tubers [12]-[14]. These variations could be due to genotype and environmental conditions during growth period [12], [15]. Varietal difference is one of the most important factor that affects the physical parameters of tubers. In addition, there were also significant effects of land preparation methods on tuber length, with the longest tuber length recorded for sweet potato vines grown on plots with ploughing, harrowing and ridging [16].

The highest dry matters of tubers was obtained in K_5 (CIP CER) of 69.10% and significantly different from K_1 (CIP LSQ) and K_{13} (CIP B19), each of 51.35% and 52.60%. This results are higher than the highest dry matter content under the studies of Kyukei No: 63 (51.1%) and Istanköy (44.2%) in Turkey [17]. Dry matter contents obtained in this study were also considerably higher than that reported by Caliscan [18]. It is reported that high dry matter content is an important characteristic of a good sweet potato variety [19] and [2]. Dry matter content above 25% is important for farmers in adopting a new variety of sweet potato. For industrial use of sweet potato varieties with a dry matter content that is above 30% of fresh root weight is required [20].

High dry matter content is also the main characteristic preferred by consumers and processors of sweet potato. The development of a new variety of sweet potato with high dry matter content requires efficient methods of crossing, selection of clones from recombined parents and evaluation of the effects of genetic by environment interactions [20]. However, [21] reported that smaller tubers may produce higher dry matter and starch than the larger ones. More dry matter and starch were accumulated during the dry season than the wet season. The production of sweet potato tubers with high dry matter and starch content for industrial processing could be achieved with the use of irrigation facilities during the dry season. The higher dry matters contents of this study may be influenced by cultivation in the dry season.

Table 3. Average L (brightness), a (red), b (yellow) values in sweet potato tubers according to type of clones

Clones	Physical Characteristics Analysis (Colour)		
	L Value (Brightness))	Value of *a* (Red)	Value of *b* (Yellow)
K_1 (CIP-LSQ)	94.70 (9.73) j	10,75 (3,27) b	40,10 (6,33) n
K_2 (CIP-1945)	76.69 (8.76) b	27,50 (5,24) gh	14,80 (3,85) h
K_3 (CIP-MAN)	89.26 (9.45)gh	11,25 (3,35) bc	21,00 (4,59) j
K_4 (CIP-513)	84.66(9.20)d-f	28,75 (5,36) gh	12,60 (3,55) g
K_5 (CIP-CER)	77.00 (8.78) b	16,25 (4,03) de	10,80 (3,28) e-g
K_6 (CIP-BDG)	73,48 (8,57) a	16,00 (4,00) de	9,60 (3,10) d-f
K_7 (CIP-WHI5)	90,75 (9,53) hi	7,00 (2,65) a	31,50 (5,61) l
K_8 (CIP-W86P)	84,55(9,20)d-f	14,25 (3,77) b-d	24,70 (4,97) k
K_9 (CIP-B9)	81,21 (9,01) c	10,75 (3,28) b	21,00 (4,58) j
K_{10} (CIP-204)	100,29 (10,02)k	6,00 (2,45) a	30,20 (5,50) l
K_{11} (CIP-440137)	81,60 (9,04) c	28,25 (5,32) gh	9,10 (3,02) de
K_{12} (CIP-AC)	77,89 (8,83) b	20,50 (4,53) ef	19,90 (4,46) ij
K_{13} (CIP-B19)	88,36 (9,40)gh	15,50 (3,93) c-e	1,30 (1,14) a
K_{14} (CIP-286)	95,39 (9,77) j	25,00 (5,00) f-h	2,40 (1,55) b
K_{15} (CIP-287)	83,04 (9,11)cd	29,50 (5,44) gh	18,20 (4,27) i
K_{16} (CIP-GA)	86,58(9,31)e-g	23,00 (4,80) fg	8,70 (2,95) d
K_{17} (SARI)	88,79 (9,43)gh	23,00 (4,80) fg	7,90 (2,81) d
K_{18} (CIP-W)	83,73(9,15)c-e	24,75 (4,98) f-h	5,00 (2,24) c
K_{19} (CIP-W104)	76,33 (8,74) b	28,25 (5,32) gh	11,40 (3,38) fg
K_{20} (Saree Cream)	82,45 (9,08)cd	30,50 (5,52) h	15,10 (3,88) h
K_{21} (Saree Orange)	94,70 (9,73) j	14,25 (3,78) b-d	34,90 (5,91) m
K_{22} (Saree Purple)	93,34 (9,66) ij	10,50 (3,24) b	35,80 (5,98) m
K_{23} (Saree Yellow)	102,81 (10,14)k	5,75 (2,25) a	36,90 (6,08) mn
K_{24} (BM Yellow)	87,13 (9,34) fg	16,25 (4,02)de	29,20 (5,41) l

Description: The number followed by the same letter in the same column is not significantly different at the 0.05% level of the DMRT test. The number (...) transformation value $\sqrt{x}$

Table 3 shows that the highest *L* value (brightness) was found in K_{23} (Saree Yellow) with yellow tuber flesh that was not significantly different from clone K_{10} (CIP-204), while the least bright is found in K_6 (CIP -BDG) with dark purple tuber. The value of *a* that denotes the red green chromatic colour. The highest *a* (red) value of sweet potato tubers was found in K_{20} (Saree Cream) with creamy flesh colour that is not significantly different from K_2 (CIP-1945), K_4 (CIP-513), K_{11} (CIP-440137), K_{14} (CIP-286), K_{15} (CIP-287), K_{18} (CIP-W), and K_{19} (CIP-W104). While the lowest a (red) value was found in K_{23} (Saree Yellow) which is not significantly different from K_7 (CIP-WHI-5) and K_{10} (CIP-204) with white flesh colour in average.

The value of *b* shows the blue yellow chromatic colour. The highest value of *b* (yellow) was found in K_1 (CIP-LSQ) which is not significantly different from K_{23} (Saree Yellow), while the lowest is in K_{13} (CIP-B19).

The colour of sweet potato tubers as well as the colour of the skin differ among clones, this is due to the genetic differences. Colour of sweet potato skin varies and is not always the same with the colour of its tuber flash. Tuber skin may be white, yellow, purple, orange, and red, while the flesh colour may be white, yellow, orange, and purple [22].

Orange and yellow fleshed cultivars recorded higher total carotenoids, β-carotene, and β-carotene-5,6-monoepoxide contents than cream- and white-fleshed cultivars [23]. It has been reported that beta-carotene, a major precursor of vitamin A, serves as an important nutritional component in foods, as [24] and that it has anti-cancer, anti-aging, and anti-ulcer properties, Due to their antioxidative activity [25]. When a food or product has an appealing colour it may cause a person's appetite to try the product because colour is one of the visual profiles that becomes the consumer's first impression of a product [26].

IV. CONCLUSION

Sweet potato tubers that have the largest diameter and tuber length are found in CIP-513, CIP-B9, SARI, and CIP-W clones. The highest L (brightness) values are in the CIP-204 and Saree yellow clones. The a (red) values were in CIP-1945, CIP-513, CIP-440137, CIP-286, CIP-287, CIP-W, CIP-W104 , Cream saree, and b (yellow) value were in CIP-LSQ and Saree yellow clones. The highest dry matter content was found in CIP-CER (69.10%).

REFERENCES

[1] A. Azhar, and M.K.Handy,"Alcohol fermentation of *sweet potato* L. acid hydrolysis and factors involved", *Biotechnol Bioeng*, vol, 23, pp. 879-886, 1981.

[2] Z. Mwanga, M. Mataa, and M. Msabaha, "Quality and yield stability of orange fleshed sweetpotato (*Ipomoea batatas*) varieties grown in different agro-ecologies", *Afr Crop Sci J*, vol. 8, pp. 339-345, 2007.

[3] Balitkabi (Balai Penelitian Tanaman Aneka Kacang dan Umbi), "Khasiat ubi jalar orange untuk mata". *Berita*, Balitkabi, Litbang. Pertanian.go.id, 2015.

[4] Darmadjati, and Sarmento. "Laporan penelitian pengembangan model agroindustri tepung cassava di Pedesaan". *Balittan*. Sukamandi, 1991.

[5] R. Soenarjo, "Potensi ubi jalar sebagai bahah baku gula fruktosa. *Jurnal Balai Penelitian dan Perkembangan Pertanian*, vol 3. no. 1, pp. 6-11, 1984.

[6] M. Mebratu, "Sweet potato (*Ipomoea batatas* (L.) Lam.) growth and yield as affected by planting density and cultivar in Wolaita Soddo. Southern Ethiopia". Unpublished M. Sc. Thesis, Haramaya University, Haramaya, 67 pp, 2014.

[7] E. U. Mbah, O. Oke Okoro. "Relationship between some growth parameters, dry matter content and yield of some sweet potato genotypes grown under rain-fed weathered Ultisol in the humid tropics", *Journal of Agronomy*, vol. 14, pp. 121-129, 2015.

[8] O.S. Hutabarat, "Kajian pengurangan gejala chilling injury tomat yang disimpan pada suhu rendah", Tesis, Institut Pertanian Bogor, Bogor, 2008.

[9] H. Stroshine, and H. Hammand, *Physical properties of agricultural and food materials*, University of Purdue, *Teaching Manual*, 1994.

[10] N. N. Mohsenin. *Physical properties of plant and animal materials*, Gordon and Breach Science Publisher, 20-89, 1986.

[11] K. Peleg. "Produce handling, packaging and distribution", Westport, Connecticut, 55-95, 1985.

[12] G. Lisinska, and W. Leszczynski, *Potato Science and Technology*, America, New York, Elsevier Science Publisher Ltd, pp. 11-202, 1989.

[13] G.O. Abong. M.W. Okoth, J.K. Imugi, and J. N. Kabira, "Evaluation of selected Kenya potato cultivars for processing into potato crisps", *Agric. Biol. J. North America*, vol .1, no. 5, pp. 886-893, 2010.

[14] D. R. Sood, S. Kalim, and Shilpa, "Biochemical evaluation of potato tubers and peels", *Indian J. Nutr. Dieted*, vol. 45, pp. 410-420, 2008.

[15] A. Tabatabaeefar, "Size and shape of potato tuber", *Int. Agrophysics*, vol. 16, pp. 301-305, 2002.

[16] O. E. Akinboye, K. O. Oyekale, and E. A. Aiyelari. "Effects of land preparation methods on the growth and yields of sweet potato (*Ipomoea batatas* LAM), *International Journal of Research in Agriculture and Forestry*, vol. 2, no. 1, pp. 33-39, 2015.

[17] Z. Yildirim, O. Tokusoglu, and G. Ozturk, "Determination of sweet potato (*Ipomoea batatas* (L.) Lam.) genotypes suitable to the Aegean region of Turkey", *Turkish Journal of Field Crops*, vol. 16, no. 1, pp. 48-53, 2011.

[18] M.E. Caliskan, E. Mert, E. Gunel, N. Isler, E. O. Sarıhan, "A research on adaptation of sweet potato (*Ipomea batata* (L.) Lam) genotypes having different origin to Hatay ecological conditions". 3rd, *Congres of Field Crops,* Adana (in Turkish), 1999, pp. 15-18.

[19] G. A. Slafer, R. Savin, "Source sink relationships and grain mass at different positions within the spike in wheat", *Field Crops Res*, vol. 37, pp. 39-49, 1994.

[20] P. Rukundo, H. Shimelis, M. Laing, and D. Gahakwa, "Storage root formation, dry matter synthesis, accumulation and genetics in sweet potato", *Australian Journal of Crop Science*, vol. 7, no. 13, pp. 2054-2061, 2013.

[21] O. A. T. Namo, and O. M. Babalola, " Season and tuber size affect dry matter, specific gravity and starch content of sweet potato (*Ipomoea batatas* (L.) Lam.) in Jos-Plateu, North Central Nigeria", *International Invention Journal of Agricultural and Soil Science*, vol. 4, no. 3, pp. 27-36. Apr. 2016.

[22] D. Juanda, and B. Cahyono, "*Budidaya dan Analisis Usaha tani Ubijalar*", Yogyakarta, Penerbit Kanisius, 2000.

[23] L. M. K'osambo, E. E. Carey, A. K. Misra, J. Wilkes and V. Hagenimana, "Influence of age, farming site, and boiling on pro-vitamin A content in sweet potato (*Ipomoea batatas* (L.) Lam.) storage roots," *Journal of Food Composition and Analysis*, vol. 11, no. 4, pp. 305- 321, 1998.

[24] L. A. Chandler and S. J. Schwartz, "Isomerization and loss of trans-β-carotene in sweet potato as affected by processing treatments," *Journal of Agriculture and Food Chemistry*, vol. 36, no. 1, pp. 129-133, 1988.

[25] J. A. Woolfe, *Sweetpotato*: *Past and Present*," in *An Untapped Food Resource*, J. A. Woolfe, Ed., New York, Cambridge University Press, pp. 15-40, 1992.

[26] P. Kartika, Hastuti, and W. Supartono, *Pedoman Uji Inderawi Bahan Pangan*, Universitas Gajah Mada, Yogyakarta, 1988.

C.8

L-ASCORBIC ACID DETERMINATION USING FTIR-ATR TERAHERTZ SPECTROSCOPY COMBINED WITH PLS2 REGRESSION

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ABSTRACT

In this research, an explicit method of linear correction for temperature compensation was conducted for L-AA determination using Fourier transform infrared-attenuated total reflectance terahertz (FTIR-ATR THz) spectroscopy. The explicit method was done by direct inclusion of temperature as y-variable in the PLS2 regression. The result showed that using explicit method the quality of the developed calibration model for L-AA determination is a little bit superior with RMSECV=1.387% (w/w) and SDR_{cv}= 4.311. The performance of the PLS2 calibration model for L-AA determination with temperature compensation was quite good and able to predict the L-AA in three different temperatures with relatively high R^2_{pred} values. All prediction also resulted in low bias and SEP values.

Keywords : PLS2 regression, explicit method, global calibration model, FTIR-ATR terahertz spectroscopy, temperature compensation.

I. INTRODUCTION

In the previous reported study [1], it has been discussed the use of implicit method to compensate the influence of temperatures on L-AA determination by developing a global calibration model instead of using local calibration model. Global calibration models try to include implicitly the variation due to external effects such as temperature variations of the samples in the model, in much the same way as unknown chemical interferents can be included in an inverse calibration model. As long as the interfering variation is present in the calibration set, an inverse calibration model can, in the ideal case of additivity and linearity, easily correct for the variation due to the unknown interferents. It is assumed in global calibration models that the new sources of spectral variation can be modeled by including a limited number of additional PLS factors (resulted in more complex model) [2], [3].

In this present study, another way to compensate the influence of temperatures on L-AA determination will be presented. In this method, we add directly the temperatures as predicted variable results in an X block containing only the THz spectra and a Y block containing the temperature and L-AA. This method was called as an explicit method of temperature compensation [4], [5]. The explicit inclusion of the temperature into the calibration model is expected to improve the accuracy of L-AA determination. In this study explicit inclusion of the temperature is done by direct inclusion in the calibration models.

II. MATERIALS AND METHODS

A. Samples

55 samples of L-AA solutions at three different temperatures (22, 31 and 40°C) were used as samples. The samples were divided into two groups, calibration and validation as well as prediction sample set. The preparation of L-AA solution was as explained in previous study [1]. Table 1 shows the characteristic of the two sample sets in detail.

B. THz spectral acquisition

The THz spectral data of L-AA solution were acquired using an FTIR-ATR-THz based spectrometer equipped with a temperature controller (FARIS-1S, JASCO Co., Tokyo, Japan) (See reference [1] for detail).

Table 1. Characteristics of samples set used for developing calibration and validation model and for prediction of L-AA and temperature determination in 22, 31 and 40°C

Prediction items	Characteristics of samples	Calibration and Validation Set	Prediction Set
L-AA	Samples	105	51
	Range	1.4414 ~ 21.3150	2.5586 ~ 21.2575
	Mean	11.53432	11.81985
	S.D	5.980041	5.855108
Temperature	Samples	105	51
	Range	22.1~ 41.9	22.1 ~ 41.9
	Mean	31.54858	31.61961
	S.D	7.522661	7.452087

L-AA is expressed as %(mass/mass). Temperature is expressed as degree Celsius (°C).

C. Temperature as Y variable in PLS2

Adding the temperature as predicted variable results in an X block containing only the spectra and a Y block containing the temperature and L-AA concentration (See Fig. 1). The simultaneous prediction of the y variable and the temperature is seen as a way to enable the model to identify the spectral regions which are temperature dependent. This is in line with inverse calibration, where the underlying variables causing the variation in the spectra are collected in the Y block. In this case the temperature is also causing variation in the spectra. Note that the temperature of the unknown sample does not have to be known; it will be predicted from the spectrum. The calibration method used is PLS2, where the suffix "2" indicates that there is more than one variable in the Y block. PLS2 uses the fact that there is correlation in the Y block or between the dependent variables (between L-AA and temperature). PLS2 might give poor results if this correlation is not present in the dataset [6].

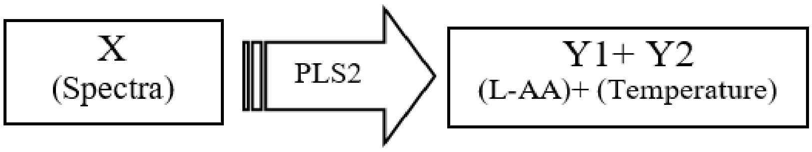

Fig. 1. PLS2 on determination of L-AA and temperature.

The calibration model was evaluated based on the following parameter: number of PLS factors, coefficient of determination (R^2_{cal}), the RMSECV, and the standard deviation ratio (SDR) of calibration (SDR_{cv}). To evaluate the prediction performance of the developed calibration model, the following parameters were used: the coefficient of determination in prediction (R^2_{pred}), the root mean square error of prediction (RMSEP), bias between the actual and predicted value, the bias-corrected standard error of prediction (SEP) and the standard deviation ratio (SDR) of prediction (SDR_{pred}).

III. RESULTS AND DISCUSSION

A. Influence of temperature on the L-AA spectra

To show the influence of temperature on L-AA spectra data, a plot of PCA result was demonstrated. Fig. 2 shows the score of PC1 and PC2 of the result of PCA on spectra dataset. Here, PC1 and PC2 in total could be able to explain more than 95% of the variation on the L-AA spectral data. From Fig. 2, the temperature effect on the spectra can clearly be seen.

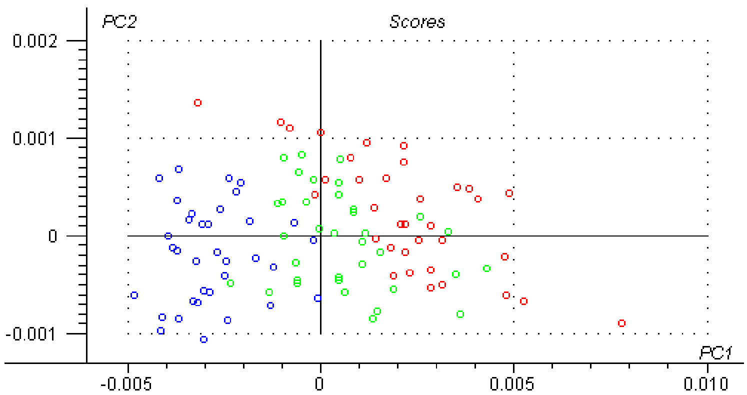

Fig. 2. PCA plot for temperature (blue for 22°C, green for 31°C and red for 40°C)

B. Developing calibration model for L-AA and temperature

Using PLS2, a calibration model for L-AA determination and temperature were developed on Savitzky-Golay smoothing spectra (with 9 segments). It has to be noted that in block Y, there are two variables (L-AA and temperature) which has different scale. For this reason, before developing calibration model, the two variables were scaled by dividing the variables with its standard deviations (S.D).

To determine the optimal number of PLS factors, the values of RMSECV was used. The lowest RMSECV was corresponding with the optimal PLS factor. Fig. 3 shows the plot of RMSECV and PLS factor for L-AA and Fig. 4 shows the plot of RMSECV and PLS factor for temperature calibration model. It can be seen that for L-AA determination the optimal PLS factor was 5 while for temperature determination the optimal PLS factor was 4.

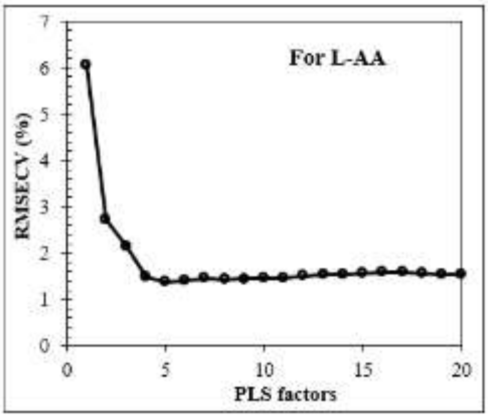

Fig. 3. Plot of PLS factors versus RMSECV for determination of L-AA.

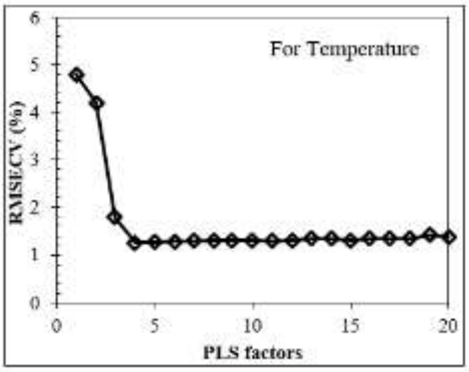

Fig. 4. Plot of PLS factors versus RMSECV for determination of temperature.

Fig. 5 shows the scatter plot of actual and predicted L-AA using 5 PLS factor for calibration and validation, respectively. The calibration resulted in high coefficient of determination (R^2_{cal}=0.954). Low RMSECV could be obtained and it therefore resulted in high SDR_{cv} value. Using implicit method, the best calibration model for L-AA determination using combination of three different temperature (22, 31 and 40°C) resulted in RMSECV=1.3890 and SDR_{cv}= 4.305 (See reference [1]). Recent result using explicit method shows that the quality of the developed calibration model for L-AA determination is a little bit superior with RMSECV=1.387112 and SDR_{cv}= 4.311.

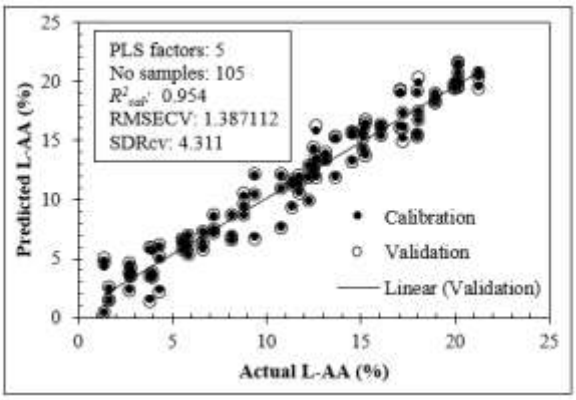

Fig. 5. Scatter plot between actual and predicted L-AA for calibration and validation using PLS2 regression method

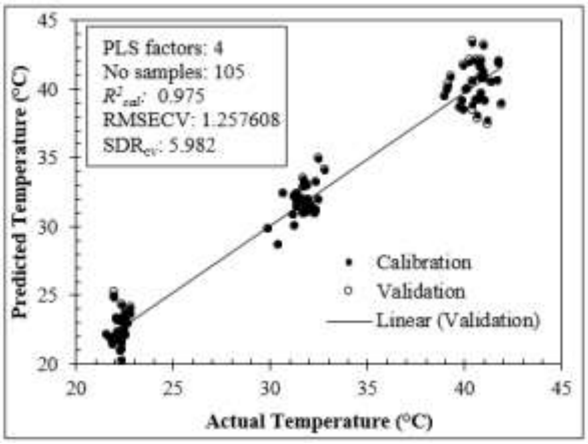

Fig. 6. Scatter plot between actual and predicted temperature for calibration and validation using PLS2 regression method

C. Prediction of L-AA and temperature

Using the developed calibration model, a prediction for L-AA and temperature was done using combined prediction sample set (51 samples). Fig. 7 shows the scatter plot of actual and predicted L-AA in the prediction result. We can see here that both SEP and bias was low. It can be seen that using PLS2 we could succeeded to compensate the influence of temperature variations on L-AA determination.

In order to compare the prediction performance of temperature correction using PLS2 in this present study and that of using PLS1 in previous reported study [1], the prediction using PLS2 was also done independently for each sample temperature (22, 31 and 40°C) . The results were shown in Table 2.

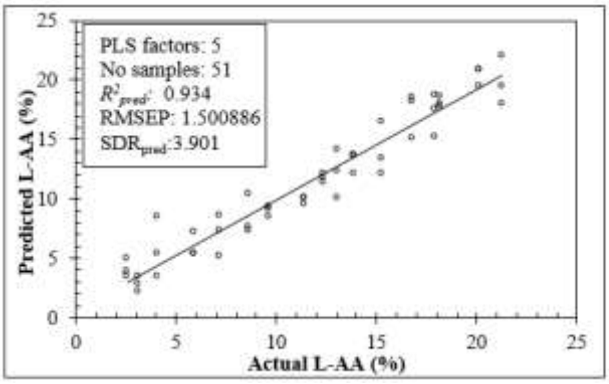

Fig. 7. Scatter plot between actual and predicted L-AA for prediction using PLS2 regression method.

The performance of the PLS2 calibration model for L-AA determination with temperature compensation was quite good and able to predict the L-AA in three different temperatures with relatively high R^2_{pred} values. All predictions also resulted in low bias and SEP values.

Table 3 shows the comparison between implicit (as explained in detail in reference [1]) and explicit method (in this present study) for linear correction of temperature influence on L-AA determination using FTIR-ATR THz spectroscopy. Here, we compared the prediction performance of implicit and explicit method for linear correction of temperatures in the term of RMSEP (%) and SDR_{pred} values.

Table 2. The performance of the PLS2 calibration model with temperature compensation for L-AA prediction using uncombined prediction sample set using the best calibration model of Savitzky-Golay smoothing spectra in the range 20-450 cm^{-1}.

Calibration model	Prediction Sample Set Temperature	R^2_{pred}	SEP	Bias	RMSEP	SDR_{pred}
22,31 and 40°C	22°C	0.955	1.271	0.119	1.239	4.822
Global calibration	31°C	0.906	1.861	-0.709	1.940	3.081
with inclusion temperature (PLS2)	40°C	0.957	1.244	-0.051	1.208	4.945

Table 3. Effect of different temperature inclusion methods on the prediction of the L-AA determination using FTIR-ATR THz spectroscopy at temperature 22, 31 and 40°C.

Temperature inclusion methods	Prediction results					
	RMSEP (%)			SDR_{pred}		
	22°C	31°C	40°C	22°C	31°C	40°C
Global model using implicit methods (no temperature inclusion)						
Combined 2 temperature (22 and 31 °C)	1.310	1.858	1.408	4.562	3.216	4.244
Combined 2 temperature (31 and 40°C)	1.216	1.908	1.262	4.914	3.132	4.735
Combined 2 temperature (22 and 40°C)	1.234	2.011	1.152	4.843	2.972	5.187
Combined 3 temperature (22, 31 and 40°C)	1.240	1.940	1.209	4.820	3.080	4.942
Global model using explicit method						
Temperature as y-variable using PLS2	1.239	1.940	1.208	4.822	3.081	4.945

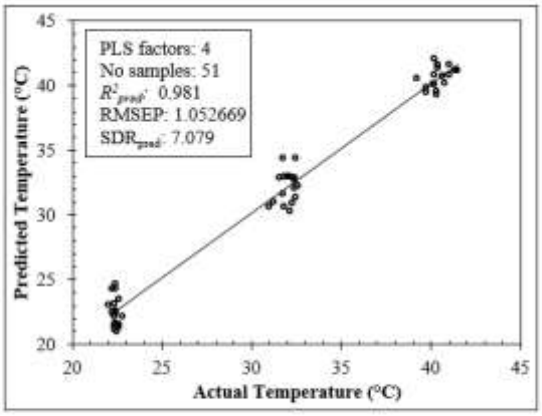

Fig. 8. Scatter plot between actual and predicted temperature for prediction using PLS2 regression method.

For the explicit temperature inclusion techniques using PLS2 the prediction results were comparable to those for the global temperature calibration model (implicit method using PLS1) (in term of RMSEP and SDR_{pred}) (See Table 3). In the previous report, Peirs *et al.* [5] also showed the similar result.

The prediction result for temperature was also acceptable with high coefficient of determination (R^2_{pred}= 0.981) (See Fig. 8). The RMSEP = 1.053 was also quite low and hence resulted in high SDR_{pred} value (SDR_{pred}= 7.079).

IV. CONCLUSION

To summarize, it has been presented in this present study, a potential use of explicit method using PLS2 for L-AA determination with temperature compensation using FTIR-ATR THz spectroscopy. It was shown that using explicit method the quality of the developed calibration model for L-AA determination is a little bit superior with RMSECV=1.387112 and SDR_{cv}= 4.311. The performance of the PLS2 calibration model for L-AA determination with temperature compensation was quite good and able to predict the L-AA in three different temperatures with relatively high R^2_{pred} values. All prediction also resulted in low bias and SEP values. It can be concluded that linear correction of for fluctuation of temperature in L-AA determination using FTIR-ATR THz spectroscopy can be constructed using a direct inclusion techniques in which temperature was as y-variable in PLS2 regression method. The comparable result of PLS2 in which the two dependent variables of L-AA and temperature simultaneously predicted proved that there is a strong correlation between L-AA and temperature [7].

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REFERENCES

[1] M. Yulia, D. Suhandy, N. Kondo, and Y. Ogawa, "Investigation on the influence of temperature in l-ascorbic acid determination using FTIR-ATR terahertz spectroscopy: calibration model with temperature compensation," *Engineering in Agriculture Environment and Food*, vol. 7, pp. 148–154, 2014.

[2] F. Wülfert, W.T. Kok, and A.K. Smilde, "Influence of temperature on vibrational spectra and consequences for the predictive ability of multivariate models," *Anal. Chem.*, vol. 70, pp. 1761–1767, 1998.
[3] H. Swierenga, F. Wülfert, O. E. de Nord, A. P. de Weijer, A.K. Smilde, and L. M. C. Buydens, "Development of robust calibration models in near infra-red spectrometric applications," *Anal. Chim. Acta,* vol. 411, pp.121–135, 2000.
[4] F. Wülfert, W.T. Kok, O.E. de Nord, and A.K. Smilde, "Correction of temperature-induced spectral variation by continuous piecewise direct standardization," *Anal. Chem.*, vol. 72, pp. 1639–1644, 2000.
[5] A. Peirs, N. Scheerlinck, and B. M. Nicolai, "Temperature compensation for near infrared reflectance measurement of apple fruit soluble solids contents," *Postharvest Biol. Technol.*, vol. 30, pp.233–248, 2003.
[6] H. Martens, and T. Naes, "Multivariate Calibration," Wiley, Chichester, UK, 419 pp., 1998.
[7] A.M.K. Pedro, and M. M.C. Ferreira, "Simultaneously calibrating solids, sugars and acidity of tomato products using PLS2 and NIR spectroscopy," *Anal. Chim. Acta*, vol. 595, pp. 221–227, 2007.

C.9

ON-LINE MEASURING GRAIN MOISTURE CONTENT USING MICROWAVE PRINCIPLES

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ABSTRACT

Moisture content is used as an indicator for determining the proper harvesting period and the potential for safe storage. It has a marked influence on rice quality. This paper presents a new method of microwave sensors to measure instantaneous moisture content of the rice grain on-the-go monitoring system. The use of microwave technology has been considered in the study because of it high precision for on-line measurements of grain moisture content in replacement of dielectric technology for the capacitance type sensor for the measurement of grain moisture content. Microwave moisture sensor works on principle of absorption of the microwave energy into the material. Grain is passed across the ceramic face of a sensor which radiates an extremely low powered electromagnetic microwave field. The measured voltages of the microwave sensor in estimating the instantaneous and non-destructive grain moisture contents were evaluated for rice moisture contents in the range of 13% to 29%.

Keywords : Rice Grain, Instantaneous Moisture Content, Moisture Content, Microwave Sensor.

I. INTRODUCTION

Moisture content is an important factor to prevent the rice from breakage during the milling process.

It is also an important factor in determining the market price of agricultural commodities. Most of the available and commonly applied methods for moisture storage and transport investigation allow for static and steady state conditions, respectively. Most moisture transport processes under real time climatic condition. A method based on non-destructive microwave characterization is used for simultaneous determination of the bulk density and moisture content of rice grain. This method can be applied regardless of the measurement technique and thus considerably simplifies the calibration procedure. Dielectric properties of materials can be useful for non-destructive, continuous determination of important characteristics such as the moisture content and bulk density of agricultural and food products. The dielectric properties are intrinsic properties that describe the wave–matter interaction and, therefore, they are dependent on internal properties of the material which include its moisture content, salt content, density and temperature (Trabelsi and Nelson, 2004).

A method for simultaneous and independent on line determination of bulk density and moisture content of a particular material by measurements of the relative complex permittivity has been proposed. The bulk density is determined, based on representation in the complex plane of relative complex permittivity normalized to bulk density. A new density independent function on dielectric properties is used for moisture content determination. The density independence calibration functions are needed because bulk density fluctuation cause significant errors in moisture content determination with various materials (Putri, et al., 2016).. Result obtained from measurements on wheat over broad ranges of microwave frequency, temperatures, densities, and moisture content are presented by Thabelsi et al. (1998).

Okabe et al. (1973) introduced a new method for measuring the grain moisture contents by using microwaves of 9-4GHz, with unhulled and ungrounded grains. The moisture content could be measured continuously. Moreover, the measurement could be carried out quite independently of the varieties of grains as well as the moisture distribution in the grain that has been dried by hot air. The results showed that the accuracy is high having measurement errors being less than ±5% for both rice and wheat having moisture contents in the range of 10 to 30% on wet basis. Trabelsi and Nelson (2007) used dielectric-based method to measure nondestructively and simultaneously bulk density and moisture content of shelled peanuts at microwave frequencies ranges from 7 to 12GHz and the temperature of 24°C. In total, two independent bulk density calibration equations and two independent moisture content calibration equations were obtained. Each calibration equation of calibration at several microwave frequencies showed that bulk density can be determined with the same accuracy, about 1.7% relative error, with either method.

Rogers (1987) studied the two-variable microwave technique for density-independent in-line moisture content measurement of several brands of instant coffee and milk powder. Results from the study showed that the technique was capable of providing a moisture measurement significantly less density-dependent than the usual microwave absorption method, A further refinement of the technique is reported, which not only eliminates the residual density dependence, and thus the error in the moisture measurement resulting from density variations, but also yields a simultaneous in-line determination of the bulk density of the product. The influence of temperature, solids composition and particle size of the coffee and milk powders on the calibration characteristics is also reported.

Trabelsi and Nelson (2010) developed a prototype low cost microwave sensor operating at 5.8 GHz for instantaneous and non-destructive determination of moisture content and bulk density of granular and particle materials. The microwave sensor utilizes the principle of free space transmission for measuring attenuation and phase shift caused by the material, and determines the real and imaginary components of the relative complex permittivity. The researcher claimed that in order to determination of moisture content and bulk density; several algorithms were required to determine of attenuation and phase shift through the material and its dielectric properties.

The use of microwave technology has been considered in the study because of it high precision for on-line measurements of grain moisture content in replacement of dielectric technology for the capacitance type sensor for the measurement of grain moisture content. This paper presents a new method of microwave sensors to measure instantaneous moisture content of the rice grain on-the-go monitoring system.

II. MATERIALS AND METHODS

A. Data collection

SWR M-Sens 2 moisture sensor was used for measuring moisture content of the clean while conveying in the grain levelling auger before dropping into the combine grain tank during the harvesting operation. The sensor has measurement range of 0 to 100% at ± 0.1% accuracy with power consumption of 0.6W and response time of 0.1sec. The sensor working ambient temperature range is 0 °C to +80 °C. This unit is operated at an input voltage 24V to give an output frequency signal having a range of 4 to 20mA. Using a 500Ω resistance, the output frequency signal is changed voltage having a range of 1 to 10V. The unit working ambient temperature range is -10 °C to +45 °C. This SWR moisture evaluation unit was connected to input channel AI4 of NI 9221 I/O module of the embedded system. (Putri et al., 2014)

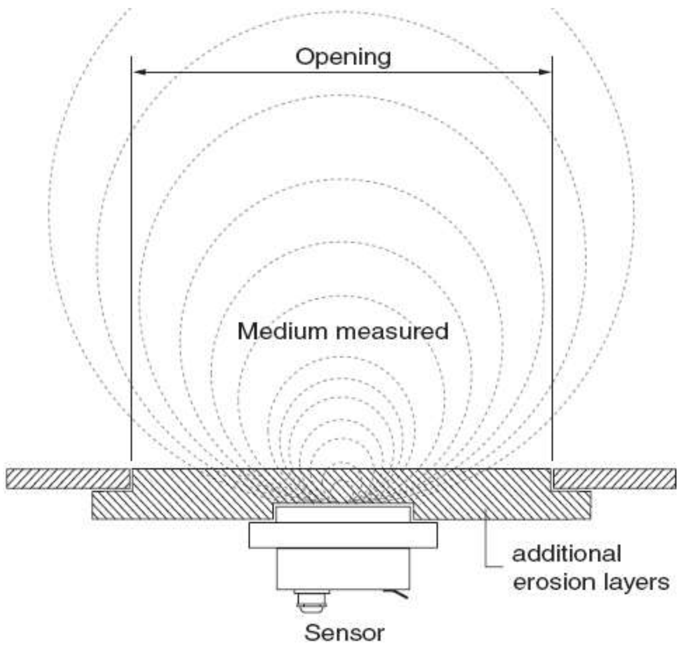

Fig. 1. Moisture Content Measurement

Fig. 1 shows the basic principle of operation for grain moisture content sensor. Microwave moisture sensor works on principle of absorption of the microwave energy into the material. Grain is passed across the ceramic face of a sensor which radiates an extremely low powered electromagnetic microwave field. The moisture content measurement uses the absorption of microwave energy corresponding to the rotational energy of the water molecules. When the electromagnetic field is applied to a dielectric material, electromagnetic energy is dissipated in the dielectric materials as a result of the dialectic relaxation process. Either by utilizing reflection or absorption of the microwave energy, the moisture measurements with microwave techniques can be performed. During transmission, where the substance to be analyzed is placed between the microwave emitter and detector, the microwave intensity arriving at the detector decreases with increasing of moisture. The moisture content can then be calculated by taking into account the absorption of the dry substance and some geometrical factors.

B. Simultaneous Determination of Moisture Content Using SWR M-Sens 2 microwave type moisture sensor in the laboratory

Rice variety MR 220 CL2 was obtained from the rice cultivation in Sungai Besar Selangor Malaysia. MR 220 CL2 is one of the varieties produced by the Malaysian Agricultural Research and Development Institute (MARDI). The determination of rice moisture content of can be accomplished using one of several approaching. A standard method for measuring moisture content in wheat is to oven dry the grain at temperature 130oC for 16 hour (ASAE S352, 1999). However, the oven dry method and moisture tester are single point measurements and cannot detect moisture content in instantaneous at wide view of range. Oven dry is the most time consuming among the existing method to determine moisture content. Currently the available equipment used in rice industries to measure rice moisture content is moisture meter or moisture tester. It is a portable and quick tester proved to be readable and a cheaper alternative for moisture content determination for rice, but it is limited to single point similar to oven dry method (Putri et al., 2015)..

The G-7 Grain Moisture Meter from Delmhorst having nominal range of 9 to 30% moisture content used as the first moisture content method. It has built-in correction factors for various grains such as barley, coffee, corn, flax, hay, oats, rapeseed, rough rice, sorghum, soybeans, wheat, and rye. The grain meter has built-in temperature correction over the range of 32° F to 160° F or 0oC to 37oC. For the oven drying method, a Sartorius GMBH Gottingen digital electronic balance was used for all weighing in making moisture content determinations. Each sample size of 15g was placed in moisture dishes. The grain samples with covered dishes were weight for before and after oven drying for 16 hours at the temperature of 130oC were weighed and recorded. The initial moisture content of the samples was determined by oven drying at 103 ± 1°C for 24 h (ASAE, 2009). Both methods were carried out in oder to check the accuracy of the grain moisture meter.

Grains moisture content was varied from 4% to 31% in wet basis by drying and overnight soaking the rice and then exposing the soaked rice to atmospheric conditions for a certain period of time. Next, certain amount rice was collected and mixed evenly to ensure that constant moisture content was obtained. The sensor face was pressed manually on the moist grain in a container. The voltage measurements recorded by the moisture sensor were immediately taken for about 20 s for 3 times per sample. These procedures were repeated by varying grain moisture contents. Meanwhile, the grain moisture contents were determined using the Delmhorst G-7 the grain moisture meter and oven drying method. Three samples were taken from each grain source for these measurements. The G-7 Grain Moisture Meter from Delmhorst was used as the first method to measure grain moisture. At the same time moisture content was also determine using oven drying method to check the accuracy of the G-7 Grain Moisture Meter. For oven drying, a Sarturius GMBH Gottingen digital electronic balance was used for all weighing for moisture content determinations. Each 15 g sample was placed in a moisture dish.
The percentage of grain moisture in wet basis is calculated using the following equation:

$$GM=((Mw-Md)/Ww)x\ 100\% \quad (1)$$

where :
GM = grain moisture content, %
Mw = mass of grain sample before oven drying, g
Md = mass of grain sample after oven drying, g

Measured mass grain moistures content from G-7 moisture meter and microwave moisture sensor were compared to that of the oven drying method. The test was repeated several times and finally graphs of measured moisture content G-7 against oven dry grain moisture and measured microwave sensor voltage oven dry against grain moisture were plotted.

C. Measurement Instantaneous Moisture Content Using SWR M-Sens 2 microwave type moisture sensor in the Field

Measurement of the SWR M-Sens 2 moisture sensor was also carried out in field at the grain collection point within the rice field. Immediately after harvest, lorries transported harvested rice to the collection point. Moisture content at the collection point was considered in this research due to the condition of rice suitable for the measurement process. The samples were randomly selected from the bulk of rice. The procedure for field tests was the same as for the laboratory test. The voltage measurements recorded by the moisture sensor were taken immediately for about 20 s for 3 times per sample. Meanwhile, the grain moisture contents were determined using the G-7 grain moisture meter. The difference from the laboratory approach omission of the over changing approach.

III. RESULT AND DISCUSSION

A. Simultaneous Determination of Moisture Content using SWR M-Sens 2 microwave type moisture sensor in the laboratory test

The SWR M-Sens 2 microwave type moisture sensor in laboratories equation is as follow:

$$Y = 41.55\ V \text{ with } R^2 = 0.82 \tag{2}$$

where :
Y = Grain moisture content wet basis, %
V = Measured voltage from sensor, V

The moisture sensor shows moderate measurement linearity with regression coefficients close to 1.0 as indicated in Fig. 2. The measured voltages of the moisture sensor in estimating the instantaneous grain moisture contents were evaluated for rice moisture contents in the range of 4 to 31%. During the laboratory test, the grain was soaked in a container to obtain the variations of moisture contents. The time for the soaking process was varied to obtain different moisture contents. Rewetting of grain is considered less accurate because the presence of water may exist on the surface or hull and does not readily migrate into the grain. Furthermore, there is variability with respect to the same to all grains differential rates of moisture migration into individual rice grain. Therefore, field test is essential overcome the problem in laboratories test.

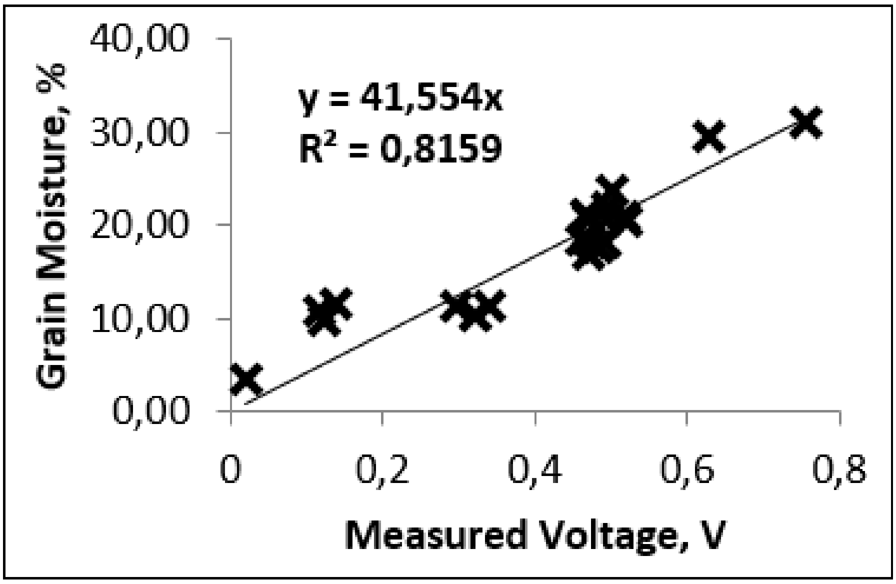

Fig. 2. Measurement of microwave type moisture sensor in the laboratories.

The oven drying method is not practical for measuring grain moisture content at the field. However, the portable G-7 grain moisture meter from Delmhors is the common in-situ measurement method for grain moisture content. Thus, measurement of the moisture meter for the field measurement of grain moisture content against the oven drying method on wet basis was necessary. The G-7 Grain Moisture Meter measurement equation as follow:

$$Y = 1.087\ X \text{ with R2} = 0.96 \tag{3}$$

where :
GM = Grain moisture measured using G-7moisture meter, web basis %
X = Grain moisture content by using oven drying method, web basis %

The G-7 Grain Moisture Meter showed excellent measurement linearity with regression coefficient close to 1.0. The G-7 moisture meter was evaluated for rice moistures content ranging from 9% to 27%. Fig. 3 shows the correlation of grain moistures measured using the oven drying method versus the G-7 moisture meter with an R^2 = 0.964 and the slope of nearly to 1. Consequently, the G-7 Grain Moisture Meter was used to determine the grain moisture content at the grain collection point for the static measurement of the SWR M-Sens 2 Microwave moisture sensor.

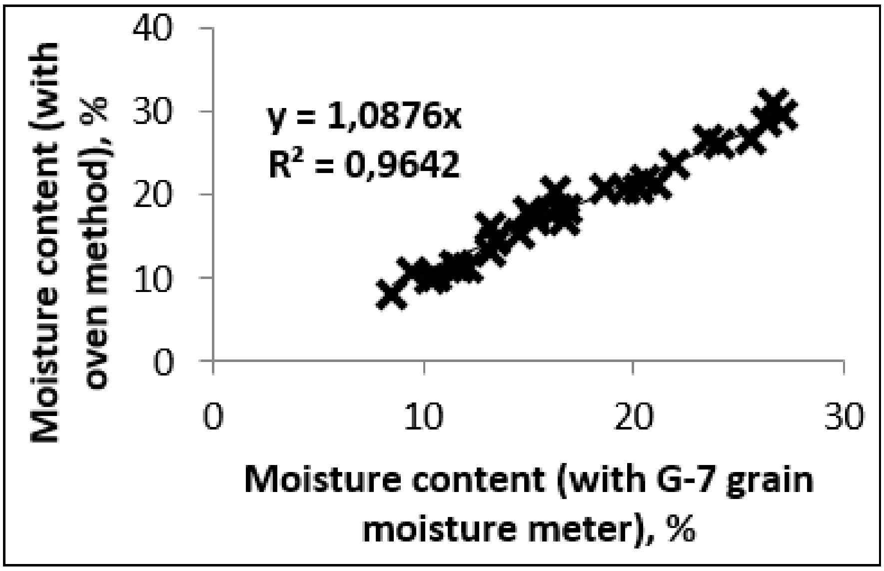

Fig. 3. The predicted moisture content the G-7 grain moisture meter versus the standard oven drying moisture content for rice grain

B. Measurement Instantaneous Moisture Content using microwave type moisture sensor in the Field

The SWR M-Sens 2 microwave type moisture sensor measurement equation is as follow:

$$Y = 22.35X\text{-}17.00 \text{ with } R2 = 0.90 \tag{4}$$

where :
Y = Grain moisture content web basis, %
X = Measured sensor voltage, V

The SWR M-Sens 2 microwave type moisture sensor showed strong measurement linearity with regression coefficient close to 1.0. This resulting measurement equation could improve the accuracy of microwave sensor when deployed in LabView. The measured voltages of the microwave moisture sensor evaluated over the moisture content range of 13% to 29% (Fig.s 4). This equation was deployed in the LabView program for the real time measurement of instantaneous moisture content during the harvesting operation with the combine.

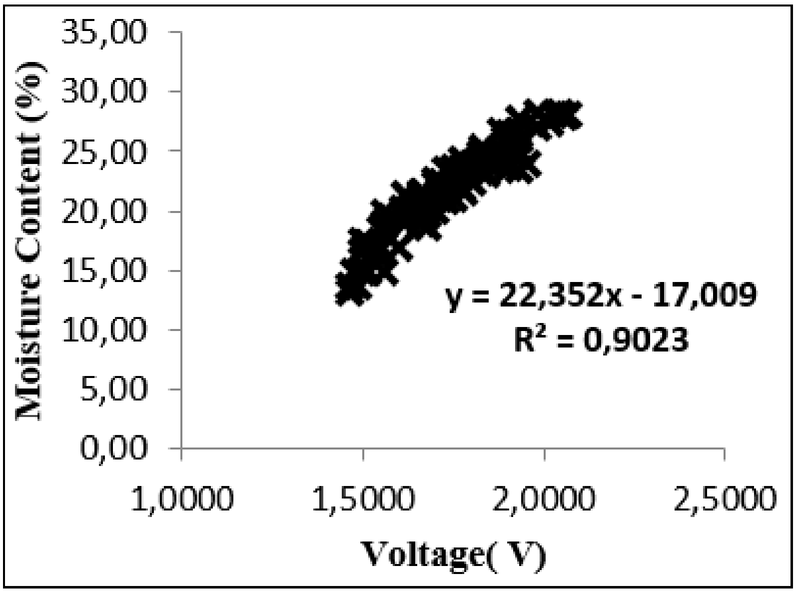

Fig. 4. Measurement of the SWR M-Sens 2 microwave type moisture sensor in the field test.

Using microwave technology in this study with the high precision for on-line measurements of grain moisture content could replace dielectric technology for the capacitance type sensor for the measurement of grain moisture content.

IV. CONCLUSION

In conclusion, a low-cost microwave sensor for simultaneous determination of SWR M-Sens 2 microwave type moisture sensor was designed, calibrated and tested successfully for rice grain. The measured voltages of the microwave sensor in estimating the instantaneous and non-destructive grain moisture contents were evaluated for rice moisture contents in the range of 13% to 29%.

REFERENCES

[1] Okabe, T., Huang, M.T. and Okamura, S. A New Method for the Measurement of Grain Moisture Content by the Use of Microwaves. J. Agric. Engng Res. 18: 59-66, 1973.

[2] Putri, R. E., Adam, N. M., & Aziz, S. A. (2016). Performance Evaluation of Yield Monitoring System for Rice Combine Harvester in Selangor, Malaysia. *International Journal on Advanced Science, Engineering and Information Technology*, *6*(1), 35-39.

[3] Putri, R. E., Yahya, A., Adam, N. M., Aziz, S. A., & Ishola, T. A. (2014). Calibration and Accuracy Determination of a Microwave Type Sensor For Measuring Grain Flow. *Advanced Materials Research*.

[4] Putri, R. E., Yahya, A., Adam, N. M., & Aziz, S. A. (2015). Correlation of moisture content to selected mechanical properties of rice grain sample. International Journal on Advanced Science, Engineering and Information Technology, 5(5), 264-267.

[5] Putri, R. E., Yahya, A., Adam, N. M., & Aziz, S. A. (2015). Laboratory Calibration and Evaluation of Microwave Type Grain Flow Sensor for Yield Monitoring in Rice Combine Harvester.

[6] Rogers, E.K. and Kent, M. (1987). Microwave Measurement of Powder Moisture and Density. Journal of Food Engineering 6: 345-376, 1973.

[7] Trabelsi, S., Kraszewski, A. W., and Nelson, S. O. Nondestructive microwave characterization for determining the bulk density and moisture content of shelled corn. Measurement Science and Technology, 9(9), 1548, 1998.

[8] Trabelsi, S. and Nelson, S. O. Calibration methods for nondestructive microwave sensing of moisture content and bulk density of granular materials," Transactions of the ASAE, vol. 47, pp. 1999- 2008, 2004.

[9] Trabelsi, S. and Nelson, S.O. Inexpensive Microwave Moisture Sensor for Granular Materials. IEEE Xplore: 297-300, 2007.

[10] Trabelsi. S., and Nelson, S. O. Microwave sensor for simultaneous and nondestructive determination of moisture content and bulk density of granular materials. European Microwave Conference (EuMC) : 493-496, 2010.

C.10

EFFECTS OF ANALYSIS METHOD IN PREDICTION CANE QUALITY USING NIR SPECTROSCOPY

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ABSTRACT

NIR spectroscopy is a secondary method that can be used to predict the quality of a raw material. Analysis of sugar cane quality takes 2 hours; the use of NIR is expected to shorten the analysis time. In this study, NIR is used to predict three parameters of cane quality (pol%cane, brix% cane and fibre%cane) with two different analytical methods. The material for research was a 10 month Bululawang (BL) variety. Sugarcane was shredded using a JEFFCO cutter grinder, and then the samples of shredded cane are separated for conventional analysis and NIR. Conventional analysis using wet disintegrator and hydraulic press method. The same cane samples were measured at wavelength 700 - 2500 nm using NIR FOSS XDS RCA. Pretreatment of NIRS absorbance using Mahalanobis distance. The calibration model uses the partial least square (PLS) regression method. The NIR results were evaluated from high correlation coefficient (r^2), low standard calibration (SEC) and high ratio of prediction to deviation (RPD). The experimental results show that the wet disintegrator method produces a better NIR calibration model than the hydraulic press method. The NIR evaluation of wet disintegrator method for pol%cane, r^2 = 0,937, SEC = 0,459, SECV = 0,127, SEP = 0,516 and RPD = 3,119. Brix %cane, r^2 = 0,905, SEC = 0,481, SECV = 0,117, SEP = 0,670 and RPD = 2,080. Fibre%cane, r^2 = 0,783, SEC = 0,999 , SECV = 2,466, SEP = 1,396 and RPD = 1,267. NIR calibration for pol%cane and brix%cane shows a good result, while the fibre%cane need to be improved. From the results of these experiments can be used as a basis for the development of NIR calibration models to analyze different cane varieties.

Keywords : NIR Spectroscopy, cane quality, NIR prediction, pol%cane

I. INTRODUCTION

Analysis of sugarcane quality is required both for sugarcane breeding and cane payment system. Sugarcane quality is analyzed in the laboratory using conventional methods referring to recognized method. Parameters for sugarcane quality were brix%cane,pol%cane and fibre%cane. Conventional sugar cane analysis requires a complex process and takes 2 hours per sample. An alternative to speed up the analysis was using near infrared spectroscopy (NIR) technology. This technology was widely applied in agriculture, food, environmental, sugarcane and many other fields for its simple, quick, nondestructive and convenient on-line analysis ([1],[2],[3],[4],[5]). Use of NIR technologies has led to a significant decrease in the costs associated with cane quality [6].

Indonesian sugar industry began using NIR in 2011. The first sugar factory (SF) in using NIR was Bungamayang SF, Lampung and applied for the determination of the quality of juice from the core sampler system [7]. Further followed by several sugar factories such as PT Gunung Madu, PT PSMI and PG Ngadiredjo in Kediri in 2015. [8] The NIR application at those sugar factory uses cane juice as a sample. Meanwhile, the use of NIR for shredded cane samples has not been done. The use of NIR as a secondary method in the world has been done. In Australia, South Africa and the United States of America (1990) ([9],[10], [11]). Then, in the late 1990s and early 2000s on-line analysis was introduced, allowing cane quality analysis to become part of the mill process ([12], [13]).

The principle of NIR is to scan a material and then record the spectrum of the material, then the spectrum in the conversion becomes absorbency at wavelength 400 - 2500 nm. Then conducted input data conventional analysis results in accordance with the recorded spectrum. The spectrum was calibrated and validated using a series of programs based on statistical processes. Improvements in the NIR data processing software show that the results of NIR analysis were similar from the laboratory analysis ([14],[15]). The validity of the NIR analysis depends on the conventional method used. There are two conventional methods used to determine the quality of sugarcane. The first method refers to the International Commission of Uniform Methods in Sugar Analysis (ICUMSA) or wet disintegrator method (WD) [16]. The second method uses a hydraulic press (HP) [17]. In this research, NIR analysis was tested using two methods with the same sugarcane sample. The objective of this study was to evaluate the best method for cane quality prediction using NIR.

II. MATERIALS AND METHODS

A. Sample Preparation

Sugarcane samples of 10 month Bululawang (BL) varieties from P3GI experimental field in February 2017 were used for this experiment. 100 stalks of sugarcane were taken from the field, then 20 stalks were analyzed on the first day. Furthermore, the remaining 80 stalks were stored in the field, each of 20 stems analyzed on the 2nd, 3rd, 4th and 5th days. Sugarcane was shredded using JEFFCO CUTTER GRINDER, then homogenized and split into three parts. 2 kg of sugar cane samples were analysed using WD method, 4 kg were analyzed using HP method and 100 gram for NIR analysis.

B. Chemical Analysis

Sugarcane quality analysis consists of three parameters, ie pol%cane, brix%cane and fibre%cane. The analysis was performed in the P3GI laboratory service using WD and HP methods. WD method using JEFFCO WET DISINTEGRATOR and bagasse dryer. HP methods use a hydraulic press and a bagasse extraction tool. Other supporting equipment were top a loading balance, Sacharomat Scmidth Haens NIR W2 model for polarization readings and ABBE Refractometer NAR-1T Liquid for brix reading.

C. Procedure Analysis of WD Method

Weight 1000 gr (± 0.1 gr) of shredded cane, then insert the sample into Wet Disintegrator. Add 2000 gr of water, closed wet disintegrator then run for 20 minutes. After the wet disintegrator had stopped, take the juice extract by filtering it using a rough filter. Homogenize the extract and then take as much as 300 ml to analyse its brix and pol contents. For moisture content analysis, weight the empty container and record the mass to the nearest 0.1 g, m_0. Add approximately 100 g (± 0.1 gr) of shredded cane to the empty container, m_1. Place the container plus shredded cane in the drying tool and dry at 110±3^{0}C for 2 hours. Weight the container plus dried shredded cane sample and record the mass to the nearest 0.1 g, m_2. The calculation as follows:

$$moisture\%cane = 100\ \frac{m1-m2}{m1-m0} \tag{1}$$

$$pol\%cane = p\ \frac{\phi+w}{\theta-b} \tag{2}$$

where :
p = pol%cane extract from wet disintegrator
b = ^{0}brix of extract from wet disintegrator

$$\phi = 100\ \frac{\frac{x+y}{x}-\left[1+\frac{z}{100}\right]}{\left[1+\frac{z}{100}\right]} \tag{3}$$

$$\theta = \frac{100}{1+\frac{z}{100}} \tag{4}$$

x = mass of cane
y = mass of water added
z = %brix free water (25% generally is used)
w = moisture%cane

$$fibre\%cane = 100\frac{100-w-b\left(\frac{x+y}{x}\right)}{100-b\left(1+\frac{z}{100}\right)} \tag{5}$$

D. Procedure Analysis of HP Method

Weight the shredded cane to the nearest 2000 gr (± 0.1 gr) and then put it into the hydraulic press machine. Run the hydraulic press machine at 250 kg/cm^2 for 1 minutes. Take the juice and stored it into a basket. The bagasse left in the hydraulic press is taken, then repeat the hydraulic press process once again. Juice from the first and second hydraulic press processes are mixed, as well as the bagasse. Juice mixture is stirred until homogeneous and then analyzed its brix and pol content. The bagasse was mixed until homogeneous then analysed pol and moisture content. The analysis pol in bagasse using the heat extraction method [18] while the analysis of the moisture content using the bagasse dryer equipment. The drying process was carried out at a temperature of 110^{0}C for 2 hours. The calculation as follows:

$$pol\%cane = \frac{\left[polEJ * \left(\frac{J}{C} * 100\right)\right] + \left[polB * \left(\frac{B}{C} * 100\right)\right]}{C} \quad (6)$$

$$brix\%cane = \frac{\left[brixEJ * \left(\frac{J}{C} * 100\right)\right] + \left[brixB * \left(\frac{B}{C} * 100\right)\right]}{C} \quad (7)$$

EJ = extracted Juice
J = Weight of juice
B = Weight of Bagasse
C = Weight of Cane

Fibre content was analyzed directly using the bag method as described by Central Cane Price Board Australia [19]. 100 grams (± 0.1 gr) shredded cane samples were inserted in the dried cloth bag. Remove brix from sugarcane by washing it with hot water. After that, the cloth bag is dried until the weight is constant. The fibre content was calculated from the weight of the bag containing the dried cane minus the weight of the dry bag. The calculation as follows:

$$fibre = \frac{A - B}{100} \quad (8)$$

A = weight of empty dry cloth bags
B = weight of cloth bags plus free brix shredded cane after drying

E. NIR Instrument and Data Analysis

The spectral data from shredded cane was collected using NIR FOSS XDS Rapid Content Analyzer, Fig 1. The spectral data was collected inside a measurement black box provided by FOSS.The spectra of dried shredded cane was recorded in reflectance mode from 400 – 2500 nm. The reflectance data was converted into absorbance data.

The result of the wet chemical analysis was input into the software and analyzed. Total 100 samples were obtained from the wet analysis.

The Vision Software package version 3 SP7 (FOSS NIRSystems, Inc) was used for data processing and statistical analysis. Quantitative calibrations were developed for predicting cane quality parameters. The prediction equation was obtained using partial least square as regression method. Data pre-processing using Mahalanobis and 2nd derivative ([20], [21]). For cross-validation, the calibration set was separated into two groups, 75 samples were used for calibrations model while 25 samples were used for validations process. Samples for validation were selected randomly by taking one of every 5 samples from the entire data. The statistics used to select the best equations were: standard error of calibration (SEC), coefficient of determination of calibration (R^2), standard error of cross-validation (SECV), coefficient of determination for cross-validation (r^2) and RPD or ratio of the standard deviation of the original data (SD) to SECV [22]. The evaluation of the best method for NIR calibrations is by comparing the statistical analysis between WD and HP method.

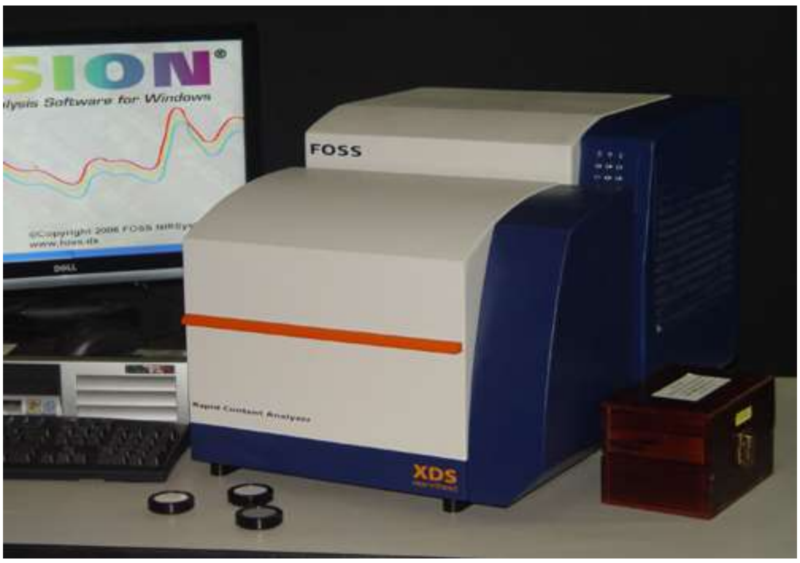

Fig. 1. NIR FOSS XDS Rapid Content Analyzer Module

III. RESULTS AND DISCUSSION

The typical raw spectra of the shredded cane are shown in Fig 2. NIR read the spectra from 400 – 2500 nm wavelength.

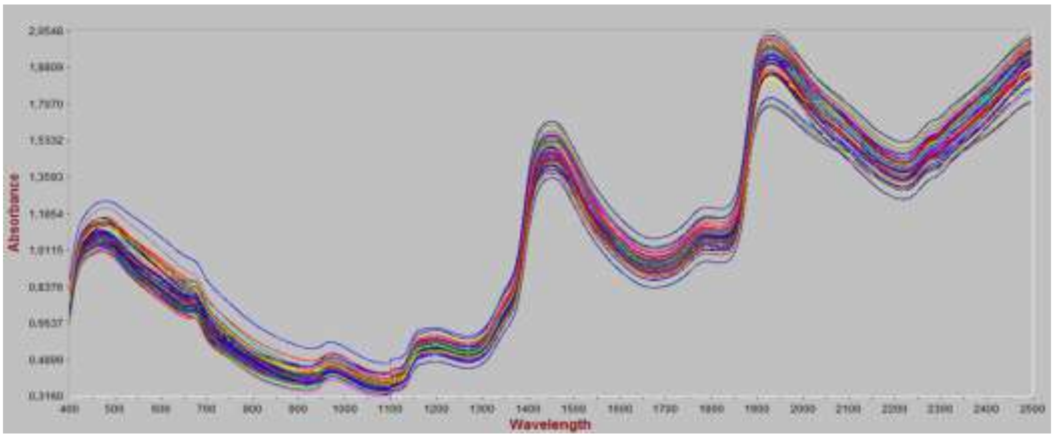

Fig. 2. Typical raw spectral curve of shredded cane

According to ([23], [24], [25], [26]) not all spectra of the shredded cane were used for the calibration process. Spectra in wavelength range 1100-2500 nm were show the absorption of sucrose. Therefore, in this study the spectra used for the calibration and validation process is in that range. According to Fig 2, the dominant peaks in the spectra were observed at wavelength 1150 nm, 1450 nm dan 1940 nm due to water absorption [27]. Therefore for the data pre-processing and calibration were used wavelength range : 1180 – 1430; 1470 – 1900; 1920 – 2500 for accurate calibration. Calibration models for NIR were used 75 samples, while another 25 samples were used to evaluate the prediction error of calibration models. The calibration models were formulated by using PLS regression method. The result of calibration and validation shown in Fig. 3 and Table 1.

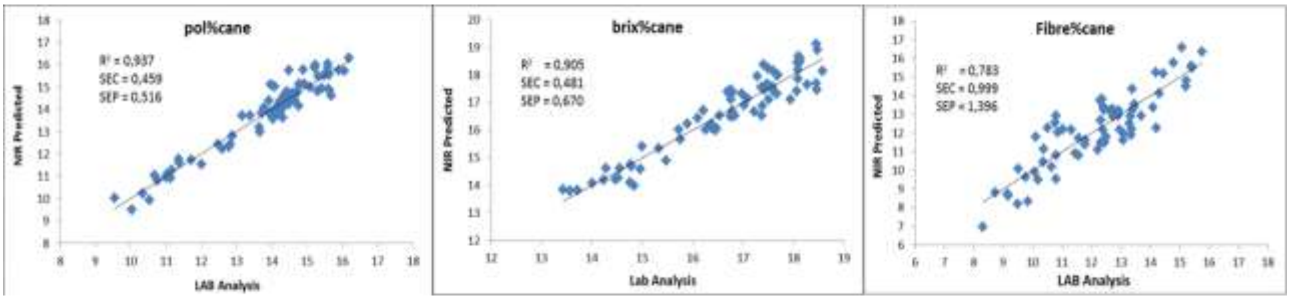

Fig. 3. NIR predicted vs LAB Analysis of pol%cane, brix%cane and fibre%cane using WD method for calibration set data

Table 1. Statistical evaluation result for cane quality analysis using WD and HP method

Parameter	Calibration Set				Validation Set		
	PLS Factor	R^2	SEC	SECV	r^2	SEP	RPD
Wet Disintegrator							
Pol%cane	9	0.937	0.459	1.027	0.935	0.516	3.119
Brix%cane	9	0.905	0.481	1.170	0.866	0.670	2.080
Fibre%cane	9	0.783	0.999	2.466	0.706	1.396	1.267
Hidraulic Press							
Pol%cane	9	0.823	0.936	1.940	0.773	1.125	1.689
Brix%cane	9	0.870	0.529	1.021	0.731	0.828	1.970
Fibre%cane	9	0.703	0.672	1.579	0.657	1.936	1.050

*n for calibration model = 75; n for prediction model = 25

There was a good correlation for pol%cane and brix%cane parameters using WD method, Table 1 and Fig 3. For pol%cane and brix%cane R^2 value for WD method were 0.937 and 0.905, respectively. While the R^2 value of pol%cane and brix%cane for HP method were 0.823 and 0.870, respectively. SEC for pol%cane and brix%cane of WD method were 0.459 and 0.481, respectively. While the value of SEC for pol%cane and brix%cane of HP method were 0.936 and 0.529, respectively. Another statistic evaluation for validation set was SEP and RPD value. The SEP and RPD for pol%cane and brix%cane of WD method were 0,516 and 0,670; 3.119 and 2.080, respectively. While the SEP and RPD value for pol%cane and brix%cane of HP method were 1.689 and 1.970, respectively.

The good association between wet analysis and NIR prediction demonstrate that NIR analysis can be used as a reliable method to predict the pol%cane and brix%cane. However the good NIR prediction depend on the wet analysis that use for calibration. Previous study of NIR prediction for cane quality were showed the same value for pol%cane and brix%cane. ([24], [28], [29], [30], [31])

However, the coefficient determinations (R^2) of fibre between the wet chemistry analyses and NIR prediction for the WP and HP method were slightly low. The value were 0.783 and 0.703, respectively. Their error (SEC and SECV) also high. The determination of fibre depends on the moisture and brix content. Shredded cane is usually accompanied by soil or trash. Consequently, NIR spectroscopy would have different reflectance wavelength for this parameter. Furthermore, the NIR prediction for fibre content will be at variance with the conventional method. The result of fibre prediction was consistent with the previous study. ([29], [30], [31]).

Table 1 shows the comparison between WD and HP methods. All the statistic evaluation were show that WP method have better NIR correlation than HP method. The good NIR calibration criteria were the higher value of R^2 and RPD, lower value of error (SEC, SECV and SEP). The HP methods have a more complex procedure than WD methods. The complex procedure of analysis includes weight the shredded cane and juice, pol of bagasse analysis using extraction and fibre determination using weight. Analytical complex procedure leads to greater error, consequently, this error will affect the NIR calibration process.

IV. CONCLUSION

NIR system was able to predict the cane quality, especially for pol%cane and brix%cane parameter. The good result of NIR calibration was influenced by the conventional methods uses for cane quality analysis. In this research, the Wet Disintegrator method show the better result for cane quality predictions than the Hydraulic Press Method.

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REFERENCES

[1] K.S. Chia, H.A. Rahim and R.A. Rahim. Prediction of soluble solids content of pineapple via non-invasive low cost visible and shortwave near infrared spectroscopy and artificial neural network. Biosystems Engineering, 113,pp.158-165.2012.

[2] L. C. de Carvalho, C. Lelis, K. M. G. de Lima, L. Junior, P. A. M. Nascimento, J. B. Faria and G. Teixeira. Determination of geographical origin and ethanol content in Brazilian sugarcane spirit using near-infrared spectroscopy coupled with discriminant analys. Anal. Methods, pp.1-27.2016

[3] A.A. Munawar and I.W. Budiastra. Non destructive inner quality prediction in intact mango with near infrared reflectance spectroscopy. Jurnal Keteknikan Pertanian, 23,pp.59-64.2009.

[4] E. Taira, E, M.Ueno, Y.Kawamitsu and Y. Tsukayama, Sugar content and trash measurement for shredded sugarcane using NIR. Proc. International Society of Sugarcane Technologists, 23, pp.3-8.2005.

[5] J.U. Porep, D.R.Kammerer and R.Karle, On-line application of near infrared (NIR) spectroscopy in food production. Trends in Food Science and Technology, pp.1-20.2015.

[6] N.Berding and D.H.Marston,. Operational validation of the efficacy of Spectracane™, a high-speed analytical system for sugarcane quality components. *Proceedings of the Australian Society of Sugar Cane Technologists* 32,pp. 445–459.2010.

[7] Anon, Pengawalan Penerapan Core Sampler Untuk Pengukuran Rendemen Tebu Individu di Pabrik Gula Bungamayang, Laporan Intern P3GI.2014.

[8] Anon, Pengawalan Aplikasi core sampler Di Pabrik Gula Ngadirejo Musim Giling Tahun 2015. Laporan Intern P3GI.2015.

[9] J.H.Meyer and R.A.Wood,. Rapid analysis of cane juice by near infrared reflectance. Proc. South African Sugar Technol. Assoc.pp. 203-207.1988.

[10] N.Berding, G.A.Brotherton, D.G.le Brocq and J.C.Skinner. Near infrared reflectance spectroscopy for analysis of sugarcane from clonal evaluation trials: I. Fibrated cane. *Crop Science* 31.1991.

[11] M.A.Clarke, L.A.Edye and W.S.Patout, Sugarcane crop analysis by NIR. Proceedings of the XXII Congress of the International Society of Sugar Cane Technologists, held 7-15 September 1995 in Cartagena, Colombia. Vol 2, pp.114-119. 1996.

[12] S.Staunton, D.Mackintosh and G.Peatey, The application of network NIR calibration equations at the Maryborough Sugar Factory. *Proceedings of the Australian Society of Sugar Cane Technologists* 26, pp.1–14. 2004.

[13] J.Simpson, S.Staunton and M.G.O'Shea .A review of NIR applications for process control purposes. *Proceedings of the Australian Society of Sugar Cane Technologists* 33, 8.2011.

[14] M.Anderson and L.A.Norgaard, Procedure to determine when NIR is better than its reference method. Proceeding 16th International Conference on Near Infrared Spectroscopy.IRSTEA France, pp.618-620. 2013.

[15] P.Krepelka and R.Kadlec.. Fuzzy interpretation of NIR spectra with additional statistic evaluation. Proceeding 16th International Conference on Near Infrared Spectroscopy.IRSTEA France. pp.627 – 629. 2013.

[16] Anon. ICUMSA GS5/7. 1994

[17] M.HOARAU. Sugarcane analysis by the hydraulic press method. International Sugar Journal. 71, pp.330-331. 1969
[18] Anon. Buletin 11. Pusat Penelitian Perkebunan Gula Indonesia.1974
[19] P.N.Steward. A quick method on fibre determination. Proceeding Queensland Society of Sugarcane Technologist. 36. pp.157-160.1969.
[20] H.Cen and Y.He. Theory and application of near infrared reflectance spectroscopy in determination of food quality. Trends in Food Science and Technology 18, pp.72-83.2007.
[21] T.Næs, T.Isaksson, T, T.Fearn and T. Davies. A user-friendly guide to multivariate calibration and classification. Charlton, Chichester, UK: NIR Publications.2004.
[22] A.Rinnan, F.V.D.Berg and S.B.Engelsen, Review of the most common pre processing techniques for near infrared spectra. Trends in Analytical Chemistry 28. pp.1201-1222. 2009.
[23] R.Mehrotra and H.W.Siesler. Application of mid infrared/near infrared spectroscopy in sugar industry. Applied Spectroscopy Reviews, 38, pp. 307–354.2003.
[24] L.R.Madsen, B.E.White and P.W.Rein, Evaluation of a near infrared spectrometer for the direct analysis of sugar cane. Journal of American Society of Sugarcane Technologists, 23, pp. 80–92.2003.
[25] P.Valderrama, J.W.B.Braga and R.J.Poppi. Validation of multivariate calibration models in the determination of sugar cane quality parameters by near infrared spectroscopy. Journal of Brazilian Chemical Society, 18, pp. 259–266.2007.
[26] E.Taira, M.Ueno and Y.Kawamitsu. Automated quality evaluation system for net and gross sugarcane samples using near infrared spectroscopy. Journal of Near Infrared Spectroscopy, 18, pp. 209–215.2010.
[27] B.G. Osborne, T.Fearn and P.H. Hindle, Practical NIR Spectroscopy with applications in Food and Beverage Analysis. Longman Scientific and Technical, Harlow, UK, p.30.1993.
[28] J.E.Larrahondo, F.Palau, A.Navarrete and C.Ramirez. Application of near infrared spectroscopy in the sugarcane industry of Columbia. *Centro de Investigacion de la Cana le Azucar de Colombia,* Cenicana, Cali, Colombia, pp 163-164.2000.
[29] G.A. Bentley, M. Habib, S.Staunton, P.G. Atherton, and C.Henderson. Application of NIR cane analysis technology to small consignments of cane in Fiji. Proceedings of the Congress – International Society of Sugarcane Technologists, 2, 59-65.2001.
[30] V. Valderrama, J.W.B.Braga and R.J. Poppi. Validation of multivariate calibration models in the determination of sugar cane quality parameters by near infrared spectroscopy. Journal of Brazilian Chemical Society, 18(2), pp. 259-266.2007.
[31] M.N. Nawi, T.Jensen, and G. Chen. The application of spectroscopic methods to predict sugarcane quality based on stalk cross-sectional scanning. *Journal American Society of Sugar Cane Technologists,* 32, pp.16-27.2012.

C.11

VIS-NIR PROXIMAL SENSING TO ESTIMATE SOIL TEXTURE

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ABSTRACT

Soil texture is one of the most important soil properties influencing most physical, chemical, and biological soil processes. Information of soil texture is important to support the agronomic decisions for farm management. The problem is how to provide reliable, fast and inexpensive information of soil texture in the subsurface from numerous soil samples and repeated measurement. The use of spectroscopy technology has emerged as a rapid and low-cost tool for extensive investigation of soil properties. The objective of this research was to develop calibration models based on laboratory Vis-NIR spectroscopy and partial least-square regression (PLSR) analysis to estimate the soil texture in two small farms of soybean crop at Yogyakarta Province. An ASD Fieldspec 3 with a spectral range from 350 nm to 2500 nm was used to measure the reflectance of 120 soil samples. Pipette method was used to measure the silt, clay and sand fractions of 40 soil samples. The PLSR with full cross-validation was performed to establish the relationship between the soil textural fractions with the pre-treated Vis-NIR soil reflectance spectra. The selection criteria of any pretreatments were the largest coefficient of multiple determinations (R^2) and the smallest of Root Mean Square Error (RMSE). The selected calibration model was used to predict the soil textural fraction in the new samples. The full cross-validation ability of PLSR is given by the value of residual prediction deviation (RPD). The results revealed that the calibration model was good for silt prediction, and excellent for clay and sand prediction. Vis-NIR spectroscopy was a reliable tool for the prediction of soil textural fraction of unknown soil samples. Different preprocessing methods should be performed in order to improve the correlations between the measured soil texture and the spectra.

Keywords : Vis-NIR spectroscopy, soil reflectance, soil texture, calibration model, Yogyakarta

I. INTRODUCTION

Soil texture associated with the ability of soil to retain water, soil moisture content, soil organic matter and minerals which are essential in agriculture. Relative amounts of sand, silt and clay influences porosity, permeability, ease of tillage and nutrient retention. The clay fraction has a significant influence on many physical and chemical processes that occur in soil. In contrast, the sand and silt fraction typically do not have much influence on chemical processes [1]. Soil texture is not usually change by management practices, however, it may be altered by erosion, deposition, truncation, and some other human interventions [2]. Since it has a major effect on the soil fertility levels, information on soil texture is important to support the agronomic decisions for farm management. The problem is how to provide reliable, fast and inexpensive information of soil texture in the subsurface from numerous soil samples and repeated measurement.

Proximal soil sensing techniques have been developed to better understand the soil variability [3]. It is the use of field-based sensors to obtain signals from the soil when the sensor's detector is in contact with or close to (within 2m) the soil [4]. Recently, visible and near infrared (Vis-NIR) diffuse reflectance spectroscopy has emerged as a rapid and low-cost tool for extensive investigation of soil properties. There are several soil attributes that often are well estimated with vis-NIR spectroscopy. The most obvious ones are soil texture, especially clay content, mineralogy, the content of soil organic carbon or soil organic matter and soil water [5]. Soil Vis-NIR (350-2500 nm) reflectance spectra contain valuable information for predicting soil textural fractions [6]. Reflectance was relatively high for soils with loamy sand texture with over 70% sand content.

The quantitative spectral analysis of soil using Vis-NIR reflectance spectroscopy requires sophisticated statistical techniques to discern the response of soil attributes from spectral properties. Various methods have been used to relate a soil spectrum to soil attributes [7]. The multivariate analysis is used because in fact the problem that occurs cannot be solved by simply link the two variables or see the effect of one variable to another. The most common calibration methods applied are based on linear regressions, namely stepwise multiple linear regression (SMLR), principal component regression (PCR), and partial least squares regression (PLSR). PCR and PLSR techniques can cope with data containing large numbers of predictor variables that are highly collinear. However, PLSR is often preferred by analysts because it relates the response and predictor variables so that the model explains more of the variance in the response with fewer components, it is more interpretable and the algorithm is computationally faster [5]. Rossel *et al*. [8] agreed with Geladi and Kowalski [9] that PLSR takes advantage of the correlation that exists between the spectra and the soil, thus the resulting spectral vectors are directly related to the soil attribute. The advantages of PLSR are that it handles multi-collinearity, it is robust in terms of data noise and missing values. They also found that spectroscopic analyses combined with PLSR were very attractive for modeling and precision agriculture.

The objective of this research was to develop calibration models based on laboratory Vis-NIR spectroscopy and PLSR analysis to estimate the soil texture in two small farms of soybean crop at Yogyakarta Province. The use of spectroscopy technology for proximal soil sensing sounds promising to solve the problem, especially to develop a precision farming system in Indonesia.

II. MATERIALS AND METHODS

A. Site Description

The research was conducted at soybean farms in two locations, i.e. Natah Village, Nglipar District, Gunung Kidul Regency (7°51'39.0"S, 110°39'19.4"E) and Jatimulyo Village, Dlingo District, Bantul Regency (7°55'22.5"S, 110°29'08.7"E) in Yogyakarta Province (Fig. 1). The elevation of Nglipar ranges from 200 to 210 m asl., while Dlingo elevation ranges from 190 to 200 m asl. The slope varies between 5° to 10° which Dlingo was steeper than Nglipar. The variability of soil classification in the research area was high, even occurred in the same landform. Soils in the study area were tentatively classified as Hapludults and Dystrudepts at Nglipar, while soils at Dlingo were classified as Hapludalfs, Eutrudepts and Udorthents [10] (Table 1).

Nglipar and Dlingo had tropical climate and classified as *Am* by Köppen and Geiger. The average annual temperatures of Nglipar and Dlingo were 25.2 °C and 25.8 °C, and the average rainfalls were 2,083 mm and 2,019 mm [11]. Table II shows the average of monthly rainfall of the past 10 years. During the research, the monthly rainfalls from October 2016 to January 2017 were: 253, 526, 305 and 369 mm at Nglipar, and 232, 312, 420 and 411 mm at Dlingo [12].

Fig. 1. Location of the research area: a. Nglipar, Gunung Kidul Regency, and b. Dlingo, Bantul District (Source: Modified from Google Map 2017).

Table 1. Soil Class and landform of Nglipar and Dlingo

Soil Class (Great group)	Proportion (%)	Landform	Parent material	Relief (% slope)
NGLIPAR, GUNUNG KIDUL: TECTONIC GROUP				
Hapludults	50-75	Undulated tectonic plain	claystonesandstone	undulated (8-15)
Dystrudepts	25-50			
DLINGO, BANTUL: KARST GROUP				
Hapludalfs	50-75	Karst hill	limestone	Small hilly (15-25)
Eutrudepts	25-50			
Udorthents	10-25			

Source: Indonesian Center for Agricultural Land Resources Research and Development (BBSDLP, 2016)

Table 2. The monthly rainfall average of 2007-2016 (mm)

NGLIPAR				DLINGO			
Jan	314	*Jul*	53	*Jan*	381	*Jul*	45
Feb	334	*Aug*	38	*Feb*	438	*Aug*	25
Mar	277	*Sep*	117	*Mar*	335	*Sep*	75
Apr	190	*Oct*	80	*Apr*	306	*Oct*	89
May	123	*Nov*	219	*May*	216	*Nov*	295
Jun	79	*Dec*	496	*Jun*	121	*Dec*	386

Source: BMKG, Sleman DIY (2017)

The activities in the farm at Nglipar and Dlingo were almost the same every year. Table 3 shows the crop pattern of both locations.

Table 3. The yearly crop pattern at Nglipar and Dlingo

NGLIPAR				DLINGO			
Jan	GN	*Jul*	-	*Jan*	SB/C	*Jul*	-
Feb	GN	*Aug*	-	*Feb*	SB/C	*Aug*	-
Mar	GN	*Sep*	-	*Mar*	SB/C	*Sep*	-
Apr	SB	*Oct*	SB	*Apr*	VB	*Oct*	SB
May	SB	*Nov*	SB	*May*	VB	*Nov*	SB
Jun	SB	*Dec*	SB	*Jun*	VB	*Dec*	SB

GN: Ground Nut; SB: Soy Bean; C: Corn; VB: Velvet Bean

B. Soil Sampling

Due to the irregular and terrace shapes of the fields (Fig. 2), the layout of sample points was set up using the grid method combined with a transect line of 5 meter interval. There were 30 sample points for each field marked with bamboo sticks. The soil was sampled 2 stages within one cropping season from October 2016 to January 2017, i.e. before planting and after harvesting the soybean. Each point was taken using auger at a depth of 5-15 cm about 500 grams and stored in a labeled zip lock plastic bag. The total samples from 2 locations (G, B) and 2 stages (I, IV) sampling were 40 samples for texture analysis and 120 samples for spectroscopic measurements. All samples were air-dried, then gently crushed to break up larger aggregates, afterward removed the visible roots and each sample was sieved at 2 mm strainer.

(a) (b)

Fig. 2 Field lay out. (a) Gunung Kidul site (1500 m^2) and (b) Bantul site (1300 m^2) (Modified from Google Earth 2012)

C. Texture Analysis

The soil texture was analyzed by the Soil Analytical Services Laboratory at UPN "Veteran" Yogyakarta using Robinson's pipette method to determine the percentage of sand, silt and clay. Then the texture was classified in accordance with the soil texture triangle of the United States Department of Agriculture [13] (Fig. 3).

D. Laboratory Vis-NIR Spectroscopy

The spectroscopy measurement was performed at the University of Palangka Raya, Central Kalimantan, using ASD Field-spec®3 350-2500 nm spectroradiometer (Analytical Spectral Devices Inc., Boulder, Colorado, USA). Each soil sample was placed into a 5 cm dia. ring sample (*Eijkelkamp*), and flattened the surface. A black aluminum ring plate (modified by TUAT Laboratory, Japan) was fitted on the top of ring sample in order to hold the ASD probe of the optic sensors and keep the same distance from the probe tip to the sample surface (Fig. 4).

The reflectance of each sample was scanned 10 times with different positions by moving the ring sample circularly, and the results averaged in post-processing. Every 15 minutes the instrument was calibrated by measuring the reflectance of the white spectralon panel as white reference. The reflectance value of each spectrum was recorded in the computer accompanied with the instrument. A ViewSpecPro software had been installed to translate from binary to ASCII.

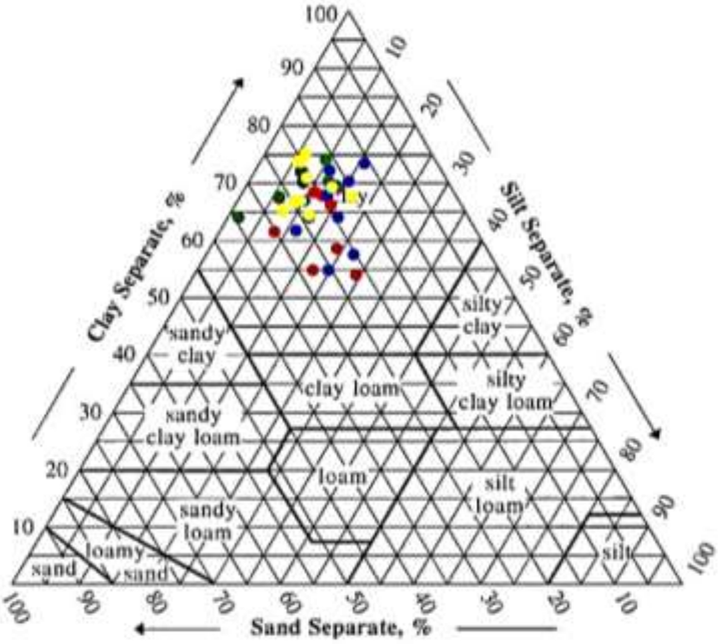
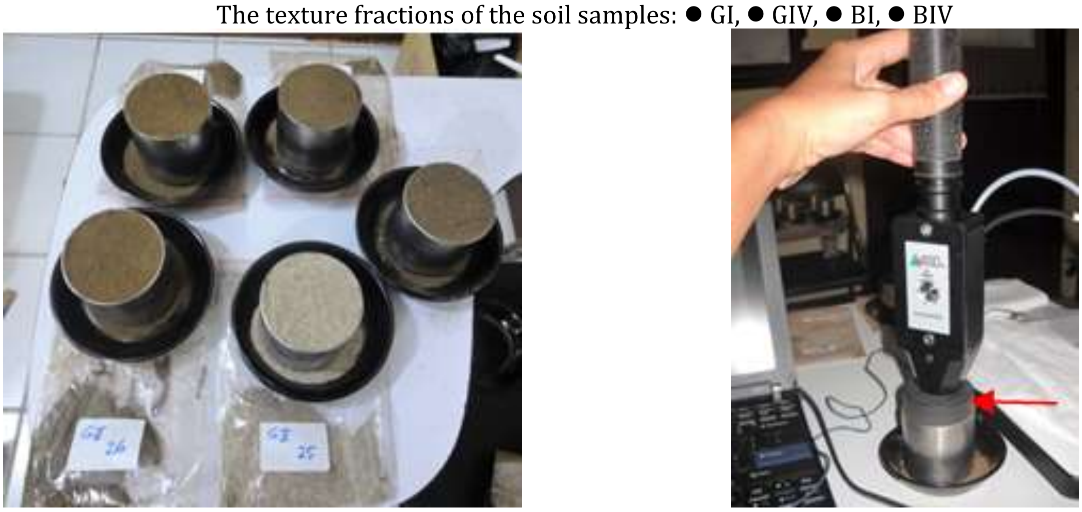


Fig. 3. USDA soil texture triangle of the percentages of sand (2-0.05 mm), silt (0.05-0.002 mm)and clay (< 0.002 mm)

The texture fractions of the soil samples: ● GI, ● GIV, ● BI, ● BIV



(a) (b)

Fig. 4. Soil reflectance measurement. (a) soils in ring sample and (b) The ASD probe was inserted into a black aluminum ring plate at the sample surface

E. Multivariate Statistical Analysis

The data of soil texture was compiled in a worksheet of MS Excel with such format compatible to be exported to the Unscrambler X to perform the multivariate analysis. The measured reflectance (R) spectra were transformed in absorbance through log (1/R) to reduce noise, offset effects, and to enhance the linearity between the measured absorbance and soil properties [6]. To enhance weak signals and remove noise due to diffuse reflection, the absorbance spectra were pre-treated using the second derivative Savitzky and Golay method [7]. Moreover, both edges of the spectra were removed as these parts of the spectra were unstable and rich in noise [14].

The calibration models were subsequently developed by applying the partial least-square regression (PLSR) technique coupled with full cross-validation to establish the relationship between the amount of soil textures (reference values) with the pre-treated Vis-NIR soil absorbance spectra from the corresponding locations [14] .

Three calibration models were developed, i.e. sand, silt and clay models. The models combined the dataset of spectra (500-2350 nm) and 40 reference values of each textural fraction. In the PLSR analysis, sample outliers were detected by checking the residual sample variance plot after the PLSR. Individual sample outliers located far from the zero line of residual variance were considered to be outliers and excluded from the analysis. Due to the small number of data set for calibration (40 samples), the number of outliers was limited to 5 samples.

The selection criteria of any pretreatments were the largest coefficient of multiple determinations (R^2) and the smallest of Root Mean Square Error (RMSE). The full cross-validation ability of PLSR was given by the value of residual prediction deviation (RPD). The ability of NIRS to predict values of soil properties can be grouped into three categories based on RPD values: category A or excellent (RPD >2.0), category B or good (RPD = 1.4~2.0), and category C or unreliable (RPD <1.4) [15]. RPD was given by the ratio of standard deviation (SD) of the reference dataset to the root mean square error of full cross-validation ($RMSE_{val}$), as in Equation (1) [14].

$$RPD = SD. RMSE_{val}^{-1} \tag{1}$$

The selected calibration model was used to predict the soil textural fraction in the new 80 samples.

III. RESULTS AND DISCUSSION

The textural fractions of different locations (G, B) and stages (I, IV) are shown in Fig. 5 Soil at G (decomposed from claystone) had about 5 % clay higher and 5 % silt lower than soil at B (decomposed from limestone). There were only small change (2 %) on the amount of clay and silt between the soils before planting (I) and after harvesting (IV). Generally, texture of a field can't easily be changed [16].

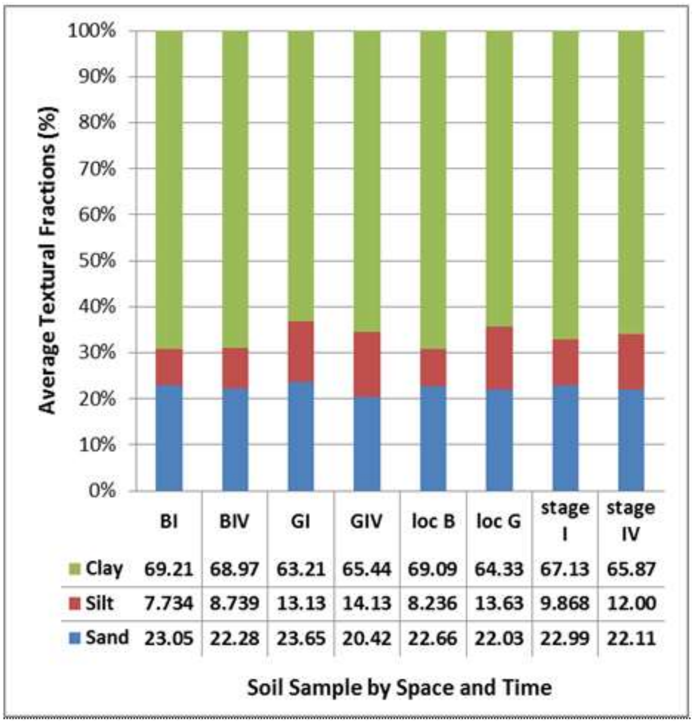


Fig. 5. The textural fractions of different location and stage
(G: Gunung Kidul, B: Bantul; I: before planting, IV: after harvesting)

The soil texture of all 40 samples shows in the soil texture triangle (Fig. 3) was classified as clay. The sand content ranges from 11.92 to 35.37 %, with a mean value of 22.35 %, the silt content varies from 0.93 to 23.67 %, with a mean value of 10.93 %, while clay content ranges from 53.49 to 74.72 %, with a mean value of 66.71 %. The descriptive statistics of the samples shows in Table 4.

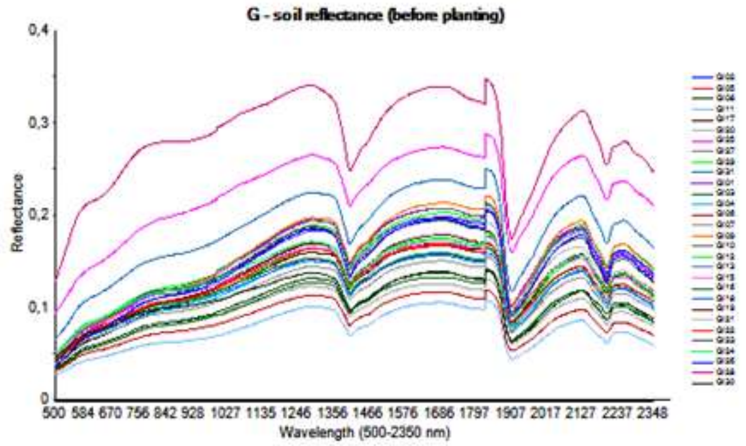
Clay soils hold large amounts of nutrients and water - may hold things too tightly, slow infiltration or high runoff means much erosion, and may shrink/swell - depends upon the type of clay minerals present [16].

Soil texture affects soil optical properties. Light is trapped in the rough surfaces of the coarse soil particles. For example, if iron and lime are present, a stronger reflectance is received than if the soil material was fine textured and dry. Variations in soil reflectance occur where there is a change in distribution of light and shadow areas with surface roughness areas [17].

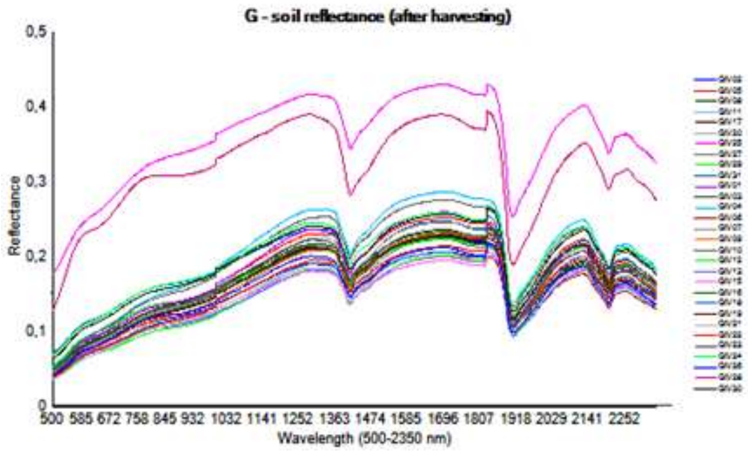
Table 4. Descriptive Statistics of textural fractions data

Fraction (%)	Clay	Silt	Sand
Samples	40	40	40
Min	53,49	0,93	11,92
Max	74,72	23,67	35,37
Range	21,23	22,74	23,44
Mean	66,71	10,93	22,35
Median	67,44	10,57	21,74
Std Deviation	5,45	4,90	4,52
Variance	29,67	23,96	20,39
RMS	66,93	11,96	22,79
Skewness	- 0,90	0,55	0,51

The soils reflectance of Nglipar (G) and Dlingo (B) shown in Fig. 5 indicate the spatial and temporal variability of soils in very small fields (+1500 m^2).

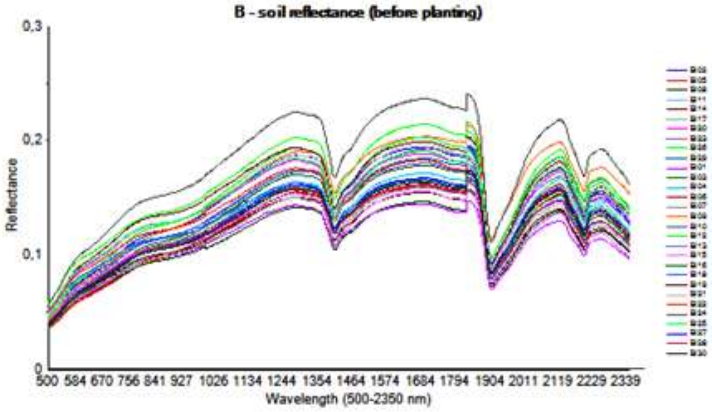


(a)

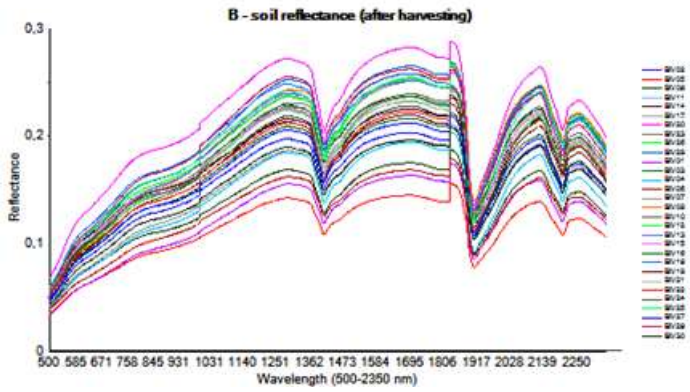


(b)

Fig. 5a. The soil reflectance of Nglipar (G) : (a) before planting and (b) after harvesting of Soybean



(a)



(b)

Fig. 5b. The soil reflectance of Bantul (B) : (a) before planting and (b) after harvesting of Soybean

In this research, soil texture was observed whether it had correlation with the soil reflectance. Table 5 shows the calibration process for each model using PLSR.

After several steps performing the PLSR, the selected calibration model was used to validate 40 reference samples and 80 new samples. The summary of PLSR results is shown in Table 6. From the RPD value indicated that the calibration models were *good* to predict clay (1.82), silt (1.47) and sand (1.41), respectively.

The Vis-NIR predicted values using PLSR for reference and new samples are described as regression models in Fig. 6, 7 and 8, Clay prediction has higher accuracy compared to sand and silt.

The better results obtained by using the PLSR method are clearly due to the fact that PLSR takes advantage of the use of the entire spectral signature [18]. The regression coefficient plotted in Fig. 9, 10 and 11 shows the investigated spectrum that should be considered important for the prediction of soil textures.

Table 5. The calibration proccess using PLSR

Pretreatments registered	1) Spectroscopic Transform (Type : Reflectance-to-absorbance) 2) Derivative Savitzky-Golay Transform (Deriv. order: 2; Polynomial order: 2; Left Points :10; Right Points :10			
Algorithm used	Wide Kernel			
Validation method	Cross validation - Full with 40 segments			
CALIB PROCESS	PLSR1	PLSR2	PLSR3	PLSR4
CLAY CALIBRATION				
Number of samples	40	39	37	35
Total number of factors	14	7	7	7
Factors suggested by model	6	6	7	7
Optimal number of factors	6	6	7	7
Samples kept out	-	37	3,15	13, 28
Variables kept out	-	-	-	-
SILT CALIBRATION				
Number of samples	40	37	35	-
Total number of factors	14	7	7	-
Factors suggested by model	6	6	6	-
Optimal number of factors	6	6	6	-
Samples kept out	-	3,5,37	14,28	-
Variables kept out	-	-	-	-
SAND CALIBRATION				
Number of samples	40	38	37	36
Total number of factors	14	9	9	7
Factors suggested by model	8	7	7	7
Optimal number of factors	8	7	7	7
Samples kept out	-	3,7	37	30
Variables kept out	-	-	-	-

Table 6. Summary of PLSR results for textural fraction calibration models

PLSR results	CLAY MODEL	SILT MODEL	SAND MODEL
Used samples	35	35	36
Optimal factors	7	6	7
R^2_{cal}	0.95	0.80	0.95
$RMSE_{cal}$	1.19	2.14	0.99
R^2_{val}	0.69	0.54	0.53
$RMSE_{val}$	3.00	3.33	3.18
SD	5.45	4.89	4.51
RPD	1.82	1.47	1.41

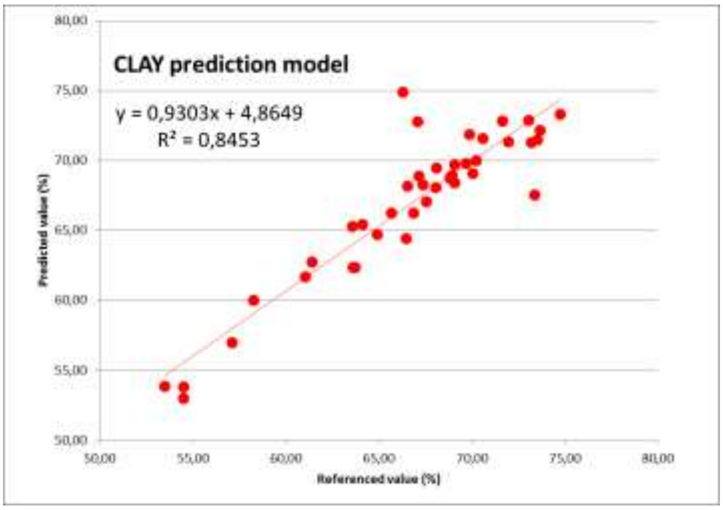


Fig. 6. Clay prediction models using PLSR

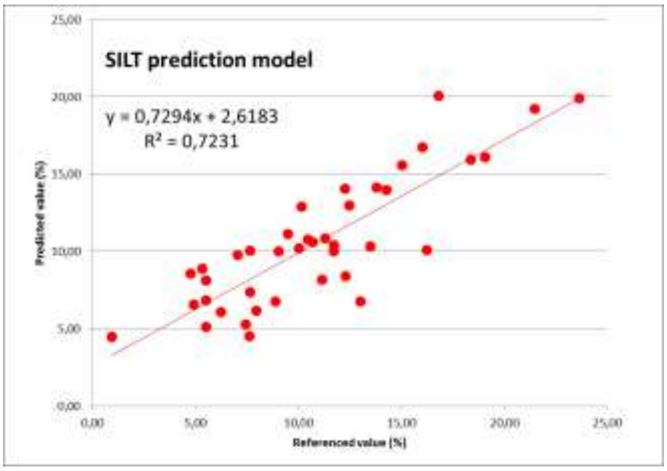


Fig. 7. Silt prediction models using PLSR

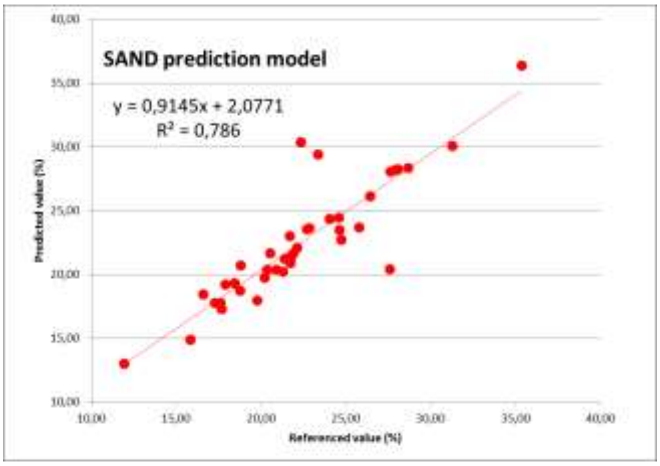


Fig. 8. Sand prediction models using PLSR

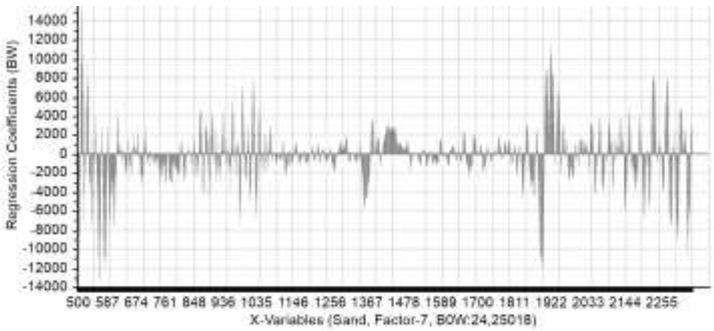


Fig. 9. The regression coefficients of sand models

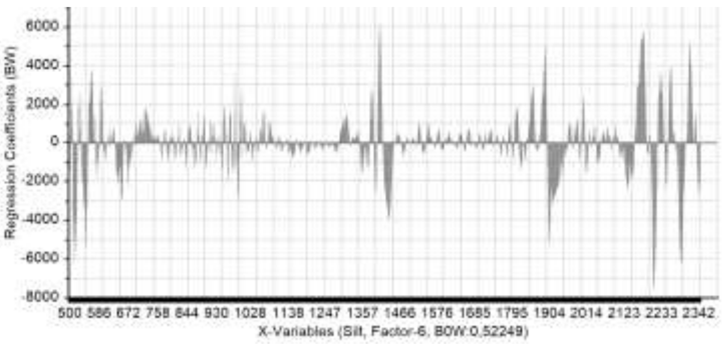


Fig. 10. The regression coefficients of silt models

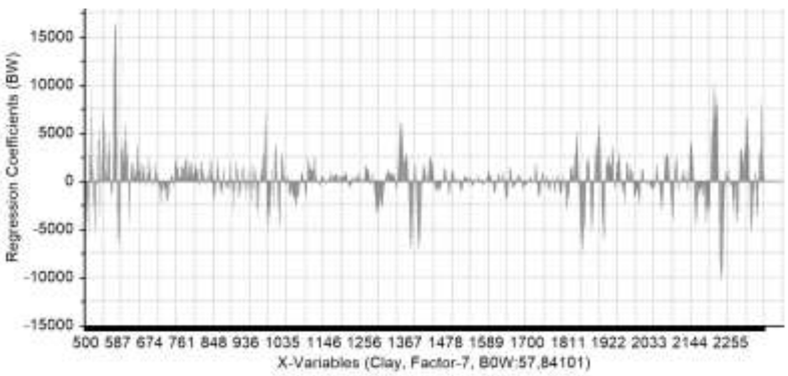


Fig. 11. The regression coefficients of clay models

IV. CONCLUSION

The performance of Vis-NIR reflectance spectroscopy to estimate soil texture using PLSR method resulted satisfactory level. It was proven from the RPD values that the calibration models were "good" to predict clay, silt and sand. Clay prediction had higher accuracy compared to sand and silt. PLSR method also allows us to investigate the important spectrum for the prediction of soil textures.

In this study, soil proximal sensing using Vis-NIR spectrum was a reliable tool for the prediction of soil textural fraction of unknown soil samples. Different preprocessing methods should be performed in order to improve the correlations between the measured soil texture and the spectra.

The same method of soil proximal sensing is being performed to estimate the other soil properties such as pH, soil organic matters, N, P and K spatially at Nglipar and Dlingo, and temporally at four stages of crop growth.

REFERENCES

[1] W.A. Jury, and R. Horton, *Soil Physics,* 6th ed. New Jersey, USA: John Wiley & Sons, Inc., 2004.
[2] K.T. Osman, *Soils: Principles, Properties and Management,* Dordrecht, The Netherland: Springer Science+Business Media, 2013.
[3] V.I. Adamchuk, B.A. Allred, and R.A.V. Rossel, "Proximal Soil Sensing: Global Perspective ," *FastTimes*, vol.17, no.1, Mar. 2012. [Online]. Available: http:// www.eegs.org/
[4] R.A.V. Rossel, V.I. Adamchuk, K.A. Sudduth, N.J. McKenzie, and C. Lobsey. "Proximal Soil Sensing: An Effective Approach for Soil Measurements in Space and Time," *Advances in Agronomy*, vol.113, pp. 237-282, 2011.
[5] B. Stenberg, R.A.V. Rossel, A.M. Mouazen, and J. Wetterlind, *Visible and Near Infrared Spectroscopy in Soil Science,* in Donald L. Sparks, Ed., Advances in Agronomy. Burlington: Academic Press, 2010, Vol. 107, pp. 163-215.
[6] M. Conforti, R. Froio, G. Matteucci, G. Buttafuoco, "Visible and near infrared spectroscopy for predicting texture in forest soil: an application in southern Italy," *iForest*, vol.8, pp. 339-347, 2015. [Online] Available: http://www.sisef.it/iforest/
[7] A. Gholizadeh, M.S.M. Amin, and M.M. Saberioon, "Potential of visible and near infrared spectroscopy for prediction of paddy soil physical properties," *Journal of Applied Spectroscopy,* vol.81: 3, pp.534-540, Jul. 2014.
[8] R.A.V. Rossel, D.J.J. Walvoort, A.B. McBratney, L.J. Janik, and J.O. Skjemstad, "Visible, near infrared, mid infrared or combined diffuse reflectance spectroscopy for simultaneous assessment of various soil properties," *Geoderma,* vol.131, pp. 59-75, 2006.
[9] P. Geladi and B.R. Kowalski, "Partial least-squares regression: a tutorial," *Analytica Chimica Acta*, vol.185, pp. 1-17, 1986.
[10] "Datasheet of Nglipar and Dlingo Soil Map Scale 1:250,000", Indonesian Center for Agricultural Land Resources Research and Development (BBSDLP). [via email]. 2016.
[11] (2017) Climate data for cities worldwide website. [Online]. Available: http://en.climate-data.org/
[12] "Monthly rainfall 2007-2017 datasheet of Dlingo and Nglipar," BMKG, Yogyakarta, Indonesia.
[13] "Soil Texture Calculator", NRCS USDA website. [Online]. Available: https://nrcs.usda.gov/
[14] B.S.N. Aliyah, S. Shibusawa and M, Kodaira, "Multiple-depth mapping of soil properties using a visible and near infrared real-time soil sensor for a paddy field," *Engineering in Agriculture, Environment and Food*, vol.8, pp.13-17, 2015.
[15] C.W. Chang, D.A. Laird, M.J. Mausbach, and C.R. Hurburgh Jr., "Near-infrared reflectance spectroscopy-principal components regression analysis of soil properties," *Soil Sci Soc Am J.*, vol.65, pp.48-90, 2001.
[16] S.W. Broome, lecture note in Soil Physical Properties. [Online]. Available: http://broome.soil.ncsu.edu/ssc012/Lecture/topic8.htm.
[17] Canadian Remote Sensing Society, article of Remote Sensing and Soil [Online]. Available: http://www.ucalgary.ca/geog/Virtual/ Remote%20Sensing/rssoils.html
[18] D. Curcio, G. Ciraolo, F. D'Asaro, M. Minacapilli, "Prediction of soil texture distributions using VNIR-SWIR reflectance spectroscopy," *Procedia Environmental Sciences*, vol. 19, pp. 494- 503, 2013

C.12

APPLICATION OF MICROCONTROLLER TO CONTROL ROOM ENVIRONMENT OF A MUSHROOM HOUSE

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ABSTRACT

The objective of this research is how to control proper room temperature and humidity in a straw mushroom producing house with the targets of 28-33°C temperature, and 80-90% relative humidity. Research was conducted by building a mushroom house (4m wide x 6m long x4m high), steel framed, asbestos roofed with 3mm plywood ceiling, and 60% screen net wall layered with 14%UV transparent plastic. The mushroom house was equipped with a microcontroller to monitor and control the room temperature and relative humidity. Twenty units of SHT22 sensor were installed to monitor the temperature and humidity; eighteen in the room, one above the ceiling, and the last was placed outside the house (above the roof). The system was equipped with 4 units of water sprayer heads to elevate the room humidity and decrease the room temperature. Two units of vents were installed at the upper wall to exhaust the room air when the humidity and temperature were above the optimum ranges. A unit of heater was added at the middle of the room to elevate the room temperature when it went down bellow 28°C. Results showed that when the temperature and humidity were not controlled, they could fluctuate out of the optimum ranges; temperature increased above 33°C and went down to 25°C. Likewise; humidity was ranging between about 50% to saturation. However; when the control was activated, the temperature and humidity were in general close to the optimum ranges.

Keywords: mushroom, microcontroller, temperature, humidity, empty fruit bunch

I. INTRODUCTION

Cultivating of straw mushroom can be a potential alternative in the term of diversification of protein sources, because straw mushroom is one nutritious food with high content of protein. Some edible mushrooms grown in Indonesia are *Agaricus bisporus*, *Auricularia auricula*, *Lentinula edodes*, *Pleurotus ostreatus*, dan *Volvariella rolvacea* or straw mushroom. Straw mushroom dominates the portion by 55%—60% of domestic prouction (Iriana, 2007). However; Production and consumption of straw mushroom in Indonesia is still low, only limited people realize its good nutrition and consume mushroom. The world's production of edible mushroom is about 3,5 million tons/year, whilst Indonesian production is only 68 thousand tons or less than 2% of the world's production (Wakchaure, 2011). The fact showed that mushroom cultivation is very prospective to develop in Indonesia.

Straw mushroom (*Volvariella volvaceae L*) is more preferable to others because of its exceptional taste besides its high content of nutrition. Some researches showed that straw mushroom's protein content was about 25.9-28.5% (Sunandar, 2010). This protein content is higher if compared to rice's protein content which is only 8,4% (ParadiGma, 2014), or to wheat's content which is about 6-17% (Aptindo, 2012). Straw mushroom also contains 9 of 10 types of essential amino acids known. 72% of fat contained in straw mushroom is unsaturated fat. Some vitamins, such as B1 (thiamine), B2 (riboflavine), niacin and biotin are also contained in the straw mushroom. Straw mushroom is also known containing various minerals such as K, P, Ca, Na, Mg, dan Cu (Sunandar, 2010).

Straw mushroom is normally grown on rice straw media, which is firstly added with some fertilizers, limes, and carbohydrate-containing materials, and then composed after all. However; straw mushroom is in fact can be grown on media some cellulose materials other than rice straw especially for agricultural solid wastes such as EFB, dried banana leaf, coconut husk, sugar cane baggase, saw dusk (Mayun, et.al. 2007; Riduwan, et.al. 2013);Additional materials such as rice bran (as sources of carbohydrates), organic/inorganic fertilizers, chicken litters (sources of decomposers and nitrogen), lime (for controlling pH) are added to the main medium and mixed prior to composting (Arifestiananda, 2015; Zuyasna dkk., 2011; Farid, 2011; Ichsan dkk., 2011).

Utilization of EFB used as the growing medium for straw mushroom is prospective in that EFB is abundant waste from palm oil industries in Lampung and even in Indonesia. In addition, EFB is high content of cellulose which is needed for mushroom's growth. The spent medium then can be used for organic fertilizer. Therefore; there is some added value of the solid waste, as the mushroom growing medium and as organic fertilizers or compost.

Straw mushroom is grown in a mushroom house which is so called "kumbung". Proper environment (room temperature and relative humidity) is needed for straw mushroom to grow well. Growers know that the optimum temperature ranges from about 28^{o}C to 33^{o}C, and the optimum relative humidity (RH) ranges from 80% to 90 %. Traditionally growers control room temperature and RH by opening and closing ventilation. They spray the floor with water in order to increase RH. This traditionally method of controlling room temperature and relative humidity is neither accurate nor effective. When temperature sharply elevates, the opening ventilation is not effective enough to naturally deliver the warming air temperature from inside to the outside mushroom house. A mechanical exhaust is apparently required to solve this problem.

Automatically controlled room environment of the mushroom house might be the best solution to get the optimum temperature and humidity needed by mushroom. Researches on the use of microcontroller for controlling hydrophonic plant's environment have been done (Candra at.al, 2016). Other research works on the use of microcontroller to control the mushroom's environment have been found too (Sunarsa dkk., 2010; Akmaludin dan Luthfi, 2014; Karsid et.al., 2015). All of the researches; however, were done in smaller scale models of mushrooms. So we need further pictures of the application of microcontroller on true size of mushroom house in term of controlling the environment. This research aims to observe temperature and humidity profiles in a 4x6x4 m^3 mushroom house.

II. MATERIALS AND METHODS

Research was started by building a mushroom house with the size of 4x6 m^2 large and 4 m high. The structure was supported by steel frame, while the wall was sealed with woven plastic screen and doubled with plastic tarpaulin to get a better thermal insulation. The roof was made of waved asbestoses; ceiling was from 3 mm plywood. The wall was equipped with 2 units of exhaust vents to draw warm air in the inside to the outside of the mushroom house.

Four units of nozzle water sprayers were mounted at the ceiling, to elevate humidity and lower temperature. A mixing vent was also installed on the ceiling in order to make room air homogeneous. A set of heater was placed underneath of the mixing vent. These equipments were all automatically controlled by assembled microcontroller using processor of Arduino Mega 2560. Twenty units of DHT sensor were mounted; 18 units inside the room, one above the ceiling, the last one above the roof (outside the building). After all, the system was calibrated, validated, and then tested before the true mushroom production. Consistency of the temperature and humidity was assessed by using trial and error.

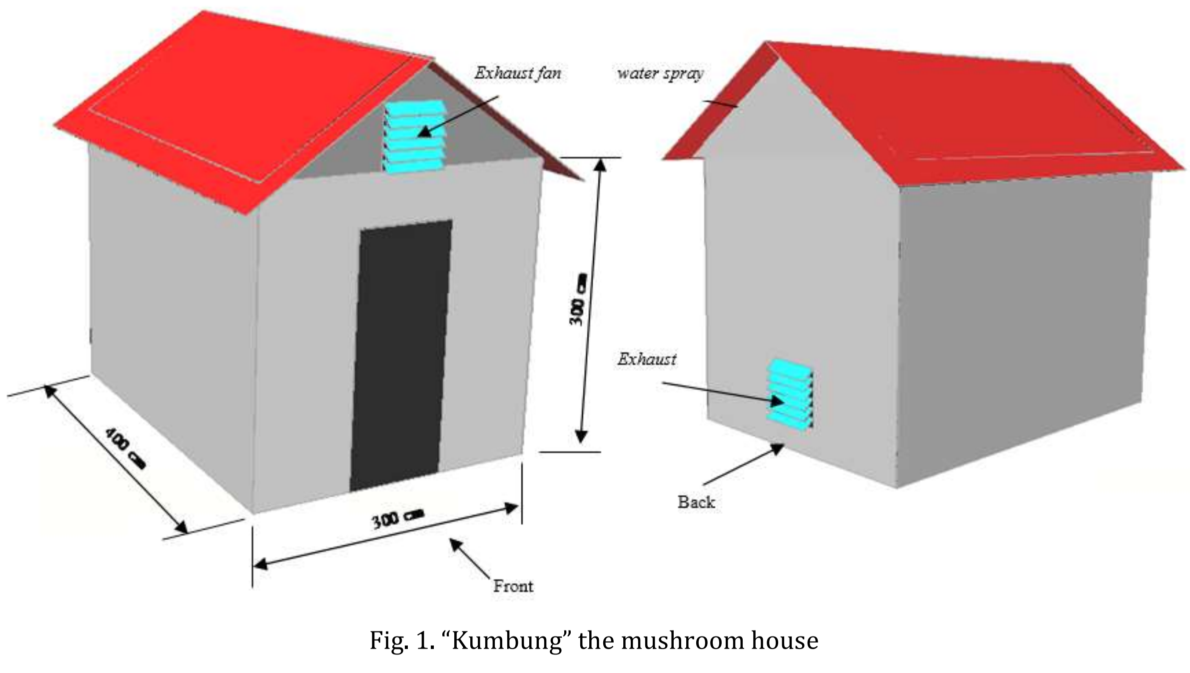

Fig. 1. "Kumbung" the mushroom house

III. RESULTS AND DISCUSSION

A set of microcontroller assembled using the Arduino mega 2560 processor was displayed on Fig. 2. This control monitored temperature and humidity outside the room (two sensors, above the ceiling and above the roof), and also control temperature and humidity inside the room through twenty units of DHT 22 sensor.

Fig. 2. Microcontroller set

Fig. 3 shows hourly temperature profile for one mount. Average outside (above the roof) temperature was 37.46°C, too high for mushroom to grow. Average ceiling (above the ceiling) temperature was 35.43°C, still high for mushroom to grow well. The temperature difference showed the sealing effect of the waved asbestoses roof. Average temperature inside the room was 37.22°C, still higher than the optimum temperature needed, showing that the room temperature needs to be controlled to around be optimum (max of 33°C). Especially just before and after noon, temperature was rising to pick points of almost 40°C which were dead points.

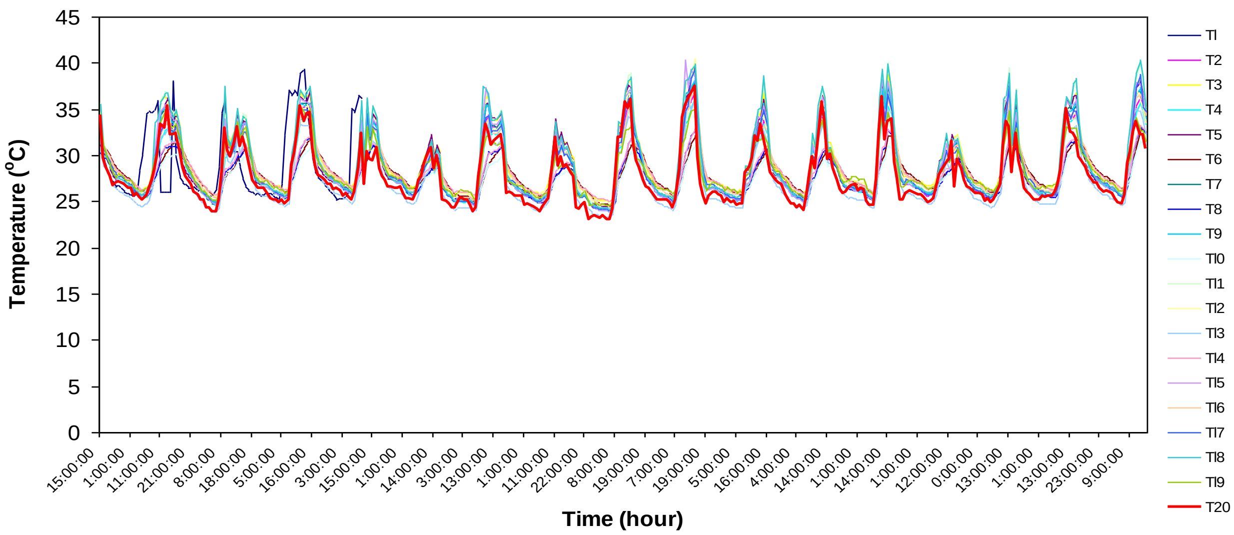

Fig. 3. Uncontrolled room, above ceiling, above roof temperatures

Fig. 4 shows humidity at room, above ceiling, and above roof of mushroom house. Humidity above roof of the mushroom was 98.9% almost saturation, minimum of 74.4%, and maximum of 99.9% just saturation. Above the ceiling, humidity was 92.7% on the average, minimum of 53.1%, and maximum of 99.9%. Inside the room of the mushroom house, humidity was 84.8% on the average, meaning that humidity met the optimum requirement. However, the minimum humidity of 63.5% was definitely too low, meaning that room humidity needs to be controlled. The maximum humidity of 94.1%; however, was fairly close to the optimum range.

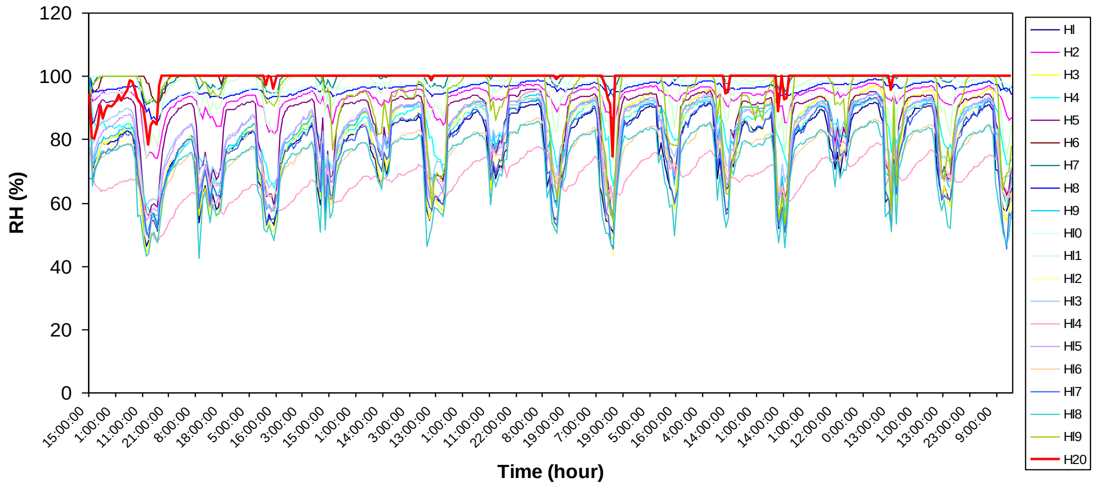

Fig. 4. Uncontrolled room, above ceiling, above roof humidity

Sensors were had to be validated to make sure that the sensor could read properly at saturated humidity. All sensors showed almost the same temperatures for average and minimum temperatures, meaning that all sensors had no problem in reading the saturated temperatures. For maximum temperatures, sensors showing the highest temperature at outside were just normal.

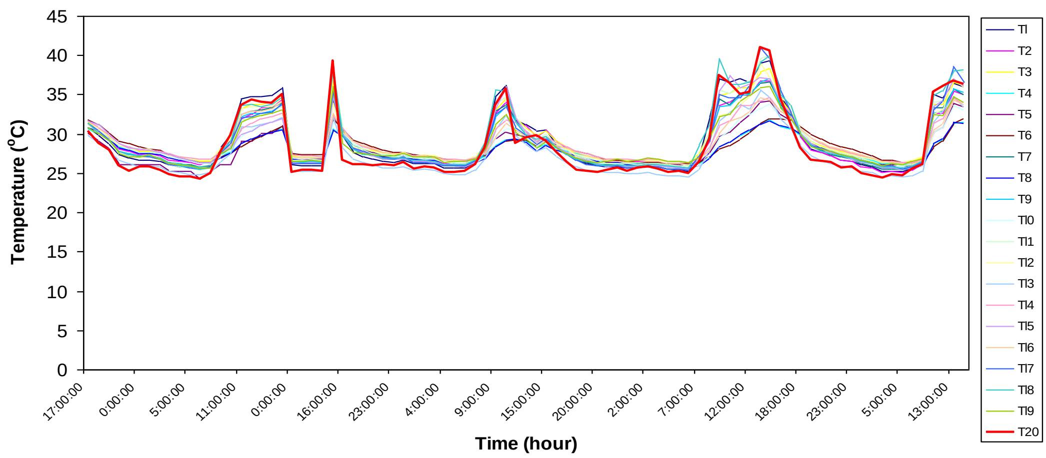

Fig. 5. Room, above ceiling, above roof temperatures at saturated humidity

For humidity validation at saturation, Fig. 6 showed just all sensors could reach saturated humidity, meaning that all sensors had no problem of reading at maximum ranges.

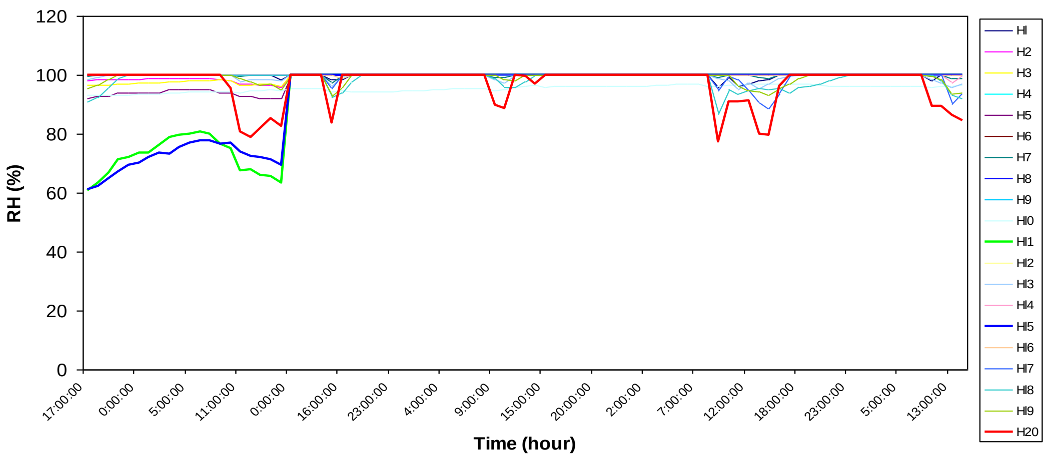

Fig. 6. Room, above ceiling, above roof humidity at saturated points

Fig. 7 showed controlled room temperature, above ceiling and above roof temperatures. Average room temperature of 28.64°C was good since it was in the optimum range. However; the minimum temperature of 25.81°C and the maximum temperature of 35.13°C were somewhat critical points. The minimum temperature of 25.81°C might not so bad, but the maximum temperature of 35.13°C might cause very serious effect on mushroom growth. These critical temperatures mostly happened just before and after noon. This problem implied that some modifications of coding of water spray and exhaust vent were needed to be done.

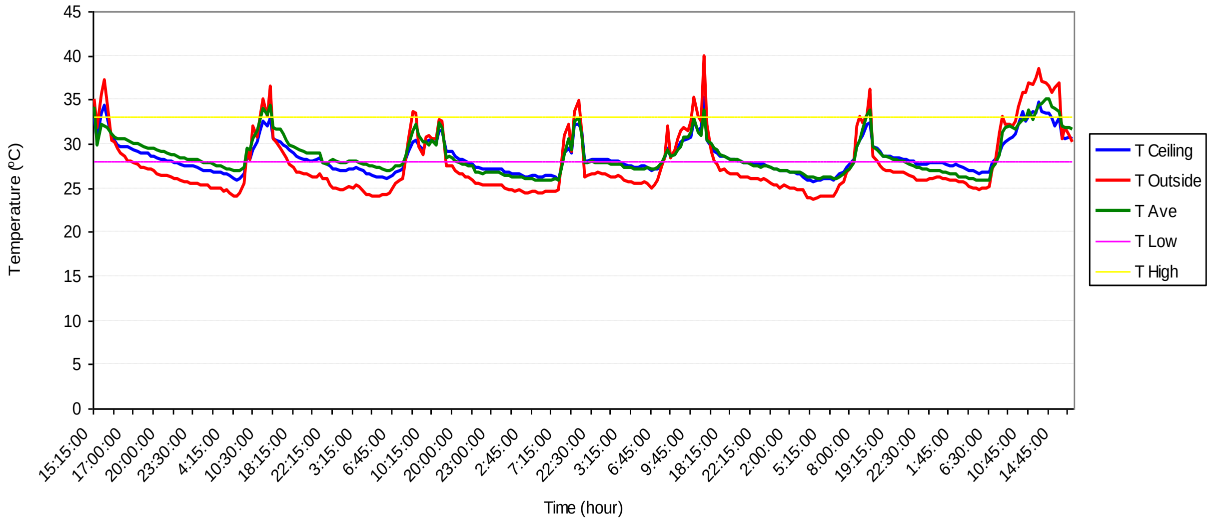

Fig. 7. Controlled room temperature, above ceiling and above roof temperatures

Fig. 8 showed controlled room humidity, above ceiling and above roof humidity. Average room temperature of 96.83 was above the designed range which is 80-90%. It suggested that some modification of exhaust vent operation modes and water sprayer were needed to be taken to get the best condition in the room in the mushroom house. However; the effect of high humidity on mushroom growth was not as critical as the effect of temperature.

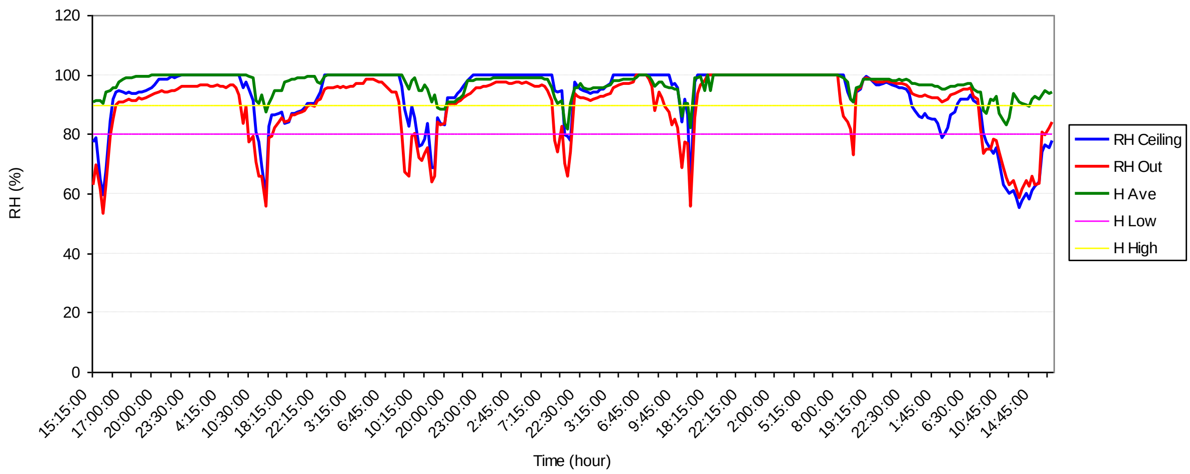

Fig. 8. Controlled room humidity, above ceiling and above roof humidity

IV. CONCLUSION

Based on the data showed, some conclusions that can be taken were:

1. Temperature and humidity Sensors (DHT 22) could work pretty well.
2. The control system designed worked very well. However, temperature was easier than controlling humidity. Average controlled inside room temperature of 28.64°C fell in the optimum range, while the average controlled humidity of 96.83% was still above the designed range, and therefore needed some adjustments of the operation modes.

REFERENCES

Akmaludin, D. dan E. T. Luthfi. 2014. Prototipe Rumah Jamur Merang Otomatis Dengan Pengendali Suhu Dan Kelembaban Menggunakan Mikrokontroller Atmega8535. Naskah tidak dipublikasi, Jurusan Teknik Informartika, STMIK AMIKOM YOGYAKARTA.

Aptindo. 2012. Gandum Serelia Berprotein Tinggi. Asosiasi Produsen Tepung Terigu Indonesia (Aptindo). http://www.aptindo.or.id/index.php?option= com_content&view=article&id=56:gandum-seralia-berprotein-tinggi-&catid=35:artikel&Itemid=57

Arifestiananda, S., Setiyono, Dan R. Soedradjad. 2015. Pengaruh Waktu Pengomposan Media Dan Dosis Kotoran Ayam Terhadap Hasil Dan Kandungan Protein Jamur Merang. *Berkala Ilmiah PERTANIAN. Volume X, Nomor X, Bulan Xxxx, Hlm X-X.*

Candra, H., S. Triyono, M. Z. Kadir, dan A. Tusi. 2016. Rancang Bangun dan Uji Kinerja Sistem Kontrol Otomatis pada Irigasi Tetes Menggunakan Mikrokontroller Arduino. J. Teknik Pertanian Lampung Vol. 4 (4), 2016: 235-244.

Farid, A., 2011. Pengaruh Pengomposan Dan Macam Sumber Karbohidrat Terhadap Pertumbuhan Dan Hasil Jamur Merang. Skripsi. Program Studi Agronomi Jurusan Budidaya Pertanian Fakultas Pertanian Universitas Jember.

Ichsan, C.N., F. Harun, dan N. Ariska. 2011. Karakteristik Pertumbuhan Dan Hasil Jamur Merang (Volvariella volvacea L.) Pada Media Tanam Dan Konsentrasi Pupuk Biogreen Yang Berbeda. J. Floratek 6: 171 – 180.

Iriana, D.W. 2007. Bisnis Jamur, Bikin Tergiur. Informasi Pertanian. http://agribisnis-indonesia.blogspot.co.id/2007/11/bisnis-jamur-bikin-tergiur.html

Karsid, R. Aziz, H. Apriyanto. 2015. Aplikasi Kontrol Otomatis Suhu dan Kelembaban untuk Peningkatan Produktivitas Budidaya Jamur Merang. Jurnal Aplikasi Teknologi Pangan 4 (3): 86-88.

Mayun, I.A. 2007. Pertumbuhan Jamur Merang (Volvariella volvaceae) pada Berbagai Media Tumbuh. Agritrop, 26 (3): 124-128.

ParadiGma. 2014. Perbedaan Nutrisi Beras Hitam, Beras Putih, dan Beras Merah. http://berashitam.net/perbedaan-nutrisi-beras-hitam-beras-putih-dan-beras-merah/

Riduwan, M., D. Hariyono, dan M. Nawawi. 2013. Pertumbuhan Dan Hasil Jamur Merang (Volvariella Volvacea) Pada Berbagai Sistem Penebaran Bibit Dan Ketebalan Media. Jurnal Produksi Tanaman 1 (1): 70-79.

Sunandar, B. 2010. Budidaya Jamur Merang. BPTP Jawa Barat, BPPP Kementan. Jakarta.

Sunarsa I.M., A.R. Widodo, S.T. Rasmana, dan Ihyauddin. 2010. Rancang Bangun Sistem Kontrol Pada Prototipe Kumbung Untuk Budidaya Jamur Merang Putih. SNASTI 2010, ICCS – 6. Naskah tidak terpublikasi. Program Studi S1 Sistem Komputer, STIKOM Surabaya.

Wakchaure, G.C. 2011. Production and Marketing of Mushrooms: Global and National Scenario. ResearchGate. https://www.researchgate.net/ publication/235951347

Zuyasna, M. Nasution, dan D. Fitriani. 2011. Pertumbuhan Dan Hasil Jamur Merang Akibat Perbedaan Media Tanam Dan Konsentrasi Pupuk Super A-1. J. Floratek 6: 92 – 103.

C.13

NEAR INFRARED REFLECTANCE SPECTROSCOPY: FAST AND SIMULTANEOUS PREDICTION OF AGRICULTURAL SOIL NUTRIENTS CONTENT

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ABSTRACT

The functions soil depends on the balances of its structure, nutrients composition as well as other chemical and physical properties. Conventional methods, used to determine nutrients content on agricultural soil were time consuming, complicated sample processing and destructive in nature. Near infrared reflectance spectroscopy (NIRS) has become one of the most promising and used non-destructive methods of analysis in many field areas including in soil science. The main aim of this present study is to apply NIRS in predicting nutrients content of soils in form of total nitrogen (N). Transmittance spectra data were obtained from a total of 18 soil samples from 8 different sites followed by N measurement using standard laboratory method. Principal component regression (PCR) with full cross validation were used to develop and validate N prediction models. The results showed that N content can be predicted very well even with raw spectra data with coefficient correlation (r) and residual predictive deviation index (RPD) were 0.95 and 3.35 respectively. Furthermore, spectra correction clearly enhances and improve prediction accuracy with r = 0.96 and RPD = 3.51. It may conclude that NIRS can be used as fast and simultaneous method in determining nutrient content of agricultural soils.

Keywords : infrared; soil; nitrogen; prediction; spectroscopy.

I. INTRODUCTION

As all we know that a major function of soil is to provide fundamental natural resources for survival of plants, animals, and the human race. The functions soil depends on the balances of its structure and composition, well as the chemical, biological, and physical properties [1].

The maintenance of soil quality is critical for ensuring the sustainability of the environment and it depends on the balances of soil structure and nutrient contents. These nutrient contents are divided onto macro and micro nutrient content. N, P, and K are major or macro nutrient contents, while Fe, Mn, Zn, Cu, B, Mo and Cl are known as micro nutrient contents. Both macro and micro are essentially required by plants to grow and develop [2].

Significantly, plants can grow optimally in a healthy soil, heavy metals free and fertile. Soil chemical properties related to the amount of nutrients required by plants, the amount needed will vary each growth phase.

It is very difficult to determine nutrient contents on soil in real time and without sample preparation. Normally, it requires standard laboratory procedures in which took some time with complicated sample preparation, and followed with multi step procedures. On the other hand, soil nutrient contents must be determined rapidly in order to take an action required and ensure optimum plant growth.

During the last two decades, infrared (IR) spectroscopy has been widely employed as an effective tool for the analysis of soil properties. Compared with traditional wet chemistry analysis, IR analysis is rapid, cost effective, non-destructive, requires minimal sample preparation and can be used in situ. More importantly, it permits a quantitative assessment of several properties from a single measure- ment. This technique mainly measures overtones and combinations of fundamental vibrational bands for O-H, N-H and C-H bonds from the mid-infrared region.

Numerous studies for the measurement of soil nitrogen (N) and organic carbon (OC) have been reported using this technique [3-5].

The IR Spectroscopy is a technique or method which uses infrared radiation of the electromagnetic spectrum to analyze the chemical composition of organic matter. It provides information through spectra signatures and patterns, regarding with the intrinsic organic bonds of the molecules and thus the primary chemical constituents of the object can be determined [6].

The term spectroscopy is the study of electromagnetic radiation as a function of wavelength, which has been reflected, absorbed or transmitted from a solid, liquid or gas material. Spectroscopy generates a unique spectral pattern of the material monitored. Each biological object has its own special optical properties, which means it has a different spectra pattern or signatures indicated its chemical compositions [7].

The main objective of this study is evaluate the feasibility of infrared spectroscopy technique, in form of near infrared transmittance spectrum for N content prediction on soil samples. Also, this study is aimed to evaluate the impact of spectra correction on prediction accuracy and robustness compared to un-corrected spectra data.

II. MATERIALS AND METHODS

A. *Soil samples and instrument preparation*

Soil samples were collected from 8 different sites in Banda Aceh and Aceh Besar district area. They cover rice field, ground/planted field and bare land. Soils amples were taken to the lab, dried and stored for 3 days prior to spectra acquisition and data analysis. Furthermore, FT-IR iptek 1516 was used as infrared instrument to acquire and record transmittance spectra of soil samples.

B. *Transmittance near infrared spectra acquisition*

In this study, infrared spectra data of all soil samples were acquired in form of transmittance spectral data. Background spectra correction was performed every hour automatically. Transmittance spectra in wavelength range of 1000 – 2500 nm with the increment of 0.2 nm resolution were acquired 32 times, averaged and recorded in SPA and CSV extension files format.

C. *Nitrogen content measurement*

Once spectra acquisitions were completed, total nitrogen content were measured using standard laboratory method. These data were used as data validation.

D. *Spectra data correction*

To enhance and improve prediction performance, spectra correction was employed to all spectra data of soil samples. Standard normal variate (SNV) was chosen as spectra data correction method [8].

E. *N content prediction*

Nitrogen content of soil samples were predicted based on transmittance spectra data using principal component regression (PCR). To validate the prediction result, full cross validation was applied during calibration model development. Model performance was quantified using statistical indicators: coefficient determination (R^2), coefficient correlation (r), the root mean square error (RMSE) and residual predictive deviation (RPD) index.

III. RESULTS AND DISCUSSION

Soil spectra spectrum for all 18 soil samples were presented in Fig.1. Soil spectral features in the infrared wavebands are highly correlated to the vibration modes of functional groups like the chemical bond of H and C, N, and O. These bonds are subject to vibrational energy changes in which two vibration patterns exist in these bonds including stretch vibration and bend vibration.

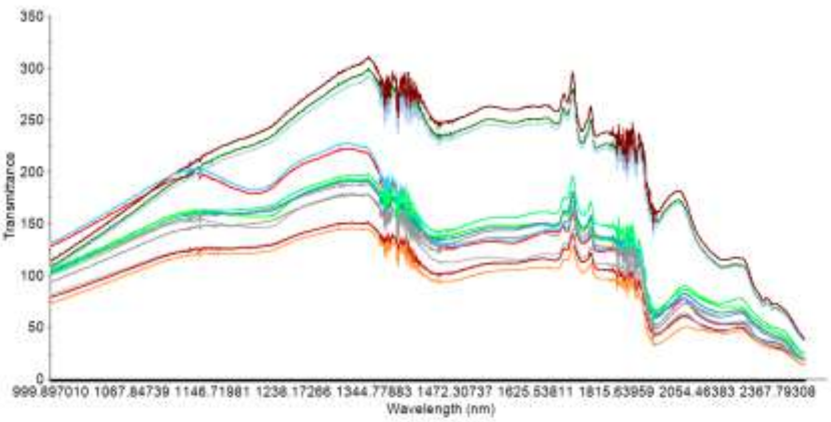

Fig. 1. Transmittance spectrum for all 18 soil samples from 8 different sites in Banda Aceh and Aceh Besar.

The nitrogen (N) content in the soil is a macro-element that plays an important role in soil nutrition along with Phosporus (P) and Kalium (K).

N content prediction, performed using raw un-corrected spectra data was firstly employed to predict N content of soil samples. Prediction result is showed in Fig.2. The accuracy of this prediction is relatively high. It generates correlation coefficient of 0.95 with RPD index of 3.25 which is categorized as excellent model performance.

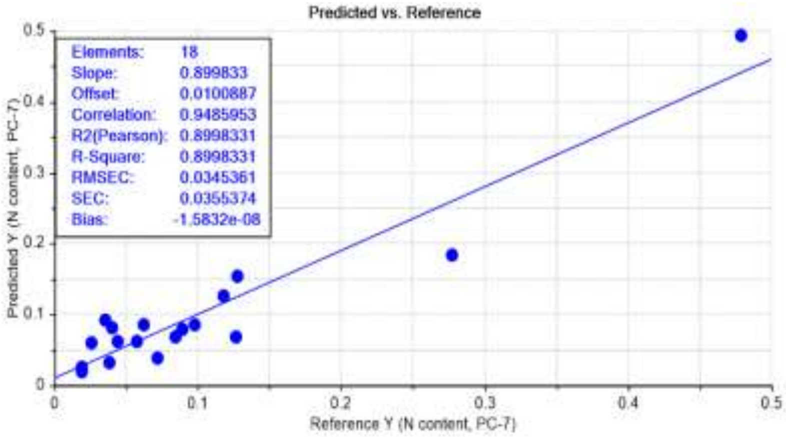

Fig. 2. N content prediction result using raw un-corrected transmittance spectra data.

We attempted to correct the spectra data in order to study the impact of this correction on prediction accuracy and robustness. SNV was chosen as a spectra correction method and the prediction result is shown in Fig. 3.

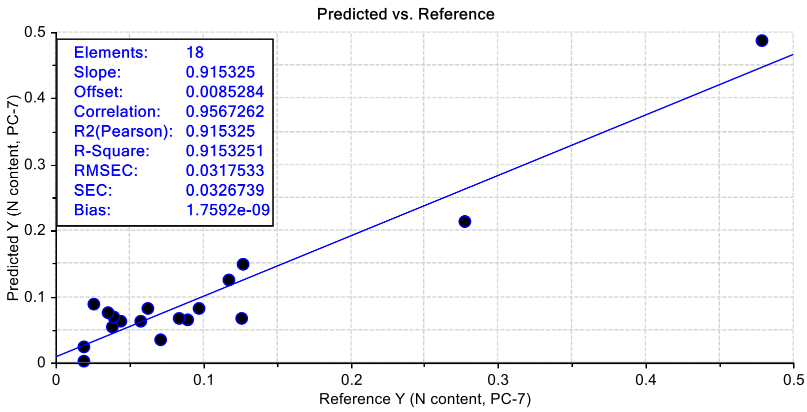

Fig. 3. N content prediction result using SNV corrected transmittance spectra data.

Most absorption bands in the infrared region are overtone or combination bands of fundamental absorption bands in the infrared region of the electromagnetic spectrum which are due to vibrational and rotational transitions.

In large molecules and in complex mixtures, such as soil structures, the multiple bands and the effect of peak-broadening result in spectral data that have a broad envelope with few sharp peaks. Soil is the biological object that contains a great quantity of hydrogenous bonds (i.e C-H, O-H and N-H).

Based on this present study, as shown in loading plot in Fig.4, the N content of soil samples can be optimally predicted in wavelength range of 1183 – 1208 nm, and also can be predicted in wavelength range of 1671 – 1753 nm, and 1905 – 1958 nm.

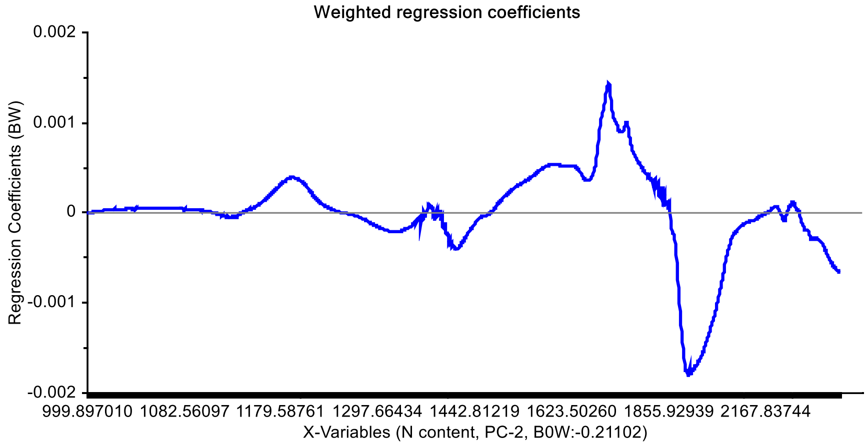

Fig. 4. Optimum and relevant wavelength range for N content prediction in NIR region

IV. CONCLUSION

The present study aimed to evaluate the feasibility of infrared technology as a rapid and non-destructive method in determining soil quality parameter in form of Nitrogen content. Obtained results shows that infrared technology was able to predict N content of soil samples satisfactory with r coefficient = 0.95 and RPD = 3.25. Furthermore, spectra correction, using SNV method was obviously improve prediction accuracy to r = 0.96 and RPD index = 3.51.

N content of soil samples can be optimally predicted in wavelength range of 1183 – 1208 nm, and also can be predicted in wavelength range of 1671 – 1753 nm, and 1905 – 1958 nm.

ACKNOWLEDGEMENT

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REFERENCES

[1] T, Shi.., Yiyun, C., Yaolin, L., & Guofeng, L. (2014). Visible and near-infrared reflectance spectroscopy: An alternative for monitoring soil contamination by heavy metals. Journal of Hazardous Materials, 265, 166–176.

[2] J. Wang, Lijuan, C., Wenxiu, C., Tiezhu, S., Yiyun, C., & Yin, G. (2014). Prediction of low heavy metal concentrations in agricultural soils using visible and near-infrared reflectance spectroscopy. Geoderma, 216, 1-9.

[3] G. Senesi, & Senesi. N. (2016). Laser-induced breakdown spectroscopy to measure quantitatively soil carbon with emphasis on soil organic carbon. A review. Analytica Chimica Acta, 938, 7 – 17.

[4] M.S Askari, Cui, J., O'Rourke, S.M., & Holden, N.M. (2015). Evaluation of soil structural quality using VIS–NIR spectra. Soil Tillage Res. 146 (Part A), 108–117.

[5] A.M.R. Bieganowski, & Witkowska, B., (2010). Determination of soil aggregate disintegration dynamics using laser diffraction. Clay Miner. 45, 23–34.

[6] H. Cen, & He, Y. (2007). Theory and application of near infrared reflectance spectroscopy in determination of food quality. *Trends in Food Science & Technology*, 18, 72-83.

[7] B. M. Nicolai, Beullens, K., Bobelyn, E., Peirs, A., Saeys, W., Theron, K. I., & Lamertyn, J. (2007). Nondestructive measurement of fruit and vegetable quality by means of NIR spectroscopy: a review. Postharvest Biology and Technology, 46, 99-118.

[8] A.A. Munawar, Hoersten, D.v., Pawelzik, E., Wegener, J.K & Moerlein, D. (2016). Rapid and non-destructive prediction of inner quality attributes of intact mango using Fourier-transform infrared and chemometrics. J. Engineering in Agriculture, Environment and Food, 9 (1): 208 – 215.

C.14

CLEAN TECHNOLOGY IN COPRA AND COCONUT SHELL PROCESSING INDUSTRY

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ABSTRACT

Objectives of the program were to : (1) improve performance of human resource in handling pollution and financial management, (2) improve quality of crafts and production capacity, and (3) broaden marketing coverage. The program was conducted in the year of 2013 to 2015. In the first year (2013), performance of the human resource in handling pollution was improved by a training and intruduction of low pollution machine in coconut shell grinding process. Financial management was also improved. In the second year (2014), capacity in producing better quality of crafts was improved by a training. Variety of craft was also developed by a training and introduction of cutting and hollow drilling mahine. Production capacity was increased by establishing 5 plasms . Marketing coverage was broadened by promoting crafts product in some exibition at Jakarta and Semarang. An outlet in center of Purwokerto city was also provided by the local government of Banyumas regency. In the third year (2015), smoke pollution produced in copra processing was reduced by improvement of smoke drying room. Coconut shell waste produced in craft production was used to make charcoal bricket. For this purpose, a charcoal production building was built and a set of charcoal bricket machine was introduced.

Keywords : copra, coconat shell, pollution, charcoal bricket, crafts.

I. INTRODUCTION

Small–middle scale industry in Banyumas regency has been giving contribution to local economy growth. Role of this scale industry should to be strengthened to enable the industry to give greater contribution because population of the industry is high in Banyumas regency. Obstacles in developing the industry are lack of human resource skills and lack of management capability.

Initial observation indicated that Somacoco was one of potential family owned industries to be developed towards better performance. The Somacoco produces copra, coconut shell crafts, and coconut shell charcoal. Motivation of the owner to develop the company was considerably high. Many supports have been accepted from Local Government of Banyumas regency. However, some problems have not been solved yet and these became obstacles for the company to achieve more profit. Available tools, machine, and building were limited and not considerably safe nor healthful to workers. Workers were exposed to pollution emitted from copra and coconut shell crafts processing. Smoke dryer room was not built properly and it caused heavy smoke pollution to the surrounding area. Heavy smoke emitted from charcoal production was also improperly managed. In crafts production, dust produced from grinding process was not properly anticipated either, and seriously threatened the workers health. In terms of profit gain, the company faced difficulties in providing sufficient quantity and quality to customers' need due to insufficient availability of production machine and capability of the workers in developing variety of products. This caused limitation of the company to gain greater profits.

Considering the above problems, a community service program was conducted. Objectives of the program were to: (1) improve performance of human resource in handling pollution and financial management, (2) improve quality of crafts and production capacity, and (3) broaden marketing coverage.

II. MATERIALS AND METHODS

The program was funded by the DGHE- Indonesia Ministry of Education through multiyear program of Hi-Link. Support was also given by the Local Government of Banyumas regency. This was a funded by Hi-Link program of DGHE-Ministry of Education, the Government of Indonesia. Activities were conducted in three phases since 2013 to 2015. The activity objectives can be seen in Table 1.

Table 1. Activities of Hi-Link programs were conducted in three phases since 2013 to 2015

Year	Objectives of Activity
2013	to strengthen management capacity of the company, to transfer knowledge and technology, and to provide appropriate tools and machines.
2014	to improve production capacity and quality of coconut shell crafts.
2015	to improve capacity of charcoal production and to develop variety of crafts

III. RESULTS AND DISCUSSION

A. *First Phase (2013)*

Outputs of the first phase can be seen on Table 2. In this phase, performance of the company was evaluated and necessary remedial action was taken both in technological and management aspects.

Table 2. Outputs in the first phase (Margiwiyatno *et al*., 2013).

Activity	Outputs	Remarks
Strengthening Management	Improvement of company staffs in understanding and skill on simple financial management. Availability of computer facilities for financial cash flow.	In house training was conducted to improve capacity of the company staffs
Improving production capacity	Availability of machines for supporting crafts production.	1 unit endless tape sanding machines, 3 units of circular sanding machines, 1 unit circular saw, 1 unit wire cutter, and Drilling machine.
	Availability of machine for producing charcoal briquette.	1 unit grinding machine, 1 unit sieving machine, 1 unit mixer, and 1 unit charcoal briquette machine.
	Availability of apparatus for producing liquid smoke.	2 units of retorts and distillatory
	Improvement of company staffs in designing and producing crafts	In house training
Students Research	Availability of information about performance of sanding machine and apparatus for producing liquid smoke.	5 students were involved in this activity

1. *Financial management*

One staff has been successfully trained to improve his capacity on simple financial database management by using computer. Before implementation of the project, there was no financial and products record document. This caused difficulties for the company in evaluating benefits and costs of production activities. Moreover, difficulties occurred when the company applying bank loan because the bank could not assess financial performance of the company.

2. *Dust pollution*

Dust pollution produced in coconut shell sanding process was also anticipated in this phase. A sanding machine was designed and built for that purpose. Performance test of the machine indicated that the sanding machine could work properly. The dust was blown into a container during sanding process. In addition, this machine could double the capacity of sanding process, i.e., 20 coconut shells/hour compared to capacity before the program implementation which was only 9 coconut shells/hour (Pratama, 2015). Before the program implementation, the company could only provide 20.000 coconut shells cup per months (Margiwiyatno, et. al., 2013), whilst the new machine could produced 50.000 coconut shells cup per month (Margiwiyatno *et. al*, 2014). Financial analysis to the new machine indicated that Break Even Point was found at about 62 hours/year or 1240 coconut shells/year (Pratama, 2015; Nugroho, 2015) .

(a)

(b)

(c)

Fig. 1. Sanding machine : (a) sanding machine used before program implementation, (b) the new built machine (circular type), (c) the new built machine (endless tape type) (Margiwiyatno *et. al.*, 2013).

3. Liquid smoke of coconut shell production apparatus

The apparatus was provided by Local Government of Banyumas regency. In performance test was found that the apparatus was not working properly. Improvement was not conducted because it was beyond the coverage of the program.

Fig. 2. Liquid smoke of coconut shell production apparatus (Margiwiyatno *et al.*, 2013).

B. Second Phase (2014)

1. Financial management

Investment in the previous year by the program has given considerable financial performance of the company. In the period of January to September 2014, total sales booked by company was Rp. 455.675.700,- and the net profit was 34%.

2. Crafts design development

Training was conducted to improve creativity of the company in developing crafts products (Fig. 2). To support the training, some machines were provided by the program, i.e. bench grinder machine, scroll saw machine, and hollow drill machine.

Fig. 3. In house training on coconut shell crafts (Margiwiyatno *et al.*, 2014).

3. Broadening marketing coverage

Before the program implementation the company has no strategy to promote the products. In the second phase of the program, a website was made to promote the products, especially coconut shell crafts. In addition, the company participated in many exhibitions at Purwokerto, Jakarta, and Semarang. The Local Government of Banyumas regency provided a space in city business center for selling the company products (Fig. 4).

Fig. 4. Outlet at city business center (Margiwiyatno *et al*., 2014).

To broaden marketing vision of the company, a study excursion was made to Tropica Nucifera Industries at Yogyakarta. In this industry, the company staffs could learn marketing and processing method in making high quality liquid smoke and charcoal of coconut shell.

C. Third Phase (2015)

1. Financial management

During the period of January to September 2015, total sale was Rp. 313.353.500,- and the profit was 20%. There was a decrease in total sales because there was lack of coconut availability (Margiwiyatno *et al*., 2015).

2. Charcoal Production

Before implementation of the program, production of charcoal was conducted in open space. Smoke produced during charcoal processing was spreaded to the environment. This caused pollution to the surrounding area. To alleviate this problem, charcoal processing building was built (Fig. 5). This could prevent the surrounding area from the smoke. Capacity of charcoal production was 1500 kg/day; this increased about 3 times than that before the implementation of the program (Margiwiyatno *et al*., 2015).

Fig. 5 Charcoal processing building(Margiwiyatno *et al*., 2015).

3. Development of craft products from coconut shell sanding dust

In the third phase, a new craft product was developed, namely coconut shell sanding dust was used to make leather (Fig. 6). This product can be used for many purposes as can be seen in Fig. 7.

Fig. 6. Coconut shell sanding dust Leather (Margiwiyatno *et al*., 2015).

Fig. 7. Use of leather for making various products(Margiwiyatno *et al*., 2015).

4. Broadening market coverage

A website was also built to promote the coconut shell crafts (Margiwiyatno *et al*., 2015). A training was conducted to enable the company staffs maintaining the website.

Fig. 8. Website to promote crafts (Margiwiyatno *et al*., 2015).

IV. CONCLUSION

Based on the program implementation results, it can be concluded that:

1. Weaknesses of the company were observed mainly in management, technological skill aspects, and awareness of pollution. Strengths of the company was mainly high motivation of the owner to develop the company.
2. Remedial action during the program implementation was considered successfully applied. It is indicated by improvement of the company in managing financial records using computerized simple system.
3. Technological intervention was successfully applied to solve problem in pollution and capacity of production.

REFERENCES

Margiwiyatno, A., Trisasiwi, W., Rosyad, A. 2013. Clean technology in Copra and Coconut Shell Crafts Processing Industry. Final Report of Hi-Link Program 2013. Jenderal Soedirman University.

Margiwiyatno, A., Trisasiwi, W., Rosyad, A. 2014. Clean technology in Copra and Coconut Shell Crafts Processing Industry. Final Report of Hi-Link Program 2014. Jenderal Soedirman University.

Margiwiyatno, A., Trisasiwi, W., Rosyad, A. 2015. Clean technology in Copra and Coconut Shell Crafts Processing Industry. Final Report of Hi-Link Program 2015. Jenderal Soedirman University.

Nugroho, A.P. 2015. Perbaikan sistem penghisap debu pada mesin pengampelas tempurung kelapa tipe circle di UKM Somacoco. Skripsi. Fakultas Pertanian, Universitas Jenderal Soedirman.

Pratama, A.N. 2015. Uji performansi pengampelas tempurung kelapa tipe circle di UKM Somacoco. Skripsi. Fakultas Pertanian, Universitas Jenderal Soedirman.

C.15

THE QUALITY OF FERMENTED CACAO BEANS IN SMALL-SCALE

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ABSTRACT

Farmers are rarely to conduct the fermentation process of cacao beans due to it requires a long time and should be done in a large scale. Indeed, they are not consider an uniform of maturity level during cacao beans are harvested. This research has purpose to determine the minimum mass of cacao bean in small scale and the effect of maturity level on fermentation product.

The main materials and equipments used cacao which was Lindak from Gedong Tataan Districts and small fermentation boxes (26 x 20 x 45 cm). This research conducted by using factorial RAL. The first factor was maturity levels (A, B, and C) and the second factor was mass cacao beans (10, 15, and 20 kg) that used three repetitions. The measured of parameter involved temperature, pH (acidity level), cut-test, and fat content. The data were analysed by using ANOVA and LSD for futher testing.

The result of ANOVA indicated that only mass factor had significant on temperature during fermentation process, total full fermented beans, and fat content of cacao beans. As a result, the mass recomendation of cacao beans for small-scale in fermentation process is 20 kg.

Key words : cacao beans, mass, maturity level, small-scale fermentation

I. INTRODUCTION

Kakao is one of the best product of Indonesian plantation. In 2010, the production of cacao in Indonesia reached the third position in worldwide after Pantai Gading and Ghana (Karmawati *et.al.*, 2010). In 2014, Indonesian cacao productions experienced about 709.331 ton with the plantation areas were approximately 1.719.087 ha and the biggest portion at 95% was community plantation (Dirjen Perkebunan, 2014). Therefore, this condition creates cacao being the important product in economic development of farmers in Indonesia.

According to SNI 2323-2008, the good quality of cacao comes from Mulia cacao or Lindak cacao which has been fermented, with or without washed, dryed, and cleaned (BSN, 2008). Indeed, the fermentation is one of an essential process in postharvest handling of cacao. This step has aims to inactive of seed so the changes happened inside of seed can be done easily such as, the colour changes, the improvement of flavour, and odour also.

Most of farmers dry process of cacao seeds use the poor equipment and simple process, so there is 90% of the bad cacao beans which are produced by farmers. The main characteristics do not passing fermented process, are less dried, are attacked by fungus, and had a contaminant. Besides lack of facilites and skill for handling, the farmers are not interest to apply the standard of process due to the minimum of cost incentive. In other words, there is no differences of the price between a good and bad cacao processed by passing handling methods.

To improve the quality of cacao bean produced by the farmer, it needs government's contribution to provide a box for fermentation. In contrast, those support is not the effective way because the majority farmers rarely conduct the fermentation. They consider that the fermentation should be done in a large scale. The average capacity of cacao which wants to be added to fermentation in the boxes has at around 40-50 kg for each process, while many farmers processing the cacao bean are less than that capacity. From those reason, the research about the quality of fermented cacao bean in small scale is needed to conduct. This research has purpose to determine the minimum mass of cacao bean in small scale and the effect of maturity level on fermentation product.

II. MATERIALS AND METHODS

This research was conducted from April to October 2016 in Bioprocess Engineering and Post-Harvest Handling Laboratory, Department of Agricultural Engineering. The instruments used include small fermentation boxes 26 x 20 x 45 cm (Fig. 1), analytical balance, magnetic stire, desicator, pH scale, blender, oven, measuring cylinder, and volumetric flask. While the object of this research used cacao beans with different maturity levels (Fig. 2), aquades, and petrolium benzen.

Fig. 1. A small fermentation box (26 x 20 x 45 cm)

(a) (b) (c)

Fig. 2. Maturity levels of cacao; (a) Yellow color covers at all of the skin, (b) Yellow color appears only on the grove and backs' fruit, and (c) Yellow color appears only on the grove.

A. Design Experiment

This experiment conducted with Completely Randomized Design of Factorial. The first factor was maturity levels A, B, and C and the second factor was the mass of fermentation (10, 15, and 20 kg) used three times for each experiment. The data were analysed by ANOVA and LSD for futher testing using SAS software.

B. Measurement Data

1. Temperature

The temperature measurement used the thermometer that located in stack of cacao beans during fermentation process in 3 different spots such as one in the upper, three spots in the central, and three spots in lower part of stuck cacao beans.

2. pH (Acidity Level)

The pH level determines the acidity level of cacao beans. In this case, the highest of pH level indicates a low acid content. The method for measuring pH started from crushing of cacao beans to putting 1 gram which was dissolved by 5 ml aquades for 3 minutes. In addition, The pH level was measured by the pH meter calibrated by standard buffer.

3. Cut Test

This testing was done by observing the colour changes visually and subjectively. There were 50 cacao beans cutted longitudinal in the exact center of beans with same shapes. The other 100 cut-beans ware observed one by one and it depend on its colours. In this research, The cacao beans has been divided into 3 levels such as the slaty colour classified as the unfermented levels, the beans have the purple dominant color classified as the underfermented level, and the brown color became the primer color classified as the fermented level. A percentage of those classification calculated by using this formulas:

$$\% \text{ unfermented beans} = \sum \frac{\text{total of slatty color beans}}{\text{total of cacao beans}} \times 100\% \quad (1)$$

$$\% \text{ underfermented beans} = \sum \frac{\text{total of purple colour beans}}{\text{total of cacao beans}} \text{ x } 100\% \quad (2)$$

$$\% \text{ fermented beans} = \sum \frac{\text{total of brown colour beans}}{\text{total of cacao beans}} \text{ x } 100\% \quad (3)$$

4. *Fat Content*

The measurement of fat content conducted in State Polytechnic of Lampung. A procedure to determine of fat content started from crushing of 2 gram that wrapped in filtering paper before entering in soxhlet extraction cylinder to an extraction's process which requires for 4-5 hours use Petrolium Benzen to solve about 75-100 ml. The next process was the drying process that adoptes the temperature at approximately 100–105°C for 30 minutes. This process produced a recidue that measured as solid fat content. Fat content pointed in the percentage as follows:

$$\% \text{ Fat content} = \frac{(B-C)}{(A)} \text{ x } 100\% \quad (4)$$

Note : A = sample weight
B = cup + fat content
C = empty cup

III. RESULTS AND DISCUSSION

A. Temperature

The average temperature of cocoa beans in the box increased to 40.7 ^{o}C on the 4th day. This indicates the activity of microorganisms that generate heat energy during the fermentation process. Yusianto *et.al.* (2008) stated that fermentation can occur in small boxes with a temperature distribution of 40-45ºC although the number of wet beans fermented only 20 kg. The temperature change during fermentation at each treatment is shown in Fig. 3.

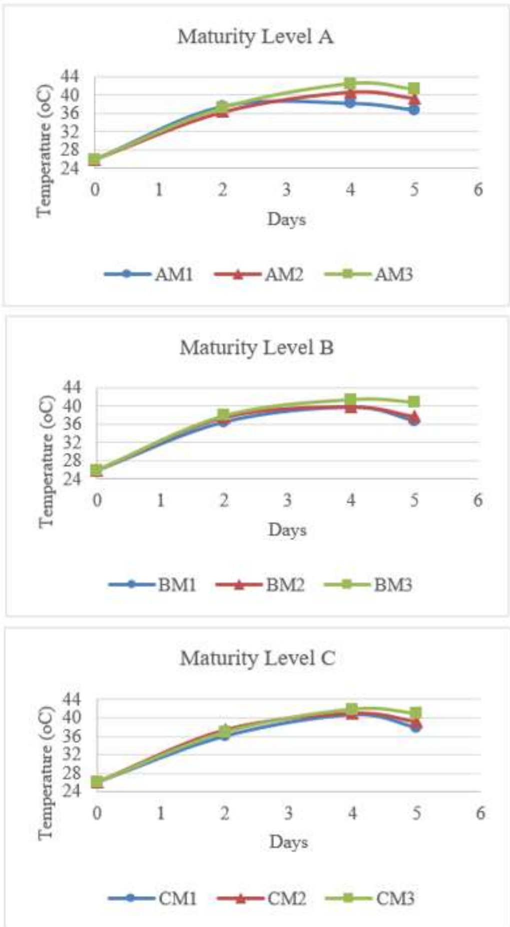

Fig. 3. The temperature change during fermentation at each treatment

Based on ANOVA result known that cocoa bean mass factor have an effect on fermentation temperature while fruit level maturity factor and interaction of both factors have no effect. LSD test results showed that the mass of 20 kg of cocoa beans gave a significantly different effect (Table 1).

B. pH (Acidity Level)

The average pH of cocoa beans increased for 5 days of fermentation. The average initial pH of 4.85 then to 5.47 at the end of fermentation. The increased pH value means a decrease in the acidity of the cocoa beans. This is similar to Pato *et.al.* (2003) that cocoa pH increased from 4.8 to 5.6 for 5 days of fermentation. Marwati *et.al.* (2013) also showed that changes in the pH of cocoa beans during fermentation ranged from 4.31 to 6.61. The pH change during fermentation at each treatment is shown in Fig. 4.

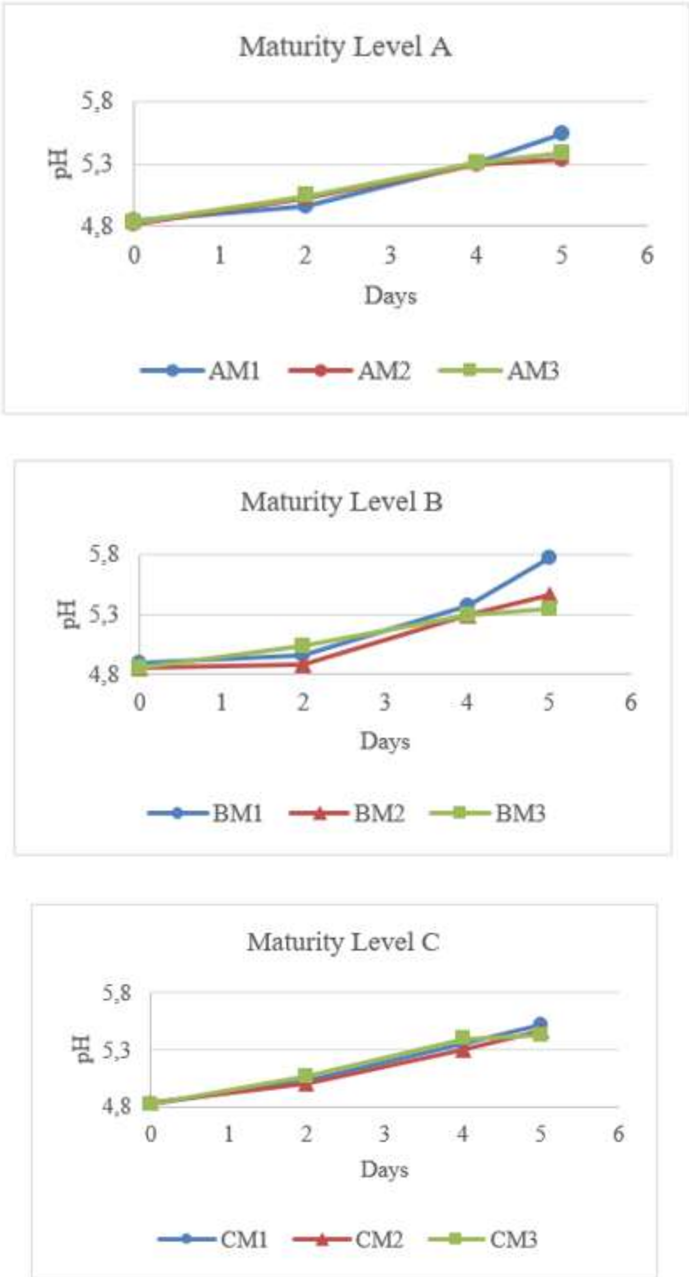

Fig. 4. The pH change during fermentation at each treatment

C. Cut Test

The cut test is performed to assess the success of the cocoa bean fermentation process based on the color of the seed pieces. Full fermented cocoa beans are brown and porous according to SNI 2323-2008 (BSN, 2008). Based on the ANOVA result, it is known that only the cocoa bean mass factor has an effect on the total fermented cocoa beans. The LSD test results show that the effect of mass 15 and 20 kg of cocoa beans is not significantly different with total fermented beans 69.51% - 70.12% (Fig. 5).

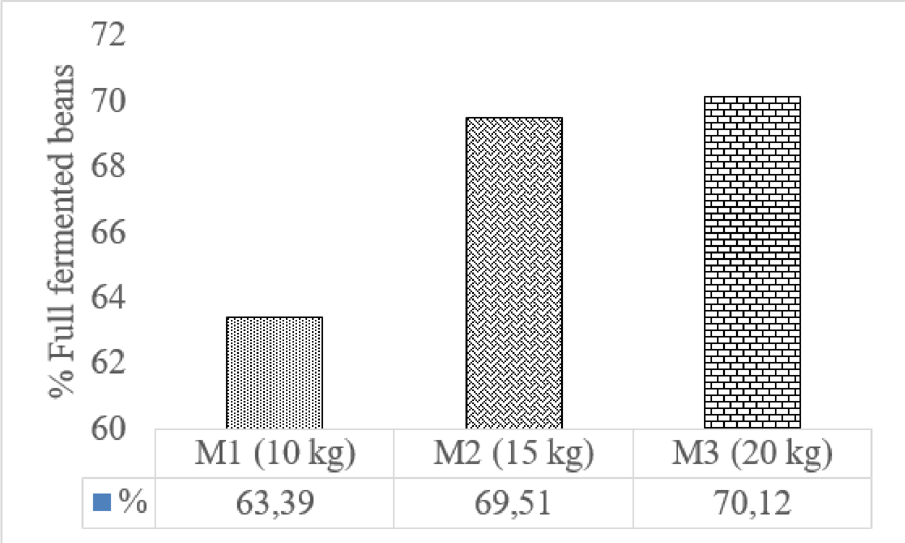

Fig. 5. Total full fermented beans

D. Fat Content

Fat is the most expensive component of cocoa beans. The average fat content of fresh cocoa beans was 1.23%, 2.35%, and 2.73% for the maturity levels C, B, and A. This value increased to 41.75% - 48.55% after fermentation. Based on the ANOVA results it is known that only the cocoa bean mass factor has an effect on the fat content. LSD test results showed that the mass of 20 kg of cocoa beans gave a significantly different effect (Fig. 6). Several previous research results show fermented cocoa fat content of 32.60% - 50.99% (Marwati *et.al.*, 2013) and by 47.8% - 49.5% (Widayat, 2015).

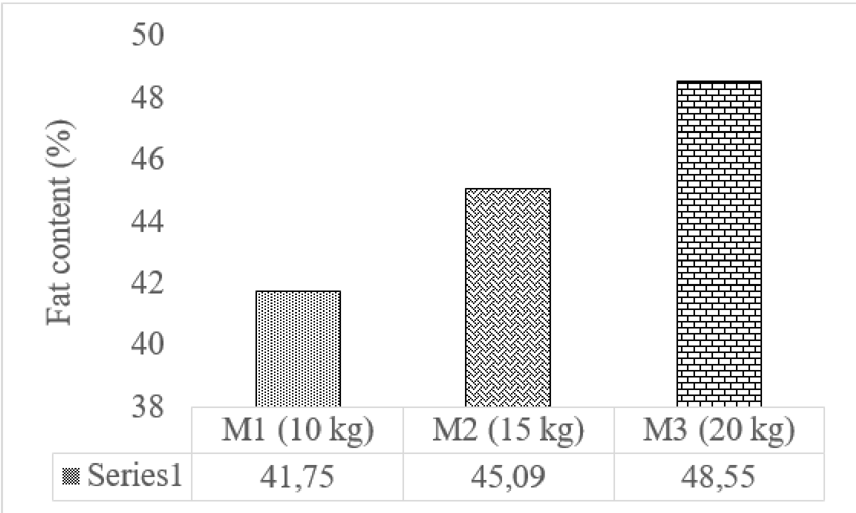

Fig. 6. Fat content of fermented beans

Table 1. The result of LSD test on mass variations

Cacoa Mass	Parameters		
	Temperature (^oC)	Cut Test (% Full Fermented)	Fat Content (%)
M1 (10 kg)	39,52 b	63,39 b	41,75 b
M2 (15 kg)	40,52 b	69,51 a	45,09 b
M3 (20 kg)	41,92 a	70,12 a	48,55 a

IV. CONCLUSION

The result of ANOVA indicated that only mass factor had significant on temperature during fermentation, total full fermented beans, and fat content of cacao beans. As a result, the mass recomendation of cacao beans for small-scale in fermentation process is 20 kg.

REFERENCES

BSN (Badan Standardisasi Nasional). 2008. Standar Nasional Indonesia (SNI) 2323-2008; Biji Kakao. BSN, Jakarta

Direktorat Jenderal Perkebunan. 2014. *Statistik Perkebunan Indonesia 2013-2015 Kakao*. Ditjenbun, Kementerian Pertanian.

Karmawati, E., Z. Mahmud, M. Syakir, S.J. Munarso, K. Ardana, dan Rubiyo. 2010. Budidaya dan Pascapanen Kakao. Pusat Penelitian dan Pengembangan Perkebunan. Bogor. 92 hlm

Marwati, H. Suprapto dan Yulianti. 2013. Pengaruh Tingkat Kematangan Terhadap Mutu Biji Kakao (*Theobroma cacao L.*) Yang Dihasilkan Petani Kakao di Teluk Kedondong Bayur Samarinda. *Jurnal Teknologi Pertanian*. 8 (1): 6 – 10.

Pato, U., Yusmarini, dan Jumar. 2003. Studi Biji Kakao Forastero yang Diolah dengan Metode *Sime Cadbury*. *Jurnal Sagu*. 2 (3): 6 – 11.

Widayat, H.P. 2015. Karakteristik Mutu Biji Kakao Aceh Hasil Fermentasi Dengan Berbagai Cara Dan Interval Waktu Pengadukan. *Jurnal Teknologi dan Industri Pertanian Indonesia*. 7 (1) : 7 – 11.

Yusianto, T. Wahyudi, dan Sulistyowati. 2008. Panduan Lengkap Kakao Manajemen Agribisnis dari Hulu hingga Hilir (Bab 15. Pascapanen). Editor: T Wahyudi, T.R. Panggabean, dan Pujiyanto. Penebar Swadaya. Jakarta.

C.16

THE TASTE OF ROBUSTA COFFEE POWDER FROM CLOSED STEAMING SYSTEM PROCESS IN HIGH TEMPERATURE

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ABSTRACT

High content of caffeine in Robusta coffee become a risk for people's health. This research aimed at the taste of Lampung Robusta coffee bean that has been reduced of caffeine content from steaming system at high temperature without chemical solvent. Coffee steamed in an autoclave at 100, 110, and 120 ^oC for 1, 2, 3, 4, 5, 6 and 7 hours respectively. The results is scores of aroma and flavor decreased while scores of after taste, body, and bitterness increased during steaming duration. Anova test showed temperature treatment and steam duration have no significant effect on all taste parameters. Caffeine content of 87%, 82%, and 75% at 100, 110, and 120 ^oC respectively. The coffee brewwed produced from this study is still good to drink. It can be an alternative choice for "regular" coffee connoisseurs who are already wary of reducing caffeine consumption.

Keywords : taste, caffeine, Robusta coffee.

I. INTRODUCTION

Coffee is one of the most popular beverages and much-drink among the people of Indonesia and even the world. Coffee drinks preferred by consumers not as a source of nutrition but as a refreshing drink because it has a distinctive taste and aroma. This flavor is due to the complex chemical compound content of which is the dominant presence of caffeine and chlorogenic acid compounds.

According to Sivetz and Desroiser (1979) the main role of caffeine in the body is to increase psychomotor work so that the body is maintained and gives physiological effects of increased energy. But coffee gain becomes invalid for patients with heart disease, diabetes, ulcers, and hypertension because it can cause heart work too hard resulting in blockage of blood vessels. Lelyana (2008) states that caffeine can cause an increase in blood pressure, so it can endanger heart patients and high blood pressure. Therefore, for coffee consumption does not cause concern for people with the disease it is necessary to decrease levels of caffeine in coffee beans called process decaffeination. Decaffeination processes generally use chemical solvents such as methylene chloride, or ethyl acetate. These chemicals will be left behind in the decaf consumed coffee beans that can interfere with health. In this study decaffeination uses water, because water is the simplest and most easily obtained solvent. In addition to cheap, water side effects on health and the environment is very small. The water's ability to dissolve caffeine from within the coffee beans is very limited if the process is done at low temperatures, so that past studies always combine it with organic solvents. Therefore, the purpose of this study is to obtain a medium coffee that still contains caffeine through the process of steaming coffee beans in a closed system at high temperatures without any solvent. The steamed coffee beans are then dried, roasted and tested for coffee taste

II. MATERIALS AND METHODS

A. Materials

Coffee powder observed in this research is coffee powder Robusta (from Lampung) steaming result in autoclave at temperature 100 ^oC, 110 ^oC, 120 ^oC each for 1, 2, 3, 4, 5, 6 and 7 hours residence time. The autoclave used LabTech brand (LA C-5040S model) has a diameter of 35 cm and a tube height of 44.7 cm.

B. Coffee Powder Preparation and Sensory Test

The drying steamed coffee are dried on a moisture content of about 12-14%. After drying each of the coffee beans the process of roasting between 210 - 215 ^oC for 7 - 8 minutes inside the machine "Uncle Jhon" coffee roaster especially for small capacity (1 - 1.2 kg). After being ignored for 24 hours roasted coffee roasted with a roller coffee machine Latina type N206 with a granular grain size of about 40 mesh. The taste of coffee tested is aroma, flavor, after taste, body (thickness), and bitterness. The experimental design diagram is shown in Fig. 1.

Taste test was done by weighing each 10 grams of ground coffee into 8 cup, 1 of which is for coffee powder test control. Then each cup poured hot water (temperature around 92-95 °C). After 5 minutes of breathing the odor is smelled by 5 (five) "cupper" people who are adequately trained (often taking coffee test at the national level). After each cupper "smells the smell of coffee, alternately they do" cupping "by tasting / sipping but not swallowing it. After tasting all samples of coffee then each "cupper" filled the score on the 'cupping' form provided (modified from Jember Coffee and Cocoa Research Institute). After tasting the cup of coffee, each "cupper" must rest for a while for neutralizing the taste buds by drinking water and fruits. The taste of the coffee brewwed is qualitative, but with the test score of "cupping" to produce data that is quantitative in the form of scores are: 1-2 (very low), 3-4 (low), 5-6 (medium), 7 -8 (high), and 9-10 (very high). This data is processed to determine the anova of coffee flavor changes.

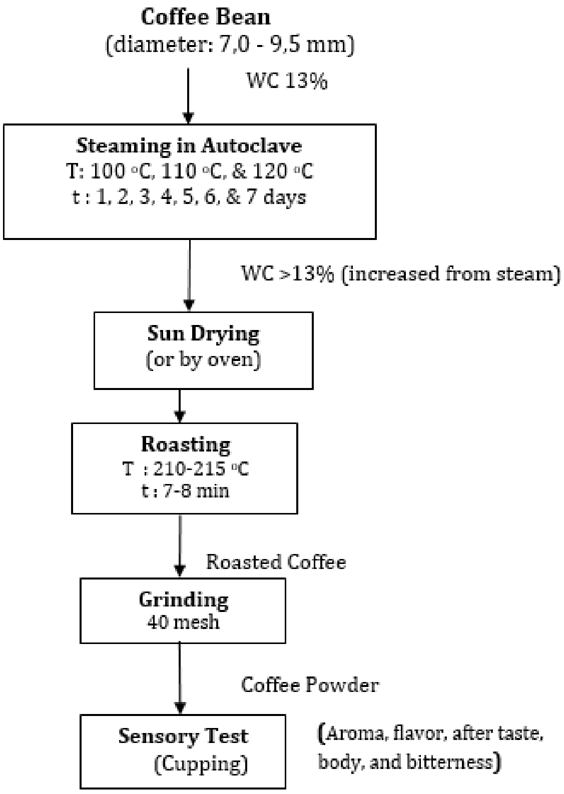

Fig. 1. Flow chart of experimental design

III. RESULTS AND DISCUSSION

A. *Aroma of coffee brewwed*

The aroma of coffee curve is shown in Fig. 2 and anova test results can be seen in Table 1.

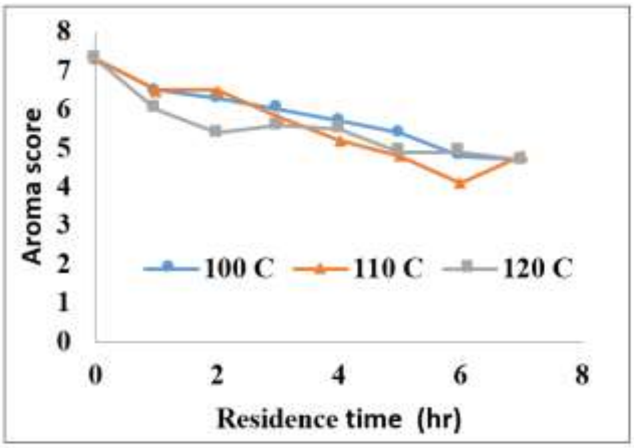

Fig 2. Curve of aroma coffee brewwed

From Fig. 1 shows that the longer and higher the temperature of the steamer, the aroma of the brewwing coffee in general has decreased from the scent very good / high (score 7) to be good / medium (score 5). This is due to the longer and higher the steaming temperature of caffeine content of the seeds also decreased, thus reducing the smell of coffee brewwed

Table 1. Anova of influence temperature to the aroma of coffee brewwed

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,380833	2	0,190417	0,046048	0,955092	3,4668
Within Groups	86,83875	21	4,135179			
Total	87,21958	23				

$F_{crit} > F_{table}$: steaming temperature is not significant to the aroma of coffee brewwed

B. The flavor of coffee brewwed

The flavour of coffee curve is shown in Fig. 3 and anova test results can be seen in Table 2.

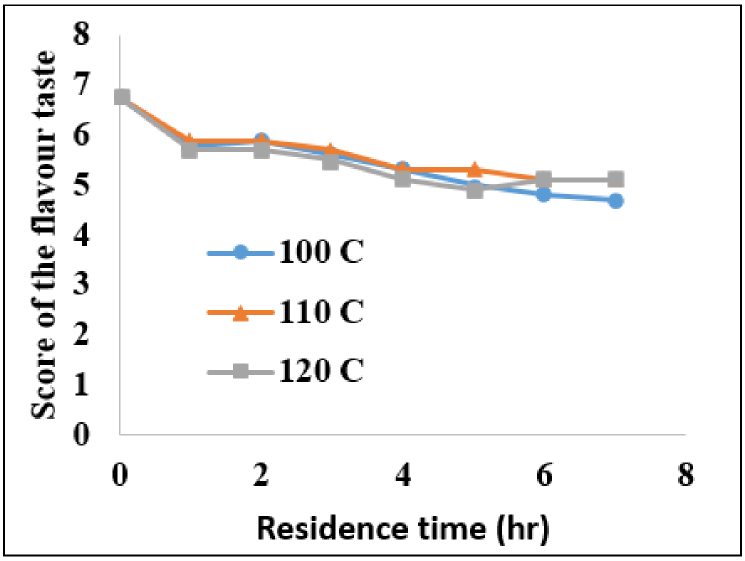

Fig. 3. The flavour curve of steamed coffee brewwed

From Fig. 3 above shows that the longer steaming, the steeping coffee flavor generally decreases with a similar pattern of the 3 temperatures. Flavor originally very good / high (score 7-8) to be good / medium (score 5). This is due to the longer and higher the steaming temperature of caffeine content also decreased, thus reducing the flavor of the coffee brewwed.

Table 2. Anova of influence temperature to the flavor of coffee brewwed

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,12	2	0,06	0,156977	0,855718	3,4668
Within Groups	8,026667	21	0,382222			
Total	8,146667	23				

$F_{crit} > F_{table}$: steaming temperature is not significant to the flavor of coffee brewwed

C. After Taste of coffee brewwed

The After Taste of coffee curve is shown in Fig. 4 and anova test results can be seen in Table 3.

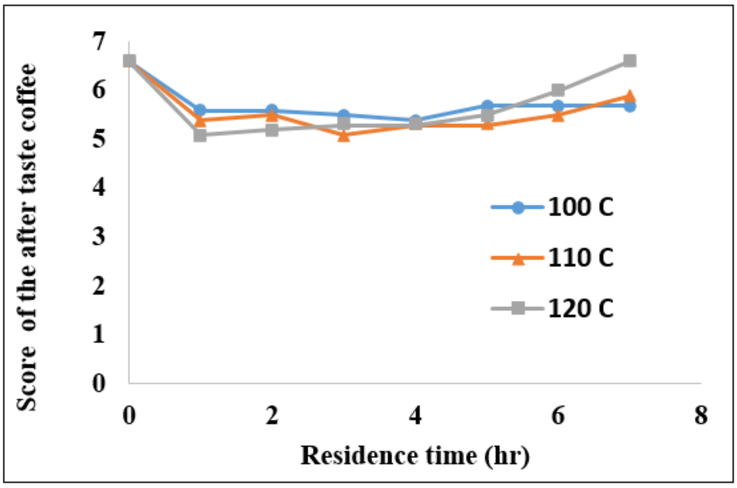

Fig. 4. After Taste curve of steamed coffee brewwed

From Fig. 4 shows that the longer steaming, after taste of coffee brewwed in general does not experience an increase in the value of the score, except at a temperature of 120 °C. The quality of the after taste remains in the medium category (score 5-6) increased to a score of 6. At 120 °C, 7 hours of steaming results in a high quality after taste of high grade coffee (score 7) equal to the value of coffee before it is steamed. It is possible steaming at high and long temperatures with a closed system causes the caffeine content in hot steam to be absorbed back into the softened beans.

Table 3. Anova of influence temperature to the After taste of coffee brewwed

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,103333	2	0,051667	0,208253	0,813658	3,4668
Within Groups	5,21	21	0,248095			
Total	5,313333	23				

$F_{crit} > F_{table}$: steaming temperature is not significant to the After Taste of coffee brewwed

D. The Body (thickness taste) of coffee brewwed

The taste thickness (Body) of coffee curve is shown in Fig. 5 and anova test results can be seen in Table 4.

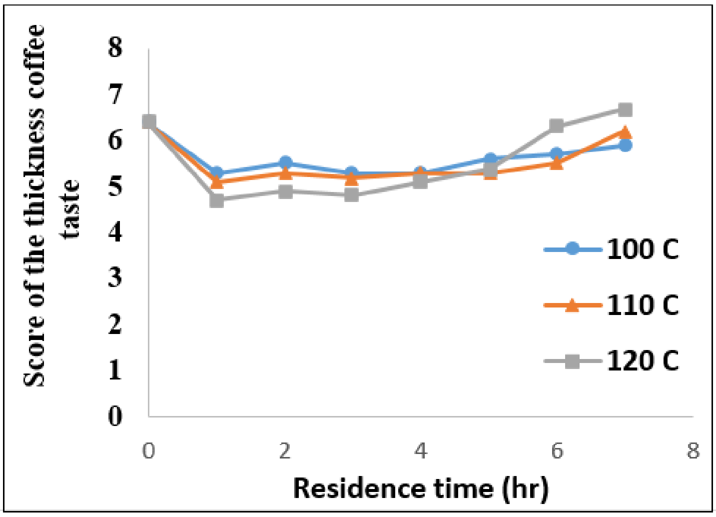

Fig. 5. The thickness coffee taste curve of steamed coffee brewwed

From Fig. 5. above shows that the longer steeping, thickness score of coffee taste steeping in general has increased. The score of thickness of the original taste in the range of number 5 increased slowly approaching the number 7 (close to high).

Table 4. Anova of influence temperature to the *Body* of coffee brewwed

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,040833	2	0,020417	0,060826	0,941152	3,4668
Within Groups	7,04875	21	0,335655			
Total	7,089583	23				

$F_{crit} > F_{table}$: steaming temperature is not significant to the *Body* (thickness) of coffee brewwed

E. The taste of bitter coffee

The taste of bitter coffee curve can be seen in Fig.6 and anova test results can be seen in Table 5.

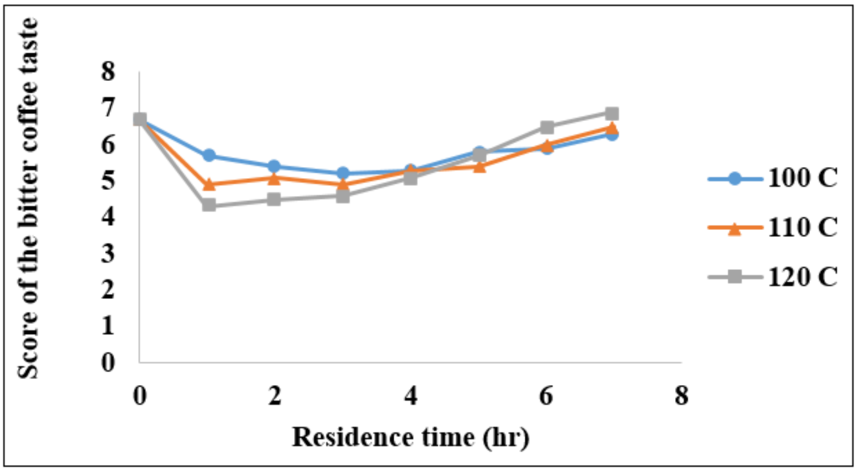

Fig. 6. The bitter coffee taste curve of steamed coffee brewwed

From Fig. 6. above shows that the longer the steeping, bitter taste coffee score generally experience an upward trend in the three steaming temperatures. The score rose sharply after 3 hours of steaming, which initially had a bitter taste score of 4 to near 6 rising close to 6 to 7 (close to high).

Table 5. Anova of influence temperature against bitterness (Bitterness) of coffee brewwed

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0,270833	2	0,135417	0,214988	0,808305	3,4668
Within Groups	13,2275	21	0,629881			
Total	13,49833	23				

$F_{crit} > F_{table}$: steaming temperature is not significant to bitter taste (Bitterness) coffee brewwed

After 7 hours of steaming, caffeine decreased at 100, 110, and 120 ^{o}C to 2.04%, 1.92%, and 1.76%, respectively, from the baseline (control) 2.34%, or respectively, each capable of reducing caffeine content by 13%, 18%, and 25%. The high content of caffeine is due to hot steam in an autoclave trapped in a closed system even though the moisture content and volume of the coffee beans increase, so that the hot vapor becomes saturated to pull the caffeine compound out of the coffee beans. Sivetz and Desroiser (1979) suggest that heat treatment can break the bonds of complex caffeine compounds, so that caffeine compounds become free with smaller size and easy to move. In this study because the condition of a closed steam system causes only a small percentage of caffeine compounds that are attracted out of the seed. And this corresponds to the initial goal of reducing some of the remaining caffeine.

There are five taste test parameters to cupping of coffee steam. It can be seen that aroma and flavor score were decreased slightly from 6-7 (medium to high) to around 5 (medium). Increased scores occurred in the after taste, body, and bitterness, averaging from about 5 in 1 hour steaming to number 6 approaching a score of 7 (high) on a 7 hour steaming duration. Looking at the magnitude of the score figures generated from cupper (trained sensory testers) ranging from 5 to 7 proves that the coffee brewwed produced from this study is still good to drink. This is in accordance with interviews and discussions with cupper who states still feel the smell of coffee steep as in general even though the actual content of caffeine has been reduced between 13 to 25%. Thus, coffee powder, the result of steaming coffee beans closed without dilution (both hot and chemical) can be an alternative choice as a medium coffee (not decaf coffee) for "regular" coffee connoisseurs who have begun anxiety due to high caffeine consumption.

IV. CONCLUSION

The taste cupping test of cupping coffee, aroma and flavor slightly decreased from 6-7 (medium to high) to around 5 (medium). Increased scores occurred in the after taste, taste of thickness, and bitterness, averaging score from about 5 in 1 hour steaming to number 6 approaching a score of 7 (high) on a 7 hour steaming duration. In general, the testers (cupper) states still feel the smell of coffee steeping in general. Generally, all of the five parameters test to cupping of coffee steam it can averaging score from about 5 in 1 hour steaming to number 6 approaching a score of 7 (high) on a 7 hour residence time. The coffee brewwed produced from this study is still good to drink. It can be an alternative choice for "regular" coffee connoisseurs who are already wary of reducing caffeine consumption.

REFERENCES

AOAC. (1995). *Official Method of Analysis*: 16th Edition – Volume2: 1995 : Chapter 30 p.2 “Caffeine in Roasted Coffee”: Chapter 44p.4 “Preparation & Use of Clariying Reagent”

Clarke, R.J. & Macrae, R. (1987). *Coffee.* Vol.2 (Technology). London. Elsivier Applied Science Publishers. 306 p.

BSN. (2004). Badan Standardisasi Nasional. SNI 01-3542-2004. Standar mutu Kopi Bubuk. 10 hal.

Haryati, Estiasih.T, Heppy, F, & Ahmadi, Kgs. (2015). *Pendugaan umur simpan menggunakan metode accelerated shelf-life testing (ASLT) dengan pendekatan Arrhenius pada produk tape ketan hitam khas Mojokerto hasil sterilisasi.* Jurnal Pangan dan Agroindustri. Vol.3 No.1 p.156-165

Lelyana, R. (2008). *Pengaruh Kopi terhadap kadar asam urat darah*. Tesis. Program Pascasarjana Ilmu Biomedik. Universitas Diponegoro. Semarang.

Panggabean, E. (2011). *Buku Pintar Kopi*. Jakarta. PT. AgroMedia Pustaka. 226 hal.

Sivetz, M. & Desroiser, N.W. (1979). Coffee Technology. The AVI Publ. Co. Inc., Westport, Connecticut.

Tripathi, H., Koshy, R., Kachroo, M., Mayachar, A.S., & B.Murali. (2014). *Method development and validation for quantification of chlorogenic acid in Coffea arabica extract using high performance liquid chromatography*. Scholars Research Library. Der Pharmacia Lettre, 2014, 6 (6):89-92. ISSN 0975-5071 USA CODEN: DPLEB4

C.17

EVALUATION OF QUALITY AND LIFE STORED THE WHITE COPRA FROM DRYING PROCESS USING SOLAR TRAY DRYER TYPE

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ABSTRACT

The purpose of this research is to evaluate the quality and life stored of dried copra products using a solar tray dryer. The methodology used in this study is an experimental method and laboratory test to measure the quality and life stored of white copra dried. Parameters measured were moisture content, oil content, and free fatty acid content produced by white copra, physical quality, organoleptic and microbiology (color, texture and mold/mushrooms total). The equipment used is Solar Dryer Tray Type, digital scales, analytical scales, electric oven, glass tools, desiccts, clocks, aluminum foil, Stem thermometers, soxhlets and other supporting tools. The results obtained from this reseach are produced white copra water content that meets SNI and Asia Pacific Coconut Community (APCC) standard, maximum moisture content of 5-6%. White copra oil and fat content during the storage average of 63.36% with storage of 4 months, and 63.28% with a storage of 14 months. Thus, the fat content in white copra has fulfilled the criteria of quality A and B based on Indonesian National Standard (SNI 01-3820-1995) that is the minimum fat content in copra of 60-65%. The results of organoleptic test showed that white copra with storage of 14 months was almost no different from white copra product with 4 months storage with very hard texture criteria, white gray color criterion, total mushroom/mold rather than Fair Merchantable Sundried (FMS) grade copra dry, clean, white, mixed with 5% - 10% bad copra.

Keywords : white copra, quality, life stored.

I. INTRODUCTION

West Nusa Tenggara (NTB) is a potential coconut producing area in Indonesia with planting area of 63,853.57 ha and total production reaches 56,481.15 tons. Especially of North Lombok district with planting area is 10,673,74 ha and total production reach is 12,643,14 ton (Animous, 2016). Some of the coconuts are traded to the Java Island, and some people processed coconut fruit into copra and partly utilized by the local community for making traditional coconut oil.

White copra is a fresh coconut fruit dried by conventional methods using sun drying, fuming or smoke drying or drying over an open fire, indirect drying, and vacuum drying. Copra processing includes; The process of water evaporation of coconut meat, the initial moisture content of fresh coconut meat is 50% lowered to 5-7% moisture content through drying process (Murad et al, 2015).

Processed coconut products, such as copra is no stranger to us and has been widely circulated and traded as raw material for cooking oil. White copra, an innovation of processed coconut products that have quality and economic value is quite high when compared with ordinary copra, because the processing of white copra is done by technology. White copra is very popular in the market and has a certain appeal to this product because it has advantages.

The quality of white copra is better than the of smoke copra because white copra has some advantages compared to smoke copra. The advantages are white copra has a low water content of up to 5% -6%, relatively free of fungus attacks, and the color is much whiter and cleaner. White copra is also free from the smell of the curing process, so the original scent of copra is much more dominant. With such a quality, white copra is much preferred by the copra processing industry because the resulting coconut oil is very clear with very high quality (Murad et al, 2016).

II. MATERIALS AND METHODS

Materials and equipment in this study are white copra, Solar Tray Dryer Type, Digital Scales, Analytical Scales, Electric Ovens, Glass Tools, Desiccts, Clocks, Aluminum foils, Stem Thermometers, soxhlets tools set and other support tools.

The dryer, operated by utilizing solar energy with radiation between 108 and 1398 W / m2. The total thermal energy during copra drying is calculated by the Simpson method. Total thermal energy obtained is 8639 kJ to 13360 kJ. For 4 days the drying room temperature is 40^{o}C to 80^{o}C, with humidity 46% - 96 %%. Copra placed on each tray as much as 3 - 5 kg. The useful energy produced by the dryer reaches 22120 kJ.

The parameters observed in this study were, the quality of white copra in terms of chemical quality, including moisture content, oil content, and free fatty acid content produced by white copra. Physical, organoleptic and microbiological qualities include color, texture and mold/mushrooms total.

A. Moisture Content

Determination of 100 gram white copra content was done by oven method at 100°C for 15 minutes, and cooled in desiccator, then weighed and the porcelain cup was cooled for 20 minutes. The moisture content was determined based on the moisture content of wet base and dry base as measured by the equation:

$$m_{bb} = \frac{W_3}{W_1} x100\% \tag{1}$$

$$m_{bk} = \frac{W_3}{W_2} x100\% \tag{2}$$

where :
m_{bb} = Moisture Content Wet Base (%bb)
m_{bk} = Moisture Content Dry Base (% bb)
W_1 = Initial weight (gram)
W_2 = Final weight (gram)
W_3 = Difference W_1 and W_2 (gram)

B. Oil Content

Fat content is determined by soxhlet method. A total of ± 2 grams The sample is wrapped using filter paper. Measurement of oil content using socxhlet with organic solvent of diethyl ether for ± 4 hours. The sample was dried in the oven for ± 3 hours then weighed. Copra oil content is calculated by using the equation:

$$\% \text{ Oil Content} = (Wa - Wb)/Wa \times 100\% \tag{3}$$

where :
Wa = Dry weight of sample before extracted (gram)
Wb = Dry weight of Sample after extracted (gram)

C. The Free Fatty Acid Content

The free fatty acid content is determined by titration method. Determination of free fatty acid content is done by the sample weighed and smoothed as much as ± 2 grams. The solution has been added with 50 ml Alcohol, then added indicator pp (phenolptalin) for 3 drops, then heated to boiling. The solution was titrated with 0.1 N NaOH until it was pink.The free fatty acid content is calculated using the formula is:

$$\%\text{FFA} = \frac{ml.NaOH \times N \times Moleculer\ Weight\ of\ Laurat\ Acid}{Sample\ weight \times 1000} \times 100\% \tag{4}$$

where :
Moleculer Weight of Laurat Acid = 200,3 gram/mol
Normalitas (N) = 0.1

D. Determining the physical and organoleftic qualities by using the scoring method.
E. Determine the quality of microbiology with direct observation on copra products to see whether or not there is mold or mold during storage.

III. RESULTS AND DISCUSSION

A. Moisture Content of White Copra

The white copra product resulting from the drying results in a Tray Type Dryer using solar energy obtained by calculating moisture content (%) on each Tray as shown in Table 1 below.

Table 1. Total Value of Moisture Content Wet and Dry Base of White Copra

Sample Position	Initial Weight (W_1)	Final Weight (W_2)	m_{bb} (%)	m_{bk} (%)
Top Tray	550.22	520.85	5.34	5.64
Midle Tray	550.39	520.80	5.38	5.68
ButtomTray	550.28	520.74	5.37	5.67
Average			5.36	5.66

Based on Table 1, and the calculation results show that the total value of white copra moisture content after drying on a tray type dryer using the average solar energy 5.36% wet basis and 5.66% dry base. Thus, the resulting white copra water content can meet the SNI and Asia Pacific Coconut Community (APCC) quality standard that is maximum 5 - 6%.

Table 2. Moisture Content Coconut before Drying Process

Treatment	Initial Weight (W_1)	Final Weight (W_2)	m_{bb} (%)	m_{bk} (%)
I	100.10	47.94	52.11	108.80
II	100.00	51.01	48.99	96.04
III	100.06	46.22	53.81	116.49
Average			51.64	107.11

Table 3. Moisture Content of White Copra After Drying Process

Treatment	Initial Weight (W_1)	Final Weight (W_2)	m_{bb} (%)	m_{bk} (%)
I	100.04	94.70	5.34	5.64
II	100.07	94.69	5.38	5.68
III	100.05	94.68	5.37	5.67
Average			5.36	5.66

One of the most important factors or components in determining the quality of white copra products is moisture content. Water content in suatau food greatly affect the quality and saving of the food. Therefore, the determination of water content in a food is very important for the process of processing and distribution of the right handling. The water content in the white copra products also determines the acceptability, and the storability of the product.

B. Oil and Fat Content of White Copra

In the experimental for determination of oil and fat content in white copra, direct extraction method with soxhlet was used. The principle of this soxhlet is the extraction by using an organic solvent which is always new, so there is a constant extraction with a constant amount of solvent in the presence of reverse cooling. The white copra samples analyzed are used white copra product with 4 months and 14 months storage time.

Based on observations and calculations, it is known that white copra fat content 63.36% with a storage times of 4 months and 63.28% with a storage times of 14 months. From these results it can be concluded that the fat contained in white copra has fulfilled the criteria of quality A and B based on Indonesian National Standard (SNI 01-3820-1995) that is the minimum fat content in copra of 60-65%.

C. Free Fatty Content (FFA) of White Copra

In the determination of free fatty content (FFA) in white copra, the titration method was used. Based on the observations and calculations, it is known that the white copra free fat content of 1.29% with a storage times of 4 months and 1.33% with a storage times of 14 months. From these results it can be concluded that the free fat contained in white copra has met the A and B quality criteria based on Indonesian National Standard (SNI 01-3820-1995) ie maximum free fat content in copra is 1-3%.

D. Organoleptic Test of White Copra

Based on the results of organoleptic test of white copra product using 20 panelists indicated that obtained some assessment results on texture, color, total fungi and other quality class parameters.

Based on the graph in Fig. 1. It shows that white copra with a one month storage obtained good criteria based on SNI and *Asia Pacific Coconut Community* (APCC) standards where the texture of this copra has a rather harsh, slightly white, slightly mushroom/mold, and quality With *Fair Merchantable* (FM) criteria mixed from dry mixed quality with low quality copra, none white copra and copra is hard.

Fig. 1. It shows that white copra with 4-month storage time still obtained good criteria based on SNI and Asia Pacific Coconut Community standard (APCC) where the texture of this copra has a rather hard criteria, rather white color, total mushroom, and quality with the Fair Merchantable Sundried (FMS) Grade criteria where the

copra is dry, clean, white, mixed with 5% - 10% unfavorable white copra. While on the texture and color with very hard criteria and white gray color.

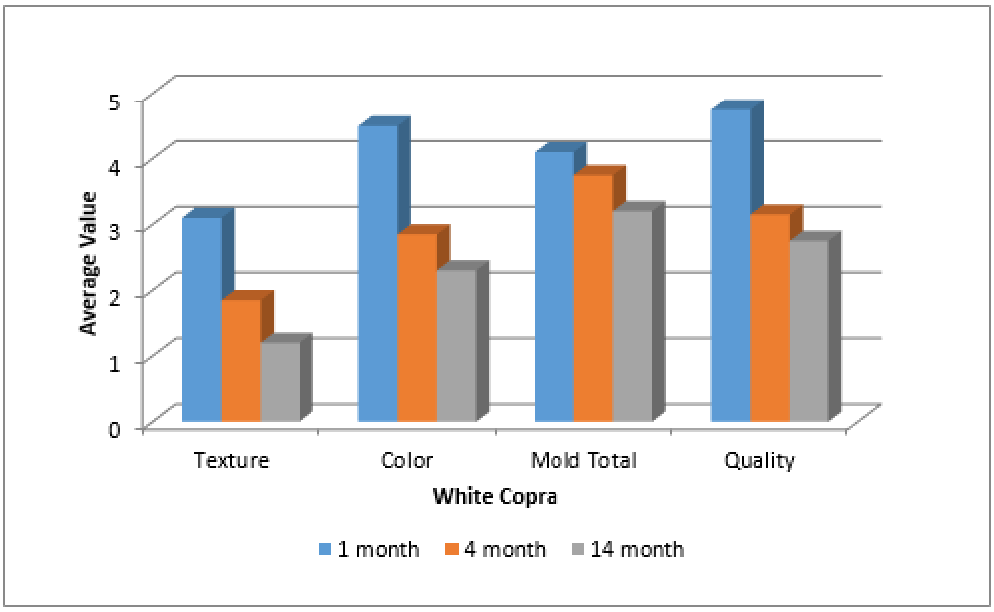

Fig. 1. Organoleptic Test Graph of White Copra

Figure above, shows that white copra with a 14-month storage is almost no different from that of white copra with a 4-month retention period in which the panelists assess the texture with very harsh criteria, while on the gray-white colored criteria. For total panelist mold/mushrooms provide a rather high criterion with Fair Merchantable Sundried (FMS) Grade dry copra, clean, white, mixed with 5% - 10% bad copra.

IV. CONCLUSION

A. Conclusions

1. Produced white copra water content that meets SNI and Asia Pacific Coconut Community (APCC) standard, maximum moisture content of 5-6%.
2. White copra oil and fat content during the storage average of 63.36% with storage of 4 months, and 63.28% with a storage of 14 months. Thus, the fat content in white copra has fulfilled the criteria of quality A and B based on Indonesian National Standard (SNI 01-3820-1995) that is the minimum fat content in copra of 60-65%.
3. The results of organoleptic test showed that white copra with storage of 14 months was almost no different from white copra product with 4 months storage with very hard texture criteria, white gray color criterion, total mushroom/mold rather than *Fair Merchantable Sundried* (FMS) grade copra dry, clean, white, mixed with 5% - 10% bad copra.

B. Suggestions

It is recommended to conduct research for other factor conditioning that affect the quality and storage time of white copra in drying process and storage, such as air and others.

REFERENCES

APCC (Asia Pacific Coconut Community), 2006. Agroindustri Pengolahan Minyak Kelapa. Agroindustri Indonesia. Accessed from : http://indonagro.blogspot.com at April 25, 2016.

Anonimous, 2016. Luas dan Produksi Perkebunan. Nusa Tenggara Barat Dalam Angka, Badan Pusat Statistik. NTB.

Brooker et al. 1992. Drying and Storage of grains and Oilseedsi. The AVI Publishing Company, Inc. New York.

Ketaren, S. 2008. Pengantar Teknologi Minyak dan Lemak Pangan. Universitas Indonesia Press. Jakarta.

Murad, Sabani, R, dan Putra, G.M.D., 2015. Karakteristik Pengeringan Kopra Putih pada Alat Pengering Tipe Rak (*Tray Dryer*) Menggunakan Energi Surya. Prosiding Seminar Nasional PERTETA Tahun 2015 No ISBN 979 587 589 2, Palembang.

Murad, Sabani, R, dan Putra, G.M.D., 2016. Pengeringan Kopra Putih pada Alat Pengering Tipe Rak (*Tray Dryer*) Menggunakan Energi Surya. Laporan Penelitian Hibah Bersaing Tahun 2016. Lembaga Penelitian Universitas Mataram.

C.18

TEMPERATURE AND RELATIVE HUMIDITY CONTROL SYSTEM IN CURLY RED CHILI SEEDLING HOUSE USING ARDUINO UNO

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ABSTRACT

Curly red chili is one of the most valuable horticultural commodities in Indonesia. Temperature and relative humidity control as part of seedling process should be managed intensively in order to obtain high quality production. The aim of this research is to develop prototype seedling house for curly red chili seedling with temperature and relative humidity control using arduino uno. Experimental method was conducted, which consist of several stages: problem identification, idea presentation, concept improvement, prototype designing of seedling house with control system, building seedling house, and performance testing of seedling house. The results showed that accuracy of temperature and relative humidity control were 99.06 ± 0.45% and 83.84 ± 0.95%, respectively. The growth of curly red chili seedlings indicates greater in number and larger in width of leaves compared to chili seedling growing in room without temperature and relative humidity control. Furthermore, the results of the research showed that automatic temperature and relative humidity control system could work according to the design and produce better seedling compared to conventional seedling.

Keywords : arduino uno, chili seedling, temperature and relative humidity control.

I. INTRODUCTION

Red chili (*Capsicum annum* var longum) is a member of the genus capsicum known as spicy and has many nutrients and vitamins such as calories, protein, fat, carbohydrates, calcium, vitamin A, B1 and C. The spicy flavor caused by capsaicin content on the chili [1]; [2]. Chili contains 0.1 to 1.5% capsaicin, depends on the type of chili and its varieties as well as environmental conditions where it grows [3]. In addition, chili is used in fresh form as raw materials for various industrial spices, food industry and medicine industry. Thus, chili is one of the leading commodities of horticulture which has important economic value in Indonesia.

According to [4], demands of chili for large cities with one million or more population are about 800,000 tons / year or 66,000 tons/month. The demands usually increase about 10-20% during celebration season or religious holidays. In order to fulfill the demand, continuous production with proper quality should be done intensively. One of the factors contributes to the success of the production is the preparing process and making nurseries accordance with appropriate climatic factors for chili growth.

Red chili can be planted with a temperature range between 21°C – 27°C [5]. Too high average temperature can degrade quality of chilli seedling, meanwhile, too low temperature can inhibit plant growth. Furthermore, [6] acknowledged that the relative humidity (RH) of air needed for chili plant growth is about 80%. RH of air should be considered since it is associated with the development of interfering microorganisms. Chili seedlings are very susceptible to pest problems, such as pest trips, aphids, mites, and caterpillars. According to [7], chilli can grow both in the highlands and lowlands. However, chili plants are not resistant to rain, especially during flowering since the flowers will fall easily. To achieve optimum chili production, suitable climate factors for chili plant growth such as daily temperature, humidity, rainfall and wind shoul be considered.

Unpredictable change of climate is one of the obstacles for the growth of chili seedlings. However, greenhouse technology can overcome these problems by reengineering and controlling the climate factors. Previous studies have shown the success in controlling climate factors in greenhouse for plant growth. Reference [8] had designed a smart greenhouse building as a cultivation plant using solar cell as a source of electricity that is tested on tomato plants. The sensor used was DHT11 which could detect changes in temperature and RH occurring within the greenhouse. Reference [9] had cultivated mustard plants in the greenhouse with resulted that the growth of mustard plants, leaf dimensions, wet weight, and leaf number better than outside the greenhouse. The temperature sensor used was a SHT11 brand sensor that could measure temperature and RH of environment.

Similar results were also reported by [10] for cayenne pepper. The results of this study showed that the control of temperature and RH of environment in accordance with the requirement of cayenne pepper plants in greenhouse had resulted more optimum development of cayenne pepper plants as indicated by higher cayenne pepper plants in greenhouse compared to pepper plants outside. In the study, they used the DHT11 sensor to detect the temperature and RH of environment inside the greenhouse.

The role of automatic control system to parameters which intended to be controlled will facilitate human work. Microcontroller is a tool that can help to create automation, including in the field of agriculture to control the temperature and RH of environment in the greenhouse. The use of arduino uno makes it easier in the automatic control process. Reference [11] acknowledged that arduino was a microcontroller board based on ATmega328. The aim of this research is to develop prototype seedling house for curly red chili seedling with temperature and relative humidity of environment control using arduino uno.

II. MATERIALS AND METHODS

The method used in this research was experimental method. There were several stages of this research: problem identification, idea presentation, concept improvement, prototype designing of seedling house with control system, building seedling house, and performance testing of seedling house.

A. Material

Prototype of the seedling house had control and seedling room. The prototype had roofs, doors, and floors. The materials used to build the prototype were acrylic, glass, plywood, and aluminum elbow.

Control room was a place of controlling the temperature and humidity of the nursery room. The materials used to build the system control unit were DHT11 sensor, Arduino Uno R3, relay, and LCD. Nursery room was a room for plant seedling equipped with LED light and irrigation system. LEDs were used as grow light to accelerate plant growth or steering light to improve plant quality. Blue-colored LEDs were suitable for plant growth stage [12]. LEDs used were 6 pieces with 4 volt voltage each.

Furthermore, the irrigation system used was sprinkler. Irrigation channel served to drain water and fertilizer to the nursery tray. Flowing water aimed to keep the room humidity and moisture of nursery soil, as well as a medium to lower the temperature in the room. Irrigation channels were made using pipes and hoses. At the end of the hose was installed nozzel as a tool of water extraction. The type of nozzle used was Even Flat Nozzle which has a spray pattern in the form of lines and spray granules spread evenly. Irrigation channel installed on the roof of the seedling house. The source of water came from the reservoir located above the control room which was channeled using a 12V water pump.

The material used for the testing of the tool was 104 chili seeds which nursed in a nursery using a plastic tray. The distance between the holes on the tray was 1 cm, with the depth of 5 cm and the hole diameter was 4 cm.

B. Implementation of Research

This research started by making prototype of seedling house, designing and assembling the control system, assembling system control on seedling house prototype and system performance test. Reference [9] acknowledged that the greenhouse prototype was made in accordance with the shape and characteristics of greenhouses in the tropics, which had a lot of air vents to avoid it became an excessive heat container. In this study, the prototype of a seedling house was made with length of 60 cm, 40 cm width and 30 cm height. Control room was made with size 15 cm width, 40 cm length and 20 cm height. Fig. 1 shows the prototype of a chili seedling house.

System control designing was done by making hardware and software. The series consisted of arduino Uno R3 which was connected with DHT11 sensor for temperature and humidity environment reading of the room. DHT11 programming used programming language library DHT.h. Library DHT.h was uploaded to arduino using the Arduino IDE software. The DHT11 sensor was able to read temperatures between 0˚ C to 50˚ C. The arduino was also connected to the LCD as a medium for displaying temperature and humidity readings. LCD used was LCD with character 16 x 2. Installation of LCD port on arduino used I2C program board. It advantages were easier installation, save usage of cable and simplifies programming language.

The tool should be calibrated by comparing the temperature and RH of environment measurements of the prototype seedling house with manual thermometer. The maximum temperature to be controlled at the seedling house was 25°C and for the minimum was 21°C. Setting point of specified seedling house was at temperature 25°C and RH 80% [13]. The irrigation system in the seedling house prototype served to control the temperature and RH of environment and as a nutrient supply for chili seedling. When the temperature rised above the specified maximum limit then automatically the LED light would be off, the pump would be on and water was sprayed through the nozzle. Conversely, when the temperature was normal, the LED lights would be on and the pump would be off. Distribution of nutrients was done by controlling the pump manually using a switch system. Distribution of nutrients and water were done 2 times a day, in the morning at 07 AM and afternoon at 06 PM, with 1 minute for 1 spraying.

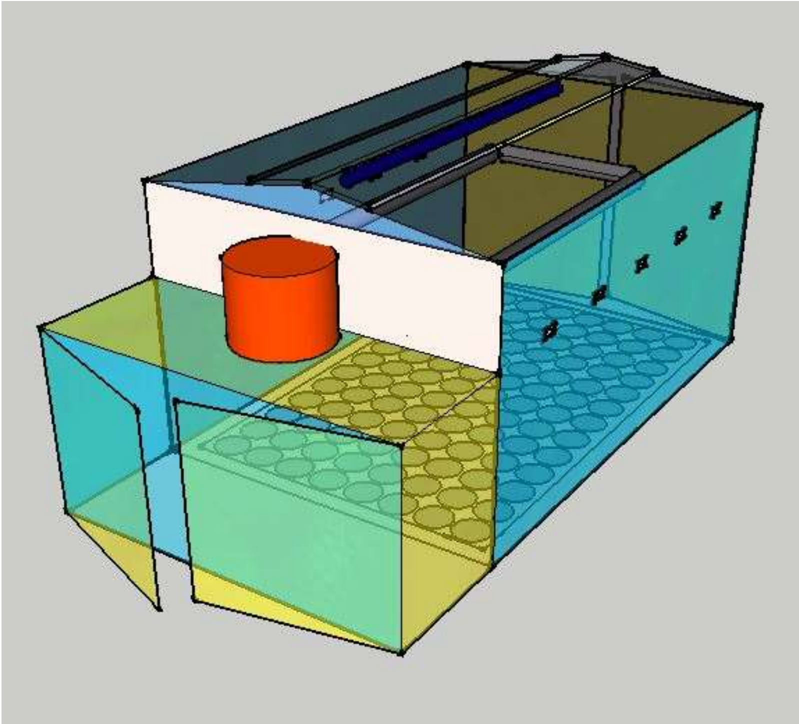

Fig.1 Prototype of seedling house of curly red chilli.

In this study, preparation of nursery media and seed germination was also done. According to [14] the medium of nursery used was soil containing a lot of organic material, and then mixed with sand with a ratio of 3: 1. The soil that had been mixed with sand, were sieved until smooth, then mixed with organic fertilizer and inserted into the tray. Seed germination process was conducted in a different place with the nursery. Seed germination required tin box fittings, 10 watt incandescent lamps, towels, sterile paper, thermometers and fungicides. The temperature control within the germination chamber was about 32 ° C-34 ° C. The process of germination in the cans lasted for 2 days. After seeds were added, the seeds were transferred to the nursery house and continued by germination process until 5 days. Furthermore, the seedlings were kept until 24 days in the nursery. Temperature, humidity, irrigation and irradiation at seedling house were always controlled for proper growth of seedlings. Temperature data collection in seedling house was divided into three retrieval time ie at 07 AM, 12 AM and 07 PM.

C. Observation

Design of observation parameters for the control system in this study was time of achieving a set point, error value, inaccuracy and accuracy of the measurement. Equations 1, 2 and 3 are the equations used to calculate the value of error or the difference in actual value and setting point, inaccuracy and accuracy for controlling temperature and relative humidity [9].

$$SN = AK - SP \tag{1}$$

$$KTACC = \frac{SN}{SP} x\ 100\% \tag{2}$$

$$ACC = 100 - KTACC \tag{3}$$

where :

SN : the difference between the actual value and the setting point (° C or %)
AK : the actual value (° C or %)
SP : the setting point value (° C or %)
KTACC : inaccuracy (%)
ACC : accuracy (%).

Meanwhile, observation parameters for the growth of chili seedlings consisted of height, leaf width and number of leaves both within the prototype of the seedling house with controlled temperature and RH environment as well as outside the prototype of the nursery without controlling the temperature and relative humidity of environment.

III. RESULT AND DISCUSSION

A. *Sensor system performance test*

Setpoint temperature attainment test showed that time required to reach set point 25 ^{0}C was 15 minutes. The achievement of set point temperature was strongly influenced by the ambient temperature. At the time of the study, the ambient temperature at the nursery location was 19°C. The use of LED lights could increase the room temperature from 19°C temperature to 25°C. When the temperature exceeded the setting point value, the LED light would be off automatically and the pump would be on for 1 minute. Pump worked well when the device performance test process took place. In addition, the LCD was also able to display the results of the temperature reading and humidity relative to the room automatically.

During the time of seedling growth within the nursery, the temperature conditions in seedling house showed a relatively stable value around the set point in both the 07.00 AM, 12.00 AM and 07.00 PM measurements. This showed that the sensor system for temperature control had shown a proper sensor performance. The maximum error value that occurs was 2^{0}C. The range of temperature values was between 23-26 ^{0}C. The accuracy value of seedling room temperature control for 24 days at 07.00 AM, 12.00 AM and 07.00 PM measurements were 98.67 ± 2.26%, 99.00 ± 1.77% and 99.50 ± 1.35%, respectively. The average accuracy of temperature control for 24 days was 99.06 ± 0.45%. Fig. 2 shows the temperature in the seedling house at the measurement at 07.00 AM, 12.00 AM and 07.00 PM for 24 days.

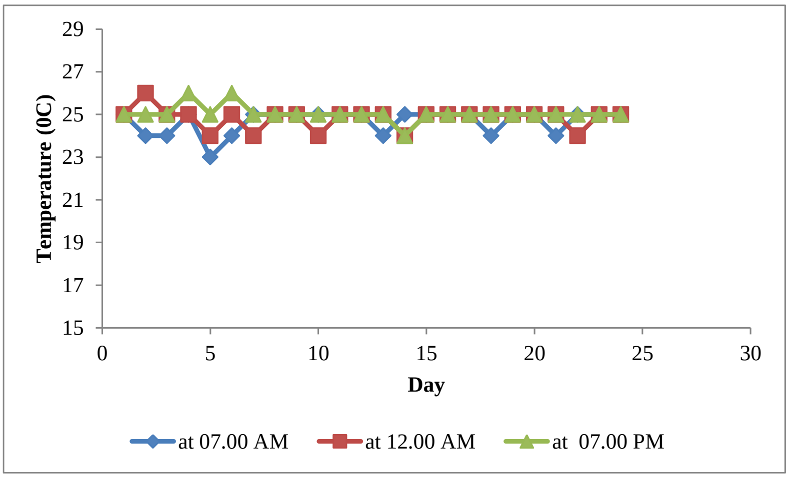

Fig. 2. Temperature in the prototype of seedling house

Meanwhile, performance of the sensor system for RH control has also showed a proper performance. The RH value ranged between 62%, - 80%. The RH of the room was always below 80%. This value corresponded to the desired set point value for the RH control of the nursery. The accuracy value of RH control of seedling house for 24 days at 07.00 AM, 12.00 AM and 07.00 PM measurements were 84.27 ± 3.06%, 82.76 ± 2.85% and 84.48 ± 4.59%, respectively. The average accuracy value of RH control of seedling house for 24 days was 83.84 ± 0.95%. Fig. 3 shows the RH of the seedling house at the measurement at 07.00 AM, 12.00 AM and 07.00 PM for 24 days.

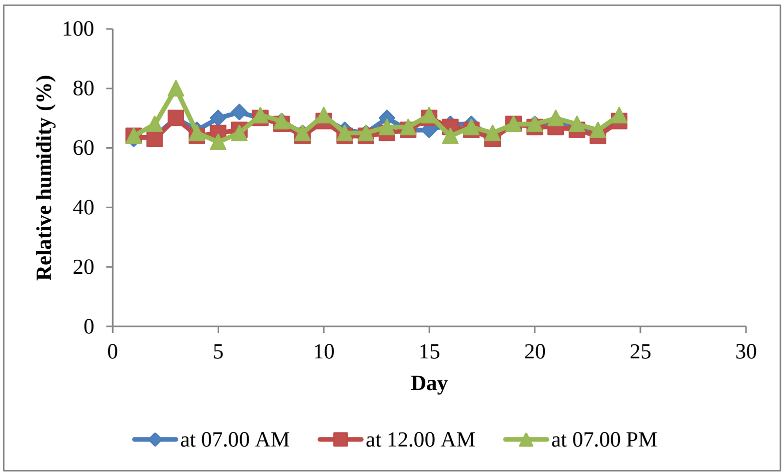

Fig. 3. Relative humidity in the prototype of seedling house

B. *The growth and development of red chili seedlings*

The growth and development of chili seedlings such as seedling height, leaf width and leaf jmlah were observation parameters used to evaluate the performance of the temperature control system and RH within the seedling house. Fig. 4 shows the growth of several samples of chili seedlings at 23 days of age. Based on observations, it was seen that the number of red chilli seedlings that could live and survive for 24 days in the prototype of seedling house was higher than the seeds that grow outside. Percentage of chili seedlings that could live and survive for 24 days in the prototype of seedling house was 87.37%. Meanwhile, the percentage of chili seedlings that could live and survive for 24 days outside the prototype of seedling house without temperature control and relative humidity was 61.63%.

Height 5.6 cm

Height 5.6 cm

Height 6 cm

Height 6.2 cm

Fig. 4. Growth of some chili seedlings at age 23 days

1. *Height of chilli seedlings*

The average daily increase of chili seedlings from day 1 to 5 was 1 cm (Fig. 5). The increasing oh height of chilli seedlings decreased when the age of seedlings reached the age of 6 days until 24 days. The maximum height that chili seeds could achieve in the seedling house prototype and outside the prototype was 6.2 cm and 6.5 cm respectively. Reference [14] found that the average height of chili with normal chilli nursery at 24 days was 5.6 cm.

Furthermore, the results of this study showed that the height of seedlings outside the prototype of seedling house was higher than in the prototype. One factor contributed to this issue was direct irradiation of LED lights to seeds that still in germination, causing stunt growth inhibition.

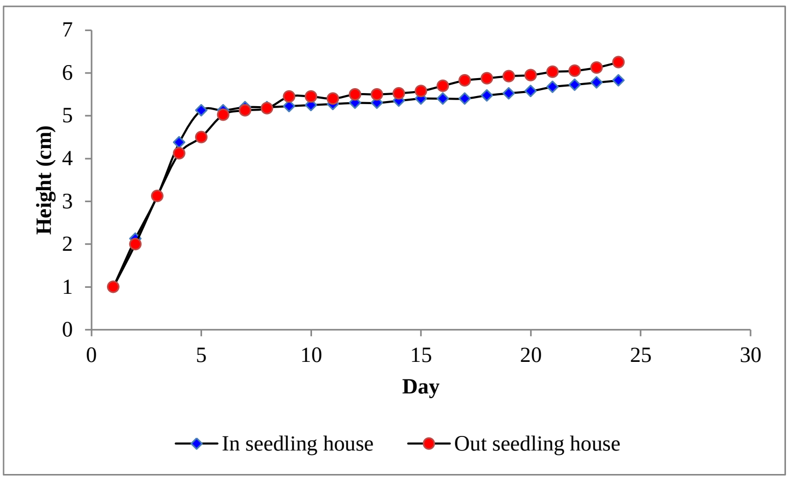

Fig. 5. Increasing of height of chilli seedling

2. The leaf width of chilli seedlings

Chili seedlings planted in the prototype of seedling house showed a rapid increase in leaf width within the range of 1 to 7 days. However, the increaseing of leaf width was slightly slow at 8 to 16 days. At the age of 17 days, fertilization was done, so that the increase in width of the leaves rised again. The maximum width of chili seedling could reach in the prototype of the seedling house and outside the prototype were 7 cm and 5 cm respectively. It was due to the use of blue LED lights which accelerate the growth of plants [12]. Fig. 6 shows the increase of width of chili seedling.

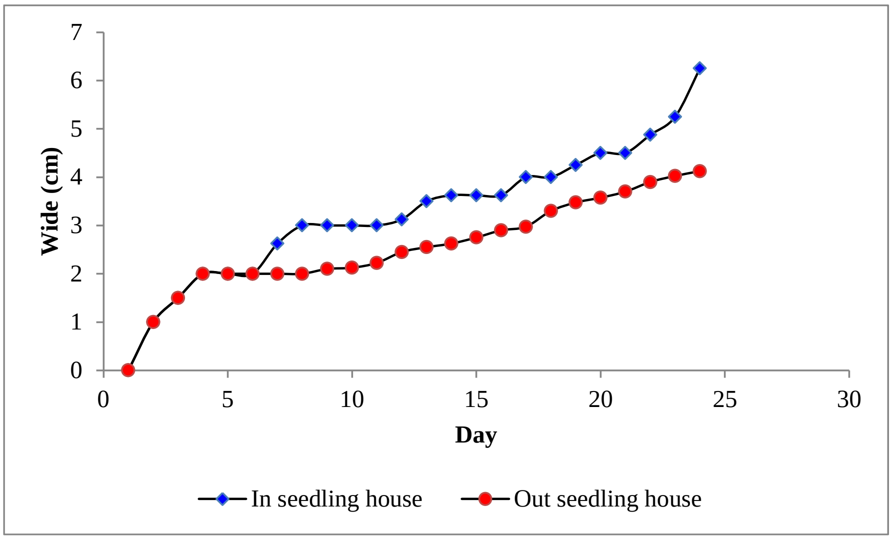

Fig. 6. Increasing of width of chili seedling

3. Number of leaves of chili seedlings

The addition of chili seedling leaves takes a long time. At the age of 1 to 2 days, leaves grew two strands, then took a long time until the leaves amount to 3 strands. The growth of chili seedlings in the prototype of the seedling house was faster than outside the prototype. In the prototype of the seedling house, the 3rd and 4th leaf appear when the seedling were at 17 days and 23 days. Meanwhile, outside the prototype of the seedling house, the 3rd appear when the seedling at aged 24. Fig. 7 shows the increasing number of leaves of chili seedling.

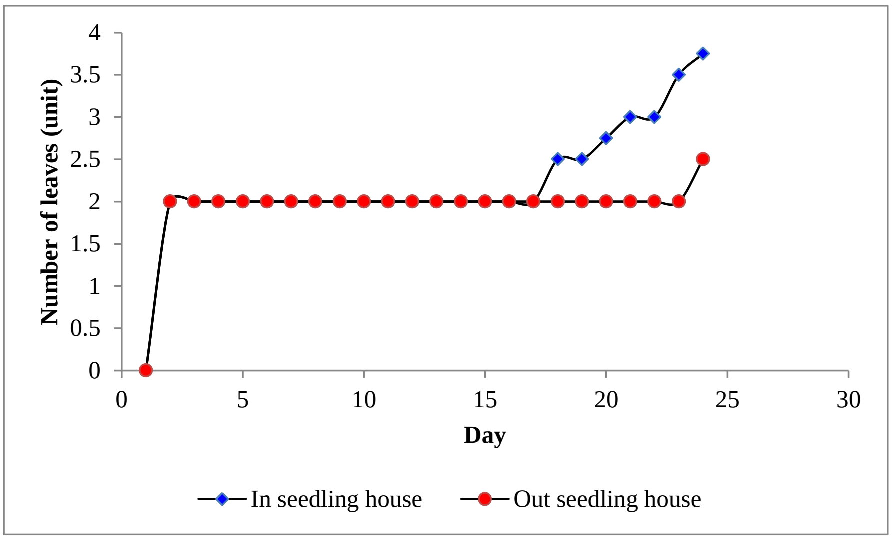

Fig. 7. The increasing number of leaves of chili seedling

IV. CONCLUSION

Development of seedling house using automatic control system for chili seedlings had been successfully done. The tool was able to work well to controll the temperature and relative humidity of the nursery room. Seedlings grown in the prototype of seedling house showed a better leaf width and leaf growth compared to seedling growth outside the prototype.

REFERENCES

[1] Andayani and La Sarido. 2013. Test of Four Kinds of Fertilizers Against Growth and Results of Curly Chili Plants (*Capsicum annum* L.). Jurnal Agrifor, XII (1):22-29.

[2] Renate D, Pratama F, Yuliati K, Priyanto G. 2014. Kinetic Model of Capsaicin Degradation on Red Chilli Paste at Various Storage Temperature. Agritech, 34 (3): 2330-336.

[3] Edmond, J.B., Senn, T.L., Andrew, F.S. dan Halfacre, F.G. 1983. Fundamentals of Horticulture. Mc Graw Hill Book, Co. Inc., London.

[4] Center for Agricultural Data and Information Systems. 2016.. Outlook of Chili Commodity Year 2016. Ministry of Agriculture.http://epublikasi.setjen.pertanian.go.id/[23 July 2017].

[5] Setiadi. 2005. Planting Chili. Penebar Swadaya. Jakarta.

[6] Prayudi, B. 2010. Cultivation and Post-Harvest of Chili Red (*Capsicum anmum* L.). Agency for Agricultural Research and Development, Agricultural Technology Assessment Center, Central Java, Indonesia.

[7] Sunarjono, H. 2010. Planting 30 Types of Vegetables. Penebar Swadaya: Depok.

[8] Abbas. H, Syam R, Jaelani B. 2015. Design a Smart Greenhouse as a Plant Cultivation Using a Solar Cell as a Power Source . Proceeding of the National Seminar of Mechanical Engineering XIV (SNTTM XIV). Banjarmasin, Indonesia, 7-8 October 2015.

[9] Telaumbanua, M, Purwantana B, Sutiarso L. 2014. Design of Micro Climate Control Actuators in Green House for Sustained Plant Growth . *Agritech*, 34 (2): 213-222.

[10] Syarief S, Neparassi WB, Nurwidiana GA. 2016. Monitoring System of Temperature and Humidity of Chili Plants in Greenhouses with Labview. Politeknologi, 15 (2): 135-140.

[11] Ichwan M, Husada MG, Rasyid MIA. 2013. Development of Prototype Electrical Equipment Control System on Android Platform , Jurnal Informatika. 1: 13-25.

[12] Hapsiati. 2010. Light as Booster Production. Buletin Trubus Online. Depok. 20 December 2016. http://www.trubus-online.co.id [10 June 2017].

[13] Hodijah, S. 2011. Red Chili Plant Cultivation. Jakarta Agricultural Counseling Center. 23 February 2011. *http:// cybex.pertanian.go.id* [22 May 2017].

[14] Wahyu, W. 2004. Extend the Productive Age of Chili. Bogor : Penebar Swadaya. 49 page.

D

AGRICULTURAL SCIENCE

D.1

THE RESPONSES OF POTATO (*Solanum tuberosum* L.) CULTIVAR GRANOLA TO DIFFERENT MEDIA AND ORGANIC COMPOUNDS IN IN VITRO CULTURE AND ACCLIMATIZATION IN MEDIUM LAND

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ABSTRACT

The aim of the experiment was to obtain the best response of potato cultivar Granola to different media and organic compounds in in vitro culture and aclimatitation in medium land. It can be used to improve the efficiency of culture media in micropropagation of potato. Experiment was conducted at the Tissue Culture Laboratory of Faculty of Agriculture, Universitas Padjadjaran in Jatinangor, Sumedang. The experiment was arranged in Randomized Complete Design (RCD) which consisted of 12 treatments with three replications, with treatment as follows : Murashige & Skoog (MS) media without organic compound, MS + coconut water 25%, MS + potato extract 20%, MS + banana extract 15%, Hyponex (foliar fertilizer) 0.2% without organic compound, Hyponex 0.2% + coconut water 25%, Hyponex 0.2% + potato extract 20%, Hyponex 0.2% + banana extract 15%, Growmore (foliar fertilizer) 0.2% without organic compound, Growmore 0.2% + coconut water 25%,Growmore 0.2% + potato extract 20%, Growmore 0.2% + banana extract. The result showed that there were responses of potato cultivar Granola to different media and organic compounds in in vitro culture. The application of MS without organic compound and Growmore 0.2% + coconut water 25% gave the best effect on plantlets height, the number of nodes and the number of leaves during incubation period, growth percentage and seed fresh weight during acclimatization period.

Keywords : *In vitro*, Media, Organic Compounds, Potato, medium land.

I. INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the largest food crops in the world besides rice, wheat and corn. This is due to the balanced nutritional content of potatoes, so it has the potential and good prospects to support the diversification program in order to realize sustainable food security. One of the problems in potato development in Indonesia is the lack of quality standards and potato productivity in Indonesia due to the limited supply of potato seeds, both in quality and quantity.

One way to obtain high quality potato seeds can be done by plant propagation in vitro or tissue culture that can produce large quantities of seedlings in a relatively short period of time, independent of climate and season and the need for a small amount of plant material (Yuwono, 2006).

Currently for plant propagation in vitro the most commonly used media is the MS medium. However, this medium in its use has a price that is quite expensive and complicated in the implementation of media creation (Laisina, 2010). Some researchers began to modify MS medium by using compound fertilizer. Hyponex is a crystal shaped macro inorganic leaf fertilizer commonly used for vegetative and generative growth of plants. According Laisina (2010), macro and micro nutrients in hyponex leaf fertilizer can also be a substitute for macro nutrients and micro MS media. Growmore contains complete nutrients with different concentrations as needed. This formula is applied to young plants for plants to quickly become strong and fast growing. Growmore fertilizer is also applied to vegetable crops.

The growth and regeneration of explants from in vitro cultures can be enhanced by a number of nutrients from organic matter. Many of these organic materials contain the sources of amino acids, peptides, fatty acids, vitamins, carbohydrates and growth compounds in different concentrations (George et al., 2008). Organic materials such as coconut water, potato extract, and banana extract.

According to George et al. (2008), coconut water is an endosperm liquid containing a number of amino acids, organic acids, nucleic acids, some vitamins, sugars, alcohol sugars, plant hormones (auxin, cytokines, gibberellins), minerals and other substances that overall support quality growth. In addition, coconut water was also successfully used in in vitro cultures while other media compositions were unable to induce explant development (Neumann et al., 2009). Widiastoety and Purbadi (2003) using coconut water with a concentration of 250 ml L^{-1} gives a good influence on explant Dendrobium sp. Potatoes contain the elements that planlet needs in tissue culture such as calcium, phosphorus, iron, vitamin B1, vitamin B2, vitamin C and niacin (USDA, 1997). Gunawan (1992) used potato extract for rice anther culture with best results at a concentration of 200 g L^{-1}. Banana extract is also often added in in vitro cultures. Just like other organic materials, banana extract contains a number of composition arrangements that can have a good effect (George et al., 2008). The usual concentration of banana extract is 150-200 g L^{-1}.(Hendaryono, 2000).

The purpose of this study was to find a combination of culture media and organic material that produced the best growth of Granola cultivar potato plantlets in the incubation period and the beginning of acclimation.

II. MATERIALS AND METHODS

The experiments were conducted at the Seed Technology Technology Tissue Laboratory and the acclimatization was done at Ciparanje experimental garden screen, Faculty of Agriculture, Padjadjaran University, Jatinangor, Sumedang, from May 2012 to July 2012.

The materials used were in vitro cuttings of potato cv. Granola (G0) from Balitsa Lembang, Murashige and Skoog (MS) media, compound fertilizer hyponex, growmore (compound fertilizer), coconut water, potato extract and banana extract, 75% alcohol, gelatin , Spirtus, and aquades, planting media in the form of a mixture of charcoal husk, cocopeat, petroganic fertilizer with a ratio of 4: 8: 1. The tools used consist of: Analytical scales, culture bottle size 100 ml, autoclave, magnetic stirrer, stirrer, beaker glass, volumetric pipette, pH meter, measuring cup, rubber band, heat-proof transparent plastic, ruler, electric stove, oven , Spiral light, hand sprayer, scalpel blade, tweezers, petridish, Laminar Air Flow (LAF), seed bed, and label.

The experimental method used was Completely Randomized Design (RAL), consisting of 12 treatments with 3 replications. The treatments were: A: MS without organic matter, B: MS + coconut water 25%, C: MS + potato extract 0,2%, D: MS + banana extract 15%, E: Hyponex 0,2% without organic matter, F: Hyponex 0.2% + coconut water 25%, G: Hyponex 0,2%+ potato extract 20%, H: Hyponex 0.2% + banana extract 15%, I: Growmore 0.2% without organic ingredients J: Growmore 2 g L-1 + coconut water 25%, K: Growmore 0.2% + potato extract 20%: Growmore 0.2% + banana extract 15%.To test the difference between treatments used F test, followed by Scott Knot test at 5%.

The media treatment added one type of organic material according to the treatment, the pH of the media is set to 5.7, then boil. Each culture bottle consists of 10 ml. The culture bottle was sterilized using an autoclave for 20 minutes, with a pressure of 15 Psi and a temperature of 121^{o}C. Explan taken from in vitro cuttings Granola cultivars. Cultures were incubated in a culture room with a temperature of 22-24^{o}C and using a 40 Watt lamp.

At the time of acclimatization the culture bottle was adapted to seed bed condition for 2 weeks before the planlet was removed from the bottle. Seed bed measuring 2 x 1 m with planting media in the form of a mixture of charcoal husk, cocopeat and petroganik fertilizer with a ratio of 4: 8: 1. Planting media used sterilized with fungicides. Planlet removed from the media, washed and dipped into fungicide. Planlet planted on seed bed with spacing 4x5 cm. Observations at the time in the culture room were: time of shoot emergence, height of plantlet, number of plantlet book, Number of leaves and root of planlet. Observations at the beginning of acclimatization were: percentage of seedling growth, and fresh weight of seedlings.

III. RESULTS AND DISCUSSION

A. Time of Shoot Emergence

The types of media and organic matter affect the time of shoot emergence. In Table 1 it can be seen that the treatment of B (MS + coconut water 25%) and F (Hyponex 0.2% + coconut water 25%) resulted in a bud emerged faster than other treatments. This is due to the coconut water is the liquid endosperm in which contained amino acids, organic acids, nucleic acids, some vitamins, purines, sugars, alcohol sugars, vitamins, growth regulators (ZPT) auxin, cytokines, gibberellins and abscisic acid (George et al ., 2008). Shoot formation in tissue culture is closely related to the role of cytokinin hormone. According to George and Sherrington (1984), the ratio high between hormones cytokines and auxin can stimulate shoot formation, so suspected higher cytokinin content than auxin in coconut water results in the emergence of the fastest shoots. In addition, nitrogen (N) can stimulate cytokinin synthesis that can stimulate shoot formation. Each of the basic media has N content though in different forms and quantities. Media without organic matter results in longer shoots appear, as well as potato extracts, because potato extract contains more carbohydrates.

B. Height of Planlet

The height of the planlet is influenced by the type of media and organic matter (Table 1). The best plantlet height is produced from MS medium without organic material and MS with potato or banana extract, and Growmore which is given organic material. . This is as stated by Daud et al. (2011) that the composition and a number of MS media nutrients significantly influence the growth, differentiation and cell totipotency capability. Based on the composition, MS media has a fairly complete vitamin content. Plants generally get vitamins from the plant itself but not in cultured plants in vitro need additional addition (Mc Donald, 2004). One of them is Tiamin (Vit B1), serves as an essential cofactor in carbohydrate metabolism and is involved in the biosynthesis of amino acids, thiamine is also often used in in vitro cultures compared to other vitamins.

Table 1. Influence of Media Types and Organic Materials on Time of Shoot Emergence, Height of Plantlet and Number of Plantlet

Treatment	Time of Shoot emergence (day)	Height of Planlet 4 WAI (cm)	Number of planlet 4 WAI
A : MS no organic matter	8,47 b	8,37 a	7,87 a
B : MS + coconut water 25%	6,80 a	6,78 b	8,20 a
C : MS + potato extract 20%	8,67 b	8,33 a	7,00 a
D : MS + banana extract 15%	9,93 c	8,60 a	8,13 a
E : Hyp 0,2% no organic matter	9,73 c	6,33 b	7,13 a
F : Hyp 0,2% + coconut water 25%	7,13 a	6,02 b	6,03 b
G :Hyp 0,2% + potato extract 20%	9,60 c	5,25 b	4,67 b
H : Hyp 0,2% + banana extract 15%	7,93 b	6,47 b	5,33 b
I :Grow 0,2% no organic matter	10,13 c	5,40 b 8,17 a	5,27 b
J : Grow 0,2% + coconut water 25%	8,47 b	5,80 a	8,40 a
K :Grow 0,2% + potato extract 20%	10,33 c	6,23 a	6,13 b
L : Grow 0,2% + banana extract 15%	10,87 c		4,67 b

Noted : The average value in each column marked with the same letter is not significantly different based on Scott Knott Test 5%

WAI : week after Incubation ; Hyp : Hyponex ; Grow : Growmore

C. Number of Node

The types of media and organic matter affect the number of books. MS medium fed and without organic ingredients, hyponex without organic ingredients and Growmore given coconut water yielded more books than other treatments. This is because the MS medium contains a fairly complete element for plantlet growth even without organic matter. Growmore media given coconut water can replace MS media to produce a number of books that are not different. Karjadi research (2007), shows that the number of books will affect the number of shoots and micro yams that are formed on the growth of potato plants. In addition, books can also be subcultured in propagation in vitro that will produce new shoots.

D. Number of Plantlet Leaves and Roots

The number of plantlet leaves and roots is not influenced by the type of media and organic matter (Table 2), but the number of leaves and the number of plantlet roots on MS and Growmore media given coconut water is likely or has the potential to produce a better number of leaves and roots than other treatments. Indicates that Growmore media can replace the original MS media plus coconut water. Widiastoety et al. (1997) stated that the addition of young and middle aged coconut water as much as 15% medium can promote high growth, length and width of leaves and length and number of roots of Dendrobium orchid planlets. According to Pandiangan and Tiurmaida (2006), the number of orchid buds of Dendrobium sp orchids was increased in all treatments of coconut water compared to without coconut water. Sugara and Raharjo (2009) stated that coconut water also contains zeatin which belong to class of cytokinin which is useful to spur the occurrence of organogenesis that can accelerate the growth of leaf.

E. Percentage of Seedling growth

Percentage of seedling growth is influenced by media type and organic material. Table 3 shows that all MS base media treatment, and the treatment of compounded fertilizers given coconut water yields a high percentage of seedlings growth. The seed condition of the treatments has sufficient growth and resistance during the incubation period, as measured by the variables measured as shown in Tables 1 and 2. Several studies have shown that the quality of in vitro plants influences the acclimatization period and subsequent developments in the field (Kowalski et al., 2006).

The lowest seedling growth percentage was obtained from G treatment (Hyponex 0.2% + potato extract 20%) which was not different from K treatment (Growmore 0.2% + potato extract 20%) and L treatment (Growmore 0.2% + banana extract 15%). This is in accordance with the opinion of Zakaria et al. (2009) that the physiological condition of plants in in vitro culture is the determine of the success of seed production process in the screen house.

F. Fresh Weight Seedlings

According to Roux (2004) fresh weight is used to measure plant growth both in vitro and in vivo. In Table 3 it was shown that all treatment of MS medium types with and without organic matter resulted in higher fresh weight of seedlings, as well as F (Hyponex 0.2% + coconut water 25%), H (Hyponex 0.2% + banana extract 15%) and J (Growmore 0.2% + coconut water 25%). This can be due to the high content of auxin and cytokines contained in coconut water and MS medium. Auxins play a role in the process of altering the osmotic properties of vacuoles and influencing cell lengthening while cytokines have an effect on cell division and differentiation. Elevation of the cell toward the vertical followed by cell development will increase the wet weight of the plant mainly due to increased water intake by plant cells. Water as well as growth regulators and nutrients contained into cells and cell walls expands, with the larger cells being formed that will affect the weight of wet shoots (Gunawan 1987, cited Matalula 2003).

Table 2. Influence of Media Types and Organic Materials on the Number of Leaves and Roots of Planlet

Treatment	Number of Planlet leaves 4 WAI	Number of planlet roots 4 WAI
A : MS without organic matter	10,80 a	4,93 a
B : MS + coconut water 25%	11,53 a	4,43 a
C : MS + potato extract 20%	9,27 a	3,40 a
D : MS + banana extract 15%	10,93 a	5,67 a
E : Hyp 0,2% without organic matter	9,33 a	4,00 a
F : Hyp 0,2% + coconut water 25%	9,47 a	3,62 a
G :Hyp 0,2% + potato extract 20%	8,13 a	2,37 a
H : Hyp 0,2% + banana extract 15%	7,53 a	4,40 a
I :Grow 0,2% without organic matter	8,20 a	3,43 a
J : Grow 0,2% + coconut water 25%	12,20 a	4,80 a
K : Grow 0,2% + potato extract 20%	9,53 a	2,40 a
L : Grow 0,2% + banana extract 15%	7,13 a	3,20 a

Noted : The average value in each column marked with the same letter is not significantly different based on Scott Knott Test 5%
WAI : week after Incubation
Hyp : Hyponex
Grow : Growmore

Table 3. Influence of Media Types and Organic Materials on Percentage of Seedling Growth and Fresh Weight Seedling at Acclimatization

Treatment	Percentage of Seedling Growth	Fresh Weight of Seedling (mg)
A : MS without organic matter	100,00 a	90,00 a
B : MS + coconut water 25%	100,00 a	86,67 a
C : MS + potato extract 20%	100,00 a	90,00 a
D : MS + banana extract 15%	100,00 a	96,67 a
E : Hyp 0,2% without organic matter	100,00 a	53,33 b
F : Hyp 0,2% + coconut water 25%	86,67 a	73,33 a
G :Hyp 0,2% + potato extract 20%	40,00 b	40,00 b
H : Hyp 0,2% + banana extract 15%	100,00 a	70,00 a
I :Grow 0,2% without organic matter	86,67 a	40,00 b
J : Grow 0,2% + coconut water 25%	100,00 a	126,67 a
K : Grow 0,2% + potato extract 20%	60,00 b	36,67 b
L : Grow 0,2% + banana extract 15%	60,00 b	33,33 b

Noted : The average value in each column marked with the same letter is not significantly different based on Scott Knott Test 5%
Hyp : Hyponex
Grow : Growmore

IV. CONCLUSION

Based on the description of the discussion can be drawn the following conclusions:

1. There was a response of different Cv. Granola potato planlets to various types of media and organic materials at the time of in vitro culture and the initial phase of acclimatization.
2. MS medium without organic matter and Growmore 2% plus coconut water 25% is the best medium in generating growth of culture and seed potato at the beginning of acclimatization.

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REFERENCES

[1] Daud, N., R. M. Taha., N. Nafizah and H. Alimon. 2011. Provision of low cost media options for in vitro culture of *Celosia* sp. African Journal of Biotechnology. Vol.10(80): 18349-18355
[2] George, E. F. and P. D. Sherrington. 1984. Handbook of Plant Propagation by Tisue Culture. Eastern Press Ltd. England. 709 p.
[3] George, E. F., Thorpe, T. A. Stasolla, Yeung, G. J. Klerk and A. Roberts. 2008. The Components of Plant Tissue Culture Media II: Organic Additions, Osmotic and pH Effect and Support Systems. Plant Propagation By Tissue Culture 3rd Edition. Vol 1. The Background. Springer-Verlag. Dodrecht. 115-173 p.
[4] Gunawan, L. W. 1992. Teknik Kultur *In Vitro* dalam Hortikultura. Penebar Swadaya
[5] Hendaryono, D. 2000. Pembibitan Anggrek dalam Botol. Kanisius, Yogyakarta
[6] Karjadi, A.K. 2007. Pengaruh penambahan kinetin, IAA dan GA3 terhadappertumbuhan planlet kentang. J. Agrivigor 6(2): 100-105.
[7] Kowalski, B., F. J. Terry, L. Herrera and D. A. Penalver. 2006. Application of soluble chitosan in vitro and in the green house to increase yield and seed quality of potato minitubers. Potato Research. 49: 167-176
[8] Laisina, J. 2010. In vitro propagation of sweet potato using inexpensive culture media. Jurnal Budidaya Pertanian. 6: 63-67.
[9] Matalula, A. J. 2003. Subtitution of MS medium with coconut water and Gandasil-D of *Chrisanthenum* tissue culture. Eugenta 9(4): 203-211.
[10] Neumann, K., A. Kumar and J. Imani. 2009. Plant Cell and Tissue Culture A Tool in Biotecnology Basic and Aplication. Springer-Verlag. Berlin Heidelberg.
[11] Pandiangan, Samse dan Tiurmaida Nainggolan. 2006. Pengaruh Pemberian Giberelin (GA3) dan Air Kelapa terhadap Pertumbuhan Komunikasi Penelitian. Volume 18 (2):30-33
[12] Roux, N. S. 2004. Mutation induction in musa. In Banana Improvement : Cellular, Molecular Biology and Induced Mutation. Enfield. Sci. Pub. Inc. 21-29p
[13] Sugara, R dan Raharjo. R. S. 2009. Jurnal Teknologi Alternatif Pemanfaatan Limbah Air Kelapa untuk Peningkatan Kualitas Produksi Budidaya Rumput Laut.
[14] USDA Nutrient Database For Standard Reference. 1997. Vegetable Nutirent. Available at: http://ndb.nal.usda.gov. (Diakses 25 Oktober 2012).
[15] Widiastoety, D., S. Kusumo dan Syafni. 1997. Pengaruh Tingkat Ketuaan Air Kelapa dan Jenis Kelapa terhadap Pertumbuhan *Plantlet* Anggrek Dendrobium. *J.Hort.* 7(3):768-772.
[16] Widiastoety, D. dan Purbadi. 2003. Pengaruh bubur ubi kayu dan ubi jalar terhadap pertumbuhan planlet anggrek *Dendrobium*. J. Hort. 13(1): 1-6.
[17] Yuwono. 2006. Bioteknologi Pertanian. Pusat Antar Universitas. Bioteknologi. Institut Perpatian Bogor. Bogor
[18] Zakaria, R., B. Zanjani and E. Sedghi. 2009. Effect of in vitro chitosan applicationon growth and minituber yield of *Solanum tuberosum* L. Plant Soil Environ. 55(6): 252-256

D.2

POTENCY OF BIOFERTILIZER FOR INCREASING YIELD OF SOYBEAN ON THE DRYLAND ACID

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ABSTRACT

Dry land acid is land that is never stagnant and are generally classified Ultisol and Inceptisol. dry land acid in Indonesia has great potential for agriculture, but low productivity. Application for Rhizobium in local farmers has to be developed to support sustainable agriculture. Bio-fertilizer is fertilizer formulas contain microbes, either single or multiple microbes, in a carrier with a function to uptake nutrients and increase crop production. Legumes such as soybeans has long been known as a plant that is capable of symbiosis with nitrogen-fixing bacteria (N) in the air to form nodules on the roots. *Rhizobium* associated with leguminous plants capable of fixation 300 kg N ha^{-1} and is able to 94 percent of their nitrogen needs. Utilization of *Rhizobium* bacteria tolerant acidic conditions with Al, Mn, and high Fe can replace the majority of in-organic N fertilizer on soybean plants grown in acidic soil, especially on lands have not been planted with soybeans. The success of a given strain inoculant also depend on its ability to compete with native *Rhizobium* (indigenous) contained in the soil. The study was to determine the potential and opportunities of biofertilizers in increasing soybean production in dry land acid. Biofertilizer was increased plant growth, the number of nodules, nutrient uptake and production of components such as root dry weight, shoot dry weight and dry seed weight per plant.

Keywords : biofertilizers ,dry land acid, soybean, yield.

I. INTRODUCTION

Fertilizer is a fertilizer formula containing microbes, either single or multiple microbes, in a carrier with the function to provide nutrients and increase crop production. Microbes that are formulated are beneficial microbes and are not as pathogenic (disease-causing) plants. Biofertilizer has good prospects to be developed and is currently increasingly in demand by farmers because besides being environmentally friendly, it can also increase crop productivity. The use of biological fertilizers containing N-blocking bacteria and phosphate solvents at the farm level should still be underway to support sustainable agriculture.

Legumes such as soybeans have long been known as plants that can symbiotic with nitrogen-fixing bacteria (N) in the air by forming nodules at the roots. *Rhizobium* is a bacterium capable of replacing lost soil N due to leaching, evaporation, binding by other minerals, and absorption by plants. Rhizobium associated with legumes is capable of fi fty 300 kg N ha^{-1} and is capable of sufficient 94% of its nitrogen requirements.

Size of acid in Indonesia reaches 102.8 million ha which is dominated by ultisol and inceptisol [1] From the extent, according to [2], which is suitable for the development of food crops of 18.5 million ha, mostly in Sumatra, Kalimantan and Papua. Sour dry land in Indonesia has great potential for agriculture, only productivity is low. If only 5% of the sour land area can be used for the development of soybean crops, then there will be an additional harvest area of about 9 thousand ha. [3] stated that to achieve self-sufficiency of soybean at least required harvest area 1.6 million ha.

The use of acid dry soils for soybean development faces several technical constraints, including low soil pH (<5.0) associated with high Al levels, high P fixation, low cation exchange capacity (KTK), Fe and Mn content reach poisoning limits and Poor biotic element. This condition is less suitable for soybean development, so that soybean crop can grow optimally and give maximum result, it needs additional ameliorant and organic material and NPK inorganic fertilizer is relatively high [4].

The utilization of tolerable rhizobium bacteria in Al, Mn, and Fe high acid conditions can replace most of the N-organic fertilizer in soybean plants grown on acid soils, especially on soils that have not been planted with soybeans [5]. Crop responses vary widely depending on soil conditions and the effectiveness of indigenous populations. [6], suggests that inoculant administration of *B. japonicum* and *Pseudomonas sp.* In soybeans can increase the weight of 100 grains and seed yield per plan.

In addition, Rhizobium bacteria also have a positive impact on the physical and chemical properties of the soil. [7] reported that all inoculated rhizobium isolates were able to form root nodules, but not all were effective for soybean crops. Therefore, the addition of fertilizer doses given to the soil can increase the growth of soybean crops. [8] Stated that the addition of 50 kg N ha^{-1} to three different genotypes of soybean plants yielded total N, N_2 bound, and tangible results when compared with the administration of 25 kg N ha^{-1}. However, [9], stated that the addition of N dosage is only effective when the applied Rhizobium isolates are incapable of providing N for the plant.

Biofertilizer formulations containing effective microorganisms such as Rhizobium can be arranged with a variety of carrier materials, which are generally organic, mineral or clay materials. According to [8], peat soil as a carrier has advantages over agar or soil. In addition to having high moisture holding capacity and high organic content content, for better shade life bacterial culture, peat soil can also increase the sustainability of *Rhizobium* cells in seed shells. According [11], plant genotypes and environmental factors affect the level of effectiveness of Rhizobium. In addition, the success of an inoculant line given also depends on its ability to compete with indigenous rhizobium in the soil. The aim of this research is to know the potency and opportunity of biological fertilizer in increasing soybean production in dry land.

Biological fertilizers are substances containing living microorganisms that colonize rhizosphere or inner parts of plants and spur growth by increasing the supply of primary nutrients and / or target plant growth stimuli when applied to seeds, plant or soil surfaces (FNCA Biofertilizer Project Group, 2006 in [10].

II. RESULTS AND DISCUSSION

A. The potential of dry land acid and the problem

In terms of breadth, dry land acid has enormous potential for the development of soybean cultivation area, because in Indonesia there are about 18.5 million ha of dry land acid that is physically suitable land for food crops commodities. This type of land is widely spread outside Java, especially in Sumatra, Kalimantan, and Papua. The land has been partially utilized for the cultivation of food crops such as rice (gogo), maize, and cassava; As well as plantation crops, mainly rubber and oil palm. Because the condition is so, soybean can be cultivated in monoculture and intercropping crop pattern with food crops and plantation commodities.

Behind its vast potential, in terms of fertility, the dry land acid is classified as sub-optimal/ marginal. This type of land is not / less fertile because in addition to poor nutrient also contains many elements that can interfere / poison the plants, namely Al, Fe, and Mn. The essential nutrients that many plants require but low availability in acid dry land, among them are nitrogen (N), phosphorus (P), and potassium (K), ie the three most-needed nutrients. For each 1.0 ton of dried seed yield, soybean crop absorbed about 67 kg N. The N nutrient requirement is much higher than the requirement of nutrient P and nutrient K 7,9 kg P (18 kg P_2O_5) and 36, 5 kg K (44 kg K_2O).

Soybean plants can obtain N nutrients from soil, from fertilizers (organic and inorganic) added, as well as from N-air through fixation of *Rhizobium* bacteria in soybean root nodules. Under optimum conditions, 60% of soybean N requirement can be met from the N-air fixation mechanism by *Rhizobium* bacteria in the root nodule. The potential role of large Rhizobium bacteria in providing nutrients N of soybean crops is naturally difficult to materialize in acid sour soil, since the population of *Rhizobium* bacteria on the land is generally very low. Therefore, inoculation of *Rhizobium* bacteria is needed. Accordingly, research to obtain an effective *rhizobium* bacteria can form a soybean root nodule that is able to fix N-air is something that is very strategic in the development of soybean on acid dry land.

The growth of soybean crops does not only rely on air N_2 aquaculture by *B. japonicum*, but also the need for N, P and K fertilizers [13]. Giving B. japonicum and chemical fertilizer is expected to be able to spur soybean production in acid land. *Rhizobium* Iletrisoy bio fertilizers are able to stimulate the formation of soybean roots in soybean dry soil, thus increasing the growth and yield of soybeans (Table-1). This fertilizer can replace the requirement of more than 75% of urea fertilizer in soybean plants in acid soils. The carrier formulation comprising a mixture of peat and wood charcoal provides a good growing environment and high viability for *Rhizobium* so that its effectiveness is maintained for up to six months of storage at room temperature.

B. The influence of biological fertilizer on the growth and yield of soybeans on dry land acid.

Biological fertilizers play a role in influencing the availability of macro and micro nutrients, nutrient efficiency, performance of enzyme systems, increasing metabolism, growth and yield of plants [14]. According to [15], legumes can be infected by more than one type of Rhizobium bacteria that has a different ability to inhibit nitrogen (N2). [16] added that the use of *Bradyrhizobium japonicum* and *Sinorhizobium fredii* simultaneously on the manufacture of microbial multipurpose fertilizer is very advantageous, because both have mutually supportive properties. [17] research results, that the *Rhizobium* bacteria began to block nitrogen after three weeks of soybean crop.

According to [18], since the formation of soybean roots, *Rhizobium* has been able to perform the formation of root nodule, which is about 4-5 days after planting and the root nodule can bind the nitrogen from the air at 10-12 days after planting so as to support the growth of plants. [19] In addition to factors of compatibility of bacteria with host plant exudates, plant genetic factors and soil conditions greatly affect the effectiveness of biological fertilizers.

The Iletrisoy biofertilizer consists of three isolates of the tolerant N *Bradyrhizobium japonicum*-tolerant bacteria that grow to react acid to pH 4.0 containing 400 µM Al, 100 ppm Mn, or 300 ppm Fe. *Rhizobium* Iletrisoy bio fertilizers are able to stimulate the formation of soybean roots in soybean dry soil, thus increasing the growth and yield of soybeans (Table 1). This fertilizer can replace the requirement of more than 75% of urea fertilizer in soybean plants in acid soils. The carrier formulation comprising a mixture of peat and wood charcoal provides a good growing environment and high viability for Rhizobium so that its effectiveness is maintained for up to six months of storage at room temperature.

Table 1. Soybean yield on *Rhizobium* inoculation and urea fertilizer on acid dry land, Lampung Timur, rainy season 2009

Urea Fertilizer (kg/ha)	Biofertilizer	Number of nodule /plant		Yield (t/ha)	
		20% Al	10% Al	20% Al	10% Al
0	Control	3.33 h	1,00 h	1,43 hi	1,10 k
0	Iletrisoy-2	21,66 fgh	42,33 a	1,73 cdef	2,14 a
0	Iletrisoy-4	32,33 b	16,66 g	1,71 def	1,82 bcd
100	Tanpa	1,66 h	3,00 h	1,28 ij	1,51 gh
100	Iletrisoy-2	23,33 def	25,00 cde	2,10 a	1,90 bc
100	Iletrisoy-4	25,16 cde	26,00 cde	1,81 bcde	1,37 hij
200	Tanpa	2,66 h	0,00 h	1,35 hij	1,23 jk
200	Iletrisoy-2	29,66 bc	25,33 cde	1,62 fg	1,80 bcdef
200	Iletrisoy-4	21,00 efg	40,00 a	1,64 efg	1,90 bc

Note : Values followed by different letters in the rows and columns are significantly diffrent at 5%. Source : Harsono et al, 2010.

Based on the results of the research on dry soil with Ultisol soil type in East Lampung district on soil with pH 3.65 Al 44.5% saturation and very low organic matter content, inoculation of Iletrisoy-2 and Iletrisoy-4 biochemical fertilizer can stimulate the formation of soybean root nodules Varieties of Anjasmoro both in conditions without urea and urea fertilizer with 100-100 kg / ha, and saturation Al derived to be 10-20% and added chicken manure 5 t / ha. In the non-inoculated treatment of *Rhizobium*, the number of effective root nodules formed ranged between 16-42 nodules / plants, 23-26 nodules / plants and 21-40 nodules.

In the soil Al saturation of about 20%, without urea fertilization, inoculation with Rhizobium Iletrisoy-2 and Iletrisoy-4 increased respectively from 1.43 t/ha to 1.73 t/ha and 1.71 t/ha or respectively - increased by 21% and 20% compared without *Rhizobium* inoculation. In saturation Al 10%, inoculation with Iletrisoy-2 and Iletrisoy-4 increased respectively from 1.10 t/ha to 2.14 t/ha and 1.82 t/ha or respectively increased by 94% and 56 %. Inoculation with inoculant iletrisoy-2 and iletrisoy-4 was able to yield higher yields than urea-fertilized 100-200 kg/ha without *Rhizobium* inoculation.

Table 2. Levels of soybean leaf N on some ameliorant administration and rhizobium inoculation

Inoculation	Concentration of N leaves age 45 day (%)			
	Control	Dolomit	Dolomit + Bokasi	Dolomit + Bokasi + 2 kg Mo
I-0 (without inoculation)	2,27 c	2,96 m	2,41 e	3,03 o
I-0 + 50 kg urea/ha	2,72 j	2, 43 f	2,34 d	2, 57 h
Iletrisoy-1	2,41 e	2, 63 i	2, 35 d	2, 73 j
Iletrisoy-2	2, 34 d	3,00 n	3, 18 p	2, 57 h
Iletrisoy-3	2, 50 g	1, 81 a	2, 26 b	2, 95 m
Iletrisoy-4	2, 42 ef	2, 80 l	2,78 k	3,47 r
Legin	3, 62 t	3, 24 q	3, 18 p	3, 61 s

Note : Values followed by different letters in the rows and columns are significantly diffrent at 5%. Source : Harsono et al, 2008.

An increase in the number of root nodules and leaf chlorophyll due to *Rhizobium* Iletrisoy-2 inoculation and Iletrisoy-3 also increased the leaf N content. Inoculation with both inoculants was able to increase N leaf content compared to without inoculation, and even inoculation of Iletrisoy-2 on ameliorant administration of 1, 5 ton dolomite + 2 t / ha bocation was also able to increase N leaf content compared to plant which only fertilized 50 kg urea / ha. Increasing the production of soybeans in acid fields requires a strategy and understanding of cultivation techniques, the provision of appropriate *rhizobium* for soybean cultivation on marginal land. The availability of sufficient nitrogen (N) in the soil is one of the keys to the success of efforts to increase soybean production in acid.

Soybean plants generally take nitrogen (N_2) from the air through N symbiotic fixation with *Bradyrhizobium* japonicum bacteria, so as to spur the growth and production of soybeans. In favorable circumstances this symbiosis is able to meet the N host plant's need for 74-90% of the total N plant requirement [20]. In general, B. japonicum is tolerant of pH 4.0-4.5 compared with other rhizobacteria. Inoculation of B. japonicum in soybean plants can modulate soybean crops grown on land with high acid and Al conditions, so as to increase soybean growth. Inoculant B. japonicum used to spur soybean production include BJ 11 (19) and BJ 11 (wt) [21]. The growth of soybean crops does not only rely on air N2 aquaculture by B. japonicum, but also the need for N, P and K fertilizers [22]. Giving B. japonicum and chemical fertilizer is expected to be able to spur soybean production in acid land.

The results of [23], inoculing of B. japonicum BJ 11 (wt), compost, and N 10 g m-2 fertilizer can increase plant height, dry weight of crown or root, number of nodules, total dry weight of nodule, and nitrogenase activity Wilis soybeans are grown on acid soil compared to when soybean crops are only fertilized N alone. It can also increase the number of pods, the number of seeds, the weight of seeds per plant per square meter, and the weight of 100 seeds.

Table 3. Inoculant effects of B. japonicum, compost, and N fertilizer on canopy dry weight, root dry weight, number of nodules, wet weight and total nodular dryness and nitrogenase activity on soybean crop.

Treatment	Canopy dry weight (g/ plant^{-1})	Root Dry Weight (g/plant $^{-1}$)	Number of nodule/plant	Nodular Dry weight (mg/ plant^{-1}	nitrogenase activity (µmol time^{-1} nodul^{-1} plant $^{-1}$)
Kontrol	0,6 g	1,3 bcd	0e	0d	0.00d
Pupuk N (50%)	12,8 bcd	1,9 abc	49bcd	130c	0.09b
Pupuk N (100%)	6,6 cde	1.2bcd	1d	50c	0.001c
Kompos + pupuk N (50%)	5,2 de	1.3bcd	102ab	180bc	0.34a
Kompos + pupuk N (100%)	11,1 bcd	1.7bcd	83abc	130c	0.28a
BJ 11 (19) + pupuk N (50%)	9,8 bcd	1.3bcd	54bcd	90c	0.30a
BJ 11 (19) + pupuk N (100%)	15,3 abc	2.2ab	54bcd	190bc	0.09b
BJ 11 (19) + kompos + pupuk N (50%)	3,2 e	0.7d	17cd	40c	0.17b
BJ 11 (19) + kompos + pupuk N (100%	10,5 bcd	1.4bcd	41bcd	60c	0.13b
BJ 11 (wt) + pupuk N (50%)	7,0 cde	1.1cd	32bcd	150bc	0.41a
BJ 11 (wt) + pupuk N (100%)	6,3 def	1.0cd	56bcd	180bc	0.10b
BJ 11 (wt) + kompos + pupuk N (50%)	9,3 bcd	1.9abc	90abc	350a	0.05b
BJ 11 (wt) + kompos + pupuk N (100%)	18,6 a	2.8a	143a	310ab	0.12b

Note : Values followed by different letters in the rows and columns are significantly diffrent at 5%. Source : Triadiati et al, 2013.

Inoculant administration of *B. japonicum*, compost and nitrogen fertilizer can affect vegetative and generative growth of soybean in acid soils with pH 4.7 and Al-dd 18.09 ppm. Plant height, canopy dry weight, dry weight of root, number of nodule, dry weight of nodule, and nitrogenase activity influenced by inoculant *B. japonicum*, compost and fertilizer N. Treatment BJ 11 (wt) + compost + N fertilizer (100%) Giving the growth response and production of real soybeans better than other treatments.

The number of root nodules on soybean roots is influenced by ammonium and oxygen levels in the soil. Low ammonium levels and high oxygen levels in the soil will inhibit the formation of root nodules. On the other hand, the results of [24] showed that the more the number of root nodules, the higher the nitrogenase activity. The number of root nodules from this study tends to be more in the treatment of BJ 11 (wt) + N fertilizer (100%) but not accompanied by high nitrogenase activity. The use of microorganism fertilizers mixed with inorganic fertilizers and energy sources with a certain ratio known as the Biological Fertilizer has been reported to improve nutrient uptake efficiency, improve growth and yield and increase resistance to pests and diseases [25].

The results of the study [26]. showed that the application of biofertilizer had no significant effect on soil pH, C-organic, N-Total soil, C / N Soil, P-available, number of root nodule weight, plant weight, nutrient uptake and Production of soybeans. The provision of an amendment significantly increased soil pH. Number of root nodule, plant weight and soybean nutrient uptake, the best amendement is clump ash. The addition of organic matter to soybean cultivation may increase the rhizobacterial population in the soybean plant rhizosphere [27]. [28] reported that there was a difference in soybean yield due to the inoculation of Rhizobium consortium with different soybean cultivars.

This is consistent with [29], which reported that inoculated soybeans with B. japonicum showed an increase in the number and weight of dry nodules as well as total dry weight of the plant compared with no inoculation. [29], revealed the interaction of N_2 microbial with host plant is one example of improved quality of plant by microb. Results of different dry weight of plants in each variety, this proves that the two varieties have different responses to Rhizobium inoculation in addition to having specific characteristics of genotypes. According to the results of the study [31], stated that single strain biological fertilizer has positive effect on soybean variety of Anjasmoro variety, while multi strain has positive effect on Mitani varieties. To increase the N uptake, the number of nodule and dry weight of plant on Mitani varieties, multi strain biological fertilizer treatment with 50% of urea addition is best, while for Anjasmoro variety is by single strain biomass fertilizer with urea 50%. The use of biological fertilizers especially rhizobium is very important for soybean cultivation.

The formation of root nodules in addition to improving soil fertility, can also increase the efficiency of fertilization and reduce environmental pollution [32]. However, in acid sites the population of Rhizobium bacteria is generally very low can range from 3 – 250 Bacteria/gram of soil [33]. So that soybeans in acid land generally do not succeed in forming root nodule. It is necessary to inoculate the tolerant rhizobium so that the bacterial population is sufficient to be symbiotic with soybean crops. Abiotic and biotic factors such as soil acidity, soil moisture, soil temperature, organic and inorganic compounds as a source of nutrients, cell density Soil rhizobium affects the process of formation of root nodule [33].

III. CONCLUSION

Biological fertilizers have the potential and opportunities to be used on acid dry land to increase soybean production and biological fertilizer can increase plant growth, number of root nodule, macro nutrient uptake and production components such as root dry weight, dry weight of crown and dry seed weight per plant.

REFERENCES

[1] Harsono, et al. 2011......

[2] Mulyani, 2006.

[3] Harsono, 2008

[4] Harsono,2011

[5] Harsono, 2009

[6] Noertjahyani," Kandungan N, P Tanaman Akibat Hasil Inokulasi Konsorsium Bradyrhizobium," *Jurnal Agroland,* vol.14, p. 6–10. 2007

[7] Purwaningsih, S,"Seleksi Biak Rhizobium dari Wonogiri, Jawa Tengah Terhadap Pertumbuhan Tanaman Kedelai (Glycine max L.) pada Media Pasir Steril di Rumah Kaca,"*Biodiversitas,vol.*6,p.168–171, 2005.

[8] Gan,Y., I. Stulen, H.V. Kuelen, and P.J.C. Kuiper," Effect of N Fertilizer Top-dressing at Various Reproductive Stages on Growth, N2 Fixation and Yield of Three Soybean (Glycine max (L.) Merr.) Genotypes.,"*Field Crops Research*, vol.80, pp 147–155, 2003.

[9] Thies, J.E., P. W. Singleton, and B.B. Bohlool, *Phenology, Growth, and Yield of Fieldgrown Soybean and Bush bean as a Function of Varying Modes of N Nutrition,* Soil Biology & Biochemistry.1995

[10] Rao, N.S, *Advanced of Agricultural Microbiology*, New Delhi India: Oxford and IBH. 1982.

[11] Soedarjo, Muchdar, Sucahyono, dan Didik,"Rencana Operasional Pelaksanaan Penelitian (ROPP)," Pusat Penelitian dan Pengembangan Tanaman Pangan Balitkabi, Malang, 2007.

[12] Simanungkalit, R. D. M dan Suriadikarta, D. A, *Pupuk Organik dan Pupuk Hayati*, Balai Besar Litbang Sumberdaya Lahan Pertanian, Bogor, 2006.

[13] Mulyadi, A, " Pengaruh pemberian legin, pupuk NPK (15:15:15) dan urea pada tanah gambut terhadap kandungan N, P total pucuk dan bintil akar kedelai (Glycine max (L.) Merr.)," *Kaunia, vol.*8,pp.21-29, 2012.

[14]] Totok Agung D. H. dan Ahadiyat Yugi Rahayu," Analisis Efisiensi Serapan N, Pertumbuhan, dan Hasil Beberapa Kultivar Kedelai Unggul Baru dengan Cekaman Kekeringan dan Pemberian Pupuk Hayati," *Agrosains* 6, vol 2, pp.70-74, 2004.

[15] Loveless,

[16] Saraswati, R," Ulas Balik: Teknologi Pupuk Mikroba Multiguna Menunjang Keberlanjutan Sistèm Produksi Kedelai," *Jurnal Mikrobiologi Indonesia, vol.* 4, pp. 1–9, 1999.

[17] Rukmana, R. 1996. Kedelai Budi Daya dan Perkembangannya. Yogyakarta: Kanisius. 18Adisarwanto, T. 2005. Kedelai. Jakarta: Penebar Swadaya. 19Sanginga, N., G. Thottappilly, and K. Dashiell. (2000). Efectiveness of Rhizobia Nodulating Recent Promiscuous Soybean Selections in The Moist Savanna of Nigeria. Soil Biology & Biochemistry. 32: 127–133.

[18] Adisarwanto,............

[19] Sanginga, N., G. Thottappilly, and K. Dashiell, " Efectiveness of Rhizobia Nodulating Recent Promiscuous Soybean Selections in The Moist Savanna of Nigeria. Soil," *Biology & Biochemistry, vol.* 32, pp. 127–133, 2000

[20] Sutoyo. 1992. Respon berbagai kultivar kedelai terhadap inokulasi B. japonicum dilacak dengan 15N. Tesis. Sekolah Pascasarjana. Institut Pertanian Bogor. Bogor.

[21] Monasari, D. 2007. Konstruksi mutan Bradyrhizobium japonicum kedelai toleran asam-aluminium untuk meningkatkan efektivitas simbiotik melalui mutagenesis transposon. Skripsi. Fakultas Matematika dan Ilmu Pengetahuan Alam. Institut Pertanian Bogor. Bogor.

[22] Mulyadi,.......

[23] Tridiati, Nisa Rachmania Mubarik, dan Yoan Ramasita,"Respon Pertumbunan Tanaman Kedelai terhadap Bradyrhizobium japonicum Toleran Masam dan Pemberian Pupuk di Tanah Masam," *J. Agron. Indonesia, vol 41,pp.*24-31. 2013.

[24] Appunu, C., B. Dhar. "Symbiotic effectiveness of acid tolerant Bradyrhizobium strains with soybean in low pH soil," *Afr. J. Biotechnol*, vol.5, pp.842-845. 2006
[25] Hardianto, R. 2000. Kembalikan Kesuburan Tanah dengan Pemanfaatan Mikro-organisme Efektif (EM) dan Bokasi. BPTP Karangploso.
[26] Triana Anggraini," Pengaruh pemberian pupuk hayati dan amandemen pada tanah gambut terhadap pertumbuhan, produksi dan serapan hara tanaman kedelai," M.Si.thesis, 2003.
[27] Grossman, J.M., M.E. Schipanski, T. Sooksanguan, S. Seehaver, L.E. Drinkwater, "Diversity of rhizobia in soybean [Glycine max (Vinton)] nodules varies under organic and conventional management,"*Appl. Soil Ecol,* vol.50,pp. 14-20, 2011
[28] Meghvansi, M. K., K. Prasad, D.Harwani, & S. K. Mahna," Original Article Response of Soybean Cultivars Toward Inoculation with Three Arbuscular Mycorrhizal Fungi and Bradyrhizobium japonicum in The Alluvial Soil," *European Journal of Soil Biology*, vol. 44, pp. 316–323, 2008.
[29] Lestari, P., K. Van, M.Y. Kim, and S.H. Lee. Nodulation and Growth of A Supernodulating Soybean Mutant SS2-2 Symbiotically Associated with Bradyrhizobium japonicum. Jurnal AgroBiogen. 2(1): 8–15. 2006.
[30] Lee et al,....
[31] Taufik et al, 2013
[32] Saraswati,2007
[33] Soedarjo et al, 2007

D.3

INCREASING OF PRODUCTIVITY AND PRODUCTION OF LOWLAND BY ENHANCING PLANTING INDEX (IP 200)

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ABSTRACT

The objective of this research is 1) to change the planting frequency of one time a year (IP 100) to twice a year (IP 200), 2) to analyze the effect of pump application to land productivity, 3) increasing the farmer income at lowland rice field, 4) to analyze effect of pump using to the whole rice income. This research was conducted at shallow lowland rice field at Pelabuhan Dalam village, Pemulutan sub-district, Ogan Ilir District, South Sumatra Province. It was a comparison study between farmers that using pump and farmers without pump facility. The results showed that pump use could increase planting index to IP 200 and procudtivity of 98.33% and income as much as Rp 9,327,000 per hectare. Feasibity analysis showed that NPV as much as Rp 29,165,830 and B/C of 1.75 and it was feaseble to run. The most affected factor was water management factor.

Keywords : lowland rice field, food security, planting index.

I. INTRODUCTION

The main problem in food security in Indonesia is that food demand is always higher than food suply and it caused importing of several kind of food. There are some constrains in food production at some area due to climate changes. Indonesia is one of the countries that could survive from the economic crisis. Many countries protected their countries by not exported food outside so that the food suply decreased significantly. It needs a serious effort to solve this problem to help farmer and poor people. This isue had to be paid attention to maintain Indonesia image that has been success to produce enough rice for its people.

Food security is the most important in agricultural development and become the top priority in national building. The objective was to garantie the availability of food, safe, good quality for local, region as well as national level. On the other side, there has been a land conversion from food land allocation to the other land use like houses, storage buildings, real estate, and plantations. In Java Island there are about 100,000 to 110,000 hectares of rice field are converted per year. The scarcity of fertile land at Java Island made government created new rice field out of Java. Lowland area was one of the areas that has been develop for rice field. It was estimated about 33,4 million hectares (about 24.2 percent of total land of Indonesia), consisted of tidal swamp area 20 million hectares and swamp area 13.4 million hectares (Bappenas, 2007).

Planting index (PI) is a terminology that shows the frequency of planting season on a land. The increase of planting frequency is one of the effort used to enhance the production of certain food to overcome the lack of food, land conversion, and limited land to extend. Swamp land rice field was very potential to be increased its planting index. Water was available although in dry season. The method could be removing the rest time for that land and multicrop technique were two ways of increasing planting season. Pump utulization is one way that could be applied in increasing PI.

Based on the water surface and how long the water was on the land, swamp land was devided into three categories, 1) shallow swamp land, height of water surface less than 50 cm and inundation time less than 3 months, 2) middle swamp land, height of water surface 50 - 100 cm and inundation time 3 - 6 months, and 3) deep swamp land, height of water surface more than 100 cm and inundation time more than 6 months.

Swamp land that was categorized into suboptimal land has been cultivated for a long time for agricultural, animal, and fish. Increasing of swamp land productivity faced many constrains like land physical, production process, postharvest technology, and low manpower quality. Therefore, there must a kind of technology that could be applied to this land. Improving should be done on every aspect like land fertility, transportation, seed quality, counseling activity, irrigation and drainage, as well as farmers skill and motivation as change agent.

The objective of this research were 1) to change farmer tradittion that usually cultivate once a year (PI 100) to twice a year (PI 200), 2) to analyze the effect of pump use to land productivity, and 3) to analyze the effect of pump use to farmers income. This research was also expected produce a technology that efective, relevant to local farmes, competitive.

II. MATERIALS AND METHODS

This research was conducted at swamp land rice field Pemulutan Sub-district, district of Pemulutan, South Sumatera. Location was choosed using *purposive sampling method*. Reasons in choosing location: (1) Pemulutan Sub-district was one of the rice production center and it is not far from the city of Palembang, (2) In term of methodology, all of the research steps were fullfilled, and (3) Research location, geographically and economically could be reached using all types of vehicles and did not spend a lot of money. Primary data and field observation were done for 8 months from February to November 2016. Pre-research was done main research.

This research was conducted on shallow swamp rice frield as a case study of an area where farmers used pump to take water from shallow well. An area without irrigation was observed as a control. The object of this research was farmers that used water. The research was aimed to determine the effect of farm irrigation to the land productivity. Technical and economic analyses were included to be observed.

Hermawan (1996) stated that the important factors that needed to concern in financial analyses were a) cost needed, b) source of capital, c) cash flow arrangement, d) investasion assesment criteria, and d) sensitivity analyses.

Profit of machinery that would be used would be calculated with principal cost (BP), while feasibility of pump technology was approached by Net Present Value (NPV) and B/C ratio.

A. Net Present Value (NPV)

Net Present Value (NPV) is a difference between revenue and cost. This criteria showed that the project will be choosed when NPV > 0. So, if a project has NPV < 0, the project is not feasible to run. NPV formula is written:

$$NPV = \sum_{t=0}^{n} (B_t - C_t)/(1+i)^t \quad (1)$$

where :

NPV = net present value
n = period time
B_t = benefit at t^{th} year
C_t = cost at 1^{st} year
i = interest rate

B. Benefit-Cost Ratio

This method is a method that compare between revenue and cost that have been discounted. The formula is written (Gaspersz, 1999):

$$\text{net B/C} = \frac{\sum \frac{Bt}{(1+i)^t}}{\sum \frac{Ct}{(1+i)^t} + Co} \quad (2)$$

The value of B/C > 1 means project revenue is higher than cost. In other words, the project is feasible to run. Conversely, if B/C < 1 the project is not feaseable.

III. RESULTS AND DISCUSSION

This research was aimed to find the effect of irrigation pump to production and farmer income. Beside that technical and economical aspects were also reviewed.

Land preparation included primary tillage using mouldboard plow and secondary tillage using rotary, each was done one time. Combine harvester was used to harvest. Agricultural mechanization must be applied to increase the efficieny and effectivity of field operation.

The swamp land rice field productivity for one time planting was 4.918 tonnes per hectare. While the productivity for second planting time was 4.836 tonnes per hectare. It indicated that there was a prodcutivity increase of 98,33 percent.

The second planting season was done by application of pump to manage the water supply to the rice field. By this water management system water supply was arranged so that at the wet season the water surface was not affected by water from the river and at the dry season the water was pumped to the rice field. To create this condition, a bedding was formed along the rice field functioned to retain rainfal water enter the rice field. At the dry season, water from shallow well was pumped into the rice field. Among rice field block was installed plastic pipes that could lowered when the rice needed water, and the pipes could standed up when the water outside the system came into the block.

Embankment was constructed by taking the soil around the field. Ditch was formed after the was taken and it functioned as a channel. The embankment could be planted with vegetables, beans, an annual plants. Water management was arranged using pumps that were placed on the embankment. The height could be made based on the information from the farmers and government agency. It is known that the height of the water surface at rainy season was about 90 cm. The height of the embankment was made 140 cm so that it was still safe when it shrinked.

Financial Analysis

An ongoing project should be evaluated whether it was still profitable or not and feasible in the future. Threfore, there must be a review to know the feasibility study for the project.

Financial Analysis was an instrument of activity assessment and determining of profit of any aspects when a decision has been made at a business activity. The purpose of financial analysis was to determine a comprehensive measurement whether a project was acceptable or not. The results of financial analysis could be used to judge the possible benefit to do a project. Financial Analysis was very useful to decide the business feasibility by calculating cost and revenue flow.

Rice field productivity of second season (PI 200) was 4,836 kg per hectare of harvested moisture content. Unhulled rice grain was assumed as much as Rp. 4,500 per kg. Revenue as much as Rp 21,762,000.

Expenditure including:

- Seed 40 kg @ Rp. 30,000,- = Rp. 1,200,000
- Land preparation = Rp. 3,000,000
- Planting cost = Rp. 2,000,000
- Plant protection = Rp. 1,500,000
- Fertilizer = Rp. 1,000,000
- Pump cost = Rp. 574,000

Total cost to grow rice for 1 hectare was Rp. 12,435,000.
Therefore, the addition farmer income was Rp. 9,327,000.

Table 1. Analysis of cash flow

Year	Revenue	Cost	DF (18%)	Revenue	Cost
1	21762000	12435500	0.8475	18443295	10539086.25
2	21762000	12435500	0.7182	15629468.4	8931176.1
3	21762000	12435500	0.6086	13244353.2	7568245.3
4	21762000	12435500	0.5158	11224839.6	6414230.9
5	21762000	12435500	0.4371	9512170.2	5435557.05
				68054126.4	38888295.6

NPV = Rp. 29,165,83

B/C ratio = 1.75

Based on the positive NPV criteria (> 0) and B/C ratio > 1, could be concluded that PI 200 was feasible to do and beneficial.

IV. CONCLUSION

Financial analysis showed that the magnitude of NPV as much as Rp. 29,165,830 and Net B/C ratio of 1.75 were feasible to do.

Water pump increased the Planting Index (PI 200), land productivity of 98.33 %, and farmers income as much as Rp. 9,327,000 per hectare.

Increasing of irrigation capacity using water pump to support food production intensification could be a good effort due to the availability of water.

REFERENCES

Ananto, E.E., M. Djojomartono, K. Abdullah dan Eriyanto, 1999. Perkembangan tenaga pertanian untuk usahatani padi sawah di Kabupaten Karawang. Suatu pendekatan simulasi sistem. Media Penelitian Sukamandi. No. 11. P4-23.

Bappenas. 2007. Kajian kebijakan pengembangan dan pengelolaan irigasi rawa di Sumatera. Direktorat Pengairan dan Irigasi Kedeputian Bidang Sarana dan Prasarana, Jakarta.

Brown, J. G. 1994. Agroindustrial Investment and Operation. Edi Development Studies. The Word Bank Washington, D. C.

Hasbi. 2012. Perbaikan Teknologi Pasca Panen Padi di Lahan Suboptimal. Jurnal Lahan Suboptimal 1 (2), 186 -196.

Hermawan. 2008. *Pemanfaatan Limbah Sekam Padi Sebagai Bahan Bakar Bentuk Beriket,* Teknik Mesin Univ. Jember.

Gaspersz, V. 1999. Ekonomi Manajerial Pembuatan Keputusan Bisnis. PT Gramedia Pustaka Utama. Jakarta.

Raharjo, B., R. Soehendi., Hasbi., Hersyamsi., Y. Hutapea., R. U. Soemantri., E. Herawati. 2012. Adaptasi Alat dan Mesin Panen Model Stripper Harvester di Lahan pasang Surut Sumatera Selatan. Laporan Akhir Penelitian Insentif Riset SINas. Balai Pengkajian Teknologi Pertanian (BPTP) Sumatera Selatan.

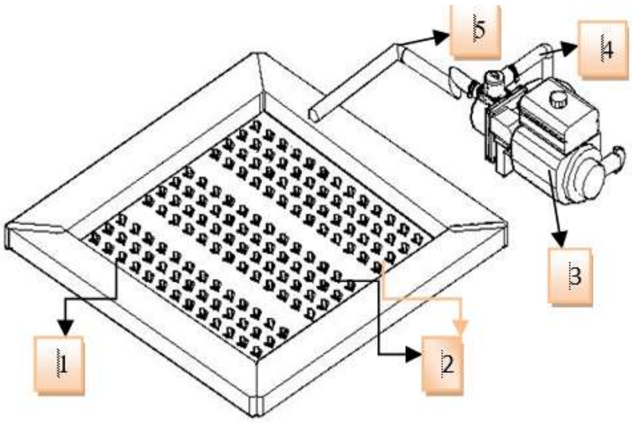
Rangkuti, F. 2004. Analisis SWOT dan SMART Keragaan fasilitas dan utilitas pasar di Indonesia, Universitas Indonesia, Depok.

Setyono, A., R. Tahir, Soeharmadi dan S. Nugraha. 1993. Perbaikan sistem pemanenan padi untuk meningkatkan mutu dan mengurangi kehilangan hasil. Media Penelitian Sukamandi No. 13 hal 1-4.

Setyono, A., Suismono, Jumali, dan Sutrisno. 2006. Studi penerapan teknik penggilingan unggul mutu untuk produksi beras bersertifikat. hlm. 633-646. *Dalam* Inovasi Teknologi Padi Menuju Swasembada Beras Berkelanjutan, Buku 2. Pusat Penelitian dan Pengembangan Tanaman Pangan, Bogor.

Setyono A., S. Nugraha, dan Sutrisno. 2008. Prinsip penanganan pascapanen padi. hlm. 439-461. *Dalam* Inovasi Teknologi dan Ketahanan Pangan. Buku I. Balai Besar Penelitian Tanaman Padi, Sukamandi.

Sutrisno, D.R. A. Jumali, dan A. Setyono. 2006. Pengaruh kapasitas kerja terhadap efisiensi pengeringan gabah menggunakan *box dryer* bahan bakar sekam. hlm. 331-341. Prosiding Seminar Nasional Mekanisasi pertanian. Balai Besar Pengembangan Mekanisasi Pertanian, Institut Pertanian Bogor, Asosiasi Perusahaan Alat dan Mesin Pertanian Indonesia.



No	Description
1	Rice field
2	Rice plant
3	Water pump
4	Suction hose
5	Discharge hose

Fig. 1 Illustration of rice field and pump

Fig. 2. Rice field

D.4

EFFECT OF MIXED CROPPING BETWEEN *Brachiaria humidicola* GRASS WITH LEGUME ON DRY MATTER YIELD OF FORAGE, CRUDE PROTEIN CONTENT AND CRUDE FIBER CONTENT OF GRASS

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ABSTRACT

Nitrogen is the most nutrients needed by both fodder and legume crops. Addition of nitrogen nutrients can be done through nitrogen fertilization by adding artificial fertilizer into the soil or through the activity of biological fixation of rhizobium bacteria found in the legume root. Through mixed cropping it is hoped that some of the biological nitrogen fixation occurring in legume root nodules can be used by grasses grown with legumes to increase dry matter yield, increase crude protein content and decrease crude fiber content of grass.

This research aimed to study the effect of mixedcropping between *Brachiaria humidicola* grass with Centro legumes (*Centrosema pubescens*), Kudzu (*Pueraria phaseoloides*), and Calopo (*Calopogonium mucunoides*) on dry matter yield,crude protein content and crude fiber of grass, and to determine the mixed cropping with the type of legume which ones produce the highest dry matter yied. This research was conducted at the Field of Laboratory of Forage Crops Faculty of Animal Husbandry, Padjadjaran University from September 2016 until January 2017. The research used randomized block design with 4 treatment ie: monoculture grass *Brachiaria humidicola* (B0), Grass + Sentro (B1), Grass + kudzu (B2), and grass + Kalopo (B3). Each treatment was repeated six times. To find the different of treatment, Duncan Multiple range test performed.The results showed that mixed cropping significantly affect on dry matter yield, crude protein content and crude fiber content of grass. The highest dry matter yield obtained in mixed cropping with *Brachiaria humidicola* grass + kudzu legume.

Keywords : *Brachiaria humidicola*, Kudzu, Calopo, Centro, mixed cropping.

I. INTRODUCTION

Legume plants, can fix nitrogen from the air if symbiotic with rhizobium bacteria. Nitrogen fixation makes nitrogen available for plants, from N_2 is fixed to NH_3 and eventually becomes NH_4^+ that can be absorbed by plants. This fixation can be done by free-living bacteria, cyanobacteria (blue green algae) that live freely on soil or water surfaces, cyanobacteria that are symbiotic with fungi in moss or with ferns and bacteria symbiotic with roots, especially legume tree roots. Nitrogen fixation through symbiosis between legume plants and rhizobium bacteria in nodules is the most productive (Halbleib and Ludden, 2000). This rhizobium activity benefits the legume crop and benefits plants growing around the legume either through the removal of nitrogen from root nodules and decomposition of root nodules and parts of legume plants by microbes. In addition rhizobium activity is also useful in saving nitrogen fertilizer. One of the things that happens to rhizobium-legum symbiosis, legumes provide carbohydrates that rhizobium can use as a source of energy, rhizobium provides nitrogen that can be utilized by legumes to synthesize amino acids and proteins. The symbiosis causes the legumes to produce higher production and quality (Peoples and Craswell, 1992).

Different legume species affect the amount of fixed nitrogen. The amount of fixed nitrogen also depends on the activity of nitrogenase. In addition to being based on the nitrogen fixation level, choosing fodder crops should also be noted for productivity, palatability and adaptability to soil and climatic conditions. Grass *Brachiaria humidicola* is a grass that has a high enough production potential, palatabel, has a thick leaves and fast growth. The grass is resistant to drought, is resistant to protection and has a good adaptability to various environmental conditions (Reksohadiprodjo, 1994). Legum Centro (*Centrosema pubescens*), Kudzu (*Pueraria phaseoloides*), and Calopo (*Calopogonium mucunoides*), are legumes that crawl, twist and climb. Centro, Kudzu and Calopo can adapt with the shade of grass plants that grow with it and can suppress weed growth. Centro, Kudzu, and Calopo can also adapt to dry conditions (Reksohadiprodjo, 1994).

Mixed grass and legume crops proved to increase forage productivity. Iin (2005) showed that mixed cropping between Siratro legumes and Benggala grass increased production and crude protein content of grass forage. The mixture of Benggala grass and legume can increase Benggala grass productivity on marginal land (Herryawan, 2009). Grassland with mixed grass and legume crops produces better productivity than grass monoculture in pastures, seen from forage production, nutritive value, forage feed distribution within a year and cattle weight gain (Harun Djuned, 1986). Increased production and quality of forage is caused by the ability of legumes to fix nitrogen free from air because it is symbiotic with rhizobium bacteria. Each legume species has different potential in fixing nitrogen. According to Iin (2011), nitrogenase activity in Centro plants is 2.72 ppm g^{-1} h^{-1}, Kudzu 2.71 ppm g^{-1} h^{-1}, and Calopo 2.85 ppm g^{-1} h^{-1}.

II. MATERIALS AND METHODS

The experiment was carried out at Field of Laboratory of Forage Crops Faculty of Animal Husbandry, Padjadjaran University from September 2016 until January 2017.The materials used are: pols of *Brachiaria humidicola* grass, seed of Centro, Kudzu and Calopo. Plots with size 4 m x 3 m. Distance between plot 0.5 m and distance between replicates were 1 m. Made a grouping based on the slope of the soil. Each slope is made 4 plots according to the amount of treatment that is: B0 (*Brachiaria humidicola* grass monoculture). B1 (*Brachiaria humidicola* + Centro), B2 (*Brachiaria humidicola* + Kudzu), B3 (*Brachiaria humidicola* + Calopo). Each treatment was repeated 6 times. Legum seed planting is arranged with spacing 1 m. Each planting hole is filled with seed 5 seeds. After one month of legume planting, leaves 2 legumes per hole, then the pols of *Brachiaria humidicola* grass planted in between the legumes. Maintenance is done in the form of weeding. Grass harvesting is done at 60 days after grass planting, leaving 5 cm of grass from the surface of the soil, then weighed to get the forage production, while the cutting of legume crop is left 20 cm from the surface of the soil and then weighed, for further result is added with forage Grass to obtain total forage production data. Grass and legume samples were then obtained from each treatment of 500 g to obtain dry matter production data by entering the sample into the oven for 48 hours at 60 ° C until no water content. After that, the sample was finely ground with a blender to analyze the crude protein content and crude fiber. Analysis of protein content using Kjeldahl method and crude fiber content using proximate analysis (AOAC, 2005).

III. RESULTS AND DISCUSSION

Data of dry matter, crude protein content and crude fiber content of grass are presented in the Table 1.

Tabel 1. Dry matter yield, crude protein content and crude fiber content as influenced by mixed cropping grass and legumes

Treatment	B0	B1	B2	B3
Dry Matter Yied (g.plot^{-1})				
Grass	497^{b}	150^{a}	198^{a}	213^{a}
Legume	-	666^{a}	2038^{b}	952^{a}
Total	497^{a}	816^{a}	2236^{b}	1165^{a}
Crude protein content (%)	9.3^{a}	10.3^{b}	11.1^{c}	12.4^{d}
Crude fiber content (%)	27.7^{a}	29.1^{b}	32.3^{c}	34.1^{d}

B0 = Monoculture *Brachiaria humidicola* grass; B2= (*Brachiaria humidicola* + Kudzu);
B1= (*Brachiaria humidicola* + Centro); B3= (*Brachiaria humidicola* + Calopo);
Letter of the same row with differet letter of its superscripts indicate significant different at probability of 0.05

A. Dry Matter yield of Forage

The production of grass dry matter on the monoculture of *Brachiaria humidicola* grasses showed the highest yield compared to grass yield in mixed crops with legumes, but the total production of forage grass and legumes on mixed cropping treatment showed higher yield than monoculture. In the mixture of grass and legumes there is competition of nutrients, living space, sunlight and water between grass and legumes so that grass production on grass monoculture is higher, but overall, total forage production in mixed crops is higher than monoculture of grass. This proves that mixed crops can increase land productivity. The results of this study are in accordance with the opinion of Indriani et al (2015) which states that cropping patterns can increase the productivity of agricultural land if the types of plants combined in this system do not compete with each other in terms of living space, sunlight, water retrieval, and nutrients . The results of this study also in accordance with the opinion of Mansyur et al (2005) that one of the advantages of mixed planting system that is to increase the productivity of land per unit area and forage production in planting a mixture higher than monoculture.

Legum Kudzu produces the highest dry matter production compared to the Centro and Calopo legumes because morphologically, Kudzu has wider leaf area than the Centro and Calopo leaf area. Kudzu has a leaf length of 5 -12 cm and a width of 2-11 cm, Calopo, 4 -10 cm and 2-5 cm, and Centro, 1.5-7 cm and 0.6-4.5 cm (Bogdan, 1977; Skerman and Riveros, 1990).

B. Crude Protein Content of Grass

Protein content of forage grasses showed a significantly different effect. Protein content of forage from grass plants grown in mixed with legume is higher than that of grasses monoculture. This is because legum symbiosis with rhizobium is able to fix the nitrogen from the air, so in mixed cropping, grass plants get additional nitrogen from the result of rhizobium fixation so that the grass protein content of the grass increases. This result is supported by the statement of Sanchez (1993) and Sturludottir et.al (2012), which states that the role of leguminosa in mixed cropping with grass is to provide additional nitrogen to the grass and to thoroughly refine the pasture, especially its protein content.

The cultivation of *Brachiaria humidicola* grass with Centro legume showed the highest proportion of crude protein than the crude protein content of grass forage on mixed cropping with Kudzu and Calopo legumes, as well as forage grasses planted by monocultures. This is due to the production of dry grass forage materials grown with fewer Centro legumes ie 150 g on average compared to forage production grown with Kudzu legumes, on average 198 g and Calopo 213 g, resulting in nitrogen fixation on grass treatment with Centro used by fewer grass plants compared to grass plants on mixed cropping treatment with Kudzu and Calopo, which causes the crude protein content of grass treatment with the highest Centro legume.

Belanger et al. (2001) cited by sturludottir et al. (2012) that the herbage nutritive value of forage grasses and legumes is negatively related to dry matter accumulation. Hence, increase in herbage dry matter yield is expected to result in decrease in nutritive value.

C. Crude Fiber Content

The crude fiber content of grass in a mix cropping is lower than that of grasses monoculture. This is because mix cropping grasses have higher nitrogen, which affects grass growth and a higher grass protein content of the grass, which is part of the cell content. If the cell content increases then the cell wall will decrease, the cell wall is part of the crude fiber. So if the cell wall decreases then the crude fiber content will also decrease.

The crude fiber content of mix cropping grasses with Centro legume is smaller than the crude fiber content of grass forage in mix cropping with Kudzu and Calopo legumes, as well as forage grasses grown in monocultures. This is due to the forage grass planted with Centro legume, the contents of the plant cells more than the contents of the cells on the grass plantation grown by monoculture or grass planted with Kudzu and Calopo legumes. This data is supported by the crude protein content of grass grown with Centro showing the highest value. The higher the content of plant cell contents, the cell wall content of plants that is reflected from the content of crude fiber has decreased.

IV. CONCLUSION

Mix cropping legumes Centro, Kudzu and Kalopo with *Brachiaria humidicola* grass, increased dry matter yield of total forage, increased crude protein content of grass and decreased crude fiber content of grass. The highest yield of the highest drying material was obtained in mixed cropping between *Brachiaria humidicola* grass and kudzu legume, while the highest content of the grass protein and the lowest crude fiber was obtained in the treatment with mixed cropping between grass and Centro.

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REFERENCES

[1] AOAC. 2005. *Official Methods of Analysis. Association of Official Analytical Chemists*. Benjamin Franklin Station, Washington.

[2] Bogdan, A.V. 1977. Tropical Pasture and Fodder Plants. Longman,

[3] London and New York.

[4] Halbleib, CM. and P.W. Ludden. 2000. Regulatin of Biological Nitrogen Fixation. Journal of Nutrition. 130:1081-1084.

[5] Harun Djuned. (1986). Evaluation on The Effects of Grazing and Harvest Management on Forage Yield and Distribution, Forage Quality and Animal Performance on Pasture. Dissertation. University of Wisconsin-Madison.

[6] Herryawan, K.M. 2009. Pengaruh Leguminosa dan Fungi Mikoriza Arbuskula (FMA) terhadap Produktivitas Rumput Benggala (*Panicum maximum* Jacq.) yang Ditanam pada Tanah Marjinal. Disertasi. Pascasarjana Universitas Padjadjaran, Bandung.

[7] Iin Susilawati. 2005. Pengaruh Berbagai Tingkat Campuran Leguminosa Siratro (*Macroptilium atropurpureum*) terhadap Pertumbuhan, Hasil dan Kandungan Protein Hijauan Rumput Raja (*Pennisetum purpuphoides),* Benggala (*Panicum maximum*)*,* dan Setaria (*Setaria sphacelata*). Tesis. Universitas Padjadjaran, Bandung.

[8] Iin Susilawati. 2011. Peningkatan Hasil dan Kualitas Pakan Hijauan Melalui Pemupukan Molibdenum pada Pertanaman Campuran Rumput dan Legum. Disertasi. Universitas Padjadjaran, bandung.

[9] Indriani, N.P., Y.Yuwariah, A. Rochana, H. Djuned. 2015. Effect of Intercropping between Corn (*Zea mays*) and Peanut (*Arachis hypogea*) with Arbuscular Mycorrhizal (AMF) on Yield and Forage Mineral Content. Pak. J. Nutrition. 14(6):362-365.

[10] Mansyur, N.P. Indriani, I, Susilawati. 2005. Peranan leguminosa Tanaman Penutup pada Sistem Pertanaman Jagung Manis untuk Penyediaan Hijauan Pakan. Prosiding Nasional Teknologi Peternakan dan Veteriner. Pusat Penelitian dan Pengembangan Peternakan. 879-885.

[11] Peoples, M.B. and E.T. Craswell. 1992. Biological Nitrogen Fixation: Investments, Expectations and Actual Contributions to Agriculture. Plant and Soil. 141: 13-39.

[12] Reksohadiprodjo, S. 1994. *Produksi Tanaman Hijauan Makanan Ternak Tropik*. Bagian Penerbitan Fakultas Ekonomi, Universitas Gajah Mada, Yogyakarta. 85-94; 148-173.

[13] Sanchez, P.A. 1993. Sifat dan Pengelolaan Tanah Tropika 2. Terjemahan Amir Hamzah. ITB, Bandung.

[14] Skerman, P. J. and F. Riveros. 1990. Tropical Grasses. FAO, Rome. 331-340; 103-120.

[15] Sturludottir, E., C. Brophyt, G. Belanger, A.M. Gustavsson, M. Jorgensen, T. Lunnan and A. Helgadottir. 2012. Benefit of Mixing Grasses and Legumes for Herbage Yield and Nutritive Value in Nothern Europe and Canada.

D.5

RESPONSE OF SEVERAL SOYBEAN VARIETIES ON ACID DRY LAND IN GUNUNG GEULIS BOGOR

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ABSTRACT

The Government of Indonesia is targeting self-sufficiency of 3 million tons soybeans in 2018. To support the program requires new land area of 2 million ha in 2025 and additional dry land of 8.7 million ha in 2045. In order to realize self-sufficiency of soybean, it is necessary to expand agricultural land on suboptimal land (acid dry land) of 108.77 million ha which has not been optimized. Environmental components determine the productivity of soybeans in Indonesia is climate factors and soil fertility (physical characteristics, biology, soil chemistry including soil acidity). Use the adaptive varieties of soybean and supported by appropriate cultivation technology is expected to increase productivity of soybean per unit area in acid dry land. This study aims to find out the best response of Indonesian soybean plants through the use of new adaptive varieties. The research was conducted at Erpour Farm Gunung Geulis, Bogor from April to July 2017. The varieties tested is Argomulyo, Anjasmoro, Demas 1, Detam 1, Devon 1, and Dena 1. Soil cultivation and plant maintenance which has been optimized. The highest productivity was obtained in Demas 1 variety with 55.06 g/plant while the lowest was in Argomulyo varieties with 36.50 g/plant. The highest percentage grows on varieties of soybean crop is Demas 1 amount of 82.50%, while the percentage grows the lowest is Dena 1 varieties with 7.50%. The conclusion is plants grow optimally with the best response is Demas 1. The suggestion for next research is using Demas 1 for planting in acid dry land.

Keywords : Soybean Indonesia, acid dry land, superior varieties

I. INTRODUCTION

The average growth of imported soybeans in 2015 was relatively high at 6.42 million tons. The amount of soybean export volume is very small compared to its imports, because domestic soybean production is only able to meet domestic demand of not more than 25% and the shortage must be imported so that the domestic soybean requirement is fulfilled. The Govermment of Indonesia is targeting self-sufficiency of 3 million tons soybeans in 2018. To support the program requires new land area of 2 million ha in 2025 and additional dry land of 8.7 million ha in 2045. Therefore, to meet the target should be increased production of soybeans. Increased production of soybeans from quantity and quality to be pursued by the government is intensification and extensification. Intensification can be done with the use of appropriate technology so as to increase production of soybean on already available land. While extensification can be done with the extension or addition of land that has not been utilized optimally [1]-[3],[10].

Extensification of Agricultural is confronted with the limitations of fertile land, Therefore since the last few years the development of agriculture leads to sub optimal land that is the land is naturally or due to the degradation process has a low level of fertility (both physical, chemical and or biological) that can not support growth optimally. Land that is classified as sub optimal land among others is swamp land (peat, tidal, lebak) acid dry land and dry land dry climate. One of the sub optimal subdivisions that are potential to be developed is acid dry land. Acid dry land available in Indonesia amounted to 108.77 million ha of total dry land area 122.05 million ha [4].

Although acid dry land has a better potential than other land, But has constraints that must be borne if the agricultural production system wants to run efficiently and sustainably. The main characteristic of cid dry land is Soil pH classified as acid (<5.5), Al content is high, causing high P fixation to become unavailable to the plant, The content of bases can be exchange and CEC is also low, Iron and manganese contents close to poison boundaries, And low biotic elements. To overcome this it can be done with the use of adaptive agricultural cultivation technology and adaptive of superior varieties. Various varieties adaptive have been produced by Balitkabi Malang. This adaptive superior variety also has different responses with positive and negative responses to plant growing environments. The response can be known from the phenotypic and physiological changes of the plant [5]-[6].

II. MATERIALS AND METHODS

The research material consists of 6 soybean varieties is Argomulyo, Anjasmoro, Demas 1, Detam 1, Dena 1 and Devon 1. The location experiment in Erpour Farm Gunung Geulis, Bogor and implemented in April to Juli 2017. The plot size was 70 x 200 cm, 50 cm x 30 cm plant distance and two plants/hill. Fertilizer of 25 kg/ha Urea, 300 kg/ha SP 36, 150 kg/ha KCl, 2000 kg/ha dolomite, and 5000 kg/ha chicken manure. Soil processing and cultivation of irrigation, weeding and pest control are done optimally. The method used is a single plant method with t-test. The parameter measured on plant hight, number of leaves, days to flowering, days to maturity, number of pods, number of filled pod, number of empety pod, 100 seed weight, and productivity.

Table 1 shows that the soil is extremely acid (pH 4.3). Therefore it is necessary to adopt appropriate agricultural technology and superior varieties adaptive to soil acidity.

Table 1. Soil Analysis in Erpour Farm Gunung Geulis

Description	pH H_2O	P_2O_5	Concentration	
		Bray I (ppm)	Al-dd	H-dd
Value	4.30	9,43	1.35	0.45

III. RESULTS AND DISCUSSION

A. Independent t-test Analysis

Independent t-test analysis data for measured parameters can be seen in table 2. Observation parameters measured as plant height, number of pods, number of pods indicated a significant difference between Demas 1 varieties of other varieties. As for the parameter the number of leaves and number of empty pods no significant difference between Demas 1 varieties with Argomulyo but for other varieties there is a significant difference. The response of plants to acid soils is influenced by soybean varieties [7].

Table 2. Mean of Independent t-test Analysis

Parameter	V3	Comparasion Varieties				
		V1	V2	V4	V5	V6
Plant Height	18.24	13.71*	16.67*	16.00*	14.25*	14.00*
Number of leaves	14.24	14.00	12.67*	10.60*	12.00*	11.20*
Total pod	46.00	15.75*	23.27*	22.50*	19.50*	25.33*
Filled pod	38.42	10.00*	14.00*	15.25*	12.75*	17.33*
Empty pod	7.58	5.75	9.27*	10.25*	4.25*	8.00
Productivity	55.06	36.50*	40.09*	38.00*	39.25*	39.33*

Note: V1 = Argomulyo 1, V2 = Anjasmoro, V3 = Demas 1, V4 = Detam 1, V5 = Devon 1, V6 = Dena 1, * = significant at p = 0.05.

B. Percentage grows

Based on table 3. Show the highest percentage grows on varieties of soybean crop is Demas 1, While the lowest plant growth was dena 1 with 7.50%. This is because the varieties of demas 1 are one of the adaptive varieties on acid dry land. Demas 1 was released by ILETRI Malang in 2014. The main feature of acid soils is low soil pH (pH <6), and generally high Al content. The presence of excessive Al in acid soil causes the growth of soybean crops disturbed and result in low yield. In acid soils, minerals Mn, Al, and Fe are excessively available, it can be poisonous to plants (Taufiq et.al 2012). Of several parameters measured showed that soybean crop varieties of Demas 1 had the best value compared to other varieties, so demas 1 is a variety that is adaptive and suitable for acid soils.

Table 3. Mean of Percentage grows in acid dry Land

Varieties	Percentage grows (%)
Argomulyo	10.00
Anjasmoro	27.50
Demas 1	82.50
Detam 1	10.00
Devon 1	10.00
Dena 1	7.50

C. Plant height and number of leaves

Plant height for the highest is Demas 1 with 18,24 cm, while the lowest in the Dena 1 variety. The highest number of leaves on soybean variety is Demas with 14.24 leaves and the lowest value is Detam 1 variety with 10.60 leaves. Decreasing in soil pH tends to increase plant height. (Adie et. al 2015) [8].

Table 4. Mean of Plant height and number of leaves

Varieties	Plant Height (cm)	Number of Leaves
Argomulyo	13.71	14.00
Anjasmoro	16.67	12.67
Demas 1	18.24	14.24
Detam 1	16.00	10.60
Devon 1	14.25	12.00
Dena 1	14.00	11.20

D. Days to Flowering and Days to Maturity

Table 5 shows the fastest flowering plant is the Detam 1 variety, while the longest flowering is Devon 1 and Dena 1 varieties. Soybean maturity in Indonesia is also very mature, ranging between 75-95 days, while soybeans in subtropical regions reach 150-160 days. In this study, mature age was found between 77-84 days. Soybean varieties adapted to acid soil which have been released in Indonesia, have days to maturity over 85 days (Iletri 2016) [9], [11].

Table 5. Mean of Days to flowering and days to maturity

Varieties	Days to flowering (days)	Days to maturity (days)
Argomulyo	38	77
Anjasmoro	38	77
Demas 1	38	77
Detam 1	33	77
Devon 1	40	77
Dena 1	40	84

E. Number of Pods and Number of filled pod

Based on Table 6 shows the highest number of pods in the soybean cropis Demas 1 variety and the lowest is Argomulyo variety. The highest number of pods contained in soybean crop is Demas 1 and lowest is Argomulyo varieties. Phosphorus is a major component of the nucleoprotein, nucleotide, phospholipids, enzymes that play an active role in energy transport. Phosphorus is also important in the process of phosphorylation, photosynthesis, respiration, synthesis, and decomposition of carbohydrates, proteins, and fats. Element P is indispensable for seed formation. Poisoning P generally occurs on acid soils that have high Fe, Al content due to fixation. Poisoning P make inhibits the formation of root nodules, root development, pods and seeds. The adequate availability of P in the soil will increase number of pods per plant. Addition of phosphate as much as 60 g / plot can produce number of pods as much as 134,80 pod/plant [6],[12].

Table 6. Mean of number of pods and number of filled pod

Varieties	Number of pods	Number of filled pod	Number of empty pod
Argomulyo	15.75	10.00	5.75
Anjasmoro	23.27	14.00	9.27
Demas 1	46.00	38.42	7.58
Detam 1	22.50	15.25	10.25
Devon 1	19.50	12.75	4.25
Dena 1	25.33	17.33	8.00

F. Productivity and 100 seed weight

Table 7. Productivity and 100 seed weight

Varieties	100 weight seed (g)	Productivity (g/plant)
Argomulyo	16.11	36.50
Anjasmoro	17.65	40.09
Demas 1	14,88	55.06
Detam 1	15.57	38.00
Devon 1	16.43	39.25
Dena 1	13.34	39.33

Table 7 shows the highest productivity was obtained in Demas 1 variety with 55.06 g/plant while the lowest was in Argomulyo varieties with 36.50 g/plant. Weight for the highest 100 seeds was obtained on Anjasmoro varieties 17.65 g and the lowest of Dena 1 varieties with 13.34 g. Varieties that are adaptive to acid soil and use of appropriate technology will grow optimally so this will increase productivity. Genotype G4AB was considered as adaptive to acid soil and as well as productive to be developed in acid soil with 2.36 t/ha. (Adie et.al 2015).

IV. CONCLUSION

Demas 1 is a variety has the best response to the cultivation of soybean crops in acid dry land.

NOMENCLATURE

Concentration me Al/100

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REFERENCES

[1] N. Rusono, A. Suanri, A. Candradijaya, A. Muharam, I. Martino, Tejaningsih, P. U. Hadi, S. H. Susilowati, M. Maulana, *Rencana Pembangunan Jangka Menengah Nasional (RPJM) Bidang Pangan Dan Pertanian 2015-2019*, Jakarta Pusat, Indonesia : Direktorat Pangan dan Pertanian, Bappenas, 2013.

[2] M. Syakir, D. Nursyamsi, *Kebijakan Pemerintah Dalam Pengembangan Lahan Sub Optimal Secara Produktif, Inklusif, dan Ekologis*, Jakarta Selatan, Indonesia : Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian, 2015.

[3] B. Lakitan, N. Gofar,"*Kebijakan Inovasi Teknologi untuk Pengelolaan Lahan Suboptimal Berkelanjutan*," pada Seminar Nasional Lahan Suboptimal, Palembang 20-21 September 2013.

[4] K. Murtilaksono, S. Anwar, "*Potensi, Kendala, dan Strategi Pemanfaatan Lahan Kering dan Kering Masam untuk Pertanian (Padi, Jagung, Kedele), Peternakan, dan Perkebunan dengan Menggunakan Teknologi Tepat Guna dan Spesifikasi Lokasi*," pada Seminar Nasional Lahan Suboptimal, Palembang 26-27 September 2014.

[5] S. Rochayati, A. Dariah,"*Prospek Pertanian Lahan Kering dalam Mendukung Ketahanan Pangan,*"Jakarta Selatan, Indonesia : Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian, 2013.

[6] A. Taufiq, T. Sundari,"*Respons Tanaman Kedelai Terhadap Lingkungan Tumbuh*," diterbitkan di Buletin Palawija No. 23: 13-26, 2012.

[7] W. Sujarweni,"*SPSS untuk Penelitian*,"Bantul Yogyakarta, Indonesia : Pustaka Baru Press, 2015.

[8] M. Adie, A. Krisnawati,"*Identification of Soybean Genotypes Adaptive and Productive to Acid Soil Agro-Ecosystem,*"ISSN: 1412-033X, vol. 17, pp. 565-570, October. 2016.

[9] Balai Penelitian Tanaman Aneka Kacang dan Umbi,"*Deskripsi Varietas Unggul Aneka Kacang dan Umbi*,"Malang, Indonesia : Balai Penelitian Aneka Kacang dan Umbi, 2016.

[10] L. Nuryati, B. Waryanto, R. Widaningsih,"Outlook Komoditas Pertanian Tanaman Pangan Kedelai, Jakarta, Indonesia: Pusat Data dan Sistem Informasi Pertanian Kementerian Pertanian, 2016.

[11] (2017) Balitkabi website. [Online]. Pada: http://balitkabi.litbang.pertanian.go.id/wp-content/uploads/2016/03/dele_4.sumarno-1.pdf

[12] D. Jayasumarta,"Pengaruh Sistem Olah Tanah dan Pupuk P Terhadap Pertumbuhan dan Produksi Tanaman Kedelai (Glycine max L. Merril)," Agrium, vol. 17, no.3, Okt. 2012.

D.6

NITROGEN, PHOSPHOR AND CALCIUM UPTAKE ON PADJADJARAN CORN HYBRID AS FEED FORAGE INTERCROPPED WITH SOY BEAN

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ABSTRACT

A study on Padjadjaran Hybrid Corn planted in intercropping needed to be developed for the farming sustainability in Arjasari Village, Arjasari Subdistrict, Bandung Regency. The intercropping system provided benefits in the utilization of environmental factors (water, nutrients and light). Nutrient uptake of macro nutrients such as N, P and Ca was needed by corn crops for productivity, growth, yield and quality of feed forage. Research on Absorption of Nitrogen, Phosphorus and Calcium of Padjadjaran corn Hybrids as Feed Forage Cultivated by Intercropping with Soybean Crops was conducted in October 2015 until January 2016. The objective of the research was to know and to compare the potential of some Padjadjaran corn Hybrid as a feed forage against N , P and Ca uptake. Corn crops was grown with intercropping system with soybean crops for 22 Padjadjaran Hybrid corn plants as treatment with 2 times replication. The method used was an experimental method with Completely Randomized Design (RAL). The results showed that N, P and Ca uptake were the same for 22 Padjadjaran Hybrid Corn plants.

Keywords : Padjadjaran hybrid, feed forage, nitrogen, phosphorus, calcium, intercropping.

I. INTRODUCTION

Corn is one of the most important foods and animal feed source in Indonesia. Corn Seed can be used as poultry feed or as concentrate for ruminants. In addition to corn seeds, the harvested corn forage can also be used for ruminants, which can be given directly or preserved by fermentation. The role of corn plant as an animal feed is very important, and then the production of maize required to be increased as an effort to meet the animal feed needs and the market demand. The efforts to improve maize productivity include the developing of the high product adaptive varieties or superior cultivars under certain environmental conditions by plant breeding methods, which generally use several crossover methods of available cross source. According to Abdelmoneim (2014), that corn plants have genetic properties with great diversity and superior in adaption to the environment. Corn plants are highly dependent on genetic, environmental and management factors. Genetic factors are highly determined by genes in the genotype of maize. The ratio of genetic variation with phenotypic variety reflects the heritability. Plant quality is the end product of the mature plants. In the selecting of the genotypes of maize on the phenotypic performance basis was influenced by the variety of environment.

Feed forage as basic requirements of livestock, especially ruminant needed in large quantities. The farming systems in the local area are greatly determine the availability of feed forage. A number of feed plants have a low value of benefits so need for efforts that can increase the benefit value. According to Yuyun (2011), Intercropping is planting of two or more plants simultaneously on the same plot of land. In intercropping patterns the competitions between plants can occur during two phases of growth, or only in part of the growth phase. Indriani (2013) states that one of the commonly intercropping is corn crop cultivated by farmers with Legumes. The results of forage crops and legumes can be used for ruminants with the high content of crude fiber and crude protein that can increase livestock productivity and it is important feed forage when the grass is difficult to obtain especially during the dry season.

The intercropping pattern system has a significant effect on the dry weight of forage where the dry weight increase compared to the single planting pattern of maize plant or leguminous plant only, other sides it can change the pattern of forage distribution. This is related to the more consumption of natural resources such as the active radiation of photosynthesis and the soil moisture in the intercropping pattern. The quality of forage crops of crude protein content increased in intercropping pattern, this is because of more nitrogen is available for maize crops in the intercropping system than on a single cropping pattern (Eskandari et al., 2009).

Nitrogen is macro nutrient that is easily lost due to continuous washing during the rainy season, evaporation and transport of crops. Soya beans (leguminous) is one of the ways to overcome the lack of nitrogen when intercropped with corn crops. Corn and soybean crops are very suitable and possible to be planted and intercropped because soybean plants is a C3 plants, and corn crops belonging to C4 plants. Corn crops are well adapted against growth and production limiting factors, higher photosynthetic rates, efficient in water use, low photorespiration and transpiration and plant height of maize crops between 100-300 cm (Falah, 2009). Soya bean plants have root nodules that can catch free nitrogen with the help of highly beneficial rhizobium bacteria, then the nitrogen in the soil is accumulated and then increase the nitrogen content for plant growth. Plants absorbing nitrogen can be in the form of NH4 + or NO3-. The nutrient P element is absorbed by plants in the form of primary orthophosphate (H2PO4-) and a small part in the form of secondary orthophosphate (HPO4-) (Havlin et al., 2005: Barker and Pilbeam, 2007). The higher the nitrogen uptake in plants, the more effective in absorbing phosphorus so that the dry weight of the plant also increases. According Resh (2004) plants absorb calcium in the form of Ca ++. High calcium absorption is indispensable to the plant as it is useful as a booster for cell walls, assisting in the cleavage of plant cells and activating some enzymes and preventing the occurrence of physiological disturbances (cracked) in the plant body. The purpose of this research is to know and to compare the potency of some kinds of Padjadjaran hybrid corn as feed forage on N, P and Ca uptake which is planted with soya bean as intercropping system.

II. MATERIALS AND METHODS

Research on Padjadjaran Hybrid Corn crops as forage are planted with soybean plant in the village of Arjasari, Arjasari subdistrict, Bandung district has been carried out in October 2016 to January 2017. Arjasari village located on a plateau with an altitude of 900 meters above Sea level. The materials used in the research are hybrid corn plant of 124 genotypes, basic fertilizer N, P and K and fertilizer. Tools used for field installations, oven cabinets for forage materials, and a set of tools for proximate analysis. Chemical analysis was carried out in the Laboratory of Plant Feed and Nutrition Laboratory Ruminant Livestock Livestock and Feed Chemistry Faculty of Animal Husbandry, Padjadjaran University. Maize Hybrids Padjadjaran planted were 124 genotype, then taken 22 genotypes of the largest dry weight and subsequently used as research data, genotype name: 8x11, 3x8, 1x8, 7x14, 11x12, 9x13, 9x11, 7x10, 6x10, 4x13, 11x14, 10x15, 5x10, 2x12, 3x15, 13x15, 8x14, 8x15, 5x12, 7x8, 6x11, 10x14. Based on Duncan multiple distance test for varied input dry weight resulted dry materials not significantly different. Planting maize crops distance 75x25 cm grown intercropping with soybean crops. Padjadjaran Hybrid Corn Plant Genotype as Treatment is 22 corn genotypes and 2 times replications . Variables measured are the absorption of nitrogen, phosphorus uptake and absorption of calcium resulting from the multiplication of each nitrogen content, phosphorus and calcium with Dry Material forage maize crops. Padjadjaran Hybrid Corn Plant is harvested at the age of 70 days. The data obtained from the research results were analyzed using the experimental method. The design used was Completely Randomized Design (RAL) with a factorial pattern of 22 treatments and repeated twice. The data were then analyzed by variant analysis. To know the average difference in each treatment, it is performed by Duncan's multiple-range test.

III. RESULTS AND DISCUSSION

New varieties requirements must have better properties that can be accepted by producers and consumers as they can add the value. It can be obtained through selection of specific populations. The results of treatment of all genotypes Padjadjaran Hybrid Corn plants where 22 genotypes were planted with soy bean plants were not significantly different for the nitrogen uptake, phosphorus uptake and absorption of calcium. Dry matter of Padjadjaran Hybrid Corn plant were recorded for 124 genotypes, then selected for 22 genotypes with the largest dry matter weight. Although the the dry weight was varied among the 22 maize genotypes, Duncan's multiple range test gave similar or not significant results. Nitrogen uptake in Hybrid Corn Plant Padjadjaran for all genotypes (22 genotypes) are the same or not significantly different. Dry matter can determine the quality content of forage corn crops, especially forage nutrients. This is in accordance with Mengel's opinion, et. Al. (2001) the nitrogen uptake in plants is closely related and is directly proportional to the dry matter of the crop. Increased nitrogen uptake can improve root development to enhance the ability of plant roots to absorb nutrients in the air and the nitrogen in the soil, thereby improving plant growth and plant dry matter.

Rhizobium present in soybean crops contributes to increase the nitrogen in the soil, so the soil becomes fertile. Furthermore, according to Hasanudin (2003), plants absorb nitrogenous nutrients in accordance with soil nitrogen conditions. Increased soil nitrogen element strongly supports the growing of the root of the better root, so the plant can absorb nitogen better, because of the nitrogen soil is available for the plant.

Phosphorus uptake of the 22 genotypes of Padjadjaran Hybrids gave the same or no significant difference. Phosphorus availability greatly determines the phosphorus uptake by plants. The higher the p available in the soil, the higher the absorption of P by the plant, thereby increasing the P concentration in the plant tissue. This is in accordance with Rochana et.al. (2016), that phosphorus is closely related to crop production and plant dry weight.

The dry matter content results are similar and then the phosphorus uptake are also the same or not significantly different.

Calcium uptake in 22 Corn Plant genotypes gave no significant difference. Calcium content in the soil is one of the factors that determines the pH of the soil, because Ca2 + ions occupy an exchange area in soil minerals and act as a buffer system, and pH is associated with nutrient supply, as a result, other nutrients also become available such as nitrogen and phosphorus Purbajanti et.al., (2010).

The Arjasari village, Arjasari subdistrict, Bandung regency is a plateau area of 900 meters above sea level, it can improve the quality of forage of corn plants such as nitrogen uptake, phosphorus and calcium uptake, then the absorption results are not significantly different. The same plant age for all treatments is 70 days when harvested, resulting in nitrogen absorption, phosphorus and calcium are not significantly different. This is in accordance with Alexandrova and Donov (2003), that Nitrogen content or uptake of maize plant remains constant after flowering age. Phosphorus uptake is also determined by the uptake of plant nitrogen. Full results on the uptake of nitrogen, phosphorus and calcium can be seen in Table 1.

Tabel 1. Local Genotype of Maize as Feed Forage on N uptake, P uptake and Ca uptake at Arjasari Village, Arjasari Subdistrict, Bandung Regency

Genotype (Treatment)	N Uptake (g/plant)	Ca Uptake (g/plant)	P Uptake (g/plant)
8 x 11	268,08 a	47,53 a	29,70 a
10 x14	149,04 a	19,88 a	7,48 a
1 x 8	246,86 a	39,24 a	21,52 a
7 x 14	177,45 a	25,84 a	16,63 a
11 x 12	181,42 a	36,65 a	17,79 a
9 x 13	132,51 a	22,33 a	12,87 a
9 x 11	245,73 a	40,73 a	24,55 a
7 x 10	176,47 a	33,25 a	18,13 a
6 x 10	271,76 a	43,95 a	22,52 a
4 x 13	229,39 a	43,48 a	22,68 a
11 x 14	229,98 a	41,96 a	21,97 a
10 x 15	248,56 a	47,70 a	23,87 a
5 x 10	217,05 a	34,67 a	18,60 a
2 x 12	243,12 a	46,16 a	21,14 a
3 x 15	267,75 a	49,81 a	25,12 a
13 x 15	221,78 a	40,00 a	20,44 a
8 x 14	228,79 a	43,87 a	17,87 a
8 x 15	211,91 a	35,64 a	15,57 a
5 x 12	162,21 a	27,10 a	11,49 a
7 x 8	214,65 a	36,59 a	16,13 a
6 x 11	199,24 a	34,22 a	11,96 a
3 x 8	168,33 a	26,77 a	17,91 a

IV. CONCLUSION

A. Conclusion

The uptake of N, P, and Ca on Padjadjaran Hybrid Corn plant for all 22 genotypes grown intercropping with soybean crops, showed similar results.

B. Suggestion

The results of the forage study of the Padjadjaran Hybrid Corn genotype can be applied as feed for ruminants from nutrient uptake of Nitrogen (N), Phosphorus (P) and Calcium (Ca).

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REFERENCES

Abdelmoneim, T.S., T.A.A. Moussa, O.A. Almaghrabi, H.S. Alzahrani and I.Abdelbagi. 2014. Increasing plant tolerance of drought stress by inoculation with Arbuscular Mycorrhizal Fungi. Life Science Journal 11(1): 10-17.

Alexandrova, P. and D. Donov. 2003. Nitrogen Content and its Uptake by Maize as Influenced by Some Meteorological Elements and Fertilization. Int. Agro physics. 17:41-45

Almaghrabi, H.S. Alzahrani and I.Abdelbagi. 2014. Increasing plant tolerance of drought stress by inoculation with Arbuscular Mycorrhizal Fungi. Life Science Journal 11(1): 10-17.

Barker, A.V. and D.J. Pilbean. 2007. Hand Book of Plant Nutrition.CRC.Press. New York.

Eskandari, H., Ghanbari, and Ahmad. 2009. Intercropping of maize (*Zea mays*) and cowpea (*Vigna sinensis*) as whole-crop forage. Notulae Botanical Horti- Agrobotanic Cluj-Napaca. 37(2):152-155.

Falah, R.N. 2009. Budidaya Jagung Semi. Balai Besar Pelatihan Pertanian Lembang. Bandung.

Hasanudin. 2003. Peningkatan ketersediaan dan serapan N dan P serta hasil tanaman jagung melalui inokulasi Mikoriza, Azotobakter dan Bahan Organik pada Ultisol. Jurnal Ilmu-Ilmu Pertanian Indonesia 5(2): 83-89.

Havlin, J.L., J.D. Beaton, S.L.Tisdale, and W.L.Nelson.2005. Soil Fertility and Fertilizer. An Introduction to Nutrient Management. Seventh Edition Pearson Education Inc.Upper. Saddle River. New Jersey.

Indriani, N.P. 2013. Pertumbuhan dan Hasil serta Kualitas Pakan Hijauan yang Dihasilkan dari Tumpangsari Sistem Baris antara Tanaman Jagung (*Zea mays*) Penghasil Jagung Semi dan Kacang Tanah (*Arachis hypogaea*) yang Diinokulasi Fungi Mikoriza Arbuskula (FMA) {Disertasi}.Program Pascasarjana. Universitas Padjadjaran. Bandung.

Mengel, K., E.A.Kirkby, H.Kosegarten and T.Appel. 2001. Principles of Plant Nutrition. 5th Ed. Kluwer Academic Publ. London

Purbajanti, E.D., R.D.Soetrisno, E. Hanudin dan S.P.S, Budhi. 2010. Penampilan fisiologi dan hasil rumput benggala (Panicum maximum Jacq.) pada tanah salin akibat pemberian pupuk kandang, gypsum dan sumber nitrogen. Jurnal Ilmu-Ilmu Pertanian. Indonesia (JIPI). 12(1):61-67.

Resh, H. 2004. Hydroponic Food Production 6th Edition. New Jersey. New Concept.p53

Rochana, A., N.P.Indriani, B.Ayuningsih, I.Hernaman, T.Dhalika, D.Rahmat, and S Suryanah. 2016. Feed forage and nutrition value at altitudes during the dry season in West Java. Journal Animal Production.18(2):85-93.

Yuyun, Y. 2011. Dasar-Dasar Sistem Tanam Ganda. Jurusan Budidaya Pertanian Fakultas Pertaniaan Universitas Padjadjaran. Bandung.

D.7

THE SELECTION OF LOCAL GENETIC SOURCE RICE POPULATION DIFFERENTIATED BY THEIR GENETIC MARKERS IN LOWLAND AND UPLAND ORGANIC ENVIRONMENT

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ABSTRACT

In resolving the global decrease of water supply, the selection of rice population ought to be accomplished in lowland as well as upland environment. The rice population was selected from local genetic source (LGS) in Lampung, Indonesia in order to revive rice lines which have been marked obsolete along the way of the Green Revolution since 1960. The lines were differentiated by their expressed quantitative trait loci (QTL) as genetic marker responsible for increasing seed production. The study accomplished in a Randomized Complete-Block Design with three replicates in the Polytechnic Research Field, Bandar Lampung using the 4 LGS-QTL lines; and the best 3 upland-introduction lines and 2 National lines as control. Data analyses included: population performances, anova mean squares which will continue on to ranking of varieties and calculating of genetic variances, broad-sense heritabilities and coefficients of genetic variances; and correlations analysis among variables in determining effective strategies in cross-combining the rice lines. The results indicated that prospective lines of Local Genetic Source- Quantitative Trait Loci (LGS-QTL) lowland rice were PBBogor-Plant Height, Gendut-Grain Number, and Tewe-Grain Number having Milled-Dry Grain (MDG) yield > 6 t ha^{-1} to the extent of 1186.00, 766.70, and 1165.30 g m^{-2} equivalent to 11.86, 7.67, and 11.65 t ha^{-1}, respectively. The prospective lines LGS-QTL for upland rice were PBBogor-Plant Height, Gendut-Grain Number, and Kesit-Plant Height having MDG yield > 4 t ha^{-1} to the extent of 430.10, 448.50, and 432.20 g m^{-2} equivalent to 4.30, 44.85, and 4.32 t ha^{-1}, respectively. The LGS-QTL lines: PBBogor-Plant Height, Tewe-Grain Number, Gendut-Grain Number, Kesit-Plant Height and the National line Ciherang-Grain Number ranked the first in all populations were prominent to be parental lines to accumulate QTL. The lines PBBogor-Plant Height, Tewe-Grain Number, Gendut-Grain Number, and Kesit-Plant Height were prospective to be drafted to the Plant Variety Protection (PVP) Committee.

Keywords : plant breeding, rice, genetic marker, local genetic source, quantitative trait loci, upland rice, lowland rice, plant variety protection

I. INTRODUCTION

The rice germplasms in gene pool I had exhausted due to their excessive utilization since 1990 (Sanchez *et al*., 1993) affecting the efforts inasmuch that to increase rice production through breeding programs were hardly effective. Rice breeding programs using germplasms of the gene pool I had been since 1960 were marked with about 250 lowland rice varieties developed through hybridization followed by 6 – 9 generation of selfing, thus quality inbred rice varieties were developed (BB Padi, 2015). However, of the 250 varieties more than 90 % of them had been obsolete (Suprihatno *et al*., 2009). In Indonesia, during the period 2008 – 2016 only some 15 varieties grown by the farmers especially IR64, Ciherang, and Gilirang.

Most of the obsolete varieties were out listed from the gene pool I mostly because of their vulnerability to pests and diseases, decreasing supply of water, and consumer preference to ask for the better quality and taste of rice they consumed. If the obsolete varieties in fact were remained grown, generally was because of the varieties ensured *in situ* superiorities like short growing time, productivity in par with newer varieties, resistant to pests and diseases *in situ*, tolerant to drought, and had a good taste (Hikam *et al*., 2015). The farmers grew the obsolete varieties as local varieties rather faithfully due to their independence to seed market. The farmers' practice to grow local rice varieties and produce own seed thereafter passing through man-made and natural selection for decades rewarded the seed to become LGS (local genetic source) germplasms (Hikam *et al*., 2014). The LGS germplasms were numerous in kind, number, and distribution which readily available to utilize as to replenish genetic sources in gene pool I (Hikam, 2013).

Rice breeding program started with phenotype difference which variabilities could be great. However, phenotypic selection was biased by environment where the rice population was grown and tested (Fehr, 1987; Hallauer *et al*., 2010). Rieseberg *et al*. (2003) and Hallauer *et al*. (2010) stated that qualitative gene action positively correlated with productivity would make genetic marker in which the phenotype performance was controlled by qualitative gene. More over, Rieseberg et al. (2003) indicated that QTL (*quantitative trait loci*) analyses proofed the existence of gene in controlling genetic marker expression. Some key QTL-controlled genetic markers utilized in the study were tolerance to drought (Prince *et al*., 2015), having great number of productive tillers (Bian *et al*., 2013; Hussein *et al*., 2014), and having great number of spikelet (Koide *et al*., 2013) and superiority in grain characteristics (Hagiwara *et al*., 2006).

To select for the rice lines tolerance to drought became the main objective in this study. Hikam *et al*. (2015) collected 27 entries consisted of nine local varieties differentiated into three distinct classes based on QTL and tested on five locations to evaluate the QTL expression. The tests were accomplished in lowland environment and four LGS-QTL lines PBBogor-Plant Height, Tewe-Grain Number, Gendut-Grain Number, and Kesit-Plant Height were tested for their tolerance to drought on rainfed-upland environment. To test the lines for drought tolerance was in line with Bayer Crop Science which targeted non-GMO wheat traits to develop heat and drought tolerance new wheat varieties (Reuter, 2011). In the Philippines, the IRRI developed “climate change-ready rice” which included drought, flood, heat, cold, high salt and iron toxicity.

Our objective in the study was to evaluate the growth and yield performances of LGS-QTL lowland rice lines on an organic rainfed upland environment. On the accomplishment of the study we could determine the adaptability of the lines to much drier environment.

II. MATERIALS AND METHODS

The study was done on two contrasting environment, irrigated lowland and rainfed upland in the State Polytechnics of Lampung Test Field. The soil was of Red-Yellow Podsolic with pH 5.6. The study was done from April – August 2016 growing four LGS-QTL (Local Genetic Source-Quantitative Trait Loci) lines PBBogor-Plant Height, Tewe-Grain Number, Gendut-Grain Number, Kesit-Plant Height, two National lines Ciherang-Grain Number and IR64-Grain Number, and three introducing upland lines CSG1, CSG2, and CSG3. The National and introducing lines were control to the LGS-QTL lines.

The study accomplished in a Randomized Complete-Block Design with three replicates (Steel and Torrie, 1981). Data analyses included: population performances, anova mean squares which will continue on to ranking of varieties and calculating of genetic variances, broad-sense heritabilities and coefficients of genetic variances; and correlations analysis among variables in determining effective strategies in cross-combining the rice lines (Hallauer *et al*., 2010).

The plots for lowland and upland planting were fertilized with 400 kg urea, 150 kg SP-36, and 100 kg KCl ha^{-1} with additional 5 t ha^{-1} partly decomposed cow dung as organic amendment. The seeds were grown to seedlings for 21 days before transplanted to the lowland plots, while on the upland plots the seeds were planted directly. The planting distance was 25 cm X 25 cm resulted in a 160000 plants ha^{-1}.

Data were measured on variables plant height (cm), tiller number hill^{-1}, productive tiller number hill^{-1}, percent productive tiller number hill^{-1} (%), grain number spike^{-1}, spike weight hill^{-1} (g), total grain number hill^{-1}, total grain weight hill^{-1} (g), 100-grain weight (g), and milled-dry grain yield m^{-2} (g).

III. RESULTS AND DISCUSSION

A. *Performance Analysis*

Lines of lowland rice endured environmental stress when grown on organic upland and their performances decreased accordingly as shown in Table 1. The stress affected on eight of 10 variables: plant height, productive tiller number hill^{-1}, percent productive tiller number hill^{-1}, spike weight hill^{-1}, grain number hill^{-1}, grain weight hill^{-1}, 100-grain weight, and milled-dry grain (MDG) yield m^{-2}. The two variables not affected were tiller number hill^{-1} and grain number spike^{-1}. The resistance of the variables to water stress might indicate that the variables were controlled qualitatively (Fehr, 1987).

The seed yield decreased 45.8 % from 937.63 to 429.75 g m^{-2} when the lines were grown upland due to the decrease of grain number hill^{-1} and 100-grain weight affected by limited water supply (Hikam *et al*., 2016). The introduction lines CSG1, CSG2, and CSG3 employed as control responded similarly as tested lines on upland environment. Hence, the finding indicated that selection should advance to improve the adaptability of tested lines to upland environment.

More further, Table 1 revealed that LGS-QTL (Local Genetic Source-Quantitative Trait Loci) lowland rice lines prospective to draft to the PVP (Plant Variety Protection) Committee were PBBogor-Plant Height, Gendut-Grain Number, and Tewe-Grain Number having MDG yield > 6 t ha^{-1} as much as 1186.00, 766.70, and 1165.30 g m^{-2}

equivalent to 11.86, 7.67, and 11.65 t ha^{-1}, respectively. For LGS-QTL upland rice lines prospective to draft were PBBogor-Plant Height, Gendut-Grain Number, and Kesit-Plant Height having MDG yield > 4 t ha^{-1} each of 430.10, 448.50, dan 432.20 g m^{-2} equivalent to 4.30, 44.85, dan 4.32 t ha^{-1}, respectively.

Table 1. The vegetative and generative performances for each parameter

		PH		TN		PTN		PPTN	
Environment	Line	Average	s.e.	Average	s.e.	Average	s.e.	Average	s.e.
Lowland	PBBogor	98.83	0.84	26.33	2.19	25.00	1.73	95.28	3.16
	Tewe	126.33	0.88	23.00	1.53	22.67	1.86	98.33	1.67
	Gendut	107.90	3.55	14.67	1.76	14.67	1.76	100.00	0.00
	Kesit	104.00	1.00	16.67	2.03	16.67	2.03	100.00	0.00
	Ciherang	104.67	4.84	24.00	2.08	24.00	2.08	100.00	0.00
	IR64	92.20	3.53	21.33	2.73	19.33	1.76	91.65	4.18
	Average	105.66	2.44	21.00	2.05	20.39	1.87	97.54	1.50
Upland	PBBogor	89.67	3.27	20.53	2.73	15.03	1.89	73.86	5.73
	Tewe	91.29	4.49	24.03	1.04	19.90	1.72	82.82	6.17
	Gendut	91.53	4.73	24.57	1.91	15.53	0.82	63.65	3.84
	Kesit	109.20	14.50	19.07	2.13	12.69	0.67	67.56	5.15
	Ciherang	73.90	10.20	20.80	2.75	14.63	2.23	70.09	5.11
	IR64	96.57	9.51	20.80	0.31	12.73	2.41	60.90	10.80
	Average	92.03	7.78	21.63	1.81	15.09	1.62	69.81	6.13
Upland Introduction Line	CSG1	73.46	0.67	22.07	2.74	12.98	1.46	60.18	7.68
	CSG2	105.47	8.81	23.27	3.49	17.57	3.17	75.14	3.97
	CSG3	96.21	2.71	22.03	3.01	18.73	3.47	83.79	4.52
	Average	89.61	6.61	21.77	2.35	15.29	2.39	69.99	6.37

Notes: PBBogor= PBBogor-Plant Height, Tewe= Tewe-Grain Number, Gendut= Gendut-Grain Number, Kesit= Kesit-Plant Height, Ciherang= Ciherang-Grain Number, IR64= IR64-Grain Number. PH= plant height (cm), TN= tiller number $hill^{-1}$, PTN= productive tiller number $hill^{-1}$, PPTN= percent productive tiller number $hill^{-1}$ (%).

Table 1. (Continued)

		GNS		SW		TGN	
Environment	Line	Average	s.e.	Average	s.e.	Average	s.e.
Lowland	PBBogor	89.69	4.82	3.30	0.12	2257.00	274.00
	Tewe	91.14	7.71	2.35	0.18	2037.30	15.40
	Gendut	101.43	4.27	2.50	0.31	1473.00	116.00
	Kesit	65.80	17.70	1.55	0.19	1026.00	143.00
	Ciherang	86.01	7.08	2.95	0.38	2038.00	102.00
	IR64	81.39	7.74	2.37	0.37	1561.00	162.00
	Average	85.91	8.22	2.50	0.25	1732.05	135.40
Upland	PBBogor	89.40	8.81	1.59	0.23	1420.00	284.00
	Tewe	65.10	8.57	1.15	0.17	1298.00	101.00
	Gendut	85.17	9.27	1.59	0.16	1419.00	150.00
	Kesit	86.40	14.10	1.37	0.17	1217.00	208.00
	Ciherang	66.63	9.86	1.56	0.18	1042.00	256.00
	IR64	101.30	11.60	1.33	0.38	1410.00	406.00
	Rerata	82.33	10.37	1.43	0.21	1301.00	234.17
Upland Introduction	CSG1	56.46	9.53	0.58	0.16	770.00	153.00
	CSG2	91.80	10.80	1.26	0.13	1628.00	260.00
	CSG3	96.73	3.81	1.60	0.33	1829.00	294.00
	Average	82.54	9.33	1.29	0.23	1330.00	267.19

Notes: PBBogor= PBBogor-Plant Height, Tewe= Tewe-Grain Number, Gendut= Gendut-Grain Number, Kesit= Kesit-Plant Height, Ciherang= Ciherang-Grain Number, IR64= IR64-Grain Number. GNS= grain number $spike^{-1}$, SW= spike weight $hill^{-1}$ (g), TGN= total grain number $hill^{-1}$.

Table 1. (Continued)

Environment	Line	TGW Average	s.e.	W100 Average	s.e.	MDGY Average	s.e.
Lowland	PBBogor	59.30	6.67	2.63	0.03	1186.00	133.00
	Tewe	58.27	0.29	2.86	0.01	1165.30	5.87
	Gendut	38.33	3.29	2.60	0.06	766.70	65.80
	Kesit	27.74	3.84	2.70	0.02	554.90	76.70
	Ciherang	56.48	2.25	2.77	0.03	1129.60	45.10
	IR64	41.17	4.73	2.63	0.07	823.30	94.50
	Average	46.88	3.51	2.70	0.04	937.63	70.16
Upland	PBBogor	21.50	1.96	1.93	0.18	430.10	39.20
	Tewe	18.06	0.93	1.73	0.02	361.10	18.60
	Gendut	22.42	1.65	1.99	0.08	448.50	43.80
	Kesit	21.61	1.49	1.84	0.06	432.20	29.90
	Ciherang	15.58	3.33	1.91	0.05	311.60	66.50
	IR64	29.74	6.99	2.35	0.10	595.00	140.00
	Average	21.48	2.73	1.96	0.08	429.75	56.33
Upland Introduction	CSG1	11.44	2.19	1.78	0.08	228.90	49.30
	CSG2	21.10	2.47	1.61	0.12	422.00	85.80
	CSG3	29.34	4.29	1.99	0.10	586.80	32.90
	Average	21.45	3.67	1.93	0.09	429.01	71.81

Notes: PBBogor= PBBogor-Plant Height, Tewe= Tewe-Grain Number, Gendut= Gendut-Grain Number, Kesit= Kesit-Plant Height, Ciherang= Ciherang-Grain Number, IR64= IR64-Grain Number. TGW= total grain weight hill^{-1} (g), W100= 100-grain weight (g), MDGY= Milled-Dry Grain yield m^{-2} (g).

B. *Mean Square Analysis*

Mean square analyses (MSA) summarized from Anova were provided in Table 4. Data in Table 2 showed that lines were different at P <0.01 except for grain number spike^{-1}. The different suggested that the lines adaptability was low still on organic upland.

Table 2. The summary of mean square values for vegetative and generative variables

Source of Variation	db	PH	TN	PTN	PPTN	GNS
Replicate	2	313.549	40.372	21.72	42.564	112.871
Line	14	543.624**	27.707	49.0736**	692.059**	579.329
Error	28	104.849	14.09	12.1246	78.457	294.48
CV %		10.512	17.423	19.925	10.861	20.52

Source of Variation	db	SW	TGN	TGW	W100	MDGY
Replicate	2	0.05	279433.6	24.99	0.032	10008.8
Line	14	1.61**	511992.9**	749.99**	0.575**	300002.6**
Error	28	0.19	132074.2	40.314	0.017	16123.01
CV %		17.42	10.512	19.92	10.86	20.52

Notes: **= P< 0.01. PH= plant height, TN= tiller number hill^{-1}, PTN= productive tiller number hill^{-1}, PPTN= percent productive tiller number hill^{-1}, GNS= grain number spike^{-1}, SW= spike weight hill^{-1}, TGN= total grain number hill^{-1}, TGW= total grain weight hill^{-1}, W100= 100-grain weight, MDGY= Milled-Dry Grain yield m^{-2}.

C. *Rank of Line Analysis*

Table 3 provided rank of lines accomplished using Tukey's $HSD_{0.05}$ test (Hikam *et al.*, 2015). The ranking categorized to six classes with the lowland rice lines were the best on 1st – 4th rank and the upland lines were on 4th – 6th. The line rank suggested that the selection on lowland rice lines could be independent on that of upland lines. Therefore in advancing the selection program, the evaluation of upland rice lines having drought resistance QTL were done separately from the evaluation of lowland lines.

The LGS-QTL lowland rice lines worth to advance were the same as those of the upland lines which were PBBogor-Plant Height dan Tewe-Grain Number.

Table 3. The rank of lines using Tukey's $HSD_{0.05}$

Environment	Line	PH	TN	PTN	PPTN	GNS
Lowland	PB Bogor	98.83a-c	26.33a	25.00a	95.28ab	89.69a
	Tewe	126.33a-c	23.00a	22.67ab	98.33a	91.14a
	Gendut	107.90ab	14.67a	14.67ab	100.00a	101.43a
	Kesit	104.00a-c	16.67a	16.67ab	100.00a	65.79a
	Ciherang	104.67a-c	24.00a	24.00a	100.00a	86.01a
	IR64	92.20bc	21.33a	19.33ab	91.65a-c	81.39a
Upland	PB Bogor	89.67bc	20.53a	15.03ab	73.86a-d	89.4a
	Tewe	91.29bc	24.03a	19.90ab	82.82a-d	65.1a
	Gendut	91.53bc	24.57a	15.53ab	63.64d	85.17a
	Kesit	109.17ab	19.07a	12.69b	67.56cd	86.36a
	Ciherang	73.87c	20.80a	14.63ab	70.09b-d	66.63a
	IR64	96.57a-c	20.80a	12.73b	60.94d	101.3a
Upland Introduction	CSG1	73.46c	22.07a	12.98b	60.18d	56.46a
	CSG2	105.47a-c	23.27a	17.57ab	75.14a-d	91.83a
	CSG3	96.21a-c	22.03a	18.73ab	83.79a-d	96.73a
	$HSD_{0.05}$	32.79	11.98	10.75	26.24	50.56

Notes: Numbers followed by the same letter were not different as tested with $HSD_{0.05}$. The letter "a" indicated the best. PBBogor= PBBogor-Plant Height, Tewe= Tewe-Grain Number, Gendut= Gendut-Grain Number, Kesit= Kesit-Plant Height, Ciherang= Ciherang-Grain Number, IR64= IR64-Grain Number. PH= plant height (cm), TN= tiller number hill^{-1}, PTN= productive tiller number hill^{-1}, PPTN= percent productive tiller number hill^{-1} (%). GNS= grain number spike^{-1}.

Table 3. (Continued)

Environment	Line	SW	TGN	W100	TGW	MDGY
Lowland	PB Bogor	3.30a	2257.0a	2.63ab	59.30a	1186.0a
	Tewe	2.35a-c	2037.3ab	2.86a	58.27a	1165.3a
	Gendut	2.50ab	1473.0a-c	2.60ab	38.33b-d	766.7b-d
	Kesit	1.55b-d	1026.0bc	2.70ab	27.74c-e	554.9c-e
	Ciherang	2.95a	2038.3ab	2.77a	56.48ab	1129.6 ab
	IR64	2.37a-c	1561.3a-c	2.63ab	41.17a-c	823.3a-c
Upland	PB Bogor	1.59b-d	1420.3a-c	1.93a	21.50de	430.1de
	Tewe	1.15cd	1297.6a-c	1.73a	18.06e	361.1e
	Gendut	1.59b-d	1418.6a-c	1.99cd	22.42c-e	448.5c-e
	Kesit	1.37b-d	1216.9a-c	1.84d	21.61de	432.2de
	Ciherang	1.56b-d	1042.1bc	1.91d	15.58e	311.6e
	IR64	1.33b-d	1410.0a-c	2.35bc	29.74c-e	594.7c-e
Upland Introduction	CSG1	0.58d	770.4c	1.78d	11.44e	228.9e
	CSG2	1.26b-d	1627.7a-c	1.61d	21.10de	422.0de
	CSG3	1.60b-d	1829.2a-c	1.99cd	29.34c-e	586.8c-e
	$HSD_{0.05}$	1.28	1134.40	0.41	18.86	377.19

Notes: Numbers followed by the same letter were not different as tested with $HSD_{0.05}$. The letter "a" indicated the best. PBBogor= PBBogor-Plant Height, Tewe= Tewe-Grain Number, Gendut= Gendut-Grain Number, Kesit= Kesit-Plant Height, Ciherang= Ciherang-Grain Number, IR64= IR64-Grain Number. SW= spike weight hill^{-1} (g), TGN= total grain number hill^{-1}, TGW= total grain weight hill^{-1} (g), W100= 100-grain weight (g), MDGY= Milled-Dry Grain yield m^{-2} (g).

Table 3. (Continued)

Environment	Line	Number of "a"	Rank
Lowland	PB Bogor	10	1
	Tewe	10	1
	Gendut	8	3
	Kesit	6	4
	Ciherang	10	1
	IR64	9	2
Upland	PB Bogor	6	4
	Tewe	6	4
	Gendut	4	5
	Kesit	4	5
	Ciherang	3	5
	IR64	4	5
Upland Introduction	CSG1	2	6
	CSG2	6	4
	CSG3	6	4
	$HSD_{0.05}$		

Notes: PBBogor= PBBogor-Plant Height, Tewe= Tewe-Grain Number, Gendut= Gendut-Grain Number, Kesit= Kesit-Plant Height, Ciherang= Ciherang-Grain Number, IR64= IR64-Grain Number lines.

D. Genetic Variation, Heritability, and Genetic Coefficient of Variation Analysis

The values of genetic variation (σ^2_g), broad-sense heritability (h^2_{BS}), and genetic coefficient of variation (CV_g) were calculated following Hallauer *et al*. (2010) and were presented in Table 4 for lowland rice lines and for upland lines in Table 5. Data in Table 4 indicated that the variables plant height, tiller number hill^{-1}, productive tiller number hill^{-1}, spike weight hill^{-1}, total grain number hill^{-1}, 100-grain weight, and MDG yield m^{-2} had the values of σ^2_g and h^2_{BS} different from 0 ($P<0.05$), whereas in Table 5 the variables were plant height, productive tiller number hill^{-1}, grain number spike^{-1}, total grain weight hill^{-1}, 100-grain weight, and MDG yield m^{-2} ($P<0.05$).

The values of σ^2_g different from 0 implied that the variation existed on the variables valuable in advancing the selection program using the variables (Hikam *et al*., 2015). The values of h^2_{BS} different from 0 suggested that the variables expressed in the progenies especially when the value of h^2_{BS} >85 % (Hikam *et al*., 2015).

The data in Table 4 and 5 concluded that tested population consisted of PBBogor-Plant Height, Tewe-Grain Number, Gendut-Grain Number, Kesit-Plant Height, dan Ciherang-Grain Number lines were prospective for advance selection program which would result in superior inbred lines or be utilized as parents in a hybridization program to accumulate QTL geometrically (Hikam *et al*., 2015).

Table 4. The values of genetic variation (σ^2g), broad-sense heritability (h^2_{BS}), and genetic coefficient of variation (CV_g) for lowland rice line variables.

Variable	σ^2g	±	s.e. σ^2g	h^2_{BS} (%)	±	s.e. h^2_{BS} (%)	CV_g
PH	127.853*	±	71.005	96.29*	±	53.47	10.70
TN	14.911*	±	10.944	74.23*	±	54.48	18.39
PTN	13.378*	±	9.469	76.70*	±	54.29	17.94
PPTN	6.372	±	6.627	54.42	±	56.59	2.59
SW	0.301*	±	0.192	84.38*	±	53.83	21.91
GNS	40.358	±	86.186	28.52	±	60.90	7.39
TGN	186857.211*	±	113479.777	88.36*	±	53.66	24.96
TGW	153.692	±	90.884	90.62*	±	53.59	26.44
W100	0.008*	±	0.005	80.60*	±	54.04	3.32
MDGY	61476.892*	±	36353.686	90.62*	±	53.59	26.44

Notes: *= σ^2_g and h^2_{BS} differed from 0 at $P<0.05$. PH= plant height, TN= tiller number hill^{-1}, PTN= productive tiller number hill^{-1}, PJAP= percent productive tiller number hill^{-1}, SW= spike weight hill^{-1}, GNS= grain number spike^{-1}, TGN= total grain number hill^{-1}, TGW= total grain weight hill^{-1} (g), W100= 100-grain weight, MDGY= Milled-Dry Grain yield m^{-2}.

Table 5. The values of genetic variation ($\sigma^2 g$), broad-sense heritability (h^2_{BS}), and genetic coefficient of variation (CV_g) for upland rice line variables

Variable	$\sigma^2 g$	±	s.e. $\sigma^2 g$	h^2_{BS} (%)	±	s.e. h^2_{BS} (%)	CV_g (%)
PH	95.972*	±	70.931	73.76*	±	54.51	10.65
TN	1.466	±	2.845	31.12	±	60.39	5.60
PTN	5.231*	±	3.792	75.07*	±	54.41	15.16
PPTN	19.029	±	37.180	30.93	±	60.43	6.25
SW	0	±	0	0	±	0	0
GNS	127.958*	±	108.059	65.46*	±	55.28	13.74
TGN	0	±	0	0	±	0	0
TGW	14.627*	±	12.831	63.28*	±	55.51	17.80
W100	0.038*	±	0.024	85.82*	±	53.76	9.99
MDGY	5855.544*	±	5134.115	63.31*	±	55.51	17.81

Notes: *= σ^2_g and h^2_{BS} differed from 0 at P< 0.05. PH= plant height, TN= tiller number hill^{-1}, PTN= productive tiller number hill^{-1}, PJAP= percent productive tiller number hill^{-1}, SW= spike weight hill^{-1}, GNS= grain number spike^{-1}, TGN= total grain number hill^{-1}, TGW= total grain weight hill^{-1} (g), W100= 100-grain weight, MDGY= Milled-Dry Grain yield m^{-2}.

E. Correlation Analysis

The correlation analysis among variables was done to reveal variables significantly correlated with MDGY m^{-2} and whether the variables would increase or decrease MDGY m^{-2}. Data in Table 6 showed that MDGY m^{-2} positively correlated (P< 0.01) with all other variables but tiller number hill^{-1}. On the other hand, productive tiller number hill^{-1} positively correlated (P< 0.01) with MDGY m^{-2}. The finding indicated that there was interference between tiller number hill^{-1} and productive tiller number hill^{-1} suggestive that not all of the tillers grown produced spike especially in the organic-upland environment (Bian *et al*., 2013, Table 3). The data in Table 3 showed that productive tiller number hill^{-1} averaged 97.54 % on the lowland rice lines and decreased to 69.81 % on the upland lines presumably due to lower water supply for the upland lines. Therefore, increasing MDGY m^{-2} of the upland rice lines could be achieved with selecting hills which produced a greater number of spikes.

Table 6. The Pearson's correlation among variables

	PH	TN	PTN	PPTN	GNS	SW	TGN	TGW	W100
TN	0.108								
PTN	0.446**	0.682**							
PPTN	0.509**	-0.132	0.623**						
GNS	0.487**	-0.146	0.003	0.168					
SW	0.46**	0.299*	0.728**	0.665**	0.328*				
TGN	0.605**	0.481**	0.765**	0.517**	0.617**	0.761**			
TGW	0.58**	0.252	0.715**	0.689**	0.413**	0.876**	0.815**		
W100	0.39**	-0.139	0.393**	0.684*	0.124	0.666**	0.34*	0.781	
MDGY	0.58**	0.252	0.715**	0.689**	0.413**	0.876**	0.815**	0998**	0.781**

Notes: Numbers in columns were the Pearson's correlation values. *= P < 0.05, **= P< 0.01. PH= plant height, TN= tiller number hill^{-1}, PTN= productive tiller number hill^{-1}, PJAP= percent productive tiller number hill^{-1}, SW= spike weight hill^{-1}, GNS= grain number spike^{-1}, TGN= total grain number hill^{-1}, TGW= total grain weight hill^{-1} (g), W100= 100-grain weight, MDGY= Milled-Dry Grain yield m^{-2}.

IV. CONCLUSION

The results indicated that the lowland rice lines decreased in their performance when grown in upland environment presumably due to lower water supply. The prospective lines of Local Genetic Source-Quantitative Trait Loci (LGS-QTL) lowland rice were PBBogor-Plant Height, Gendut-Grain Number, and Tewe-Grain Number having Milled-Dry Grain (MDG) yield > 6 t ha^{-1} to the extent of 1186.00, 766.70, and 1165.30 g m^{-2} equivalent to 11.86, 7.67, dan 11.65 t ha^{-1}, respectively. The prospective lines LGS-QTL for upland rice were PBBogor-Plant Height, Gendut-Grain Number, and Kesit-Plant Height having MDGY > 4 t ha^{-1} to the extent of 430.10, 448.50, dan 432.20 g m^{-2} equivalent to 4.30, 44.85, dan 4.32 t ha^{-1}, respectively. The LGS-QTL lines: PBBogor-Plant Height, Tewe-Grain Number, Gendut-Grain Number, Kesit-Plant Height and the National line Ciherang-Grain Number ranked the 1st in all populations were prominent to be parental lines to accumulate QTL. The lines PBBogor-Plant

Height, Tewe-Grain Number, Gendut-Grain Number, and Kesit-Plant Height were prospective to be drafted to the Plant Variety Protection (PVP) Committee.

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REFERENCES

BB Padi. 2015. Pembentukan varietas unggul padi di Indonesia. Balai Besar Penelitian Tanaman Padi. Balitbangtan Kementerian Pertanian.

Bian, Jianmin, He, Haohua, Shi, Huan, Zhu, Changlan, Peng, Xiaosong, Li, Cuijuan, Fu, Junru, He, Xiaopeng, Chen, Xiaorong, Hu, Lifang, and Ouyang, Linjuan. 2013. Dynamic QTL detection and analysis of tiller number before and after heading in Japonica rice. *Autralian Journal of Crop Sci*. 7(8):1189-1197.

Fehr, W.R. 1987. *Principles of Cultivar Development*. *Volume* 1. *Theory and Technique*. Iowa State Univ. Press. Ames. Iowa. USA.

Hagiwara, W. E., K. Onishi, I. Takamure, and Y. Sano. 2006. Transgressive segregation due to linked QTLs for grain characteristics of rice. *Euphytica* 150:27 – 35. Springer. The Netherland.

Hallauer, A.R., M.J. Carena, and J.B. Miranda Filho. 2010. *Quantitative Genetics in Maize Breeding. Handbook of Plant Breeding Vol.6*. Springer-Verlag. New York. 664 pp.

Hikam, S. 2013. Temu-ulang dan adopsi plasma nutfah komoditas pangan dan hortikultura untuk dataran rendah Podsolik Merah Kuning. Kajian pada jagung, jagung manis, cabai, kentang, dan padi. Makalah disampaikan pada Lokakarya Pengelolaan Sumberdaya Genetik Lokal Lampung. Balai Pengkajian Teknologi Pertanian Lampung di Bandar Lampung pada tanggal 13 Desember 2013.

Hikam, S., P.B. Timotiwu, dan D. Sudrajat. 2016. MEGOU, varietas padi gogo beras merah organik yang dikembangkan melalui pemanfaatan transgresi genetik. In *106 Indonesia Innovations (6)*. Business Innovation Center, Jakarta, Indonesia. pp. 16 – 17. ISBN 978-602-95290-5-0

Hikam, S., P.B. Timotiwu, dan D. Sudrajat. 2015. Studi kemangkusan varietas sumber genetik lokal padi sawah di Provinsi Lampung untuk dimanfaatkan sebagai varietas harapan dan tetua kros. *Prosiding Seminar Nasional Sains & Teknologi VI*. Lembaga Penelitian dan Pengabdian Universitas Lampung. 3 November 2015. pp. 167 – 178.

Hussien, A., E. Tavakol, D.S. Horner, M. Munoz-Amatriain, G.J. Muehelbauer, and L. Rossini. 2014. Genetics of tillering in rice and barley. *The Plant Genome*. doi: 10.3835/ plantgenome2013.10.0032.

IRRI. 2017. Climate change-ready rice. irri.org

Koide, Yohei, Fujita, Daisuke, Tagle, Analiza, Sasaki, Kazuhito, Ishimaru, Tsutomu, Fukuta, Yoshimimichi, Kobayashi, Nobuya. 2013. QTL for spikelet number from a high-yielding rice variety, Hoshiaoba, detected in an introgression line with the genetic background of an indica rice variety, IR64. *Euphytica*, Jul 2013, Vol 192 Issue 1. p 97.

Prince, S.J., Beena, R., Gomez, S.M., Senthivel, S., Babu, R.C. 2015. Mapping consistent rice (*Oryza sativa* L.) yield QTLs under drough stress in target rainfed environments. *Rice* 2015 8:25. doi: 10.1186/s 12284-015-0053-6.

Reuter USA. 2011. Bayer Crop Science targets non-GMO wheat traits. Reuter USA. Electronic publ.

Rieseberg, L.H., A. Widmer, A. M. Arntz, and J. M. Burke. 2003. The genetic architecture necessary for transgressive segregation is common in both natural and domesticated populations. *Phil. Trans. R. Soc. Lond.* B. DOI 10.1098/ rstb.2003.1283

Steel, R.G.D. and D.H. Torrie. 1981. *Principles and Procedures of Statistics. A Biometric Approach*. McGraw-Hill Inc. New York. NY.

Sanchez, P.L., T.H. Borromeo, and N.E. Munoz. 1993. Genetic resources conservation of rice in the Phillipines. *Agris*. FAO.

Suprihatno, B., A.A. Darajat, Satoto, Baehaki S.E., I.N. Widiarta, A. Setyono, S. D. Indrasari, O.S Lesmana, dan H. Sembiring. 2009. *Deskripsi Varietas Padi*. BB Padi. Balibangtan. Departemen Pertanian. Sukamandi, Jawa Barat. 113 pp.

D.8

COMPOSTING OF RICE STRAW

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ABSTRACT

Crop residues such as rice straw can reach about 20 - 30 ton/ha which can be used as raw material for composting. The purpose of this research was to find the compost quality produced from rice straw. Two treatments were conducted, namely P1 = composting for local variety rice straw, and P2 = composting for supreme variety rice straw. About 1.5 m long, 1 m wide and 1 m high of dimension of compost heap respectively were conducted. The variables measured were temperature, water content, yield, pH, nitrogen, carbon and C/N ratio. The composting process lasted for 12 weeks with a temperature ranged for 30°C – 41°C, the water content of compost were between 31% - 32%, and the yields were between 72% - 74%. C/N ratio of compost were between 20 - 21. The results of compost were appropriate the standard of compost appointed by the Regulation of the Minister of Agriculture of the Republic of Indonesia Number 70/Permentan/SR.140/10/2011.

Keywords : rice straw, composting, quality.

I. INTRODUCTION

The province of Bali has agricultural land especially rice fields with an area of 81,165 hectares (Anonymous, 2014). Based on the measurements, rice straw can reach approximately 25 tons/ha for supreme rice straw and 35 tons/ha for local rice straw variety. Farmers in Bali have not used much of the potential of residual straw of rice crops to the maximum. Generally farmers only burn the rice straw directly on the land.

Rice straw contains some of compounds such as water, crude fiber, crude protein, basic carbohydrates, fats, ash, oxygen, carbon, hydrogen, silica, nitrogen, cellulose, pentose and lignin that are useful for improving soil fertility (Anonymous 2015). From the results of laboratory analysis, the content of local rice straw variety and supreme rice straw variety is presented in Table 1.

Table 1. The content of rice straw

Varieties	Local rice straw	Supreme rice straw
Diameter of raw materials	12 mm	8 mm
Water content	34.94%	33.48%
pH	7.01	6.98
Carbon content	43.59%	40.61%
Nitrogen content	0.98%	1.02%
C/N Ratio	44.48	39.82

Source: the results of laboratory analysis.

Further handling is needed to utilize rice straw, one of them as the main source of compost fertilizer. One of the composting processes can occur in sufficient conditions of oxygen (aerobic composting). Aerobic composting must be conditioned in such a way that each part of the compost material obtains sufficient oxygen supply. In order for the aeration to smooth, composting can be done in the open so that air can enter from various sides and periodically done the reversal of compost (Habibi, 2008).

II. MATERIALS AND METHODS

The main materials used in this research are supreme rice straw (Ciherang variety) and local varieties rice (Jatiluwih red rice variety). Additional ingredients to be used include water, molasses, EM4 and materials for chemical analysis such as chemical solutions used for Carbon and Nitrogen tests.

The research was conducted with two treatments, namely: P1(composting of rice straw of local variety), and P2 (composting of rice straw of supreme varieties). Each treatment is repeated 3 times.

The variables observed in this study were (i) the temperature during the composting process observed every 3 days. (ii) Compost quality includes pH, water content, Carbon, Nitrogen, and C/N ratio of compost, (iii) Yield is the compost weight ratio that obtained from the compost weight that compared wit total of raw material. To calculate the resulting yield can be calculated by the formula:

$$R = \frac{Bk}{Ba} x100\% \tag{1}$$

where,

R = Yield
Bk = compost weight (kg)
Ba = weight of raw material (kg).

The composting process begins with rice straw is taken from the waste of the rice harvest (1 week after harvesting). Rice straw that has been collected then chopped with a size of approximately 5-10cm to uniform size. The rice straw is then stacked with a height of 1 meter with a length of 1.5 meters and a width of 1 meter. In one pile there is 30 kg of rice straw. In this stage, an EM4 is added. After all the compost is mixed and stacked, the compost pile is then covered using a tarp. The composting process began to run and observations conducted. Regular turnover and wetting of compost is done every 6 days to keep the temperature and humidity of the compost.

III. RESULTS AND DISCUSSION

A. Temperature during the Composting Process

The results of temperature observation during the composting process are presented in Fig. 1.

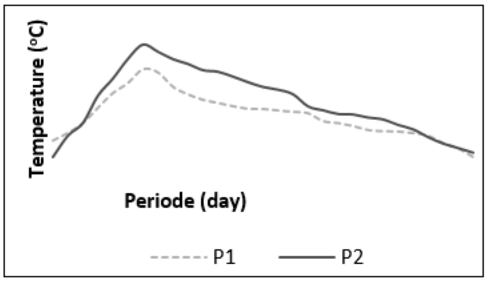

Fig. 1. Temperature during the composting process

The temperature at all treatments began to increase on the 3rd day until the 18th day on the composting process of rice straw. Increased temperature is an indicator of the decomposition process of compost material is active. The rise in temperature is due to the surrounding resulting from the composting process greater than the temperature of the environment. When the organic matter is simplified by microorganisms, it releases some heat energy. The flow of heat coming out of the composting process occurs due to the temperature difference between the compost pile and the ambient temperature (Dalzell et al, 1987).

In the composting process has been done, as in Fig. 1. based on temperature changes seen that the treatment with the highest temperature distribution is P2 treatment with the highest temperature reached 41.17 ^{o}C. While the treatment with the lowest temperature distribution is P1 treatment with the highest temperature of 35.07 ^{o}C. After the temperature reaches peak on the 18th day, the temperature of the compost material further decreases until the composting process is stopped.

The cause of the decrease in temperature is the heat generated from the composting process is less, so the temperature of the composting process is almost equal to the temperature of the environment. The temperature change of the compost during the composting process shows that the composting reaction is going well.

The composting temperature indicates that the two treatments of the composting process can only reach the mesophilic phase. While good compost should be able to reach thermophilic phase at the time of composting process is running. The temperature at the composting process affects the microorganisms that live in the compost material. In the aerobic composting process there are two phases of 23-45^{o}C as mesophilic phase and 45-65^{o}C as thermophilic phase. The ideal temperature range of the compost pile is 55-65^{o}C. At that temperature, the microorganism's proliferation is the best to be good growth population. In addition, the enzyme produced to decompose organic materials that have the most effective degradation (Sastrawijaya, 1991).

The average temperature of the composting process is presented in Table 2. Table 2. shows that the average temperature achieved in the composting process of P1 treatment is less than P2.

Table 2.The average temperature of the composting process (^0C)

The treatments	The average temperature (^oC)
P1	33.09
P2	34.63

B. Compost Quality

In this research, Regulation of the Minister of Agriculture of the Republic of Indonesia number 70/Permentan/SR.140/10/2011 on solid compost standard is used as a reference of compost quality. The compost content being the reference includes pH, water content, Carbon, Nitrogen, and C/N ratio of compost.

1. pH of compost

pH of compost data are presented in Table 3.

Table 3. pH of compost data

Treatments	The average pH	Standard
P1	7,3	4 - 9
P2	7,5	

Both treatments have a pH value that is still in the limits range of pH of compost according to the compost standard Regulation of the Minister of Agriculture of the Republic of Indonesia is 4 - 9. Microbes in the composting process will work on a neutral pH to slightly acid with a pH range between 5.5 to 8. Early decomposition process, will in organic acids condition. This acidic condition will promote mold growth and will decompose lignin and cellulose in the compost material. During the composting process takes place, the organic acids will become neutral and the compost becomes mature, usually reaching a pH between 6-8 (Indriani, 2007).

2. Water content of compost

The data of water content of compost are presented in Table 4.

Table 4. water content of compost data

Treatments	The average water content (%)	Standard
P1	32,14	15 - 25 %
P2	31,88	

Table 4. shows that the water content of both compost treatments is close to the compost standard from the Regulation of the Minister of Agriculture of the Republic of Indonesia. Dissolving microorganisms need water to live. Lack of water in the compost pile will cause biochemical reactions slowly. Contrary in high a water content, the space between particles of material becomes fulfilled by water and prevents air movement in the material pile (Sangatana and Sangatanan, 1987; Mitchel, 1992).

3. Carbon content of compost

The results of laboratory tests of carbon content of compost are presented in Table 5.

Table 5. Carbon content of compost

Treatments	Carbon content (%)	Standard
P1	32,48	Minimal 15%
P2	31,41	

Viewed from the average Carbon content produced from the research that has been done, both treatments have met the standard of compost by Regulation of the Minister of Agriculture of the Republic of Indonesia. However, P1 treatment had higher Carbon content (32.48%). The compost material on treatment P1 has a high initial Carbon content of about 43.59% and the size of the local rice straw greater than that of the supreme rice straw causes the composting process to run rather slowly.

4. Nitrogen content of compost

Laboratory test results of Nitrogen content of compost are presented in Table 6.

Table 6. Nitrogen content of compost

Treatments	Nitrogen content (%)	Standard
P1	1,52	Minimal 4
P2	1,52	

The Nitrogen value of the compost from the two composting treatments showed similar results. Rice varieties are not affect the Nitrogen value of the compost produced. The properties of Nitrogen (nitrogen carrier) especially in the form of ammonia will generally be lost to the environment along with heat from the composting process (Hardjowigeno, 1992).

5. C/N Ratio of Compost

The C/N ratio of compost is presented in Table 7.

Table 7. The C/N ratio of compost

Treatments	C/N Ratio	Standard
P1	21,15	15 - 25
P2	20,66	

Treatment of P1 and P2 has complied with the Regulation of the Minister of Agriculture of the Republic of Indonesia on compost standard. The C/N ratio of compost at P1 is higher than P2. This is because the treatment of P1 has a high ratio of Carbon content with low Nitrogen content. The initial Carbon content of local rice straw reached 43.59%, while the initial Nitrogen content of local rice straw was 0.98%. The initial C/N ratio of compost on treatment P1 ie local rice straw raw material reached 44.48.

In addition to high C/N ratios, local rice varieties have larger sizes of supreme rice varieties. The size of the large compost material causes the air cavity to increase so that the compost pile becomes more tenuous and the air supply into the compost pile more. As a result the compost material dries faster and loses heat coming out into the environment. This will inhibit the activity of decomposing microorganisms in decomposing the compost material (Ana Nurhasanah dan Harmanto, 2008).

6. Yield of compost

During the composting process, there is shrinkage of biomass materials. From the research that has been done, obtained the composting yield as follows.

Table 8. Yield of compost (%)

Treatments	Yield (%)
P1	74,1
P2	72,1

Table 8 shows that treatment P1 yield's a higher than P2 yield's.

IV. CONCLUSION

From the research that has been discussed, it can be concluded as follows:

1. The quality of compost from supreme variety rice straw is almost same with compost from local rice straw.
2. Generally, the quality of the compost produced from rice straw raw material is good and appointed the compost standard by the Regulation of the Minister of Agriculture of the Republic of Indonesia. Compost content especially C/N ratio is treatment P1 = 21,15 and P2 = 20,66.

REFERENCES

[1] Anonymous. 2014. *Luas Lahan (Hektar) Per Kabupaten/Kota Menurut Penggunaannya Tahun 2013*. Badan Pusat Statistik Provinsi Bali. http://bali.bps.go.id/tabel_detail.php?ed=607001&od=7&id=7

[2] Anonymous. 2015. *Cara Membuat Kompos*. Alamtani Buletin Agribisnis. http://alamtani.com/cara-membuat-kompos.html

[3] Anonymous. 2015. *Kandungan Bahan Organik Jerami Padi*. http://agroteknologi.web.id/

[4] Dalzell HW, Bidlestone AJ, Gray KR, Thurairajan K. 1987. *Soil Management: Compost Production and Use in Tropical and Subtropical Environment.* Soil Bulletin 56. Food and Agricultural Organization of The United Nation.

[5] Gaur, A. C. 1983. *A Manual of Rural Composting*. Project Field Document No. 15 FAO, Rome.

[6] Habibi, Latfran. 2008. *Pembuatan Pupuk Kompos Dari Limbah Rumah Tangga*. Titian Ilmu, Bandung.

[7] Hardjowigeno, S. 1992. *Ilmu Tanah*. Mediyatama Sarana Perkasa, Jakarta.

[8] Ikrarwati. 2008. *Pembuatan Kompos Jerami Di Lahan Sawah*. Balai Pengkajian Teknologi Pertanian. Jakarta.

[9] Indriani, Novita Hety. 2007. *Membuat Kompos Secara Kilat*. Penebar Swadaya. Jakarta.

[10] L. Murbandono. 1997. *Membuat Kompos*. Penerbit Penebar Swadaya, Jakarta.

[11] Mitchell, R. 1992. *Environtmental Microbiology*. Wisley-Liss A. John Wisley and Sons. Inc. Publication. New York.

[12] Sastrawijaya, A. Tresna. 1991. *Pencemaran Lingkungan*. Penerbit Rineka Cipta, Jakarta.

[13] Yuliarti, Nurheti. 2009. *1001 Cara Menghasilkan Pupuk Organik*. Penerbit Andi Offset, Yogyakarta

D.9

QUALITY OF POTATO SEEDS FROM SOME MODELS OF CULTIVATION AFTER STORAGE

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ABSTRACT

The availability of quality potato seeds is an important factor on increasing the production of potatoes in Bali to reach more than 30 tons / ha. Potato seeds from East Java, Central Java and West Java average 30-50% could not be planted because they are damaged, and farmers in Bali often use low-quality seedlings. Development of seed potato storage model to produce quality seeds of G2 is the purpose of this research. Potato tubers weighing 30 - 60 g of cultivation are stored in a room with a temperature of 20 - 24 ^{o}C, RH 70 - 80% . The number of potato samples stored for each cultivation treatment was 500 tubers with replicates in each treatment 3 times, the parameters observed every two weeks were the number of damaged bulbs and the number of rotten tubers. After storage observed the number of shoots that grow from each tuber with the number of samples from each treatment is 20 tubers and it was repeated 3 times. Viability test was done by planting tubers in open field, the number of observations on viability of each treatment was from 20 predetermined plants, the observation of viability of each treatment was repeated three times. The results showed that the number of damaged tubers more than 30% after being stored for 16 weeks is the result of cultivation treatment in open land with fertilizer using chicken compost or cow manure compost. However, the number of damaged cultivars in the greenhouse averaged less than 5% with the average number of apical buds per tuber of 3.85 ± 0.57 and the average viability of 90.6 ± 0.7%. The best potato seeds are the result of cultivation in greenhouse with leaf compost.

Keywords : potato tubers, storage, apical buds, viability.

I. INTRODUCTION

Granola potato seed potato damage between 30 - 50% before planting often occurs in the planting area of Baturiti District of Tabanan regency, Bali, the indication of damage is the skin of potato tubers attacked by fusarium [6], so that the seedlings could not be planted despite growing shoots as high as 1 cm. The result of identification by Suaryanti at 2012th of land in District of Baturiti which is fertilized with chicken dung compost still contain fusarium, so that during wet season planting year 2013 farmers early harvest potatoes because of indication of crop failure.

Fertilization using compost is one of good cultivation practices (Good Agriculture Practices or GAP), this practice is also in accordance with the low external input on sustainable agriculture or LEISA In the 2013 and 2014 study and research on Udayana University invention grant 2015 and 2016, Sapid and chicken manure can improve the physical, chemical and biological properties of the soil [8, 9]. The microbes present in the compost are able to reduce the residual pesticide residue on the farm and decompose the compost into micro nutrients and Macro Improving the quality of agricultural land has an impact on improving the quality of seed potato produced [9]. In addition to the cultivation factor to produce good potato seeds is a storage factor. Potatoes stored for seeds are best stored in a room with good light diffusion. Accumulated chlorophyll and solanine will protect seed potatoes from insect pests and decomposing organisms. As previously described, tuber damage during storage is about 50% due to the selection, washing, desinfection and disinfecting process, and seed grading, in addition to how storage has not been properly performed.

The difference of potato storage consumption with seed potatoes is in storage time. The consumption time of potato consumption is shorter than seed potato storage time, because in potato consumption storage is avoided apical shoot growth process. Seed potatoes that had been certified, and it was stored in the storage space (cool storage) which has a bright temperature of 4 ^{0}C with room temperature (18-25 ^{o}C). Especially for the type of consumption potatoes was stored in the dark warehouse. The storage process in the dark warehouse to minimize the chances of the appearance of green color due to potato tubers contain poison solanin that can degrade the quality of potatoes.

Storage at low temperatures lowers respiration rates and metabolism, but does not decrease all aspects of metabolism equally. Some reactions are sensitive to low temperatures but at temperatures below the critical point of reaction can be stopped. The overall effect is the incidence of unbalanced ¬ metabolism and, if immediate enough, the unavailability of an essential substrate or accumulated toxic product may be seen as a brown tissue area. Metabolic disorders that occur at low temperatures are generally chilling injury (cold-temperature defect) and physiological damage.

Cold temperatures in addition to inhibiting respiration which means to inhibit heat generation and also inhibit the proliferation of microbes, causing potatoes during storage will not experience a setback that leads to damage. After harvesting potato tubers need to be treated at cold temperatures 7 - 18 ^{0}C or hot temperatures 40 - 45 ^{o}C with high humidity for 10-14 days, in order to occur the process of grinding the skin layer (suberization), especially the formation of periderma layer on the scars. The formation of this portery layer actually takes place faster at a temperature of 21 ^{0}C, but lower temperatures are recommended to reduce the process of decomposition, after which the storage temperature begins to be gradually reduced to a temperature of about 4 ^{0}C. At this temperature, there is a minimal reproduction process and low shrinkage [11].

The main objectives of the storage process of horticultural products including potatoes are the control process metabolism (respiration and transponder), disease infection control, and maintain product quality. In principle, this storage technique is to suppress to the smallest possible or negate the occurrence of respiration (respiration), and transpiration (evaporation). Improperly stored consumption potatoes can cause weight loss and quality due to physiological processes and pest / disease attacks during storage, in addition to temperature control, humidity and irradiation also greatly affect the storage of seed potato stockings.

II. MATERIALS AND METHODS

G2 seed group potatoes with 30-60 g bulbs cultivated in greenhouse and open field with compost organic fertilizer from charcoal husk, leaves, chicken manure and cow manure kept for 16 weeks at room temperature 20 - 24 oC, RH 70 - 80% . The codes for each treatment are: (1) GS-G = aquaculture with chaff charcoal compost in the greenhouse, (2) GD-G = cultivation with leaf compost in greenhouse, (3) GKS-G = cultivation with cow dung compost in Greenhouse, (4) GKA-G = cultivation with chicken manure compost in greenhouse, (5) GKA-T = cultivation with chicken manure compost in open field and (6) GKS-T = cultivation with cow dung compost in open field. Potato seed potato harvested at 100 days. The number of potato samples stored for each cultivation treatment was 500 tubers with replicates in each treatment 3 times, the parameters observed every two weeks were the number of damaged bulbs and the number of rotten tubers.

After storage observed the number of shoots that grow from each tuber with the number of samples from each treatment is 20 tubers and repeated 3 times. Tubal viability test was done by planting tubers in open field, the number of observations on viability of each treatment was from 20 predetermined plants, the observation of viability of each treatment was repeated three times.

III.RESULTS AND DISCUSSION

A. Potato Seed Rheology Properties

Potato tubers at the beginning of storage with weight category 30-60 g have properties such as Table 2. Statistically characteristics of potato tubers selected for storage are very different from the parameters of weight quality, spericity, and water content, whereas from the parameter of the specific gravity quality Differs markedly. The results of the cultivation model yielded different seed potato qualities due to physical conditions, soil fertility and biology [8, 9].

Table 1. Properties of seed potato seed group G2

Quality Parameters	GS_G	GD-G	GKS_G	GKA_G	GKA_T
Weight, g	40,5±3,2	42,7±4,1	42,2±4,2	41,7±1,8	45,5±3,2
Spericity, %	90,2±1,1	87,2±1,8	85,2±2,2	88,3±1,9	92,2±1,7
Specific gravity g/cc	0.92±0,5	0,92±0,3	0,93±0,4	0,92±0,1	0,93±0,2
Moisture content, % W.b	80,2±2,1	80,1±1,2	81,1±1,5	82,2±1,3	80,6±1,1

From the quality parameters the potato seed potato tubers are potatoes healthy and have no physical disability. However, after storage almost all tubers have a heavy shrinkage with a velocity of 0.92 ± 0.22 g / month [2]. Heavy shrinkage is caused by the evaporation of water contained in the potato tuber.

B. Number of Damaged Potato Bulbs

The number of damaged or rotted potato tubers during storage is illustrated in Fig. 1. Treatment of GKA-G, GKS-T and GKA-T the number of damaged tubers were 19, 29 and 27%, respectively. G-1 seed potato cultivation in open fields or with chicken manure compost is not recommended. Cultivation in open land has already contained bacteria capable of causing fusarium wilt disease [10].

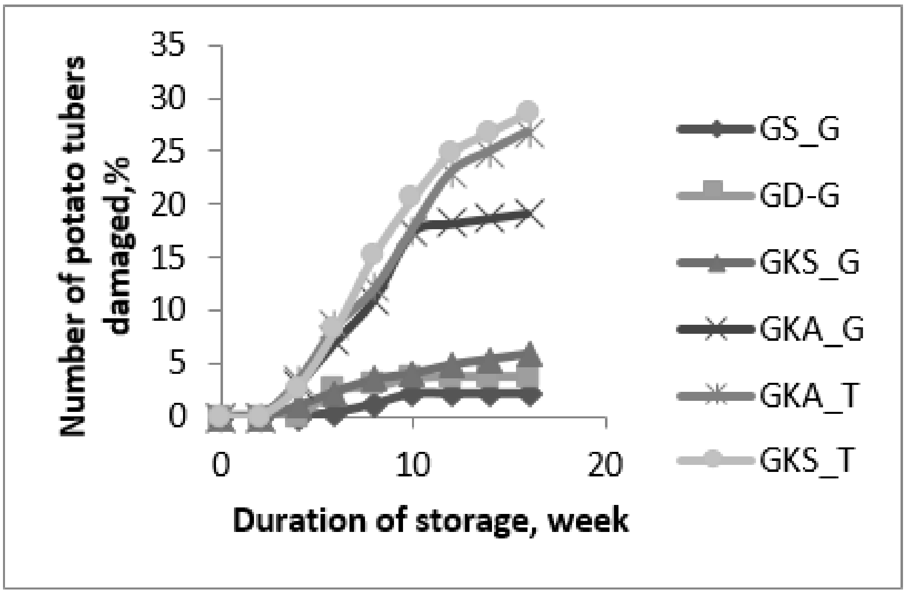

Fig. 1 Accumulated damage to potato tubers during storage

Cultivation results mentioned above, occurs because the land for cultivation is less sterile and too fertile. In the indicated cultivation on the land there are still fusarium microbes, with the number of plants affected 5 - 10%. In addition the land contains organic materials between 5 - 5.5% [8], the cultivation of potatoes for seedlings should be done on the condition of planting media a little poor nutrients.

The result of G-2 seed potato cultivation in greenhouse with planting media mixed with charcoal husk (GS-G), leaf compost (GD-G) and cow dung compost (GKS-G) produces good seed, because 4 months storage process The number of damaged tubers are 2.2, 3.8 and 5.8%, respectively. The quality of the planting medium is as simple as the potato seed potato tuber free from fusarium disease.

Potato tubers before being stored were immersed in a 30-ppm concentration selvin solution for 30 minutes and then dried on the drying floor for 2 days. Soaking in this solution can kill pathogenic microbes that are sourced in planting medium, but for tubers produced in open land there are still microbes that can cause decay of tubers. The process of drying at a temperature of 28-37 oC for two days can strengthen the skin layer of potato tubers. With the grinding process.

Statistically the number of potato seed potato damaged by cultivation treatment is very different. This is because sterilnya planting media and organic matter content in the planting medium.

Table 2 is an illustration of the occurrence of seed damage based on qualification of potato seeds from G1 to G4 and planting season. Damage to potato seeds is strongly influenced by the growing season and potato tuber groups. The number of damaged bulbs is greater when the seeds used generations higher, because the level of generations of potato seed potato was determined level of contamination of the disease on the tubers. In addition to cultivation in the rainy season of pests and plant diseases that attack the tubers more and more, so the cultivation in the rainy season the number of damaged bulbs more than the cultivation in the dry season.

Table 2. Damage to potato seeds during storage

Seed group	% damage	
	Rain season cultivation	Dry season cultivation
G1	8 - 10 %	3 – 5 %
G2	10 – 15 %	4 – 7 %
G3	12 – 20 %	5 – 10 %
G4	15 – 30 %	8 – 15 %

C. Number of Potato Growers Growing Apical Shoots

Fig. 2 illustrates the accumulation of tuber quantity of granola varieties that grow apical buds during storage in a room having a temperature of 20-24 °C and 4 months of storage. The dormancy period of potato tubers is 3 months, but at the time of storage for 1.5 months for all treatments begins there are tubers that grow apical buds. Immersion in a solution of selvin gives a hormone that is able to stimulate the growth of apical buds.

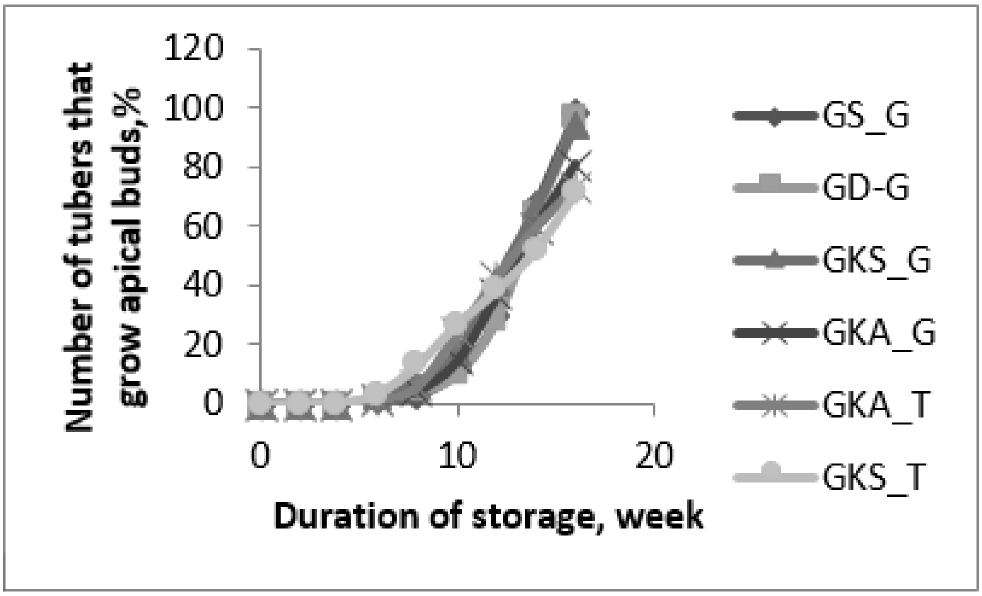

Fig. 2 Number of potato tubers of G-2 granola varieties that grow apical buds

The apical buds of potato sprouts grow well after the dormancy period when the storage process is performed in a room without sunlight or stored on the ground and still in the soil. Sprout growth rate is influenced by temperature and humidity. Good storage space temperatures are 25 - 30 °C with humidity below 80%. In low air humidity, the potato tubers will lose weight and greatly affect the growth of shoots.

Storage at temperatures above 25 ° C can decrease the dormancy mass of potato tubers, potato dormancy mass to less than 84 days or 24 weeks [1, 12]. Potato dormancy period becomes longer if storage is carried out at temperatures below 25 °C as storage in Baturiti, Bedugul-Bali.

The number of potato tubers that grow apical buds more than 80% is the treatment for cultivation conducted in the greenhouse, with the number of bulbs that grow most is in the treatment of fertilization using charcoal husk. The less fertile and the more sterile the planting medium causes the potato tubers to grow more and more apical buds.

In the shoot growth phase (preemergence), shoots can grow both in storage and in the field, with or without sunlight [3]. After the tuber ends the dormancy period, the buds begin to grow. The growth rate of buds depends on temperature and humidity. At high temperatures the buds grow faster so that the plants grow earlier on the ground. If the soil conditions dry, the bulbs lose weight so that the bud grows more slowly [4]. The selvin solution attached to the surface of the potato skin is capable of functioning as a disinfectant, so that the spinning microbes are not able to multiply and can finally maintain the quality of the seed potatoes during transplantation.

Table 3 Number of apical Shoots and seed viability

Tratment	Number of apical buds	Seed Viability, %
GS-G	3.8±0,8	90±3
GD-G	3.9±0,5	91±2,9
GKS-G	3.9±0,7	91±3,7
GKA-G	4±0,7	90±3,8
GKA-T	4.1±0,7	87±3,5
GKS-T	4.2±0,6	87±3,2

Apical shoots grown from all treatments after the seed potato seeds of the G1 group grown on open land have more than 85% viability. Purity of potato seed granola varieties result of all cultivation treatment becomes the main factor for the value of seed viability.

The optimal temperature for growth is 18-21 ^{0}C. Tuber growth will be retarded if the soil temperature is less than 10 ^{0}C and more than 30 ^{0}C. Appropriate moisture for the potato plant is 80 - 90%. Excessive vegetation will cause pests and diseases.

Seed potatoes of granola varieties are cultivated on land containing less than 5% organic material with a soil C/N value of more than 20. Therefore, the compost used as organic fertilizer must meet the requirements of SNI standard. In the cultivation of seed potatoes with LEISA system the land used must have good physical, chemical and biological properties. Fertilization using chicken manure compost of 10-15 tons/ha from Setiyo research result is able to produce potato seed size more than 70% ([7].

IV. CONCLUSION

The results showed that the number of damaged tubers more than 30% after being stored for 16 weeks is the result of cultivation treatment in open land with fertilizer using chicken compost or cow dung compost. However, the number of damaged cultivars in the greenhouse averaged less than 5% with the average number of apical buds per tuber of 3.85 ± 0.57 and the average viability of 90.6 ± 0.7%. The best potato seeds are the result of cultivation in greenhouse with leaf compost.

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REFERENCES

[1] Abbasi, Kashif Sarfraz and Masud, Tariq and Qayyum, Abdul and Khan, Sami Ullah and Abbas, Shabbar and Jenks, Matthew A. (2016) *Storage stability of potato variety Lady Rosetta under comparative temperature regimes.* Sains Malaysiana, 45 (5). pp. 677-688. ISSN 0126-6039

[2] *Afifah Farida Jufri, Megayani Sri Rahayu, dan Asep Setiawan. 2015.* Handling of Seed Potato Storage (Solanum tuberosum L.) in Bandung. Jurnal of Agrohorti Vol 3, No 1 (2015)

[3] Ayie, Y. Setiyo, I.B.P. Gunadnya, G. Mainaka. 2012. Rapid Test of Viability on Potato G5 With Immersion Treatment Using Chlorine and Gibreline Acid Solutions. Proceedings of PERHORTI National Seminar. Denpasar.

[4] Dandago, M.A. and Gungula, D.T. 2011. Effects of various storage methods on the quality and nutritional composition of sweet potato (*Ipomea batatas* L.) in Yola Nigeria. *International Food Research Journal 18: 271-278 (2011)*

[5] Setiyo, Y., Supartha Utama, Budi Susrusa, IBP Gunadnya. 2012. Productivity Optimization of Granola G3 Potato With Implementation of Plastic Mulch Technology and In-situ Bioremediation Process. Proceedings of the National Seminar of PERTETA Denpasar

[6] Setiyo, Y., Supartha Utama, Budi Susrusa, IBP Gunadnya. 2013. Optimizing Productivity of Potato Seeds of Varieties Granola G3 With Manipulation of Fertilization Dose. UNUD WORKS FOR CHILDREN NATIONS 2013 ISBN: 578-602-7774-76-0.Udayana University

[7] Setiyo, Y., K. Budi Susrusa, Dewa Gde Mayun P, I G.A. Lani Triani. 2015. LEISA System Development On Potato Cultivation To Improve Quality and Productivity. Proceedings of National Seminar SENASTEK 2015. Bali

[8] Setiyo, Y., I.B.W. Gunam, I.B.P. Gunadnya, Budi Susrusa, Dewa Gde Mayun Permana, and IGA Lani Triani. Improving Soil Physical And Chemical Characteristic On Potatoes (Solanum tuberosum L.) Cultivation By Implementation Of LEISA System. IC-Fanres Symposium Malang 2015. Agriculture and agricultural science procedia. 2016; 9; 325 -331.

[9] Setiyo, Y., I.B.W. Gunam, I.B.P. Gunadnya, and Budi Susrusa. The implementation of low external input sustainable agriculture system to increase productivity of potatoes (*Solanum tuberosum* L.). Journal of Food, Agriculture & Environment JFAE. 2017; 15 (2); 62 – 67.

[10] Suaryanti. 2012. Antagon Fungus and Bacteria Activity Is Against Fusarium Wilt Disease On Potato Plant in Bedugul Bali. Thesis S-2 PS. Biology of Udayana University. Denpasar

[11] Sudjatha, W dan Wisaniyasa, W. 2001. Physiology and Technology Post Harvest Fruits and Vegetables. Udayana University. Denpasar.

[12] Voss R.E., Extension Vegetable Specialist, Davis; K. G. Baghott, Farm Advisor, Modoc-Siskiyou Counties; and H. Timm. Proper environment for potato storage. Vegetable Research and Information Center. The University of California.

D.10

PRELIMINARY RESEARCH ON THE EFFICACY OF BIOLOGICAL AGENTS INDUCING RESISTANCE IN MAIZE PLANTS TO CONTROL DOWNY MILDEW AND LEAF BLIGHT

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ABSTRACT

The main problems in maize cultivation in Indonesia include downy mildew caused by *Peronosclerospora maydis* and leaf blight due to *Drechslera maydis*. The objectives of the study were to isolate fungi having potential to induce systematic resistance and to test its efficacy to control the intensity of maize diseases. Soils samples were taken from the rizosphere of maize plants that did not show symptoms of any disease. Each sample was placed in a plastic bag and carried in a cooler to the laboratory. Fungi were isolated from the soil by using potato dextrose agar medium with rosebengal (PDA-R). The experiment was repeated once. Maize seeds were mixed with *Trichoderma* culture of respective isolate then were planted in the soil in polybags. The plants were then inoculated artificially with suspension of *P. maydis* conidia and natural inoculation with *P. sorghi* and *D. maydis*. In the first test, the plants showed symtoms of leaf blight, but not downy mildew symptoms. The treatment had no significant effect on leaf blight or plant height. In the second test, the plant showed symptoms of both downy mildew and leaf blight. In the Pioneer variety, the treatment did not significantly affect the incidence of downy mildew, while in the local IR varieties three *Trichoderma* isolates decreased disease incidence 21 days after inoculation. The treatment had no significant effect on the severity of leaf blight. In local IR varieties, three *Trichoderma* isolates increased plant height, while in Pioneer variety the treatment had no significant effect.

Keywords : maize, induced systemic resistance, downy mildew, maize leaf blight, *Trichoderma*

I. INTRODUCTION

So far, one of the main problems in the cultivation of maize is the downy mildew commonly found in all maize producing areas in Indonesia ([1]–[5]). The affected maize plant shows localized or systemic symptoms of chlorosis so they fail to produce kernels if young plants are infected or form little seeds if older plants are attacked [5], [6].

Downy mildew of maize is caused by *Peronosclerospora* spp. Previously, the name of the pathogen was *Sclerospora maydis* (Rac.) Butl. Shaw states that *Peronosclerospora* is separated from *Sclerospora* by forming a conidia (sporangia) that instantly germinates by forming germ tubes. This pathogenic fungus is obligate and can be transmitted through seeds and wind [5], [6].

In the field, disease control is generally done by planting resistant cultivars and/or seed treatment using synthetic fungicide such as metalaxyl [5], [6]. Many of the maize seeds sold have been treated with metalaxyl. However, in the field, there are still frequent bursts of downy mildew in Indonesia, including in Lampung Province. It is important to investigate whether the affected plants are from seeds not subjected to metalaxil or planting resistant varieties and metalaxil applications are sometimes ineffective. Another possibility is that the failure of the fungicide application is caused by the fact that the disease occur after the effect of metalaxyl is diminished. The application of metallaxil has been based on the notion that the incidence of bulai only occurred during the initial growth of maize crop (14 days). In fact it turns out that in some varieties of the disease many occur after the plants are 14 days, even up to 45 days after planting. Another possibility is that the failure to plant new varieties may be due to the emergence of new resistant strains of *Peronosclerospora* spp. [5] or other causes.

Therefore, it is necessary to find another way to control downy mildew of maize. The strategy we propose here is the use of biological agents of fungi that induce resistance to maize plants resistant to the pathogens.

It has been found that fungal isolates can be used as an agent inducing systematic resistance in maize plants to various pathogens abroad such as *Trichoderma harizianum* Strain T-39 in tomato, chilli, tobacco and lettuce, *T. harzianum* T-22 strains in maize, rice, Chilies, etc. So far this agent has been studied more as an antagonist, not as an inducer for resistance to the disease proposed in this study [7].

The objective of this study was to isolate fungal isolates that had potential as an ISR booster of maize rhizosphere and to select isolates based on the inducing power of the isolates to cause resistance to plants.

II. THE MATERIALS AND METHODS

A. Isolation of Biological Agents

Five soil samples were were taken from two maize fields in Central Lampung and three maize fields in Metro. Soil samples were taken from the rizosphere of healthy maize plants around the plant showing downy mildew symptoms. Each soil sample was placed in a plastic bag and carried in a thermos of ice/cooler to the laboratory. Isolation of fungi from the soil samples was done by using potato dextrose agar medium with rosebengal (PDA-R). Rosebengal (40 ppm) serves to minimize the fungal colony without inhibiting its growth and suppress the growth of bacteria. A total of four isolates suspected *Trichoderma* were obtained from a Metro soil sample and transferred to PDA-L media to obtain pure culture. Furthermore, all four *Trichoderma* isolates were identified to species based on Gams & Bisset [8].

B. Efficacy Tests

The efficacy test was conducted for six isolates of *Trichoderma*, four isolates resulted from our current isolation and the other two isolates taken from the previous study. Each *Trichoderma* isolate was grown on PDA-L (potato dextrose agar added lactic acid) medium. The maize seeds were soaked in sterile distilled water for 5 minutes then transferred into a small plastic bag. *Trichoderma* culture aged 7 days shrunk with a scalpel and then put into the plastic and mixed evenly with the maize seeds. In the control treatment, maize seeds were only soaked in sterile distilled water. Ten maize seeds were planted 3 cm deep on a planting pot with a diameter of 22 cm. The efficacy test was performed twice. In the first test, local IR varieties were used. In the second test, two experiments were performed separately for each of the Pioneer 27 (P27) and local IR varieties.

C. Inoculation of Maize Plants with P. sorghi and D. maydis

Plant inoculation with *P. sorghi* was done naturally and manually, while inoculation with *D. maydis* was only done naturally. Natural inoculation with *P. sorghi* was performed at 7 days after planting (DAP) and artificial inoculation was performed at 10 HST. Natural inoculation was done by placing six plants with symptoms of downy mildew and daun blight, they were four plants each of four experimental field corners and two plants were in the middle of the field.

Inoculation of plants with *P. sorghi* artificially done at 5:00 am. Previously conidia were harvested from the underside of maize leaves that showed symptoms. Spore suspension of 10^6 ml^{-1} was used in inoculation by spraying with hand sprayer until all surfaces of the maize leaves were wet.

D. Observation and Data Analysis

The variables observed were disease incidence of downy mildew, disease severity of leaf blight, plant height and weight of dried stalk. Observations were made during 14 - 50 days after planting with a 3-day interval. The incidence of downy mildew was calculated by the formula of ID = n / N x 100% with ID = incidence of downy mildew (%), n = number of symptomatic plants, and N = total plants observed. The severity of leaf blight was calculated using a score of leaf blight symptoms from 0 (asymptomatic) to 5 (over 80% of plants showed symptoms) and calculated severity with of formula SD = Σ (nxv) / ZN x 100% with SD = disease severity (%), n = number of plants with a certain score, z = score value on a particular plant, N = total number of plants observed, and Z = highest crop scores. To know the weight of the dried plant, the plant was taken at 50 days after planting, the roots are washed, then dried in the sun to dry. The plants of each treatment were cut into small pieces and wrapped in newspapers then ovened at 70 ^{0}C for 3 days then weighed.

The data obtained were then analyzed statistically with ANOVA and if the F test was significantly different then the analysis was continued with Duncan test. All tests were performed at the 5% significant level.

III. RESULTS AND DISCUSSION

A. Results

1. Symptoms and Diagnosis.

In the first test, the disease that occured only maize leaf blight, while downy mildew did not occur. Symptoms of maize leaf blight were small brownish spots at first then developed and elongated. In some leaves several spots converged to form a wide necrotic leaf tissue that colored like straw. The observation of fungal conidia indicates that the casual agent was *Drechslera maydis*.

In the second test, downy mildew and leaf blight occurred on test plants. The symptoms of downy mildew could be observed 4 days after inoculation. The symptoms were necrotic tissue on the leaves. The necrotic tissue extended and eventually covered the entire leaf surface. A few days later, a white thin layer was formed and developed on the lower surface of the leaves, which consisted of conidiofors and conidia. The observation of fungal conidia indicated that the pathogen was *Peronosclerospora sorghi* that formed oval conidia.

2. Isolation of Trichoderma and First Efficacy Test.

Out of five soil samples taken in Metro and Central Lampung, one sample taken form Metro yielded four *Trichoderma* isolates: M21 (*T. reseei*), M22 (*T. koningii*), M22 (*T. koningii*), and M23 (*T. koningii*). The efficacy test was performed twice for all four isolates as well as two isolates from the collection in the laboratory: TV isolates (*T. Viride*) and TK (*T. koningii*) (Table 1). In this first test, treatment did not significantly affect leaf blight (Table 1) or plant height (Table 2).

Table 1. Severity of leaf blight in local IR cultivar 4 weeks after inoculation in maize treated with various isolates *Trichoderma* spp.

Treatment[1)]	Disease Severity (%)
Control +	39,85
Control -	46,97
TV (*T. viride*)	46,45
TK (*T. koningii*)	45,97
M21 (*T. reseei*)	44,18
M22 (*T. koningii*)	47,39
M23 (*T. koningii*)	44,90
M24 (*T. koningii*)	44,07

[1)]Control + = plants not receiving *Trichoderma* treatment, but inoculated with *P. sorghi.*
Control - = plants not receiving *Trichoderma* treatment and were not inoculated with *P. sorghi*.
The treatment did not significantly affect the severity of leaf blight disease.

Table 2. The height of maize plants treated with various isolates of *Trichoderma* spp.

Treatment[1)]	Height (cm) 1 and 2 weeks after planting	
	1	2
Control +	6,91	40,07
Control -	8,67	41,27
TV (*T. viride*)	7,73	42,67
TK (*T. koningii*)	7,20	40,97
M21 (*T. reseei*)	8,26	42,50
M22 (*T. koningii*)	8,17	41,97
M23 (*T. koningii*)	7,31	42,53
M24 (*T. koningii*)	8,18	41,03

[1)]Note like Table 1.

3. Second Efficacy Test.

In the second test, both maize leaf blight and downy mildew occurred on tested plants. The treatment did not significantly affect the incubation period of both local IR and P27 varieties (Table 3). The treatments significantly affected the incidence of downy mildew on the the local IR variety, but did not significantly affect the incidence on P27 variety (Table 4). Isolate TK (*T. koningii*), M22 (*T. koningii*), and M23 (*T. koningii*) decreased the incidence of the disease significantly (P <0.05). The disease progress of downy mildew on local IR and P27 varieties could be seen in Fig. 1 and 2, respectively.

Table 3. The average of incubation period of downy mildew on local IR variety and P27 derivative

Treatment	Inkubation Period (days) [1)]	
	Lokal IR	P27
Control	5.67	5.67
TV (*T. viride*)	5.67	7.67
TK (*T. koningii*)	6.33	8.33
M21 (*T. reseei*)	5.33	7.33
M22 (*T. koningii*)	5.00	7.00
M23 (*T. koningii*)	5.33	7.67
M24 (*T. koningii*)	4.33	6.67

[1)]The treatment did not significantly affect the incubation period of downy mildew.

The treatment did not significantly affect the severity of leaf blight disease in local IR varieties or P27 derivative (Table 5). For plant height variables, the treatments had significant effect on plant height on local IR variety, but had no significant effect on P27 variety (Table 6). Isolates of TV (*T. viride*), M23 (*T. koningii*), and M24 (*T. koningii*) increased the yield of maize significantly (P <0.05). The treatment also had no significant effect on dry weight of whole plants on local IR variety or P27 derivative (Table 7).

Table 4. The incidence of downy mildew on local IR variety 8 weeks after inoculation and on P27 variety 6 weeks after inoculation

Treatment	Disease Incidence (%)[1)]	
	Lokal IR	P27
Control	88.89 a	100.00
TV (*T. viride*)	70.83 abc	85.93
TK (*T. koningii*)	50.00 c	75.00
M21 (*T. reseei*)	79.17 a	93.33
M22 (*T. koningii*)	53.81 bc	93.33
M23 (*T. koningii*)	57.14 bc	73.90
M24 (*T. koningii*)	86.31 a	92.50

[1)]Values followed by the same letter were not significantly difference.

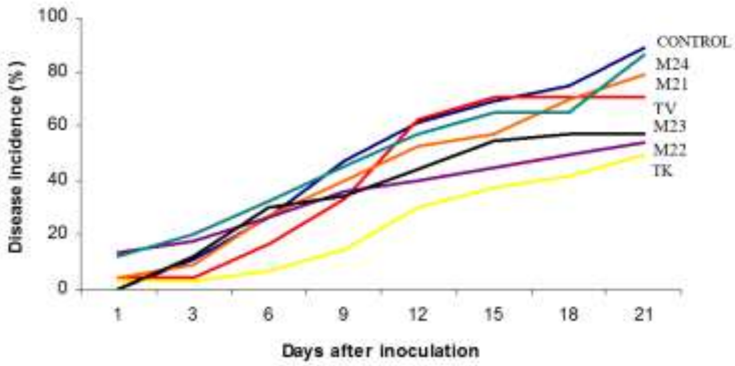

Fig. 1. The incidence of downy mildew on maize plants of local IR variety.

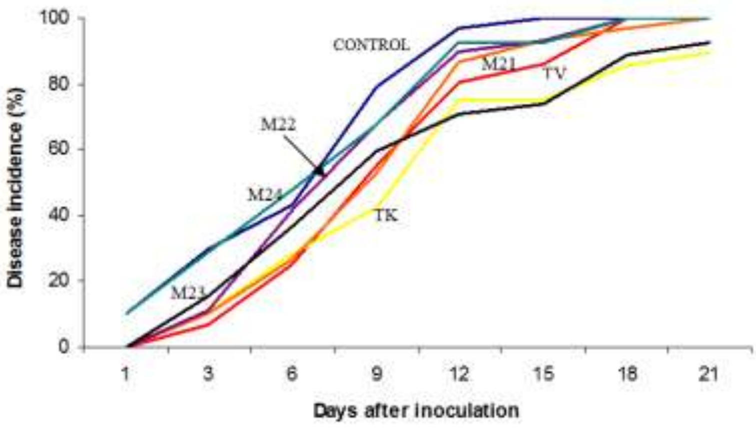

Fig. 2. The incidence of downy mildew on maize plants of P27 variety.

Table 5. The severity of maize leaf blight in local variety and P27 derivative at 24 days after inoculation

Treatment	Disease Severity (%)[1)]	
	Lokal IR	P27
Control	77.02	92.63
TV (*T. viride*)	65.23	83.32
TK (*T. koningii*)	71.63	81.38
M21 (*T. reseei*)	71.42	88.82
M22 (*T. koningii*)	67.81	87.83
M23 (*T. koningii*)	64.05	87.60
M24 (*T. koningii*)	68.87	87.80

[1)]The treatment did not significantly affect the severity of maize leaf blight.

Table 6. Plant height of lokal IR dan P27 on 21 days after inoculation

Treatment	Plant Height[1)]	
	Lokal IR	P27
Control	58.62 a	58.97 a
TV (*T. viride*)	68.43 bc	56.67 a
TK (*T. koningii*)	61.29 ab	68.57 a
M21 (*T. reseei*)	58.69 a	64.00 a
M22 (*T. koningii*)	58.17 a	65.90 a
M23 (*T. koningii*)	69.75 bc	69.87 a
M24 (*T. koningii*)	71.35 c	69.67 a

1)For each column, values followed by the same letter were not significantly difference.

Tabel 7. Dry Weight of Whole Plants of local IR and P27 varieties

Treatment	Dry Weight of Whole Plants[1)]	
	Lokal IR	P27
Control	15.83	14.78
TV (*T. viride*)	53.99	19.41
TK (*T. koningii*)	48.19	33.74
M21 (*T. reseei*)	53.99	19.41
M22 (*T. koningii*)	30.48	22.51
M23 (*T. koningii*)	30.38	30.06
M24 (*T. koningii*)	35.55	24.09

1)The treatment did not significantly affect the severity of maize leaf blight.

B. Discussion

The pathogen causing downy mildew in Lampung was so far thought to be *P. maydis* [5]. However, the observation of fungal conidia in this study showed that the form of conidia was oval indicating that causal agent of the disease was *P. sorghi* [9], [10], [11] while conidia of *P. maydis* is spherical.

Trichoderma application significantly affected the incidence of downy mildew on local IR variety, but had no effect on P27 variety (Table 4). The results of this study indicated the presence of differences between varietal responses to *Trichoderma* applications. This needs to be noted in future research in the development of *Trichoderma* application to affect the resistance of maize crops. In addition, there were different effects among *Trichoderma* isolates. These data showed the prospective of research in this area. In future research, more isolates of *Trichoderma* should be isolated and tested to give better opportunity to find isolates effective to induce resistance.

The mechanism of reducing the incidence of downy mildew on local IR variety was not investigated, but it could involve several enzymes. Peroxidase and polyphenoloxidase play a role in defense mechanisms against pathogens through the oxidase of phenolic compounds into quinine leading to increased antimicrobial activity so that it can directly halt the development of pathogens (Ozbay and Newman, 2006 and Melo *et al*., 2006 in [12]). Similarly, reference [13] with *T. virens* as an resistance inducer, it was suggested that *T. virens* controlled tomato wilt disease by the mechanism of increasing peroxidase enzyme (PO) and polyfenol oxidase (PPO) activity.

Reference [14] reported that the application of *T. harzianum* on soil media can cause chili stems to resist *Phytophthora capsici* attack. The roots of the maize plant applied with *T. harzianum* T-22 caused that the leaves become resistant to *Colletotrichum graminicola* [15]. Resistance was formed by increased enzymes (proteins) that play a role in the resistance of maize to leaf disease [16]. Reference [17] and [18] suggested the same mechanism.

Local IR variety responded by decreasing the incidence of downy mildew due to application of each of three *Trichoderma* isolates (Table 4). However, the same treatment did not succeed in suppressing the severity of leaf blight in the two efficacy trials performed on local IR varieties. This indicates that the resistance response that occurs in maize plants due to *Trichoderma* treatment depended upon the pathogens that attack the plant. This needs to be further investigated.

IV. CONCLUSION

Trichoderma isolates had no significant effect on leaf blight or plant height. The ttreatment did not significantly affect the incidence of downy mildew on the Pioneer variety, while three *Trichoderma* isolates decreased disease incidence on the local IR varieties 21 days after inoculation. In addition, three *Trichoderma* isolates increased plant height on local IR varieties, but bot on Pioneer variety.

REFERENCES

[1] Anonim, 2011. Teknologi pengendalian penyakit bulai pada jagung [In Indonesian: Control Technologies of Downy Mildew on Maize]. Badan Penyuluhan dan Pengembangan SDM Pertanian, Kementerian Pertanian.

http://cybex.deptan.go.id/ penyuluhan/teknologi-pengendalian-penyakit-bulai-pada-jagung. Diakses pada 7 Maret 2013.

[2] Surtikanti. 2012. Penyakit bulai pada jagung [In Indonesian: Downy mildew on maize]. Suara Perlindungan Tanaman Vol. 2, No. 1. http://jurnal.peipfi-komdasulsel.org/wp-content/uploads/2012/01/9-surtikanti-penyakit-bulai-2.pdf. Diakses pada 7 Maret 2013.

[3] Surtikanti & Efendi, R. 2010. Penampilan ketahanan beberapa genotipe jagung terhadap intensitas serangan penyakit bulai (*Peronosclerospora* sp.) [In Indonedian: Performance of resistance of several genotypes of maize to the intensity of disease]. Prosiding Pekan Serelalia Nasional 2010. http://balitsereal.litbang.deptan.go.id/ind/images/stiries/p47.pdf. Diakses pada 7 Maret 2013.

[4] Talanca, A.H. 2011. Reaksi beberapa varietas jagung hibrida terhadap penyakit bulai [In Indonesian: Reaction of several varieties of hybrid maize to downy mildew]. Prosiding Seminar Serealia Nasional 2011.

[5] H. Semangun, *Penyakit-penyakit Tanaman Pangan Di Indonesia* [In Indonesian: *Diseases of Food Crops in Indonesia*], Yogyakarta, Indonesia: Gadjah Mada University Press, 2004.

[6] G.N. Agrios, *Plant Pathology*, 5th ed., Burlingkton, USA: Elsevier Academic Press, 2005.

[7] G.E. Harman, C.R. Howell, A. Viterbo, I. Chet, and M. Lorito,"Trichoderma species – opportunistic, avirulent plant symbionts," *Nat. Rev. Microbiol*., vol. 2, pp. 43–56, 2004a.

[8] G. E. Harman and C. P. Kubicek, eds., *Morphology and identification of Trichoderma.*, in: Trichoderma & Gliocladium. London, England: Taylor and Francis, 1998, vol. 1.

[9] .... (2012) The CIMMYT website. [online]. Available:. http://maizedoctor.org/downy-mildew-extended-information.

[10] Hikmahwati, T. Kuswinanti, Melina, and M.B. Pabendon, "*Karakterisasi morfologi* Peronosclerospora *spp., penyebab penyakit bulai pada tanaman jagung, dari beberapa daerah di Indonesia* [In Indonesian: Morphological characterization of *Peronosclerospora* spp., the causal agent of downy mildew on maize, from several regions of Indonesia]," *J. Fitomedika,* vol. 7, pp. 159–161, 2011.

[11] Muis, N. Nonci, and M.B. Pabendon,"Geographical distribution of *Perenosclerospora* spp., the causal organism of maize downy mildew, in Indonesia," *AAB Bioflux*, vol. 8, pp. 143–155, 2016.

[12] A.A. Houssien, S.M. Ahmed, and A.A. Ismail,"Activation of tomato plant defense response against *Fusarium* wilt disease using *Trichoderma harzianum* and salicylic acid under greenhouse conditions," *Res. J. of Agric. and Biol. Sci*., vol. 6, pp. 328–338, 2010.

[13] D.J. Christopher, T.S. Raj, S. Rani, and R. Udhayakumar,"Role of defense enzymes activity in tomato as induced by *Trichoderma virens* against Fusarium wilt caused by *Fusarium oxysporum f. sp. Lycopersici*," *J. Biopesticides,* vol. 3 (1 Special Issue), pp. 158–162, 2010.

[14] A.S. Ahmed, C.P. Sanchez, and M.E. Candela,"Evaluation of induction of systemic resistance in pepper plants (*Capsicum annuum*) to *Phytophthora capsici* using *Trichoderma harzianum* and its relation with capsidiol accumulation," *Eur. J. Plant Pathol.,* vol. 106, pp .817–824, 2000.

[15] G.E. Harman, R. Petzoldt, A. Comis, and J. Chen,"Interaction between *Trichoderma harzianum* T22 and maize inbreed line Mo17 and effedts of these interactions on diseases caused by *Pythium ultimum* and *Colletotrichum graminicola*," *Phytopathol*, vol. 94, pp. 147–153, 2004b.

[16] M. Shoresh and G.E. Harman,"The molecular basis of shoot responses of maize seedling to *Trichoderma harzianum* T22 inoculation of the root: A proteomic approach," *Plant Physiol.*, vol. 147, pp. 2147–2163, 2008.

[17] S. Djonovic, M.J. Pozo, L.J. Dangott, C.R. Howell, and C.M. Kenerley,"Sm1, aproteinaceous elicitor secreted by the biocontrol fungus *Trichoderma virens* induces plant defense responses and systemic resistance," *Molec. Plant Microbe Interact.*, vol 8, pp. 838–853. 2006.

[18] S. Djonovic, W.A. Vargas, M.V. Kolomiets, M. Horndeski, A. Weist, and C.M. Kenerley," A proteinaceous elicitor Sm1 from the beneficial fungus *Trichoderma virens*, is required for systemic resistance in maize," *Plant Physiol.*, vol. 145, pp. 875–889, 2007.

D.11

STRUCTURE, BEHAVIOR, AND PERFORMANCE OF RUBBER MARKETING IN SINTANG DISTRICT ON WEST KALIMANTAN

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ABSTRACT

This study aims at identifying the structure, the conduct and the performance of the market at the community rubber located at Sintang Regency. That Sintang Regency is one of the larges rubber producing in West Kalimantan Province. The length of the marketing chain depends on the number of marketing organizations involved in the marketing This research was conducted from January to June 2016. The primary data were obtained from 153 rubber farmers from three sub-districts and 15 marketing organizations involved in the community rubber marketing. The marketing organizations were made up of 9 small traders and 6 wholesalers. The snowball sampling method was used to determine the samples of the organizations involved in marketing rubber. The secondary data were obtained from library research, documentation and from the related institutions. The data were analyzed using *market share*, herfindal index, CR4, analysis of price correlation and price transmission; marketing margin, the shared price received by the farmers and Profit and cost ratio. The results of the study show that there are four marketing channels as far as the community rubber marketing at Sintang Regency is concerned. They are: (1) the farmers → small traders → wholesalers → district exporter; (2) the farmers → wholesalers → district exporter; (3) the farmers → small traders → wholesalers → province exporter; (4) the farmers → wholesalers → province exporter. From the results of the analysis of the market share, CR4 and herfindal index, it can be concluded that the structure of community rubber market at Sintang Regency tended to develop to the oligopsony market structure. Market behavior is indicated by the imperfectness of rubber price integration on one market with rubber prices in other markets, both horizontally and vertically; From market performance, the biggest marketing margin occurs on marketing channel 3 which is Rp. 7,700, - per kg, and the lowest on marketing channel 2 is Rp. 4,500, - per kg, while the largest share received by farmers in each region is also found in channels two and four, respectively at 60.9 percent and 52.7 percent. Therefore, it can be stated that the performance of the community rubber market at Sintang Regency was inefficient yet. The reason is that there was no equal share received the marketing organizations. In other words, the community rubber market at Sintang Regency, if viewed from the market structure, behavior and performance, was inefficient yet.

Keywords : marketing, rubber, community, structure, behavior and performance.

I. INTRODUCTION

Plantation sub sector has great potential and strategic value, both in economic development and in employment. The economic development of this sub-sector can be judged from the development of plantations and production value. Currently, plantation area reached 19.53 million hectares with smallholder plantations 74%, 6% of the country estates and private estates 20% with an average growth rate reached 3.67% per year [1].

Nominal GDP at current prices plantation sub-sector increased, namely from Rp.63,40 trillion in 2006 to Rp.153,88 trillion in 2011, growing an average of 19.78% per year.

One of the strategic commodities of plantation sub-sector is rubber that has developed rapidly in the last few decades, both from plantation area and production value. Rubber agribusiness conditions at this time indicates that the rubber is managed by the people, country estates and private plantations. The growth of smallholder rubber is still positive although slow, that is 1.58% / year, while the state and private plantations are equally decreased to 0.15% / year. Therefore, the foundation of rubber development will be more on smallholder agriculture. Rubber plantation area in 2011 totaled more than 3.4 million ha spread across Indonesia. Of which

85% is owned rubber plantations of the people, and only 7% of large estates and 8% state owned large private estates. This amount will be increased further still by rejuvenating and empowering land-agricultural land owned by farmers as well as vacant land / unproductive suitable for rubber plantations [2].

Indonesia is the world's second largest producer of natural rubber (about 28 percent of world rubber production in 2010), slightly behind Thailand (about 30 percent). Although in terms of production area Indonesia (3.4 million hectares) is the largest, but its productivity is still far behind Malaysia (1.6 million hectares) and Thailand (2.8 million hectares), the average productivity of Indonesian rubber only 926 Kg/ha/year, while Malaysia 1,450 Kg/ha/year and Thailand 1,705 Kg/ha/year. Productivity problem occurs in people with a rubber plantation garden is largely a condition of the old rubber plants were less well maintained (not fertilized), using a random seed, bokar low quality so that productivity is still far below the normal potential. In 2011, the productivity of smallholder rubber plantation reached 926 kg/ha/year compared to country plantation that has reached 1,327 kg/ha/year and Big Private Plantation reached 1,565 kg/ha/year (Ministry of Agriculture, 2015).

Smallholder rubber plantations in West Kalimantan, especially in Sintang has already entrenched in the lives of everyday people and has been the main livelihood. Generally operated by small-scale farmers in the traditional system. In contrast with those which is afforded by the publi /private company, where the operation is done on a large scale with modern technology systems.

The productivity of smallholder rubber in Sintang is around 1,049 kg/ha/year (Heri, 2011). It has been higher than the national smallholder rubber productivity, but still considered not been optimal yet and still can be improved. Besides, the quality of the processed rubber is also low. One reason is the factor of technology ownership and resource capacities of farmers is still low, so thatwhen it comes to the market, Indonesian rubber product known as low quality product. While Thailand and Malaysia remain able to maintain their quality of the rubber product, so they are still able to control the rubber market in the World.

International natural rubber prices had reached the highest average price of US $ 4.5/kg in 2011, even though prices received by farmers only 10000-18000 Rp/kg at that time (Gea, 2011). This is consistent with the statement of Mubyarto and Dewanta (1991) that farmers receive tapping rubber prices (sleb) amount up to 25-30% of the export price of natural rubber, which is relatively low when compared to Malaysia, where the Malaysian rubber farmers receive 70-80% of the export price (FOB).

Mastery of market information by farmers today is considered very less, the orientation of the farmers are still focused on *on-farm* and many of them still do not understand much about the processing and marketing. In addition, the government, does not providing agricultural information to farmers, especilly about the price of agricultural commodities and plantations. Most of the government's attention is directed to things like counseling, provision of seeds and fertilizer and agricultural regulations. In fact, things like that do not create sustainable livelihoods for farmers. Farmers shall have adequate fertilizer, seedlings, plant knowledge and are also protected through regulation. However, farmers still do not have the information and the capability to determine the ideal market price, determine commodity prices and take advantage of the sale of their commodities.

The price of rubber is determined by the middlemen in which was subsequently accepted by the farmers. Rubber farmers themselves have almost no bargaining power against the price determined by the middleman. In the economic field, if one of the parties of a transaction has more information or better than the other party is called asymmetric information. Generally, the seller who has more information about the product than the buyer, even though the opposite may also occur.

The marketing system undertaken by the large plantations have been relatively integrated. In contrast, smallholder’s rubber marketing system covering approximately 85% of the total Indonesian production has not been coordinated, so that there are technical and economic inefficiencies that need to be addressed. Most people's plantation locations in Sintang located in the hinterland, while the location of the processing plant around the capital of Province or the export port. Besides, the applicable payment system is still based on the weight of the wet rubber, so that in the process of buying and selling in real trade only approximately 50% of dry rubber, the rest consisting of dirt, water and materials instead of the rubber. The two things lead to high transportation costs and poor quality if the rubber material (bokar) traded. Based on the above problems, the purpose of this study is to identify the structure, behavior and performance of markets in rubber marketing people in Sintang.

II. MATERIALS AND METHODS

The basic method used in this research is descriptive analytical method, a method that focuses on solving the problems that exist. The data has been collected, initially prepared, described and then analyzed (Surakhmad, 1994).

Siting study was done intentionally *(purposive sampling),* namely by selecting the location of research in Sintang which is a center of rubber production in West Kalimantan. The selection of District of Sepauk, District Tempunak, and Sei. Tebelian were taken randomly from the fourteen existing sub-district. The number of farmers as the respondent is determined as much as 150 respondents farmer who were distributed evenly on each sub-district.

Marketing agencies involved ranging from farmers until the factory is determined by the method of *snowball* sampling,namely the determination of respondents marketing agencies that initially based on information from the respondents farmers, the next based on marketing agency designated by the respondents farmers, and so on until the saturation of the respondent or respondents difficult to achieved. This model is used because the target population of the marketing agency is unknown and difficult to reach by other means [7].

A. Market Structure of Smallholder Rubber

Market structure is a market classification based on its structure. In this case the analysis of smallholder rubber market structure is seen from the farmer up to the level of final consumers (factories). In this study, to look at the structure of the market used market share analysis, the concentration ratio of the four largest companies, the Herfindahl Index.

1. Market Share

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Table 1. *Market Share* Marketing Agencies

Marketing Agencies	purchasing capacity	Market share	*Market share* (%)
1	A	a / x	(a / x). 100%
2	B	b / x	(b / x). 100%
3	C	c / x	(c / x). 100%
4	D	d / x	(d / x). 100%
....	....	....	
N	M	m / x	(m / x). 100%
Total	a + b + c + d + ... + m = x		1100

Criteria for market share:
1. Pure Monopsoni, if a company owns 100% of the market share
2. The dominant Company, if it has 50-100% of market share and without a strong competitor.
3. Tight Oligopoli, if the merger of four leading companies have 60 to close to 100% of the market share.
4. Loose Oligopoli, when the merger of four leading companies have 40% or less of the market share.
5. Monopolistic competition, if many of the efffective competitors none of them has more than 10% market share.
6. Pure Competition, more than 50 competitors, but none have a significant market share (Jakarta, 2001).

2. Herfindahl Index (IH)

This analysis tool is intended to determine the degree of concentration of buyers in a market area, so, the picture of the balance bargaining power of farmers (sellers) to traders (buyers) can be known generally. The Formula of Herfindahl index is as follows:

$$\mathrm{IH} = \sum_{i=1}^{n} (\mathrm{Pi})^2 \tag{1}$$

Where:
IH :Herfindahl index
n :The total number of companies in the industry
Pi :The market share of industry i-th

Assessment criteria (Sumarno et al, *in* Roniardian, 2002):
1. IH = 0: the structure of the relevant market are likely to perfectly competitive market
2. IH = 1: the structure of the relevant market tends to monopsony market
3. 0 <IH <1: the structure of the market tends to oligopoly / oligopsony

3. The concentration ratio (CR4)

CR4 is an analytical tool to determine the degree of concentration of the four largest buyers of a market area, according to the formula:

$$\mathrm{CR}_4 = \frac{\mathrm{P}_1 + \mathrm{P}_2 + \mathrm{P}_3 + \mathrm{P}_4}{\mathrm{TPP}} \tag{2}$$

CR_4 : The concentration ratio of the four biggest buyer company

P_n : The market share of the biggest companies to- n
TPP : Total share purchases that exist

The Rating:
1. CR4 < 0.4 means perfect competitive market structure (competitive) or monopolistic competition (monopolistic competition needs to be seen whether there is product differentiation)
2. 0.4 < CR4 < 0.8 means the market structure is olygopoly / oligopsony (often when the CR4 value between 60-80% is called a tight oligopoly and CR4 value between 40-60% is called loose oligopoly, although the meaning is often unclear as to measure the power of an oligopoly / monopoly can be tested through *market power* but is discussed further.
3. CR4> 0 , 8 the structure of the market tends to monopoly / monopsony (Martin, 1994).

B. Market Behavior of Smallholder Rubber

In this study, to see the market behavior can be used the analysis of market integration. According to Tomek and Robinson (1990), vertical market integration can be used to view the state of the market in the local / village, sub-district, district and province, or between producers market with consumer markets. Analysis of market integration can be seen through the analysis of price correlations and price transmission elasticity.

1. Coefficient of Correlation Price

To find out the relationship or how much the effect of price changing in producer level with consumer level, the analysis of market integration is used by using Gujarati model (1993) of regression analysis as follows:

$$Pfi = \beta_0 + \beta_1 \, Pri + \varepsilon \tag{3}$$

Where:
PFI : farmgate prices
Pri : end consumer prices (factory)

correlation coefficient between Pr and Pf are:

$$\beta_1 = \frac{n\Sigma \mathrm{Pr}_i \, Pf_i - (\Sigma \mathrm{Pr}_i)(\Sigma Pf_i)}{\sqrt{\{n\Sigma \mathrm{Pr}i^2 - (\Sigma \mathrm{Pr}i)^2\}\{nPf_i^2 - Pf_i)^2\}}} \tag{4}$$

Where:
β1 :coefficient of correlation
Pf : Price at the farm level
Pr :Price at the level of final consumers (factories)
n :Number of sampel

If the value of coefficient correlation $\beta_{1>}$ 1, then the market structure is monopoly or oligopoly, which means the increase in the price of one unit at the consumer level is followed by the increases of greater price than 1 unit at the producer level (the market is not perfectly integrated). Vice versa, if the value of β_1 <1, means the market is monopsony or oligopsony in which the increase in the price of 1 unit at the consumer level is followed by price increases that are smaller than 1 unit at the producer level (the market is not perfectly integrated), and if β_1 = 1 1 unit means the price increases at the consumer level will be followed by the increase in the price of one unit is also at the producer level (perfectly integrated market) [13].

2. Elasticity Analysis of Price Transmission

Relations elasticity prices at the level of farmers and consumers can be seen from the elasticity of transmission costs,that is the ratio of the change in the relative of consumer prices with changes in relative prices at the producer level (Azzaino, 1982) that can be formulated as follows:

$$\mathrm{Et} = \frac{\delta \mathrm{Pr}}{\delta \mathrm{Pf}} \cdot \frac{\mathrm{Pf}}{\mathrm{Pr}} \tag{5}$$

As for the judging criteria used are as follows:
1. Et <1 means that the price changes by 1% at the retail level will lead to changes in the price of less than 1% at the farm level and shape of the market leads to a monopsony (the market is not efficient).
2. Et = 1 price changes by 1% at the retail level will lead to changes in prices of 1% at the farm level and it is a perfectly competitive market (market efficiency).
3. Et > 1 change in the price of 1% at the retail level will lead to changes in the greater price than 1% at the farm level and the shape of the market leading to a monopoly (market inefficient)[14].

C. Market Performance

Market performance is a criterion to determine how far the marketing process is running and how far the extent of its marketing objectives achieved well. In this research, market performance can be analyzed by measuring several aspects, including marketing channels, marketing margin, *the farmer's* share, the ratio of gains and costs.

1. *Marketing Margin*

To determine the marketing margin rubber which is the difference between the price at the factory level with the price at the farm level according to Sudiyono (2001) can be calculated using the formula:

$$MP = Pk - Pf \tag{5}$$

Where:
MP : marketing margins of rubber (Rp/kg)
Pk : average price of rubber at the factory / processor (Rp)
Pf : average price of rubber at the level of the farmer (Rp)

While for middlemen marketing margin represents total marketing costs coupled with merchant marketing advantage.

$$MPPi = \pi i + Bi \tag{6}$$

where:
MPPI = marketing margin traders to-i
πi = profits traders to-i
Bi = marketing costs merchants ato-i

2. *The prices received by farmers (farmer's share)*

Analysis is performed to determine the percentage of share prices that is received byrubber farmers from marketing margin, that is prices received by farmers and the prices paid by the rubber factory can be calculated using the following formula:

$$S_f = \frac{\mathrm{Pf}}{\mathrm{Pr}} x100\% \tag{7}$$

Where:
S_f = part*(share)*received by the farmers of rubber (%)
Pf = average price of rubber at the level of the farmer / grower (Rp / kg)
Pr = average price of rubber at the plant level (Rp / kg)

Then it is analyzed by calculating the percentage of share prices received by farmers in each marketing channel, based on the ratio of the price at the farm level and at the level of the factory. So, it that can be known the magnitude of the average section prices that have been received by farmers, in each marketing agencies and its marketing channels.

According to Kohl and Uhl (1980) *in* Mahreda (2002), if the *share* received by farmer less than 50%, it can be said that the marketing system is not efficient yet.

3. *Profits and Cost Ratio*

Efficiency rate of a marketing system can be seen from the amount of marketing margin and the farmer's share, also can be seen from the spread ratio of benefits and costs. The more uneven distribution of the ratio of benefits to costs in each marketing institution then technically the marketing system is more efficient (Roniardian, 2012). The ratio of benefits and costs can be used to determine how big the profits received by the marketing agency when marketing costs increased by one unit. deployment ratio of benefits and costs of each marketing agencies can be formulated as follows:

$$\pi/_{C}\ \mathrm{ratio} = \frac{\mathrm{Li}}{\mathrm{Ci}}.100\% \tag{8}$$

Where:
Li = advantage marketing agency
Ci = marketing fee

III. RESULTS AND DISCUSSION

A. Market Structure of Smallholder Rubber

Based on the research, there are two intermediary marketing agencies which play a role in bringing bokar from farmers to factory rubber that is the traders consists of 9 people and big merchants as much as 6 people. Traders are in the village, usually the original inhabitants of the village, these traders have become intermediaries between farmers and wholesalers. While wholesalers located in the District or District, which becomes the intermediary mediates between the trader and a rubber factory.

1. Market Share

The purpose of knowing the market share is to look for an idea of how farmers' bargaining position of the rubber against the existing intermediaries. Calculation of the market share of smallholder rubber marketing intermediaries are presented in Table 2.

Tabla 2. Market Share Marketing Agencies in Level Traders Gatherer Sintang 2016

Marketing Agencies	Purchase Capacity (kg)	Market share	*Market share* (%)
1	20000	0.177	17,7
2	16000	0.142	14,2
3	15000	0.133	13,3
4	15000	0.133	13,3
5	15000	0.133	13,3
6	10000	0.088	8,8
7	10000	0.088	8,8
8	7000	0.062	6,2
9	5000	0.044	4,4
Total	113000	1	100

Source: Data processed, 2017

Based on table 2 above, it can be seen that the highest market share of bokar traders was 17.7% and the lowest was 4.4%. The fact that there are no middlemen which have a market share of 100% prove that the market structure formed in rubber marketing of trader level, is oligopsony.

Table 3. *Market Share* of Marketing Agencies in Wholesalers Level in Sintang Regency 2016

Marketing Agencies	Purchase Capacity (kg)	Market share	*Market share* (%)
1	150000	0.278	27,8
2	100000	0.185	18,5
3	90000	0.167	16,7
4	80000	0.148	14,8
5	60000	0.111	11,1
6	60000	0.111	11,1
Total	540000	1	100

Source: processed data, 2017

Table 3 is no different from table 2, namely that the market structure formed in rubber marketing in the wholesale level is olygopsony.

2. Herfindahl Index (IH)

Data collected from traders and wholesalers in tables 2 and 3 above, then be used to calculate the Herfindahl index (IH). The result of the calculation of the Herfindahl index of traders is 0.126 and wholesalers is 0.186. So, this result illustrates that the market structure of the rubber people in Sintang is oligopsony.

3. The concentration ratio of 4 Wholesalers (CR4)

To know the description of market structure on the marketing of smallholder rubber in the research area, is shown in Table 4.

The result of table 4 illustrates the structural conditions of the market in the area of research that at the level of traders and wholesalers the shape is oligopsony with the CR4 value was 0.58 and 0.78.

From the test results of three kinds of analysis tools that is the calculation of market shares, herfindal index and CR_4 analysis it can be known that the structure of the wine market in the Banjar village is in *imperfect* condition that lead to the bargaining position of the wine growers are in a weak condition, farmers are always in a price taker position.

Table 4. Calculation of CR_4 Marketing of smallholder rubber

Purchase Capacity (kg)	Total Purchase of the largest four	CR_4	market structure
traders			
20000 16000 15000 15000	66000	0,58	oligopsony
wholesalers			
150000 100000 90000 80000	420000	0,78	oligopsony

Source: processed data, 2017

B. Market Behavior of Smallholder Rubber

Market behavior is closely related to the market structure, the market structure oligopsony, where there are many sellers and little/some buyers,so the trader or marketing agencies who buy bokar from the farmers can make fair prices for farmers. Especially if there is collusion from those institutions so that it discredit the farmers to accept the price*(price*takers).

1. *Coeffficient of Price Correlation*

Based on calculations using statistical applications, it is obtained the values as follows:

Table 5. Coefficient correlation value

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-561.395	170.538		-3.292	.008
	X	.471	.008	.998	56.135	.000

a. Dependent Variable: Y

In table 5 it can be seen that the coefficient correlation in farmers level with a selling price of wholesalers to rubber factory in Sintang amount to 0.471 <1, means that

The market is not perfectly integrated, any increase in the price of one unit at the level of wholesalers is followed by an increase of a smaller price of one unit at the level of the rubber farmers. The coefficient corrrelation between 0-0.5 indicates a weak correlation, means that farmers do not have a good bargaining position in determining prices.

2. *Elasticity of Price Transmission*

Transmission of price elasticity is the ratio of the changed price at farmers and at the factory level. It is calculated by using the formula:

$$Et = \frac{\delta Pr}{\delta Pf} \cdot \frac{Pf}{Pr} \tag{9}$$

From the results of the data processed from the price time series of data available, it is obtained that the value of transmission price rates of 0.28 which indicates a value of less than 1. This means that any price changes by 1 unit at the retail level will lead to changes in the price of 0.28 unit at the farmer level.

C. Market Performance of Smallholder Rubber

1. *Marketing Channel*

Based on the data obtained in the field it is found that there were four (4) rubber marketing channels. Analysis of the four marketing channels shown in Fig. 1 are:
Channel 1: Farmer rubber – traders – wholesalers – factory in the District
Channel 2: Farmer rubber – Wholesalers – Factory in the District
Channel 3: Farmer rubber – traders – wholesalers – factory in Province
Channel 4: Farmer rubber – wholesalers – factory in the Province

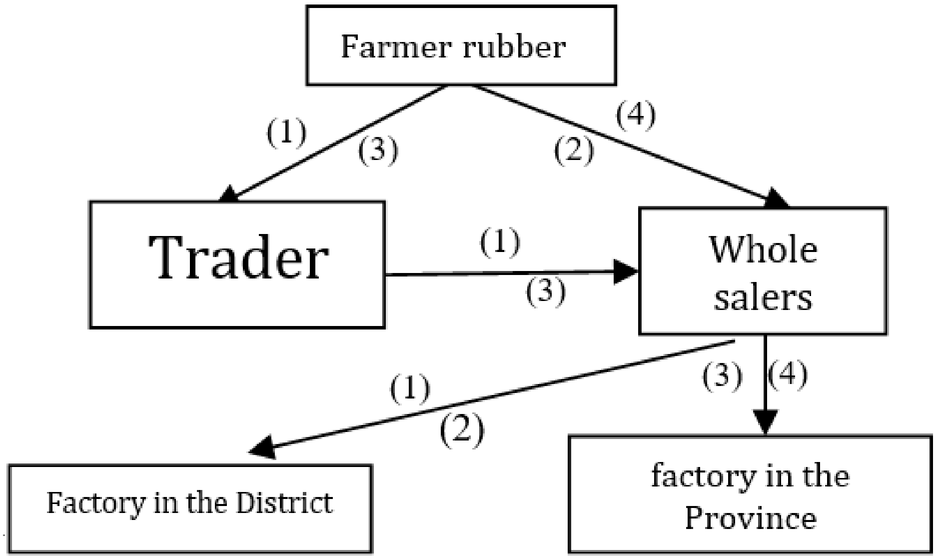

Fig. 1 Rubber Marketing Channels in Sintang Regency

2. *Marketing Margins*

Analysis result data for marketing margin can be seen in Table 6, the largest marketing margins occurs on the marketing channel 3 amount Rp. 7.700, - per kg, and the lowest is in the marketing channel 2 amount Rp. 4.500, - per kg. The data in Table 1 demonstrates that the longer the marketing chain, the greater the costs incurred by the institutions involved in the smallholder rubber marketing so that it implicates the high marketing margins.

The interesting thing to study is the number of wholesalers who sell bokar to the factories in provinces, though the costs incurred are higher than when it sold to factories in the District, but the factory in the province is willing to buy at a higher price, for example, is in Table 6 that when factory in County just bought at a price of Rp.11,500, - per kg, factories in the province inhesitant to buy at a price of Rp.15,000, - per kg. So,in mathematical calculations, it would be advantageous if bokar sold to factories in the province.

Table 6. Margin, f*armer share* and Marketing Efficiency Rubber

No	Description	Channel I	Channel II	Channel III	Channel IV
A	Farmer				
1	selling price	6500	7000	7300	7900
B	Trader				
1	Purchasing price	6500		7300	
2	Marketing Costs				
	a. taking of bokar	56		56	
	b. Shrinkage (1-3%)	65		65	
	Total marketing expenses	121		121	
3	Advantages	879		1579	
4	Selling price	7500		9000	
C	Wholesalers				
1	Purchasing price	7500	7000	9000	7900
2	marketing				
	a.load	20	20	60	60
	b.load	10	10	30	30
	c. transportation	115	115	420	420
	d. levy (tax)	120	120	120	120
	e. Depreciation (3-11%)	279	279	791	791
	f. Trucks rental	100	100	229	229
	g. Taking of bokar		50		50
	total marketing expenses	644	694	1650	1700
3	Gain	3356	3806	6050	5400
4	The selling price	11500	11500	15000	15000
D	Factory rubber				
1	The purchasing price	11500	11500	15000	15000
	Marketing Margin	5000	4500	7700	7100
	Farmer's share	56.5	60.9	48.7	52.7

3. The share price received by Farmer (Farmer's Share)

The results of data analysis shows that the highest *share* that the farmers receive from channel 1 to channel IV is through channel 2 (Farmer rubber—wholesaler -factoryin the District) that is equal to 60.9 percent.

Although it can be said that it is more profitable to sell directly to wholesalers, but this can not be done by all of the rubber farmers, especially those with a narrow land area. Farmers who sell directly to wholesalers usually are farmers with a very large rubber tree plantation exactly more than 3 hectares, so the farmers can sell directly to wholesalers with a minimum of 5 to 10 tons of all sales.

4. Profits and Cost Ratio

Table 7 describes the magnitude of the ratio of profit on each marketing channel. Marketing channel 1 has the highest profit ratio and total expense compared to other channels, that is equal to 5,53. The interpretation is that every Rp. 1.00 spent on marketing costs in this channel generated a profit of Rp. 5,53 per kilogram. The ratio of profits and the next largest expense is on channel 2 at 5,48, followed by channel 3 and channel 4 by 4,3 by 3,18.

Table 7. Ratio and Marketing Cost Advantages of Smallholder Marketing Rubber in Sintang Regency

Marketing Agencies	Cost (Rp / kg)	Profit (Rp / kg)	ratio of Profits and Costs
Marketing Channels 1			
Traders	121	879	7.26
Wholesalers	644	3356	5.21
Total	765	4235	5.53
Marketing Channels 2			
Traders	-	-	-
Wholesalers	694	3806	5.48
Total	694	3806	5.48
Marketing Channels 3			
Traders	121	1579	13.05
Wholesalers	1650	6050	3.67
Total	1771	7629	4,3
Marketing Channels 4			
Traders	-	-	-
Wholesalers	1700	5400	3.18
Total	1700	5400	3.18

Source: processed data, 2017

IV. CONCLUSION

The market structure that is formed on the smallholder rubber marketing in Sintang Regency is imperfectly competitive market and lead to oligopsony. It can be seen after analyzing the market share, the Herfindahl Index and Concentration Ratio of 4 Largest Traders (CR_4).While the behavior of smallholder rubber market indicates that the price of rubber between the marketing agency or other markets are not perfectly integrated, where farmers as *price takers* do not get the appropriate information and tend to be harmful.

Studies of the rubber on the marketing of smallholder rubber plantations in Sintang found four marketing channels. Two channels are sold to factories in the county and two other channels are sold to factories in province. Analysis of the data shows that the longer the marketing channel, the greater marketing margin in which the *farmer's share* is getting smaller and more inefficient marketing channels.

REFERENCES

[1] Romahurmuziy, M. 2011. 'Perkebunan Rakyat Sebagai Lokomotif Pengentasan Kemiskinan di Perdesaan'. *Prosiding Seminar Nasional Inovasi Perkebunan*. Litbang Perkebunan. Jakarta.

[2] Ditjenbun. 2012. *Pedoman Teknis Peremajaan Tanaman Karet*. Kementerian Pertanian Republik Indonesia. Jakarta.

[3] Heri.2011. *Produktifitas Karet Sintang Optimal*. http://www.kalimantan-news.com. Diakses tanggal 10 Desember 2012

[4] Gea, Y. 2011. *Permintaan China Melonjak, Harga Karet Melambung di Tingkat Petani*. http://www.bumn.go.id. diakses tanggal 10 Desember 2012

[5] Mubyarto, dan Dewanta Setya A. 1991. *Karet Kajian Sosial-Ekonomi*. Aditya Media. Yogyakarta.

[6] Sudiyono. 2001. *Pemasaran Pertanian*. Program Studi Agribisnis Fakultas Pertanian. Universitas Muhammadiyah Malang. UMM Press. Malang.

[7] Sarantakos, S., 1993. *Social Research*. Macmillan Education Australia PTY. LTD. Australia.

[8] Stanton, William. J, 1993. *Prinsip Pemasaran jilid 2*. (Diterjemahkan oleh : Sadu Sundaru). Erlangga. Jakarta.

[9] Jaya, Wihana K. (2001). *Ekonomi Industri*. BPFE UGM. Yogyakarta

[10] Martin, S. 1994. *Industrial Economics: Economic Analysis and Public Policy*. 2nd Edition, Macmillan Publishing Company. New York

[11] Tomek, W.G and Robinson, K.L. 1990. *Agricultural Product Prices*. Cornell University Press. Ithaca, New York.

[12] Gujarati, D. 1993. *Ekonometrika Dasar*. Terjemahan Cetakan Ketiga. Jakarta: Erlangga.

[13] Mahreda, E. S. 2002. Efisiensi Pemasaran Ikan Laut Segar di Kalimantan Selatan. Disertas*i* (*unpublished*). Universitas Gadjah Mada. Yogyakarta.
[14] Sudiyono. 2001. *Pemasaran Pertanian*. Program Studi Agribisnis Fakultas Pertanian. Universitas Muhammadiyah Malang. UMM Press. Malang.

D.12

A STUDY OF VIGOR OF STORABILITY OF SEEDS OF SOME SORGHUM (*Sorghum bicolor* L. Moench.) GENOTYPES WITH ACCELERATED AGEING

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ABSTRACT

An experiments evaluating vigor of storability of seeds of several genotypes of sorghum were conducted during March - October 2015. The sorghum seeds harvested from the planting area in Village of Marhaen, Sub district of Sulusuban, District of Central Lampung, Lampung Province, Indonesia were used in this experiment. The accelerated ageing method with temperature of 40^{0}C and relative humidity of 100% for 0 (control), 2, 4, ..., 16 days were used to make seed ageing took place fast. After each treatment applied, viability of sorghum seeds were evaluated to measure percentage of normal seedling (PNS), germination speed (GS), seed leakage (SL), and percentage of dead seeds (PDS). Grouping genotype based on vigor of storability was conducted using cluster analysis with similarity of 70% by variable of PNS. Result showed that the 34 genotypes can be grouped into four groups of vigor of storability, namely high vigor (9 genotypes), medium-high vigor (7 genotypes), medium-low vigor (9 genotypes), and low vigor (9 genotypes).

Keywords: accelerated ageing, sorghum seed, vigor of storability.

I. INTRODUCTION

Sorghum (*Sorghum bicolor* [L.] Moench.) is one of the species of the open-seeded plant class (Spermatophyta, Angiospermae), single-seeded cotyledone (Monocotiledonae), order of Poales, family of graminae (poaceae), genus of Shorghum (Iriany and Makkulawu, 2013) which has potential to be developed in Indonesia. The potential of the sorghum includes a) it is annual crops of C4 metabolism plant; b) it can produce grain 2.8-3.0 tones/ha (Pabendon *et al*., 2013) with good nutrition (71% carbohydrate, 10.4% protein, and 3.1% fat) (Ministry of Health of Republic of Indonesia, 1992) (Pabendon *et al.,* 2013), c) it can produce livestock feed (17.1-21.4 ton / ha fresh forage) (Pabendon *et al*., 2013), d) it can produce bioethanol (3900-5700 L/ ha) (Pabendon *et al*., 2013); e) it is more water-efficient crop (332 kg water per kg of dry matter) than corn (368 kg water per kg of dry matter) (House 1995, Reddy *et al*. 2005);f) its ratun plants can produce grain and fresh stover enough high (Setyowati *et al*., 2005; Efendi *et al*., 2013); and g) it can keep high production at high level of CO_2 (700 mol.mol^{-1}) and at high temperature (26-36^{0}C) (Prasad *et al*., 2006).

Level of CO2 recorded increased 35% (Keeling and Whorf, 2003) from pre-industry to 2002. In 2016, CO2 levels became 0.04%, or increased 33%, and the world average temperature increased 1.1 C^0 from before Industrial revolution 1860-1899 (Kompas.com, 2017). The monthly average temperature in Indonesia 2000-2011 was between 26.0-27,5^{0}C, with a maximum temperature of 30.2-32.1^{0}C and a minimum temperature of 23.4-24.4 ^{0}C (Fadholi, 2013)

Up to now, a lot enough of superior varieties of Indonesia sorghum had been released since 1970-2013 by Cereals Plant Research Institute in Maros (Aqil *et al*., 2013), among others 1) No.6C, 2) UPCA-S2, 3) KD4, 4) Keris, 5) UPCA-S1, 6) Badik, 7) Hegari Genjah, 8) Mandau, 10) Numbu, 11) Kawali, 12) Super-1, and 13) Super-2, 14) Suri-3, 15) Suri-4; and 3 varieties released from breeders of the National Atomic Energy Agency (BATAN) have also been released by the Government of Indonesia, namely Pahat, Samurai-1, and Samurai-2 (Human, 2012). The improved line (IL) of sorghum produced by sorghum breeders from BATAN was also a lot enough.

The problem that arises was what genotypes that have seed with high, medium, or low vigor of storability. The vigor of storability (VSA) is the functional line of the relationship between the value of viability on the Y axis and the natural time or relative time of accelerated aging intensity, and can be expressed as a straight line (Pramono, 2000; 2001; 2009a; 2009b). Differences VSA among seed lots can be expressed as the difference in slope value of the VSA line (Pramono, 2010), i.e. the larger the slope value of the VSA line the lower the VSA value of the seed lot or vice versa. This VSA was related to the storability (SA) of seed lot. The storability of seed is the ability of seeds can be stored (Sadjad, 1989) which retains high viability and vigor upon replanting. The storability can also mean the time period required by viability of a seeds lot to decrease to a certain viability value in a certain storage condition (Pramono, 2009b). The higher the VSA the higher the storability (SA) of a seed lot.

The accelerated aging method was to accelerate aging of seeds by giving seeds with treatments of high temperature (40^{0}C) and high relative humidity (100%) over a certain time interval, as introduced by Delouche and Baskin (1973). This method has been used by many researchers to differentiate the vigor of storability among seed lots, among others radish (Neeru, Kopaar, and Saxena, 2006), peanut seeds (Pramono, 2008), and soybean seeds (Pramono 2000 and 2001). This accelerated aging method can also evaluate the difference of soybean seed vigor due to differences in storage environment (Mbofung et al., 2013).

This study aimed to determine the VSA of seeds from 34 genotypes of sorghum using accelerated aging method. Furthermore, the 34 genotypes of sorghum were grouped into high, medium, and low based on the vigor of storability of its seeds. By knowing VSA with this accelerated aging method, the relative storability of the seed can be predicted. Seeds that have high relative storability can be stored longer than those with lower relative storability.

II. MATERIALS AND METHODS

A. *Seed preparation*

The sorghum seeds of 34 genotypes were harvested from late July to early August 2015 from the cultivated land in Village of Marhaen, Subdistrick of Anak Tuha, Districk of Central Lampung, Lampung Province, Indonesia were used in this experiment. The seeds were from monoculture cultivation of sorghum with spacing of 80cm x 20cm, and fertilized with Urea 200kg/ha, SP36 100kg/ha, and KCl 100 kg/ha. The seeds were harvested at the maturity level 41 days after flowering. The sorghum seeds in panicles were dried until the water content reached 9-10% and then the seeds were threshed from the panicles, and the clean seeds were packed in a plastic bag with clip and stored in a refrigerator at ± 8°C until the seeds were treated with an accelerated ageing treatment. Testing seed vigor of storability was done at Laboratory of Seed and Plant Breeding, Department of Agronomy and Horticulture, Faculty of Agriculture, University of Lampung, and it was held from September to October 2015.

B. *Application of Accelerated Aging Treatment*

Seed of sorghum, 50 grains in a bag of strimin cloth dipped in a fungicide solution (2 g/l) for one minute, then drained. Then put in an incubator chamber with 100% relative humidity and 40^{0}C temperature, following accelerated aging method by Delouche and Baskin (1973). Viability and leakage of seeds were observed at each accelerated aging interval of 0 day (control), 2, 4, 6, 8, 10, 12, 14, and 16 days.

C. *Seed germination test*

A number of 50 seeds were placed between the moist straw-paper which was then rolled together with the moist straw-paper according to the rolled paper test layered with plastic (ISTA rule modified by Sadjad, 1972), then this rolled paper was placed in a germinator Type IPB 72-1 under room temperature (26 ± 2.2 ^{0}C) with upright position. Observations and calculations of normal seedlings were performed at 2, 3, 4, and 5 days after seeds germinated. The variables measured in the viability test were 1) the percentage of normal seedling (PNS), 2) the speed of germination (SG), and 3) percentage of dead seed (PDS). The PNS was the normal percentage of seedling that appear during the test period up to 5 days, which is the total count of 2, 3, 4, and 5 days, so PNS = ΣP_i with P_i = the percentage of normal seedling that appeared on the i-day observation and i= {2, 3, 4, 5]. The speed germination (SG) was calculated as the cumulative number of percentage of daily normal seedlings, up to 5 days. By mathematical formula, SB was calculated as follows (Maguire, 1962), SG= $\Sigma P_i / T_i$; with P_i = the percentage of normal seedling that appeared on i-day observations and T_i = number of days since the germinated seed on observation i-day, {i = 2, ..., 5}

D. *Measurement of electric conductivity (EC) for seed leakage*

Electric conductivity measured seeds leakage that indicate the deterioration of seeds. A number of 25 grains of sorghum seeds were soaked in 50 ml distilled water for 24 hours. The EC value was measured in the water immersion of the seeds with a EC-meter device *Type Cyber Scan Con 11*, by dipping the end of the sensor in the water until an EC value appeared on the display screen. The measured variable was EC water immersing the seeds reduced by EC distilled water, in units of $\mu S.cm^{-1}$, which was an indicator of seeds leakage.

E. *Experimental design and data analysis*.

This experiment used a randomized complete block design with three blocks as replicates. A single treatment of 34 genotypes of sorghum were plotted randomly in each of three blocks. Data obtained in this experiment were the percentage of normal seedlings (PNS), speed germination (SG), percentage of dead seed (PDS), and electric conductivity (EC). Grouping genotypes based on the vigor of storability of seed was done by dendrogram cluster method using variable of PNS.

III. RESULTS AND DISCUSSION

A. Grouping genotypes based on vigor of storability

Percentage of normal seedling (PNS) data from seeds of 34 sorghum genotypes was presented in Table 1. Grouping the 34 sorghum genotypes based on seed vigor of storability was done by PNS variable using cluster dendogram analysis. Result of the dendogram cluster analysis was presented in Fig. 1. The cluster divided the 34 genotypes of sorghum into 4 groups of VSA, namely:

- Group A consisted of 7 genotypes, namely Numbu, Samurai 2, Cymit, GH-4, GH-5, GH-8, and GH-10);
- Group B consisted of 9 genotypes, namely Super-1, Super-2, UPCA, Mandau, P / F 5-193-C, P / F 10-90A, P / W WHP, GH-6, and GH- 7)
- Group C consisted of 9 genotypes, namely Samurai-1, GH-2, GH-9, GH-11, GH-13, GH-33, GHP-3, GHP-5, GHP-11; and
- Group D consisted of 9 genotypes (Kawali, Pahat, GHP-1, Talaga Bodas, GH-1, GH-3, GH-12, GH-14, and GHP-29). The vigor line of seed of storability of the four different groups was presented in Fig. 2.

According to Fig. 2, group B were genotypes that have a high vigor of storability, group A was genotypes that have a medium-high vigor of storability, group D was genotypes that have a low-storage vigor of storability, and group C was genotypes that have low vigor of storability. Consistently, the genotypes that have high seed vigor of storability also have higher percentage of normal seedlings, higher speed germination, lower percentage of dead seeds, and lower electric conductivity than those genotypes with lower vigor of storability. Vigor of storability, sequentially from the highest to the lowest was group B > A > D > C.

This difference in vigor of storability (VSA) was a genetic vigor, because the VSA was comparing among 34 genotypes of sorghum. Some properties of genetic factors that may be the cause of VSA differences were a) the chemical content of seeds and b) the physical traits of the seed. In rice seeds reported by Kapoor *et al*. (2011), the dissolved protein content decreased proportionately as the intensity of rapid aging was increase, but did not show any apparent correlation to the decrease in germination percentage. The decrease in germination percentage was not only influenced by the protein content of the seeds, but also by the carbohydrate content as indicated by the decline of java bean seed (*Cicer arietinum* L.) (Kapoor *et al*., 2010). Arief and Saenong (2006) reported that the smaller-seed size of corn variety of Lamuru had lower vigor storability than large ones. The different in seed size in sorghum seeds may affect VSA of sorghum seeds. The Penaloza *et al*. (2005) study on lettuce seed (*Lactuca sativa* L.) showed that large seeds had higher germination, higher SSAA (Saturated Salt Accelerated Aging) values, higher index of SVIS (Seed Vigor Imaging System), and faster and more uniform in the greenhouse emergence. Black-seed varieties of lettuce had higher seed quality and fewer fungus attack when evaluated by SSAA test. In relation to Penaloza *et al*. (2005) research, it can be estimated that physical seed size seeds, and other physical properties of seeds, may affect seed vigor of storability. Mohammad-Yasseen *et al*. (1994) stated that the seed coat was very influential, both physically and biochemically, on seed viability, and this wuld certainly affect the seed vigor of storability . In soybean seeds (De Souza and Marcos-Filho, 2001) seed coat permeability was closely related to porosity, and colors that affect seed vigor, storability, fungal attack, and sensitivity to imbibition damage.

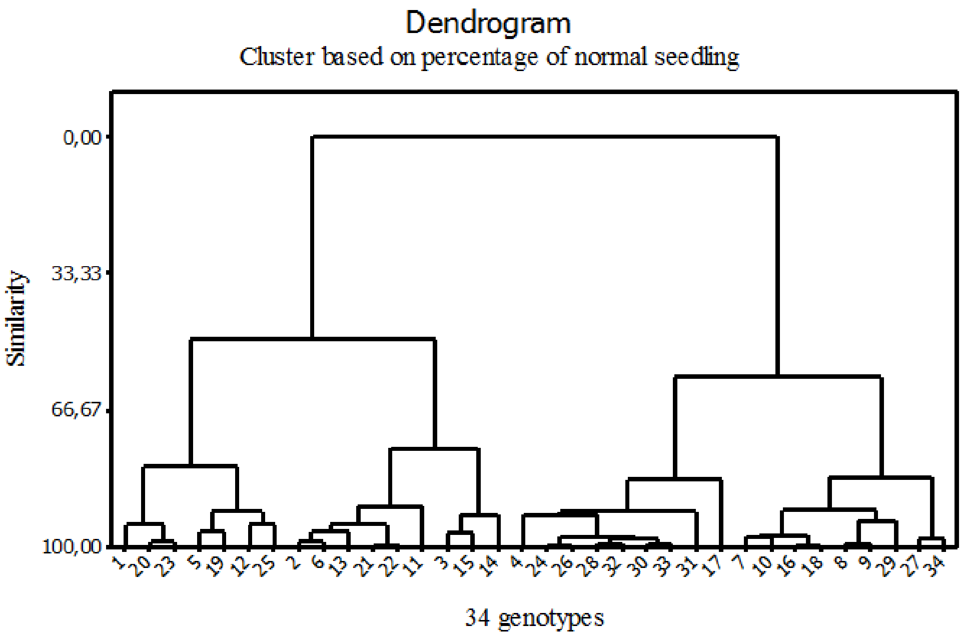

Fig. 1. Cluster dendogram of grouping genotypes based on vigor of storability (VSA) from 34 genotypes of sorghum using variable of percentage of normal seedling.

Table 1. Percentage of normal seedling (PNS) of seeds of 34 genotypes of sorghum during deterioration by accelerated ageing.

Genotype	Accelerate ageing Intensity (days)									
	0	2	4	6	8	10	12	14	16	Total
Numbu	98,7	93,3	92,7	81,3	86,7	25,3	22,7	2,7	0,0	503,4
Super-1	96,0	99,3	96,7	91,3	94,0	62,7	65,3	25,3	0,0	630,6
Super-2	96,0	97,3	96,0	96,7	92,0	86,7	46,7	53,3	1,3	666,0
Samurai 1	100,0	88,7	84,0	45,3	47,3	0,0	0,0	0,0	0,0	365,3
Samurai 2	96,0	88,0	78,0	66,7	84,7	53,3	57,3	16,0	0,0	540,0
UPCA	100,0	93,3	91,3	89,3	89,3	64,0	56,0	44,0	0,0	627,2
Kawali	96,0	92,7	92,0	86,0	77,3	8,0	18,7	0,0	0,0	470,7
Pahat	97,3	93,3	88,0	73,3	72,7	8,0	2,7	0,0	0,0	435,3
GHP-1	96,0	94,0	86,7	74,7	58,7	16,0	10,7	2,7	0,0	439,5
Talaga	94,7	92,7	84,7	84,7	85,3	0,0	18,7	1,3	0,0	462,1
Mandau	98,7	97,3	92,7	91,3	71,3	73,3	58,7	18,7	0,0	602,0
Cymit	97,3	98,0	98,7	95,3	89,3	54,7	14,7	20,0	5,3	573,3
P/F 5-193-C	98,7	95,3	94,0	90,7	88,7	64,0	54,7	38,7	16,0	640,8
P/F 10-90A	98,7	98,7	96,0	92,7	87,3	73,3	65,3	69,3	12,0	693,3
P/W WHP	96,0	93,3	86,0	85,3	74,0	65,3	76,0	64,0	30,7	670,6
GH-1	98,7	86,7	80,7	85,3	77,3	26,7	4,0	9,3	1,3	470,0
GH-2	98,7	84,7	60,0	36,7	29,3	4,0	0,0	0,0	0,0	313,4
GH-3	97,3	93,3	89,3	81,3	78,0	10,7	17,3	1,3	0,0	468,5
GH-4	96,0	92,7	85,3	74,7	70,0	65,3	37,3	17,3	4,0	542,6
GH-5	96,0	93,3	88,0	74,7	61,3	56,0	16,0	18,7	0,0	504,0
GH-6	96,0	96,7	92,0	84,0	86,0	52,0	61,3	37,3	16,0	621,3
GH-7	97,3	97,3	91,3	91,3	92,7	58,7	53,3	29,3	12,0	623,2
GH-8	96,0	82,7	90,7	88,0	74,7	37,3	21,3	9,3	0,0	500,0
GH-9	96,0	88,7	71,3	55,3	56,0	5,3	0,0	0,0	0,0	372,6
GH-10	96,0	92,7	92,0	93,3	74,0	69,3	29,3	9,3	0,0	555,9
GH-11	94,7	83,3	71,3	69,3	52,7	1,3	0,0	0,0	0,0	372,6
GH-12	94,7	86,0	79,3	69,3	45,3	30,7	8,0	1,3	0,0	414,6
GH-13	96,0	94,7	78,7	68,7	35,3	2,7	0,0	0,0	0,0	376,1
GH-14	96,0	93,3	76,7	78,7	82,7	13,3	6,7	0,0	0,0	447,4
GH-33	97,3	97,3	71,3	70,7	32,7	0,0	0,0	0,0	0,0	369,3
GHP-3	94,7	73,3	85,3	56,0	36,0	0,0	0,0	0,0	0,0	345,3
GHP-5	93,3	83,3	85,3	68,0	41,3	4,0	0,0	0,0	0,0	375,2
GHP-11	96,0	71,3	85,3	58,7	58,7	0,0	0,0	0,0	0,0	370,0
GHP-29	96,0	94,7	84,7	84,0	52,0	0,0	0,0	0,0	0,0	411,4

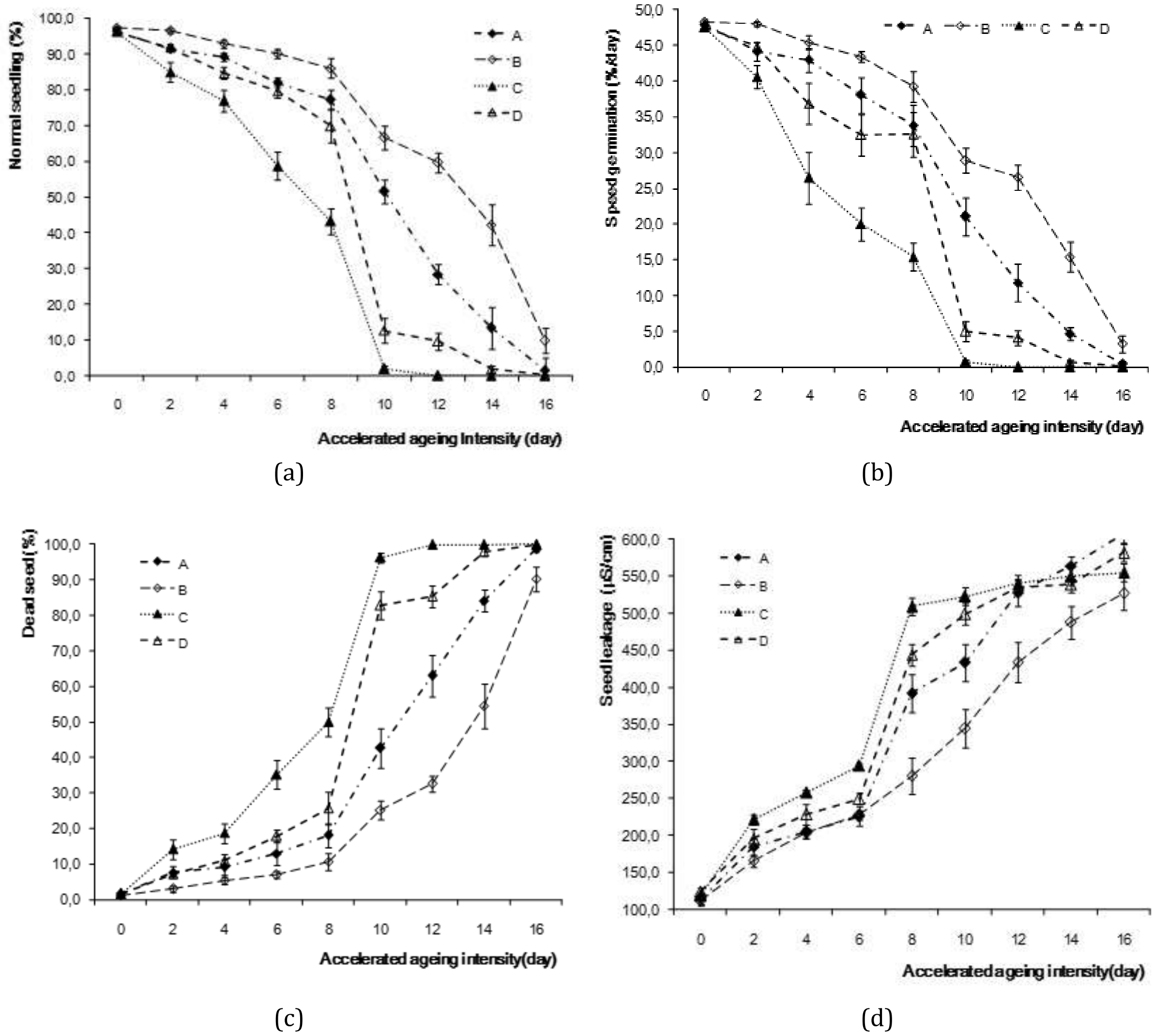

Fig. 2. Curves of vigor of storability of seed 4 groups of sorghum genotype, based on percentage of normal seedling (a); Speed Germination (b); Percentage of dead seed (c); and electrical conductivity of seed leakage (d). Bars were standar error of mean.

IV. CONCLUSION

The vigor of storability of seed of 34 genotypes of sorghum could be grouped into 4 groups based on the total percent normal germination percentage. The four groups were,

1. Genotypes having high vigor of storability, consisting of 9 genotypes, namely 1) Super-1, 2) Super-2, 3) UPCA, 4) Mandau, 5) P / F 5-193-C, 6) P / F 10-90A, 7) P / W WHP, 8) GH-6, and 9) GH-7;
2. Genotypes having a medium-high vigor of storability, consisting of 7 genotypes, namely 1) Numbu, 2) Samurai-2, 3) Cymit, 4) GH-4, 5) GH-5, 6) GH-8, 7) GH-10,
3. Genotypes having a medium-low vigor of storability consisting of 9 genotypes, namely 1) Kawali, 2) Pahat, 3) GHP-1, 4) Talaga Bodas, 5) GH-1, 6) GH-3, 7) GH-12, 8) GH-14, and 9) GHP-2,
4. Genotypes having a low vigor of storability, consisting of 9 genotypes, ie 1) Samurai-1, 2) GH-2, 3) GH-9, 4) GH-11, 5) GH-13, 5) GH -33, 7) GHP-3, 8) GHP-5, and 9) GHP-11.

The relationship between the vigor of storability of sorghum seed and the components of genetic factors of physical properties and physiological properties is suggested for further investigation. The nest research will be to find out the variables directly related to seed vigor of storability.

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REFERENCES

Aqil, M., Zubachtirodin, and C. Rapar. 2013. Description of superior varieties of corn, sorghum, and wheat. 2013 Edition. Cereals Plant Research Institute. Maros.

Arief, R. and S. Saenong. 2006. Effect of Seed Size and Seed Storage Periods on Growth and Maize Results. *Agricultural Crops Research* 25 (1): 52-56.

Delouche, J. C., and C.C. Baskin. 1973. Accelerated aging technique for predicting the relative storability of seed lots. Seed Sci. And Technol. I: 433.

De Souza, F. h. D., snd J. Marcos-Filho. 2001. The seed coat as a modulator of seed-environment relationships in Fabaceae. *Brazilian Journal of Botany* 24(4): 365-375.

Efendi, R., Fatmawati, and Bunyamin Z. 2013. Prospects of Ratun Sorgum Management. Pp. 205-221. In Sumarno, D. S. Damardjati, M. Sham, and Hermanto (Editors). *Sorgum*: Technological Innovation and Development. Agency for Agricultural Research and Development. Ministry of Agriculture Republic of Indonesia. Jakarta.

Fadholi, A. 2013. Test of Average Change of Air Temperature and Rainfall in Pangkalpinang City. *Journal of Mathematics*, *Science and Technology* 14 (1): 11-25.

House, L.R. 1995. A Guide to sorghum breeding. International Crops Research Institute for Semi-Arid Tropics. Andhra Pradesh, India. 238p

Human, S. 2012. Breeding of Sorghum with Nuclear Science and Technology. National Nuclear Energy Agency (Batan). Https:\\www.batan.go.id.

Iriany, R. N. and A. T. Makkulawu, 2013. The Origins and Taxonomy of Sorghum Plants. Pp. 38-47. In Sumarno, D. S. Damardjati, M. Sham, and Hermanto (Editor). *Sorgum*: *Technological Innovation and Development*. Agency for Agricultural Research and Development Ministry of Agriculture Republic of Indonesia. Jakarta.

Kapoor, N., A. Arya, M. A. Siddiqui, A. Amir, and H. Kumar. 2010. Seed deterioration in chickpea (*Cicer arietinum* L.). *American Journal of Plant Sciences* 9(3):158-162.

Kapoor, N., A. Arya, M. A. Siddiqui, H. Kumar, and A. Amir. 2011. Biochemical and physiological changes during seed deterioration in aged seeds of rice (*Oryza sativa* L.). *American Journal of Plant Physiology* 6(1):28-35.

Keeling, C.D., Whorf, T.P., 2003. Atmospheric CO2 records from sites in the SIO air sampling networks. Carbon Dioxide Inf. *Anal. Center Commun*. 30, 4.

Kompas.com. 2017. Earth Temperature Rises 1.1 Degrees Celsius. Kompas.com - 20/01/2017, 14:50 WIB

Maguire, J.D. 1962. Speed of germination aid in selection and evalua¬tion for seedling emergence and vigor. Crop Science 2: 176 177.

Mbofung, G. C. Y., A. S. Goggi, L. F. S. Leandro, and R. E. Mullen. 2013. Effects of Storage Temperature and Relative Humidity on Viability and Vigor of Treated Soybean Seeds. Crop Science, 53: 1086-1095.

Ministry of Health Republic of Indonesia. 1992. List of ingredients. Jakarta: Bhratara.

Mohamed-Yasseen, Y., S. A. Barringer, W. E. Splittstoesser, and S. Costanza. 1994. The role of seed coats in seed viability. *The Botanical Review* 60(4): 426–439

Neeru, J., R. Kopaar, S. Saxena. 2006. Effect of Accerelated Aging on Seed of Radish (Raphanus sativus L.). Asian J. of Plant Sci. 5 (3): 461-464.

Pabendon, M.B., S. Mas'ud, R.S. Sarungallo, and Amin Nur. 2013. Phenotypic appearance and stability of sweet sorghum for bioethanol feedstock. *Journal of Agricultural Crops Research*, 31 (1): 60-69

Peñaloza, P., Ramirez-Rosales, G., McDonald, M. B., and Bennett, M. A. 2005. Lettuce (*Lactuca sativa* L.) seed quality evaluation using seed physical attributes, saturated salt accelerated aging and the seed vigour imaging system. *Electronic Journal of Biotechnology* 8(3):299-307

Pramono, E. 2000. Estimation of storability of soybean seed by using chemical accerelated ageing method. Proceedings of the 3rd National Seminar on Dry Land Area Development. pp. 180-187. University of Lampung. Bandar Lampung, Indonesia.

Pramono, E. 2001. Equivalence between deterioration and devigoration of physical rapid ageing method on soybean seed (*Glycine max* [L.] Merill.). *J. Agrin* 5: 18-25.

Pramono, E. 2008. Equivalence between natural of storage period (NSP) and rapid ageing intensity (RAI) on peanut (*Arachis hipogaea* L.). Research Report. Fac. Agriculture Univ. Lampung. Bandar Lampung. 23 p. Not published.

Pramono, E. 2009a. Measurement of Vigor of Seed of storability of Five Superior Varieties of Rice (Oryza sativa L.) with Fast Chemical Methods of Etanol Steam Removal (MPCKU). Research Report. Fak. Agriculture Univ. Lampung. Bandar Lampung. 23 p. Not published.

Pramono, E. 2009b. Estimated storability 90% (ESA-90) of intensity of chemical accelerated ageing with ethanol vapour (IPCKU) on peanut seeds (*Arahis hypogaea* L.). Proceedings of Seminar on Research Result & Community Service. Pp. B12-18. University of Lampung. Bandar Lampung. Indonesia.

Pramono, E. 2010. Effect of organic fertilizer, micro fertilizer, and varieties on vigor of storability of rice seed (*Oryza sativa* L.). Proceedings of the National Seminar of SMAP 8-9 December 2010. pp. 48-57.

Prasad P.V. V., K J. Boote, L. H. Allen Jr. 2006. Adverse high temperature effects on pollen viability, seed-set, seed yield and harvest index of grain-sorghum [*Sorghum bicolor* (L.) Moench] are more severe at elevated carbon dioxide due to higher tissue temperatures. *Agricultural and Forest Meteorology* 139: 237-251.

Reddy, B.V.S., S. Ramesh, P.S. Reddy, B. Ramaiah, P.M. Salimath, and R. Kachapur. 2005. Sweet sorghum-a potential alternate raw material for bio-ethanol and bio-energy. Int. Sorghum Millets Newslett. 46: 79-86.

Sadjad, S. 1972. Straw Paper for Test of Seed Viability in Indonesia. Doctoral dissertation. Faculty of Graduate School of Bogor Agric. University. Bogor. 281 p. (Unpublished).

Sadjad, S. 1989. The Steinbauer-Sadjad Conception as the foundation of seed mathematic in Indonesia. Scientific Speech. Bogor Agricultura University. Bogor. Indonesia. 42 p.

Setyowati, M., Hadiatmi, and Sutoro. 2005. Evaluation of growth and yield of sorghum germ plasm (*Sorghum vulgare* (L.) Moench.) from mother plant and ratun. *Germplasm Bulletin* 11 (2): 41-49.

D.13

CHEMICAL AND PHYSICAL PROPERTIES OF CASSAVA STARCH CM-CHITOSAN-ACRYLIC ACID HYDROGEL PREPARED FROM RADIATION-INDUCED CROSSLINKING

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ABSTRACT

Starch is a renewable natural polymer that can be decomposed easily in the environment and can be modified to various applications such as biomedical, agricultural and pharmaceutical applications. Copolymerization of gelatinized starch - CM-chitosan and acrylic acid (AAc) in aqueous medium using γ-irradiation was carried out. The preparation conditions, such as irradiation dose and AAc concentration were investigated. The copolymers were characterized by FTIR spectroscopy, thermo-gravimetric analysis (TGA) and scanning electron microscopy (SEM). The results show that by increasing of irradiation dose the gel fraction increases till the dose of 15 kGy. Above the stating dose the gel fraction decreases. The Equilibrium Degree of Swelling (EDS) value slightly increases with increasing irradiation dose and after dose of 15 kGy is decreasing.The swelling of starch-CM chitosan-AAc hydro gels reduced as the gel content increases. The results indicated that the optimum condition for obtaining hydro gels with desirable properties was irradiated at dose of 15 kGy. The results indicated that SEM revealed that the higher the dose, the lower the copolymer pore size. The starch – CM chitosan – AAc copolymers have thermal stability higher than that for starch individually.

Keywords : Cassava starch, Cm-chitosan, Acrylic acid, Radiation Copolymerization.

I. INTRODUCTION

Radiation has been recognized as a highly suitable tool for the formation of hydrogels[1,2]. Hydrogels can be defined as hydrophilic polymer networks that can retain a significant amount of water within their structures and swell without dissolving in water.

The radiation processing has many advantages such as easy process control, simultaneous cross-linking of polymer to hydrogel formation and sterility of the product and the technology is environment friendly since it leaves no residue or pollutant in the environment [3,4]. The radiation induced hydrogel with or without cross-linker is much durable with respect to chemically prepared hydrogel [5]. These qualities make irradiation the method of choice in the synthesis of hydro gels. When a polymer in aqueous solution is subjected to gamma irradiation, three main reactive species; hydrated electrons, hydroxyl radicals and hydrogen atoms, are formed [6,7]. Hydroxyl radicals have been shown to be the main species responsible for reactivity transfer from water to the polymer chains. They abstract hydrogen atoms from macromolecules, therefore macro radicals are formed.

The use of radiation has been introduced to many applications such as environmental, agricultural, food science, industrial and especially medical applications [3]. Natural polymers such as cassava starch, chitin and chitosan are natural materials with high potential for a number of applications such as medical, environmental and agricultural applications. This is due to their unique characteristics and non-toxicity[8] .

Starch is a renewable natural polymer that can decompose easily in the environment and can be modified to various applications. With its biodegradability, biocompatibility and abundance, cassava starch has become an attractive candidate for the development of biomedical materials. Chitin, the most abundant naturally is undoubtedly one of the most promising and attracting resources present in quantity. Chitosan is a linier polysaccharide derived from chitin, a major component of the shell of the crustacean organisms and the second most abundant biopolymer in nature next to cellulose. In the last year chitosan has proved to be valuable product for using in different application such as seed coating, chelating and growth promoters etc. Chitosan reported to have various biological functions, for instance, antimicrobial activity, growth inhibitor of some pathogens [9].

Hydro gels can be classified as homopolymer hydro gels, copolymer hydro gels, multipolymer hydro gels or interpenetrating polymeric hydro gels. Homopolymer hydro gels are cross-linked network of one type of hydrophilic monomer unit, while copolymer hydro gels are prepared from the cross-linking of two co monomer units, one of which must be hydrophilic. Multipolymer hydro gels are formed by the cross-linking of more than three monomers, Interpenetrating polymeric hydro gels are formed by first swelling a network in a monomer after that reacting the latter to form a second interpenetrating network structure [11].

The purpose of this research is to convert natural polymers into useful products potentially applicable for agriculture application such as slow release material for NPK fertilizer. In this study, a series of hydro gels were prepared from gelatinized cassava starch mix with CM-chitosan and acrylic acid by gamma radiation-induced graft copolymerization

II. MATERIALS AND METHODS

A. Materials

Chitosan was extracted from shrimp shell (*Penaeus Monodon*) was obtained from Muara Karang, North Jakarta. Cassava starch was obtained from local chemical store in Jakarta, acrylic acid (p.a), NaOH (p.a), HCl (p.a), were obtained from E Merck, Germany.

B. Instrumentation

1. Irradiation

Gamma radiation source of Co-60, IRKA batch irradiator, with irradiation dose rate about 7,5 kGy/hr was employed in these experiments. This radiation source is located at Center for Application of Isotopes and Radiation, Jakarta, Indonesia.

2. FTIR Analysis

Infrared spectra were taken from a Fourier Transform Infrared Spectrometer (Bruker Tensor). For powder samples, the samples were pressed into KBr pellets and analyzed using transmission mode. For hydro gel samples, the samples were shaped into films and characterized using Attenuated Total Reflectance (ATR) technique, with 64 co-added scans and a resolution of 4 cm^{-1}

3. Thermal Analysis

Thermal Gravimetric Analyzer (TGA/SDTA851) from Mettler Toledo were used to characterize the thermal properties of the samples. All experiments were done under nitrogen purge; with a flow rate of 60 ml/min. A heating rate of 10°C/min was used for TGA experiments.

C. Procedure

1. Preparation of chitosan

White shrimp shell (*Penaceaus Merguiensis*) was dried in vacum oven at 50°C for 12 hr. Then the isolation of chitin by soaking the dried shrimp shell in 1N HCl at temperature of 80°C for 3 hr to remove mineral and 1 N NaOH for 5 hr at 80°C to remove protein. The dried chitin was then pulverized and reacted with 50%(w/w) NaOH in the mixing reactor at 100°C in the ratio of 1: 10 for 5 hr.

2. Preparation of CM-chitosan

Chitosan and pure ethanol were mixed and stirred in a flask for 30 min, then 50% (w/v) NaOH solution was gradually dropped into the mixture, and stirring continued for another 20 min. Sodium mono chloric acid (SMCA) was added to the solution. The mixture was heated to 45-50°C and continuously stirred at this temperature for 2 hr. The synthesized CM-chitosan samples were filtered, washed thoroughly with water, and finally dried in a vacuum oven at 50 °C.

3. Preparation of Starch- CM chitosan –Acrylic acid gel

In a gelatinization container 25 g of starch and 10 g CM chitosan was mixed with 500 mL of distilled water. The mixture was continuously stirred using a mechanical stirrer. The gelatinization was done under nitrogen purge. The mixture was gradually heated from ambient temperature to 80°C and held at this temperature for 1 hr. The mixture was left to cool down to room temperature to yield the gelatinized starch. The obtained gelatinized starch-CM chitosan was mixed with Acrylic acid (AAc) solution in distilled water, with the final concentration of starch and AAc at 1% and 3%, respectively. The mixture was continuously stirred to form a homogeneous blend. The mixture was then transferred into screw-capped glass tubes, exposed to gamma radiation at various doses. After irradiation, the obtained hydro gels were washed well with water and dried in a vacuum oven at 50°C until the weight was constant.

4. *Irradiation and drying*

The above mixture was gamma-irradiated in the presence of oxygen in the gamma C0-60 source at absorbed doses of 5, 10, 15, 20 , 25 kGy. After irradiation the product was dried in a vacuum oven at 50°C for 24 hr.

5. *Gel Fraction*

The gel samples were wrapped into a 200-mesh than soxhlet extraction using methanol for 6 h to remove the soluble (sol) fraction. The samples were then taken out and dried in a vacuum oven at 50°C to constant weight to gravimetrically determine the insoluble (gel) fraction using the following equation:

$$\text{Gel Fraction} = W_d / W_i \times 100 \quad (1)$$

where W_d is the weight of dried gel after extraction and W_i is the initial weight of gel before extraction.

6. *Equilibrium Degree of Swelling (EDS)*

The gel samples were immersed directly in distilled water for 72 h at ambient temperature, to reach the equilibrium state of swelling. The weight of the swollen gel (W_s) was then measured. The swollen gels were later dried in a vacuum oven at 50°C until the weight of the dried gels (W_d) remained constant. EDS was determined from the following equation:

$$EDS = W_s / W_d \times 100 \quad (2)$$

III. RESULTS AND DISCUSSION

A. *The gel Fraction value*

The effect of acrylic a monomer concentration on the gel fraction with concentration of 1,0% and 3,0% with variation doses of 5, 10, 15, 20 and 25 kGy is shown in Fig. 1. It can be seen that the gel fraction independent of the AAc monomer concentration. The concentration of 3% gives higher gel fraction value compare with 1%.

The effect of the total dose on the gel fraction is also presented in Fig. 1. With increasing dose, gel fraction value begins to rise until doses of 15 kGy and finally above 15 kGy decreases. This is because during the irradiation process, the energy from gamma radiation is transferred to the irradiated material, resulting in a variety of modifications that change the chemical and molecular structure of the material [12.13].

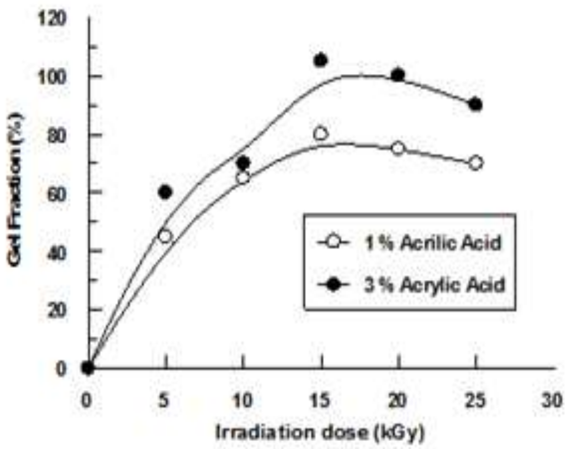


Fig. 1. The effect on irradiation dose and acrylic acid concentration on the gel fraction value

These modifications include cross-linking, degradation, grafting, crystal lattice modification, and polymerization (curing) of monomers and polymer. Generally, when a polymer is irradiated, cross-linking and degradation take place simultaneously. But the ratio of their rates depends on a number of factors, including the chemical structure of the polymer, its physical state, and the irradiation state. Polymers are generally divided into those that predominantly cross-link and those that predominantly degrade.

CM-chitosan and acrylic acid is easily cross-linked in its homogeneous mixture with water, while starch easily decomposes upon irradiation. It can be concluded that the optimum irradiation dose for get highest gel fraction value is 15 kGy.

B. *Swelling behavior*

The swelling ratio of the starch-CM-chitosan-AAc hydro gels as a function of concentration of AAc (1% and 3%) and dose is presented in Fig. 2.

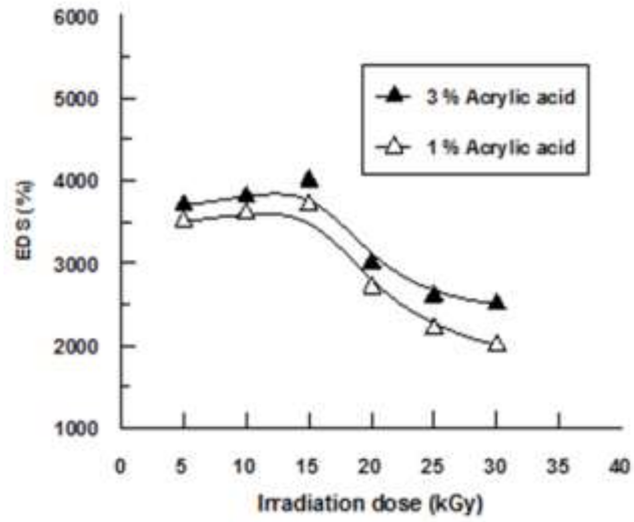


Fig. 2. The effect on irradiation dose and acrylic acid concentration on the swelling behavior

The swelling ratio in deionizer water almost constant till irradiation dose of 15 kGy. Above 15 kGy the swelling ratio decreases with increasing dose. This is probably due to the increase of cross linking density with irradiation dose [14].

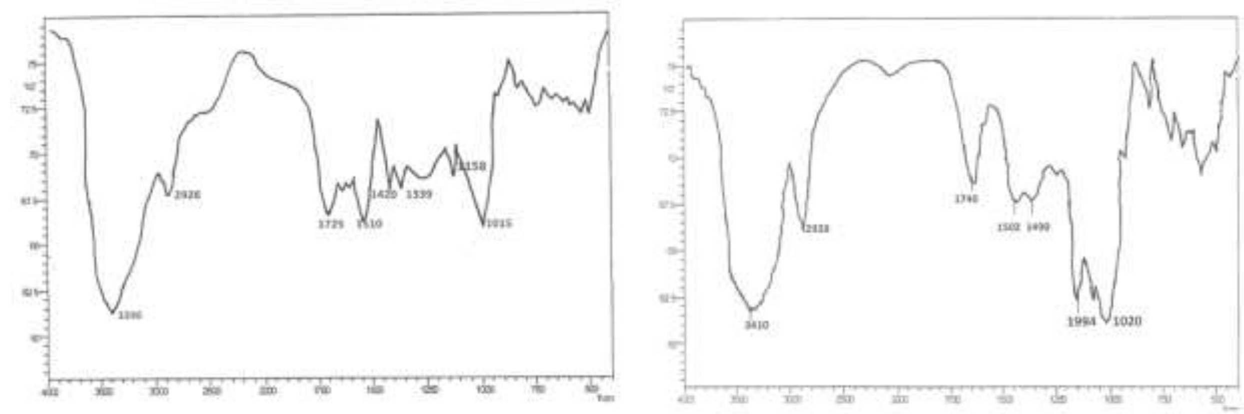
A hydrogel has the ability to absorb and hold significant amount of solvent (water) in network structure and swelling ratio is an important property in consideration as water absorbent. Swelling ratio reflects the cross-linking of a polymer. With an increased cross-linked density, the swelling ratio usually decreases because void spaces in the polymer network are reduced for free water entrance.

Swelling ratio decreased with an increased irradiation dose but it increased with an increase in the concentration of AAc. The increasing trend of swelling ratio with addition of AAc in cassava starch solution may be due to the increased number of hydrophilic groups (COOH) in gel. Carboxylic group (COOH) on gel network becomes ionized in swelling medium, creating an electrostatic repulsion which increases swelling ratio (15).

C. FTIR analysis

FTIR analysis was used to provide evidences for copolymerization reaction of AAc onto starch and CM-chitosan. The FTIR spectra of the original starch, and starch-CM-chitosan-AAc irradiated 15 kGy.The spectrum of dried hydro gel are taken and comparatively shown in Fig. 3 and 4.

In the spectrum of cassava starch, the band at 2928 cm^{-1} is attributed to the asymmetric stretching of C–H, while the band at 1725 cm^{-1} is ascribed to adsorbed water and the bands at 1420 cm^{-1} and at 1339 cm^{-1} to the angular deformation of C–H. The C–O ether band shows stretching at 1158 cm^{-1} while the C–O alcohol band shows stretching at 1015 cm^{-1}. But in the spectrum of cassava starch/acrylic acid copolymers, a new peak at 1740 cm^{-1} shows for the C=O stretching of carbonyl group of acrylic acid. This C=O stretching of carbonyl group peak is also found in the spectrum of acrylic acid. This result indicates that acrylic acid interacts/entraps with cassava starch.

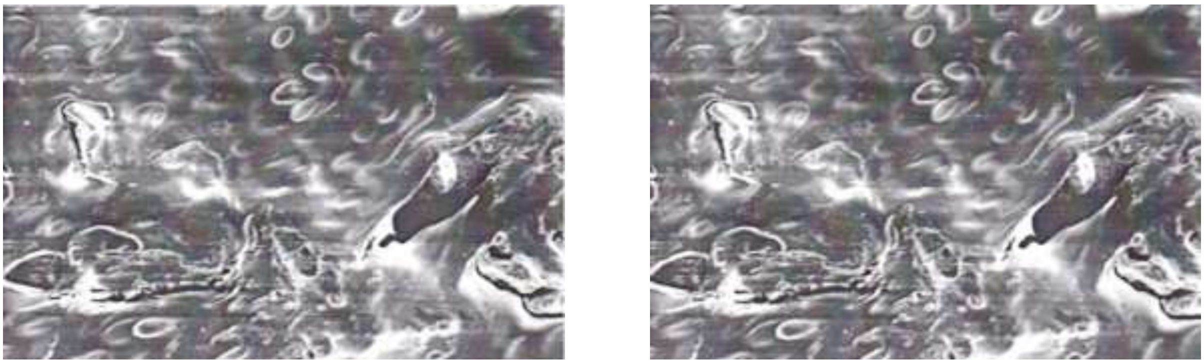


(a) (b)

Fig. 3. The FTIR spectrum of starch (a) and (b) starch-CM-chitosan AAc

D. Scanning Electron Microscopy

The surface of the starch-CM-chitosan-AAc irradiated 5 kGy and 15 kGy hydro gel films were observed by using a SEM. This hydro gel films samples in dried hydro gel were prepared, and the SEM images are shown in the Fig. 4. The Figure shows the surface of the starch-CM-chitosan-AAc respectively, of dried hydro gels films. The flat and featureless images indicate that the films have a condensed structure and clearly show the appearance of a porous structure.



(a) (b)

Fig. 4. SEM Micrographs of: starch-CM-chitosan-AAc irradiated (a) 5 kGy and (b) 15 kGy

These pictures verify that the copolymers of starch-CM-chitosan-AAc have a porous structure. It is supposed that these pores are the regions of water permeation and interaction sites of external stimuli with the hydrophilic groups of the copolymers (16,17).

E. TGA Analysis

TGA thermograms of Starch and starch-CM-chitosan-Aac irradiated are shown in Fig. 5.

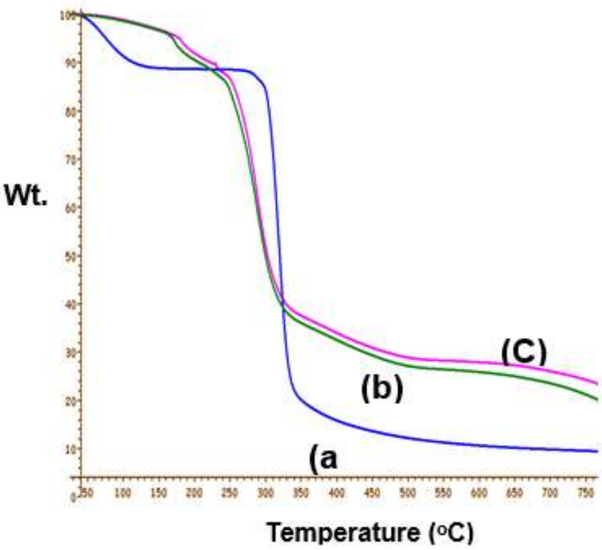


Fig. 5. TGA Curves of: (a) Starch, (b) starch-CM-chitosan-AAc irradiated 5 kGy. (c) starch-CM-chitosan-AAc irradiated 15 kGy

The thermogram of starch displayed a two-stage weight loss process. The first process started very early and slowly continued until 160^{o}C, indicating the evaporation of approximately 12% moisture content in starch. The second weight loss process began at about 270^{o}C and reached its maximum rate of weight loss at roughly 320^{o}C. The amount of char left at 800^{o}C is nearly 10%. Compared with copolymers of starch-CM-chitosan-Aac irradiated 5 kGy and 15 kGy illustrated slightly different thermograms, with the first process of weight loss shifting to lower temperature (about 160^{o}C) and the second one shifting towards higher temperature (roughly 240^{o}C). A major difference took place at approximately 330^{o}C, where starch continued to degrade with high rate of weight loss, but copolymers of starch-CM-chitosan-AAc irradiated 5 kGy and 15 kGy did so with a gradual rate, leaving around 19% and 21% char yield, respectively. This clearly demonstrates that copolymers of starch-CM-chitosan-Aac irradiated 5 kGy and 15 kGy have different chemical structures, compared with starch, and also better thermal stability.

IV. CONCLUSION

Copolymerization of starch-CM-chitosan-Aac hydro gel was successfully synthesized by radiation-induced cross linking. The results show that by increasing of irradiation dose the gel fraction increases till the dose of 15 kGy. Above the stating dose the gel fraction decreases. In the other hand the Equilibrium Degree of Swelling (EDS) value decreased with increasing irradiation dose and after dose of 15 kGy, decreasing of EDS low relatively.

The swelling of starch-CM chitosan-AAc hydro gels reduced as the gel content increases. The results indicated that the optimum condition for obtaining hydro gels with desirable properties was irradiated at dose of 15 kGy. At higher doses, the gel fraction tends to diminish due to the domination of degradation over cross-linking.

The copolymers of starch- CMchitosan- AAc were characterized by FTIR spectroscopy, thermo-gravimetric analysis (TGA) and scanning electron microscopy (SEM). The results indicated that SEM revealed that the higher the dose, the lower the copolymer pore size. The starch– CM chitosan – AAc copolymers have thermal stability higher than that for starch.

REFERENCES

[1] Abad, L, S., Aranilla ,C,T ., Dela Rosa., 2003, *Radiation Physics and Chemistry*, 68, 901-908.
[2] Park, K,R., Nho ,Y,C., *Radiation Physics and Chemistry*, 2003, 67, 361-365.
[3] Radoslaw ,A,W., Hiroshi Mitomo., Nagasawa, N., Yoshii, F., 2003, *Radiat. Phys.Chem.,* 68, 771-779,
[4] Radoslaw , A, W., Nagasawa, N., Mitomo, H., Kume, T., Fumio Yoshii., Long Zhao., 2003, *Nucl. Instr. Methods in Phys. Res*, B, 208, 320-324
[5] Guozhong Wu., Dewu Long., Shuiping Chen., Side Yao., 2005, *Carbohydrate Polymers*, 60, 61-65.
[6] Chen P, Zhang W, Luo W, Fang,Y., 2004, *J. Appl. Polym. Sci*, 93, 1748-1755.
[7] Dafader, N,C., Haque, ME., Akhtar, F., Ahmad, M,U., 2006, *Radiat. Phys. Chem,* 75, 168-172.
[8] Fei .B., Wach, R,A., Mitomo H., Yoshii F., Kume, T ., 2000, *J. Appl. Polym. Sci.* 78, 278–283.
[9] Wasikiewicz, J. M., Yoshii, F., Nagasawa, N., Wach, R. A., Mitomo, H., *Radiat. Phys. Chem,* 2005, 73, 287-295.
[10] Wasikiewicz., J, M., Mitomo, H., Nagasawa, N., Yagi, T., Tamada, M., Yoshii, F., 2006, *Journal of Applied Polymer Science,* 102, 758-767.
[11] Zhai, M., Yoshii, F., Kume., T., 2003, *Carbo-hydrate Polymers,* 52, 311-317.
[12] Nagasawa, N., Yagi, T., Kume, T., Yoshii, F., 2004, *Carbohydrate Polymers,* 58, 109-113.
[13] Zhang, J., Wang,Q., Wang, A., 2007, Carbohydrate Polymers, 68, 367-374.
[14] Saraydin, D., Karadag, E., Isikver, Y., Sahinef, N., Guven, O., 2004, *J. Macromol. Sci. A Pure Appl. Chem*., A41, 419–431
[15] Zhan, F,L., Liu, M, Z., Guo ,M,Y., and Wu L., 2004, *Journal of Applied Polymer Science,* 92, 3417-3421.
[16] Zhou B., 2003, *Journal of the Chemical Fertilizer Industry,* 30, 55-56.
[17] He, X,S., Zhang, F, D., 2005, *Plant Nutrition and Fertilizer Science,* 11, 334-339.

D.14

APPLICATION OF ONE CYCLE RED-BLUE ARTIFICIAL LIGHT IMPROVED THE PRODUCTIVITY OF CHRYSANTHEMUM

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ABSTRACT

Chrysanthemum as a sub-tropical plant needs sun light of 16 hours a day. In tropical region such as Indonesia, the need of 16 hour light a day can't be fulfilled naturally by sun, so the application of artificial light is required for the cultivation of chrysanthemum. The artificial light was applied by using electrical lamps for 4 hours after the sun set. This research aimed to determine the productivity of chrysanthemum as affected by the application of red-blue artificial lights (LED lamp) using cyclic method, as well as to determine the cyclic number that resulted the best productivity of chrysanthemum. The artificial light applied in this research was red-blue LED lights in a cyclic (off-on-off) manner. The cyclic number tried was 1 cycle, 2 cycles, 3 cycles, 4 cycles, 5 cycles and controls. The variables observed included plant growth, productivity, and quality of flower. The results showed that the addition of red-blue LED lights in a cyclic manner gave significant impact on the productivity, in both vegetative and generative phases of chrysanthemum. The less the number of addition red-blue LED light cycle, the better the growth rate, production and quality of chrysanthemum. The addition of one cycle red-blue LED light gave the best effect on chrysanthemum growth, which was produced the highest growth rate of plant height, the leaves number, and the canopy area. In generative phase, the addition of one cycle red-blue LED light provided the highest number of flowers (19.66 pcs), the widest of flower area (66.89 cm^2), and the brightest of flower color (at level 2.97 on a color chart).

Keywords : chrysanthemum, productivity, red-blue artificial light, cyclic, vegetative phase, generative phase.

I. INTRODUCTION

Chrysanthemum is a Chinese plant that requires light for 14 hours or more per day for vegetative growth, and 12 hours per day or less for reproductive growth [1]. Cultivation of chrysanthemum plants in Indonesia requires the addition of artificial light because the duration of solar irradiance in Indonesia an average of 12 hours per day. McMahon [2] states that for growth in the vegetative phase requires the addition of artificial light at least 2 hours, then the addition of artificial light is stopped until the plant has a high plant that can produce the desired flower quality. The optimum light intensity required by chrysanthemum plants is 70-100 lux [3].

Generally, additional light is given for 4 hours either continuously or cyclically from 10:00 to 2:00 daily for 3 to 6 weeks from planting [4]. Compared to the continuous method, the addition of light by cyclic method is said to save more electricity consumption, but less than optimal [5]. According to Maaswinke [6], additional cyclic light is recommended using a cyclic pattern of 10-20 x 6 (10 minutes of lights followed by 20 minutes of lights off in one cycle for 6 cycle periods). After the plant is 30 days old, additional light is stopped.

Lightweight research on White Fiji and Yellow Fiji cultivars, with an 18 watt fluorescent light source, resulted in the addition of 4 and 5 hours of artificial light, can increase the length of the flower stalk. However, additional 4 hours of irradiation is more efficient because it is capable of producing the same quality of flower as that of an additional 5 hours irradiation [7]. Furthermore Sach and Kofranek [8], stated that the manipulation of day length can be done by using light from the source of incandescent lamps or tube lamps. In addition to these two lights, the addition of light to the plant can be done by using LED lights. This is because; LEDs have diverse colors of light with different wavelengths that can be absorbed by plants. The appropriate light color will be absorbed for photosynthesis process will result in better growth [9].

The additional color of light given will affect the growth of chrysanthemum plants, because each color of light has a certain wavelength range. The wavelength of light received by plants can affect the width of stomatal openings in photosynthesis. Ermawati et al. [10], found that the addition of additional light in various colors can increase the height of the chrysanthemum plants, the additional red light enlarge the diameter of the white Fijian flower, and the yellow Fijian varieties have larger flower diameters when given additional blue light. Syafriyudin et al. [9], which examines the continuous addition of light using 5 color LED lights to 7 varieties of chrysanthemum, resulting in the use of red and blue LEDs can optimize the process of photosynthesis of chrysanthemum plants. However, Wiguna [11], explained that the red LED lights give the best effect on the production and quality of chrysanthemum flowers.

From several studies that have been done, known blue and red light can increase the productivity of chrysanthemums. This is because the two spectrum of light, the process of photosynthesis in the plant takes place optimally. Therefore, in this research, additional red-blue color LED combination with cyclic method is applied. The purpose of this research is to find out the productivity of chrysanthemum plant in giving the light of red-blue color combination LED with cyclic method, and to determine the cyclic pattern that produces the best productivity.

II. MATERIALS AND METHODS

A. *Tools and Materials*

The tools used in this research are LED HEMAT e27 (red and blue color, 2 watt, color temperature 6500K), 18 Watt warm white energy saving lamp, plant chamber, digital timer (maximum power 16A/36000W), Ligh/lux Meter, Iphone5 8MP camera, ruler, calipers, color chart, thermo hygrometer, analytical scales, oven, software Adobe Photoshop CS4, and software Matlab 2009. Meanwhile, the materials used are chrysanthemum of Fiji Yellow varieties, polybag diameter 15 cm, KNO_3 fertilizer red and white, fertile soil, pesticide (Greentonik, Gandasil B, Dethane and Konfidor).

B. *Experimental design*

This study used a completely randomized design with one factor, namely the addition of a red-blue color combination LED lamp with a different cyclic (OFF-ON-OFF) pattern. The addition of light was performed cyclically on the vegetative phase for 30 days, between 18.00-06.00. The total addition of light is 4 hours a day. The cyclic pattern treatments applied in this study were 5 treatments: 1 cyclic, 2 cyclic, 3 cyclic, 4 cyclic and 5 cyclic.

C. *Implementation of research*

First of all prepared a red-blue LED light, warm 18 Watt warm white and plant chamber. Chamber serves as a place of chrysanthemums when given additional light, so that outside light does not enter, so the plants only get a red-blue light with it. The chamber used is 55 cm long, 40 cm wide and 120 cm high. The distance between the LED lights and the plants can be adjusted to get a light intensity of 70 lux. Then chrysanthemum seed selection is performed. Chrysanthemum seeds used are chrysanthemum seedlings that have a number of leaves and a uniform height of 5-7 leaf blade and 7,5 -10 cm high. Chrysanthemum seedlings are then grown in polybag (diameter 15 cm) which has contained the planting medium. Planting medium used is a mixture of fertile soil and compost with a ratio of 2: 1. The plants were watered once every 3 days, given a red KNO_3 fertilizer every week during the vegetative phase and white KNO_3 during the generative phase of 5 g/m^3. In addition to watering and fertilizing also carried out pest and disease control by using Greentonik, Gandasil B, Dethane and Konfidor. Treatment of the research that is providing additional LED light red-blue combination with cyclic method performed starting plant chrysanthemum planted until 30 day (vegetative phase). Harvesting is done when there are 3 pieces of flowers that bloom perfectly from all the flowers on a stem of chrysanthemum plants (age of plants entering the age of 13 weeks).

D. *Variable observed*

The variables observed include growth variables, production variables and quality variables. The growth variable consists of plant height, leaf number, and canopy area. This growth variable is measured every week for 8 weeks from the start of planting. Plant height measured from the base of the stem to the highest end of the leaf using ruler [12], the number of leaves calculated is all leaves that have been fully open [13], the area of the canopy is measured using the image estimation method (program of Matlab software 2009).

The production variables consist of the number of flowers, the number of perfect blooming flowers, and the root length. The sum of the flowers is the total flower buds that appear, while the number of perfect blooming flowers is the total flowers that have been completely open form a vertical line. Root length of the plant was measured after harvest (week 13).

III. RESULTS AND DISCUSSION

A. *Plant High Growth*

The high growth of chrysanthemum plants during the vegetative phase by the addition of red-blue combined LED combination with cyclic method is shown in Fig. 1. In Fig. 1 it is seen that the growth of plant height follows the quadratic pattern. Cyclic method treatments have a significant effect on plant growth. The addition of cyclic numbers causes slower growth. This can be seen from the accelerated growth of plant height decreasing with increasing number of cycles given (Fig. 2). The highest growth acceleration of the plant height is seen in the addition of one-cycle red-blue LED light.

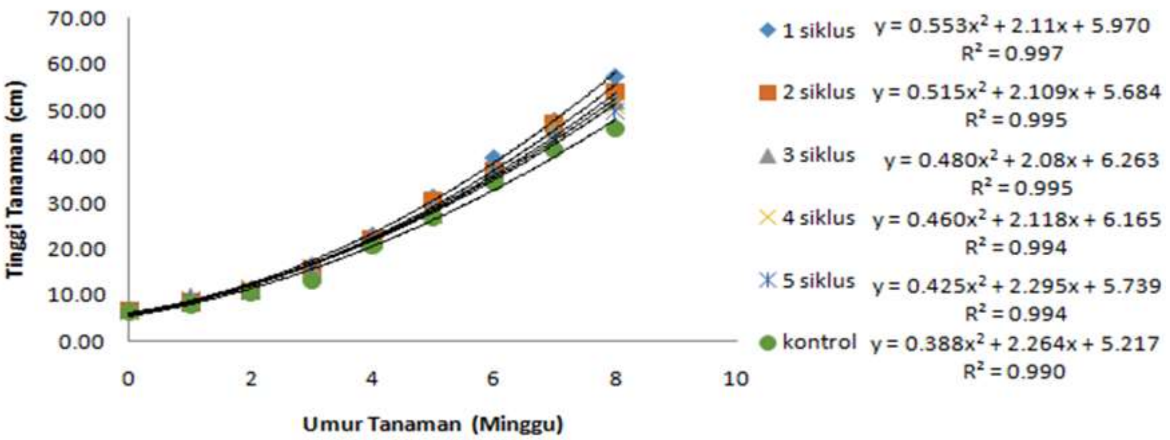

Fig. 1. The high growth of chrysanthemum plants

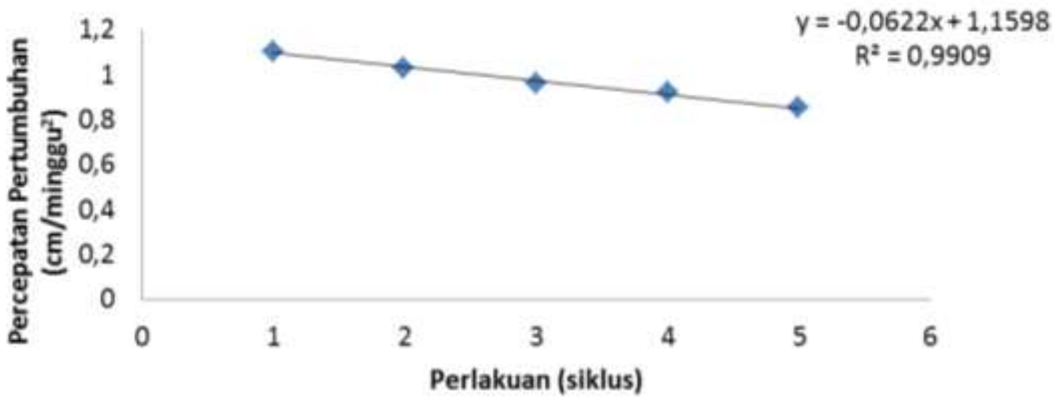

Fig. 2. Acceleration of plant height growth

B. Leaf Amount Growth

As well as the growth of plant height, the growth of the number of leaves also shows a quadratic relationship pattern between the number of leaves and the age of the plant (Fig. 3). The number of chrysanthemum leaves grows quadratically as the plant age increases. The acceleration of the growth of the number of leaves also shows a decrease when the number of additional light-giving cycles is added (Fig. 4). The greatest growth acceleration is seen in giving additional light one cycle and decreasing with increasing number of given cycles.

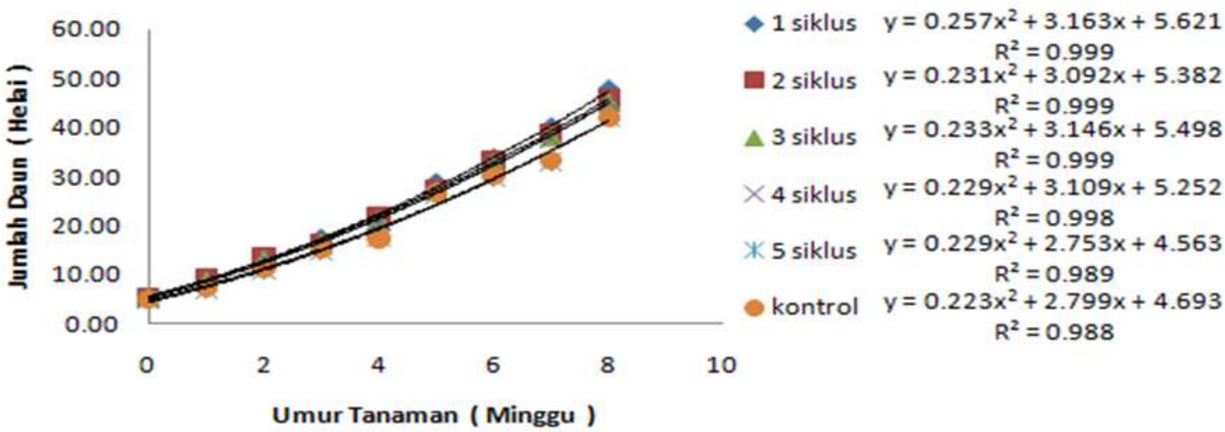

Fig. 3. Growth of Chrysanthemum Leaves

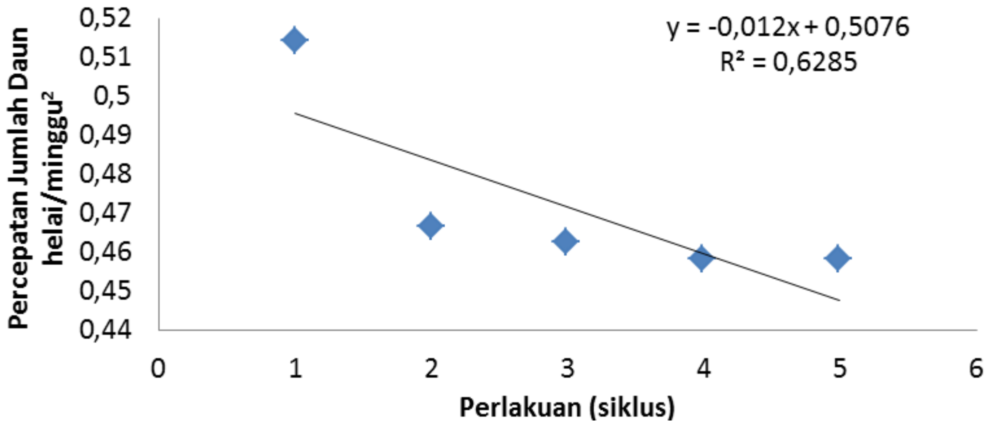

Fig. 4. Acceleration of Leaf Amount Growth

C. Canopy Area Growth

The measured canopy area is to determine the area of the leaf which is the main component used by plants for photosynthesis [14]. From result of calculation of canopy area by using image processing analysis obtained result like Fig. 5. In Fig. 5 it can be seen that the area of chrysanthemum tree leaf canopy increases quadratically with increasing of plant age. In the figure it is also seen that the addition of the number of cycles causes a decrease in the area of the leaf canopy.

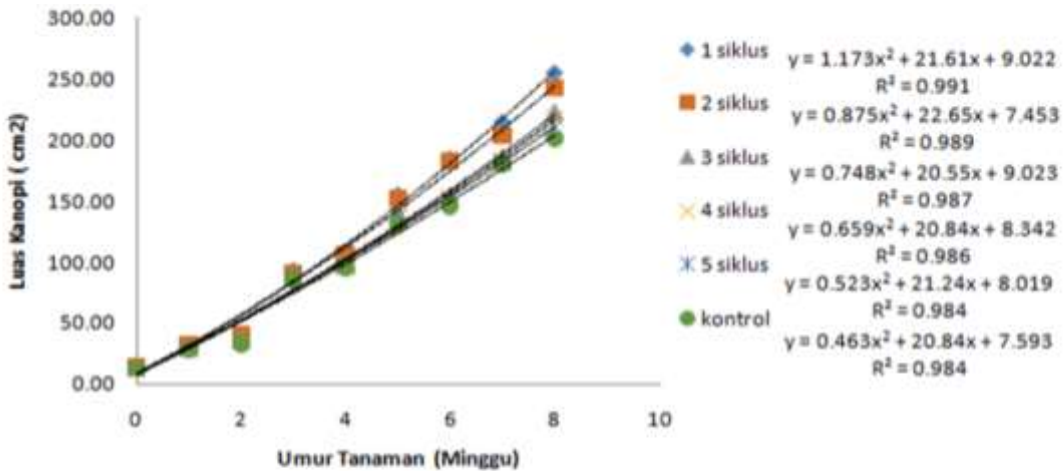

Fig. 5. Wide Growth of the Canopy

In Fig. 6 it is seen that the treatment of the number of cycles of red-blue combination LED light additions, negatively impacts the growth of the area of the canopy. The greatest growth acceleration of the canopy area is seen in the treatment of one additional light-emitting cycle. When compared to the control, the addition of red-blue combined LED light treatment resulted in greater acceleration of canopy growth.

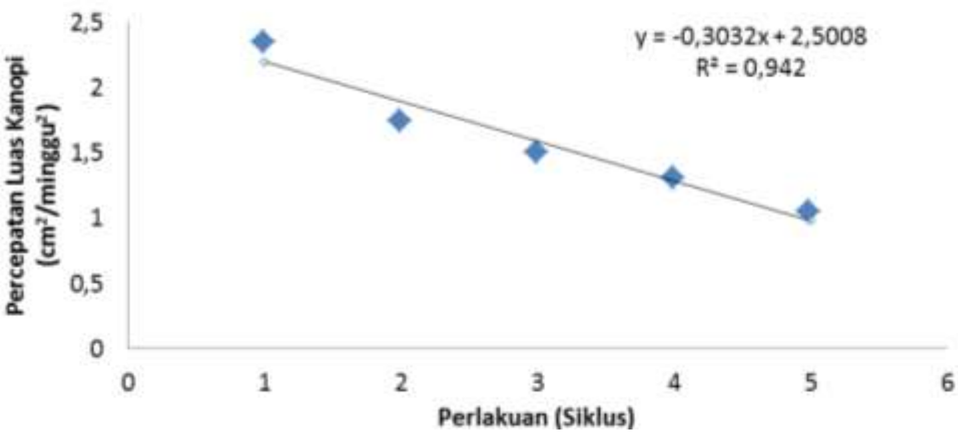

Fig. 6. Acceleration of Canopy Wide Growth

D. Number of Flowers

The result of statistical analysis shows that the addition of red-blue color combination LED light with cyclic method has significant effect (P <0,05) to the amount of flowers generated (Table 1). The fewer the number of cycles that are used, the more flowers will be generated. The highest number of flowers is generated at the treatment of the number of cycles one time, then followed by the number of cycles of 2, 3, 4, and 5 cycles. When compared to the control, the addition of red-blue color combination LED light with cyclic method produces more amount of flowers. Control only yields 16 flowers, which is markedly different from the treatment, which produces 17-20 pieces of flowers.

According to Heddy [15], the number of flowers produced by plants varies depending on the total amount of light received by the leaves. The area of the leaf will affect the quantity of light absorption in the plant. When light and nutrients are available in sufficient quantities, the number of branches, leaves and flowers will increase [16]. The amount of flowers generated is influenced in addition to external factors such as environmental influences, also influenced by factors in the genes and hormones possessed by plants [17].

Table 1. Average Number of Chrysanthemum Flowers

Treatment	Average Number of Flowers (pcs)	Standard Deviation
Control	16.00a	1.73
1 cycle	19.67c	0.58
2 cycle	18.67bc	0.58
3 cycle	17.67ab	0.58
4 cycle	17.67ab	0.58
5 cycle	17.00ab	1.73

Note: Average values followed by different letters in the same column show a significant difference (P <0.05)

E. Number of Perfect Blooming Flowers

The result of statistical analysis on the number of perfect blooms shows that the treatment of additional red-blue LED lights has no significant effect on the amount of perfect flowering (Table 2). The average number of perfect blooms produced ranged from 9 pieces to 11 flowers. Control also produces a perfect blooming number of 9 pieces although the total flowers generated are less than the treatment.

Table 2. Average Number of Perfect Bloom Flowers

Treatment	Average Number of Perfect Bloom Flowers (pcs)	Standard Deviation
Control	9.00a	2.65
1 cycle	10.66a	0.58
2 cycle	9.66a	1.53
3 cycle	9.33a	1.53
4 cycle	9.00a	1.00
5 cycle	9.00a	1.00

Note: Average values followed by different letters in the same column show a significant difference (P <0.05)

F. Root Length

Roots have a very important role for growth, because it works to uplift the plants, absorb water and minerals that dissolve in the soil, as well as a place to store food reserves. The length of chrysanthemum root of each treatment can be seen in Fig. 7 and Table 3. Fig. 7 show that the roots of chrysanthemum plants for each treatment have almost the same length.

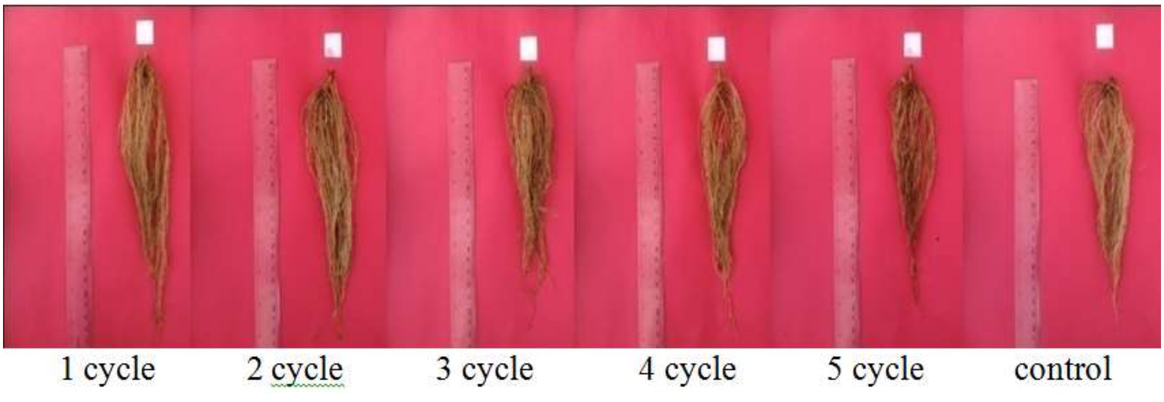

Fig. 7. Chrysanthemum Root Length of Each Treatment

Table 3. Average root length (cm)

Treatment	Average Root Length (cm)	Standard Deviation
Control	19.33a	2.31
1 cycle	23.33b	0.58
2 cycle	22.83b	0.76
3 cycle	22.00ab	1.32
4 cycle	21.00ab	1.32
5 cycle	19.66a	1.53

Note: Average values followed by different letters in the same column show a significant difference (P <0.05)

However, the results of statistical analysis showed that the addition of red-blue color combination LED with cyclic method has significant effect (P < 0,05) to root length of chrysanthemum plant. The addition of the number of cycles tends to produce shorter root lengths. When compared to the control, the addition of red-blue color combination LED treatment with cyclic method tends to produce longer roots. According to Ferita et al. [18], roots do not forever grow elongated to obtain the required nutrients. If the top growth is good then root growth will also be good.

G. Flower Color

The sharpness of the flower color is measured by comparing the color with the color chart (Fig. 8). The average value of the color of chrysanthemum flowers for each treatment can be seen in Table 4. Statistical analysis shows that the addition of red-blue color combination LED with cyclic method has no significant effect on flower color. However, the treatment of one cycle has the highest color brightness value. Controls produce flowers with the smallest color brightness.

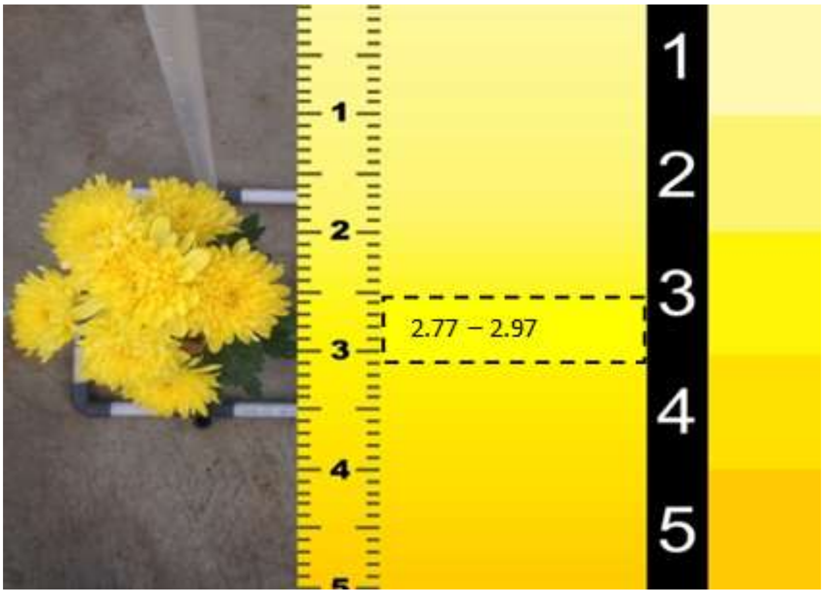

Fig. 8. The Color of Chrysanthemum Flowers

Table 4. Average Color of Flowers

Treatment	Average Color of Flowers	Standard Deviation
Control	2.77a	0.28
1 cycle	2.97a	0.47
2 cycle	2.84a	0.25
3 cycle	2.82a	0.47
4 cycle	2.82a	0.40
5 cycle	2.80a	0.07

Note: Average values followed by different letters in the same column show a significant difference (P <0.05)

H. Area of Flower

The results of the measurement of the area of chrysanthemum flowers for each treatment of addition of a red-blue color combination LED light are shown in Fig. 9 and Table 5. From Fig. 9 we can see the difference in the area of flowers generated in each treatment and control. The addition of a red-blue color combination LED light produces a larger area of flowers compared to the control.

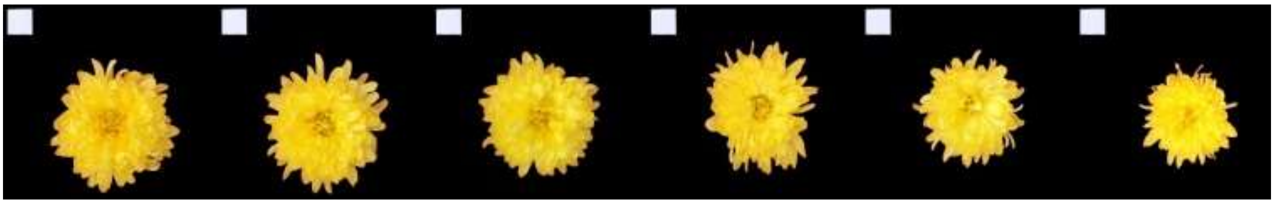

Fig. 9 Area of Chrysanthemum Flower Each Treatment

Table 5. Average Area of Flower (cm^2)

Treatment	Average Area of Flower (cm^2)	Standard Deviation
Control	45.45a	7.78
1 cycle	66.89d	2.99
2 cycle	58.80cd	3.15
3 cycle	56.88bcd	5.03
4 cycle	54.03abc	5.70
5 cycle	47.89ab	6.13

Note: Average values followed by different letters in the same column show a significant difference (P <0.05)

The result of statistical analysis shows that the addition of red-blue color combination LED light has significant effect (P <0,05) to the area of flowers. Treatment of the number of additional light-giving cycles, negatively impacting the area of flowers generated. The average value of the largest area of flowers is generated in the treatment of additional red-blue color LED lights combinations of 1-cycle.

IV. CONCLUSION

The addition of red-blue color combination LED light gives a positive impact on growth, productivity and quality of chrysanthemum flower compared with the addition of warm white light. The addition of red-blue color combination LED light produces better amount of flower and flower quality compared to the addition of warm white light bulb. However, the number of additional light cycles does not have a positive impact on growth, productivity and quality of chrysanthemum flower. The best cyclical pattern of red-blue color combination LED light for chrysanthemum plant productivity is 1 cycle (240 minutes off, 240 minutes on, 240 minutes off). The addition of a 1-cycle red-blue color combination LED light produces the most number of flowers, the largest flower area, and the brightest flower color.

REFERENCES

[1] Nxumalo, S.S. and P.K. Wahome. 2010. Effects of Application of Short-days at Different Periods of the Day on Growth and Flowering in Chrysanthemum (Dendranthema grandiforum). J. Agric. Soc. Sci. 6(2): 39-42.

[2] McMahon, M.1999. Development of Chrysanthemum Mesistems Grown Under Far-red Absorbsing Filters and Long or Short Photoperiods. J. Amer. Soc.Hort. Sci. 124(5):483-487.

[3] Kofranek, AM. 1980. Cut chrysanthemum, 5-43p, In Introduction to Floriculture, LARSON, RA. (Ed), Academic Press.

[4] Fides. 1992. Fides Mum Manual: for all year round Chrysanthemum. Fides. Alsmeer. 102p.

[5] Ariesna, Fitria dan Sudiarso. 2014. Respon 3 Varietas Tanaman Krisan (Chrysanthemum morifolium) Pada Berbagai Warna Cahaya Tambahan. http://download.fortalgaruda.org/article (diakses pada tanggal 30 November 2015).

[6] Maaswinke. 2006. Budidaya Krisan bunga potong: Prosedur sistem produksi. Jakarta. Puslitbanghorti.60 hal. ISBN : 979-8842-20-0.

[7] Mufarrikha. L, Ninuk H, Eko W. 2014. Respon Dua Kultivar Tanaman Krisan (Chrysanthemum morifolium) pada berbagai lama penambahan cahaya buatan. http:// Protan.studentjournal.ub.ac.id (diakses pada tanggal 30 November 2015).

[8] Sach, R. M. and A. M. Konfranek. 1963. Comparative cytohistological studies on inhibition and promotion of stem growth in Chrysanthemum morifolium. Amer. Bot. 50:772-778.

[9] Syarifudin, dan Noviani. 2015. Analisis Pertumbuhan Tanaman Krisan Pada Variabel Warna Cahaya Lampu LED. http://jurtek.akprind.ac.id/sites/default/files/83-87_syarifudin.pdf (diakses pada tanggal 30 November 2015).

[10] Ermawati, Dewi. dan Indradewa. 2012. Pengaruh Warna Cahaya Tambahan Terhadap Pertumbuhan Dan Pembungaan Tiga Varietas Tanaman Krisan (Chrysanthemum morifolium) potong. http://jurnal.ugm.ac.id/index.php/jbp/article/download/1354/pdf_4 (diakses pada tanggal 28 November 2015).

[11] Wiguna, I K. W., Wijaya, I M. A. S., dan Nada, I M. 2015. Pertumbuhan Tanaman Krisan (Crhysantemum) Dengan Berbagai Penambahan Warna Cahaya Lampu LED Selama 30 Hari Pada Fase Vegetatif.J. BETA vol. 3 no. 2. http://ojs.unud.ac.id/index.php/ beta/article/view/16659 (diakses pada tanggal 20 Desember 2015).

[12] Marliah, A., Jumini dan Jamilah. 2010. Pengaruh Jarak Tanam Antar Barisan Pada Sistem Tumpangsari Beberapa Varietas Jagung Manis Dengan Kacang Merah Terhadap Pertumbuhan Dan Hasil. Agrista vol. 14 No. 1. http://jurnal.unsyiah.ac.id/agrista/article/viewFile/ 693/645 (diakses pada tanggal 11 Januari 2016).

[13] Riyanti, Y. 2009. Pengaruh Jenis Media Tanam Terhadap Pertumbuhan Bibit Sirih Merah (Piper crocatum Ruiz and Pav.). Institut Pertanian Bogor, Bogor .http://repository.ipb.ac.id/bitstream/ 123456789/3032/4/A08yri.pdf (diakses pada tanggal 12 Januari 2016).
[14] Pertamawati. 2010. Pengaruh Fotosinintesis Terhadap Pertumbuhan Tanaman Kentang (Solanum Tuberosum L.) Dalam Lingkungan Fotoautotrop Secara Invitro. http://ejurnal.bppt.go.id (diakses pada tanggal 18 Desember 2015).
[15] Heddy, S. 1986. Hormon Tumbuhan. CV. Rajawali. Jakarta.
[16] Setyanti, Y. 2013. Karakteristik Fotosintetik dan Serapan Fospor Hijauan Alfalfa (medicago sativa) pada Tinggi Pemotongan dan Pemupukan Nitrogen yang Berbeda. Animal Agriculture. 2(1):86-96
[17] Gallan, P. A. 2005. Magnetoreception In Plant. Journal of plant research. The Botanical Society of Japan and springer Verlag Tokyo. 2005.118 : 371-389. http://www.springerlirrl.com (diakses 21 Mei 20115).
[18] Ferita, I., N. Akhir, H.Fauza, dan E.Syofyanti. 2009. Pengaruh Intensitas Cahaya Terhadap Pertumbuhan Bibit Gambir (Uncria Gambir.Roxb). Jerami. 2(2): 249-254.

D.15

ENDOPHYTE FUNGAL EXPLORATION FROM GRAMINAE ROOT WITH PLANT GROWTH PROMOTER POTENTIAL

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ABSTRACT

Graminae family (grasses) with its large varieties, grow widely on earth. The stems of Graminae are usually hollow and cylindrical, leaves are with specific long blade-like form and flowers are characterized by the arrangement of spikelets. The aim of this research is to isolate and identify fungal endophytes that colonize graminae root which have the potential to promote growth of rice seedlings. Graminae root samples were taken from Desa Tanjungsari, which is the agricultural area of District of Sumedang. All activities for this research took place in Micology Laboratory of Life Sciences Institute Technology Bandung. Organs taken from parts of healthy graminae roots were firstly washed thoroughly using clean water, then cut into 1 cm pieces. All already inoculated media were incubated in room temperature (27-28^{o}C). Isolation process was performed in Laminar Air Flow cabinet. Fungal endophytes were isolated from various graminae roots, included elephant grass (*Pennisetum purpureum*), alang-alang *(Imperata cylindrica*), sugarcane (*Saccharum oficinarum*), maize (*Zea mays*), rice (*Oryza sativa),* and cyperus *(Cyperus* rotundus). Isolation technique used in this process was direct planting. Rice seeds prepared above then planted in petri dish already fully covered by graminiae root-fungal endophytes (7-14 days old). Sterilized rice seeds then planted in petri dish with PDA media where root-fungal endophytes were already grown in. There were 10 seeds of rice planted in every petri dish isolate. Based on the research, the 124 isolates obtained comprised of 27 isolates from elephant grass (*Pennisetum Purpureum*), 25 isolates from alang-alang (*Imperata Cylindrica*), 14 isolates from sugarcane (*Saccharum Officinarum*), 9 isolates from maize (*Zea mays*), 23 isolates from rice (*Oryza sativa*) and 26 isolates from cyperus (*Cyperus rotundus*). From the 124 isolates obtained in this research, only 12 isolates showed the capability of promoting rice sprouts growth, demonstrated by negative sprouts growth inhibition in petri dish in pathogenicity test. To twelve (12) of these isolates include : *Gaeumannomyces graminis, Meyerozyme guilermondii, Bipolaris setariae, Hipocrea virens, Fusarium oxyporium, Fusarium solani, Gaeumamomyces amomi, Trichoderma longibraticum, Dothiodeomycetes sp, Pseudopestaliopsis theae, Phialemonium dimorphosporum, Starmelella bombicola*.

Key Words: Root Fungal Endophyte, Growth promoter, *Oryza sativa*

I. INTRODUCTION

Graminae tribes (grasses) grow all over the world as well as diverse. Rods Graminae generally generally shaped hollow tubes, typical leaves are long narrow strands and flower-shaped flowers. Rice plants include gramineae and are the most important commodities for Indonesian society, this is because most of Indonesian people are mainly rice. Almost throughout the year rice crops are always planted to meet the national food needs that continue to increase every year in line with the increasing number of people in Indonesia. According Hermanto (2012), that every Indonesian people consume rice every year amounted to 139.5 kg / person / year. To enlarge the contribution of rice production, the government has paid attention to the development of upland rice, especially the expansion of planting areas to dry land areas in Indonesia. According to the Central Bureau of Statistics (2016), the increase in production in 2015 occurred in Java as much as 2.31 million tons and outside Java as much as 2.21 million tons. The relatively large increase in rice production in 2015 occurred in the provinces of Central Java, East Java, South Sumatra and Aceh. While the decline of rice production is relatively large occurred in the Provinces of West Java, Jambi and West kalimantan. The diversity of endophytic microorganisms is very important to examine more deeply, one of which is the diversity of endophytic fungi present in the roots of graminae plants. Endophytic fungi are the most common microorganisms found in plant organs and form a symbiotic mutualism (Prihatiningtyas, 2006).

Endophytic fungi are a group of taxonomically classic fungi including Ascomycota class (Angelini et al., And Qadri et al., 2013), Basidiomycota (Suwannarach et al., 2012 and Qadri et al.), And Zygomycota (Bhagobaty and Joshi 2012; Maheswari and Rajagopal 2013). Also endopitic fungi belong to the Deuteuromycota class (Varvas et al., 2013 and Xiong et al., 2013). Every plant in its natural ecosystem can be symbiotic with endophytic fungi. This fungus enters through natural holes (stomata or lentisel) in plants, wounds or through pollination by insects (Rodriguez et al., 2009). This fungus will remain in a favorable relationship during a balance between fungal colonization and plant resistance (Kogel et al., 2006). Naturally, endophytic fungi provide benefits to its host, including protecting host from pathogen infection through its ability to produce inhibiting metabolite compounds or induce plant defense systems (Here et al., 2007). In addition, the symbiosis between certain endophytic fungi and its host will affect plant ecophysiology (eg expanding root system, stimulating root hair elongation, and increasing exudation of root phenolic compounds in rhizosphere) in the face of biological environmental stress (Rodriguez et al., 2009) Hubbard et al., 2012). In general, the mechanism of symbiosis of the endophytic fungus as resistance induction can spur the growth of rice crops so resistant to plant diseases and increased crop production, this endophytic fungus is able to control the disease and reject and attack pathogens so that the growth of plants becomes healthier.

The purpose of this study was to obtain endophytic fungi from graminae roots that were able to increase growth of upland rice plants. The isolated endophytic fungus is a genetic source for other purposes.

II. MATERIALS AND METHODS

This research was carried out from May to September 2016. All activities for this research took place in Micology Laboratory, School of Life Sciences and Technology Institute Teknologi Bandung. The graminae root sampling site is from Tanjungsari Village, Sumedang Regency, West Java, which has a height of 750 m above sea level.

There are three stages to get endofit fungi isolate on graminae root that is: 1). Isolate healthy plant organs especially the root part. 2). Purification of fungal endophytes 3). Selection of fungal endophytes. 4). Identification of fungal endophytes.

A. Isolation of Fungal Endophytes

Isolation of graminae root-fungal endophyte was the methods introduced by Nakagiri et al., (2005) with modifications. Healthy graminiae roots were firstly washed thoroughly using clean water, then cut into 1 cm pieces. All media which have been inoculated was incubated in room temperature (27-28 °C). Isolation process was performed in Laminar Air Flow. Fungal endophytes were isolated from various graminiae roots, included: elephant grass (Pennisetum purpureum), alang-alang (Imperata cylindrica), cane (Saccharum oficinarum), maize (Zea mays), rice (Oryza sativa), and cyperus (Cyperus rotundus). Graminiae root-fungal endophyte grown in PDA agar then went through purification process. Isolates purification selections was done through identification of colony characters and morphology based on the observation of color, shape and colony distribution patterns. Each fungal endophytes then separated, and drawn off using ose needle, to be grown in fresh PDA media.

B. Furifification of Fungal Endophytes

Endophytic fungus of graminae root that has grown on the media for PDA is then purified. Purification is done by selecting isolates based on differences in colonial morphological characters viewed from the colors, shapes and patterns of colony spread. Each endophytic fungus is separated, taken using an ose needle, then re-grown on a new PDA medium. Purification of the spore-forming fungus is done by means of single spore isolation (Gandjar *et al*., 1992). As for mushrooms that do not form spores is done by growing mushrooms on the medium of PDAs; And with the help of Stereo microscopy, a single hyphae from the fungus is transferred to the PDA medium (Nakagiri *et al*., 2005).

C. Selection of Fungal Endophytes

Rice seeds in sterilization on the surface, then added to a pure culture containing endophytic fungal isolates whose growth has filled petri dishes (approximately 14 days). If the seeds planted in the pure culture are not able to germinate, the fungus is pathogenic and the fungus can not be used as an antagonistic agent. The seeds that have germinated normally are transferred into polybags containing sterile soil media and further observed disease symptoms that arise as a result of the inoculation of the endophytic fungus.

D. Identification of Fungal Endophytes

Purified fungal endophyte isolates were observed through microscopic, macroscopic and cellular process and followed by identification. Identification of all these isolates were conducted based on macroscopic (form, color, colony growth) and microscopic (conidiophor, mycellium formation, spores shape) observations. *Ilustrated Genera of Imperfect Fungi* (Barnett and Hunter, 1960) guide book is used for identification process. Molecular observations were conducted using PCR with sequencing analysis. Molecular identification for fungi species was done through DNA analysis of graminiae root-fungal endophytes mycellium. Mycellium was extracted using provided kit. Each PCR products was then purified using QIA quick PCR purification kit, followed by sequncing using ITS 1f and ITS 4 primers. The result of this DNA sequence was compared with Gene Bank data base in *National Center for Biotechnology Information* (NCBI) and UNITE using *Basic Local Alignment Search Tool Algorithm*(BLAST) program. The sequence was matched and analyzed using neighbor-joining (NJ) at NCBI to interpret the species, genera, and family levels.

III. RESULTS AND DISCUSSION

A. Isolation and Selection of Fungal Endophytes

Isolation result of fungal endophytes in graminae came from the agriculture area of Tanjungsari Village, Sumedang Regencies. Selection process was done by planting sterile rice seeds on PDA media in petridish already covered by root-fungal endophytes. Of the 124 isolates, 12 isolate genera were selected and suspected to be the trigger for the growth of seed seed sprouts. The twelve isolates consist of 4 isolates of endophytic fungus from root of *Oryza sativa*, 1 endophytic fungal isolates from *Saccharum oficinarum* root, 2 isolates of endophytic fungal from *Cyperus rotundus*, 2 isolates of endophytic fungal from *Imperata cylindrica*, 1 endophytic fungal isolates from *Pennisetum purpureum*, and 2 endophytic fungal isolates from *Zea mays*.

The picture shows that graminae root-fungal endophytes population was dominant in elephant grass (*Pennisetum purpureum*), in cyperus (*Cyperus rotundus*) and alang-alang (*Imperata cylindrica*) (Fig. 1). In general, the whole life cycle of fungal endophyte in grass acted as non-patogenic endophyte or epiphyte which did not cause any damage to the tissue of their host. Based on the association of fungal endophyte and its host plant, Carrol (1988) divided them into two groups, namely constitutive and inductive mutualism. Constitutive mutualism is a close association between fungi and its host plant, specially the grasses. In this group, fungal endophytes that infect host ovule and are propagated in host seed and through host pollination. Inductive mutualism is an association between fungi and its host plants which disseminate independently through air or in water. They infected only vegetative parts of the host and remaining metabolically inactive for a long periods.

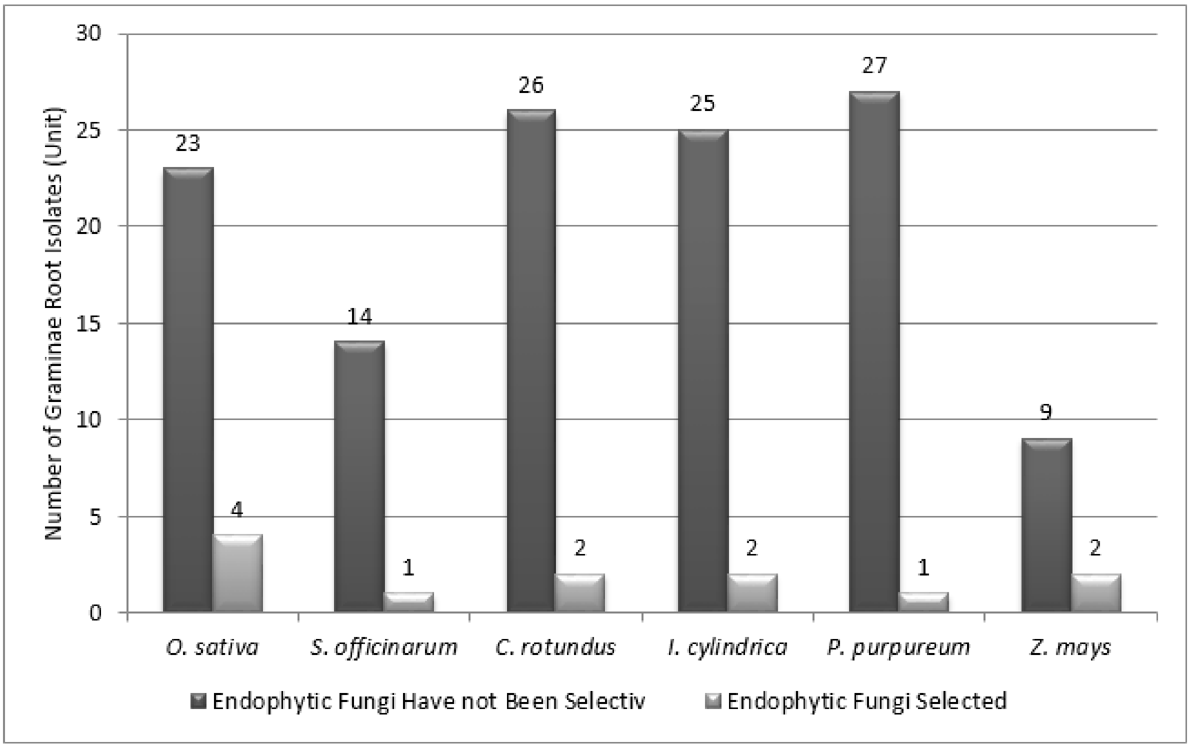
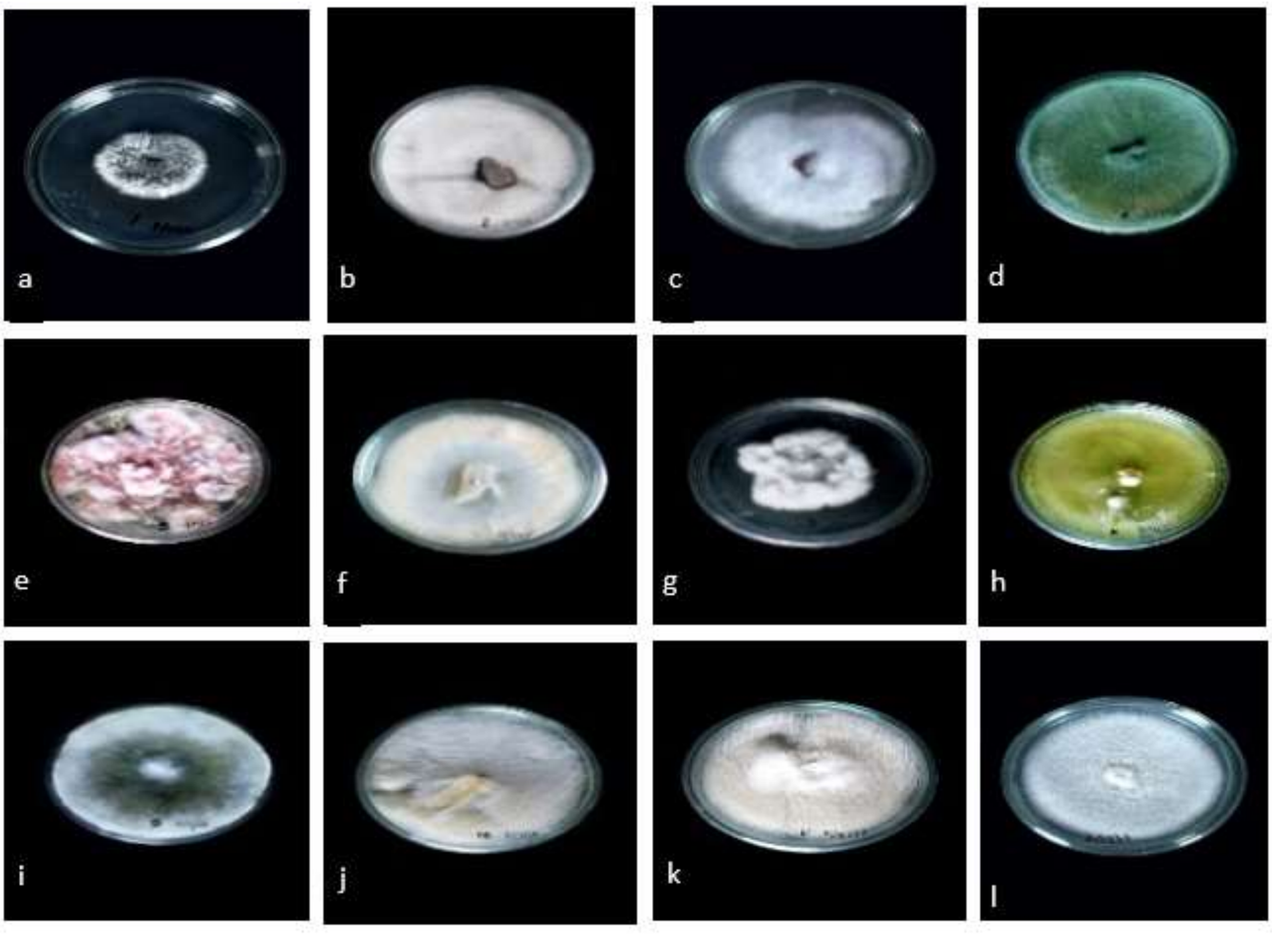


Fig. 1. Histogram of Graminae Root Fungal Endophytes Population

Fungal endophytes can infect whole parts of host plants with various number of endophytes. These fungal endophytes will then stay in parts of plant's tissues in full or parts of life cycle inapparent infections which do not cause harm to the host. Almost all class of plants spread around the world are known as host of endophytes microorganism (Zhang, *et al*., 2006), although the present of endophytes in plants tissues commonly unspecific for certain plants (Cohen, 2006). Fungal endophytes can be found in plants with different class or family, from various environment geographically or ecologically, nevertheless some types of fungal endophytes sometimes can only be found in certain organ of certain species. This specific fungal endophyte is from group Clacivitaceous which can only be found in the grasses (Rodriguez *et al*., 2009). Environment factors around plants affect number and species of fungal endophytes that penetrate into plants tissues. Plants condition, such as genotype factor and leaf and root characters also play an important role in the determination of fungal ephytic propagules presence in plants leaves or roots (Arnold & Herre, 2003). Elephant grass, cyperus and alang-alang are grasses that can be found easily around agricultural farms and these plants grow all year round, so fungal endophytes on these grasses are found in abundance. From the three species mentioned above, the most with widespread distribution based on isolation result was the isolate of elephant grass (*Pennisetum Purpureum*) fungal endophytes.

Molecular identification of species names of the twelve isolates graminiae root-fungal endophytes is presented in Fig. 2 From the twelve isolates obtained, they showed variety of shape, edge, surface, conidiophor shape, hyphae form and color, and colony color. Fig. 2 shows various root-fungal endophytes found in graminiae. Graminiae root-fungal endophytes diversity caused by process of symbiosis between certain fungal endophytes and host would affect plants ecophysiology (among others by extending root system, stimulating root hair elongation, and increasing exudation of phenolic substances of root rhizosphere) in facing biological (Rodgriguez *et al*., 2009) or physical (Hubbard *et al*., 2012) environment stresses . According to Carrol and Clay (1988) in Worang (2003), fungal endophytes are found in tissues system of leaves, seeds, flowers, branches and roots of host plants. These show that every isolate has its own specific characteristics. Colony color difference is caused by intercelullar pigments produced by microbes, such as anthocyanin, melanin, carotenoid, tripirylmethane and phenozin and each pigment will show different shade of color (Safrida, 2012). Fungal endophytes are plants mutualistic symbiont. The is play an inportant a role against pathogenic infections (Narisawa *et al*., 2000), and accelerating growth and enhancing sustainability to drought and high temperature (Lehtonen *et al*., 2005) and as health bioindicator of plants (Genarro 2003). According to Syarmalina in Herlina et al., (2013), fungal endophytes in plants has the ability to accelerate germination process, to survive in unfavourable condition, speed up growth and increase sustainability under environment stresses. The ability of fungal endophytes to promote rice plants growth depends on the ability to produce metabolites that enhance growth. Growth promoter substances such as gibberellin, auxin and cytokinin are produced by this fungal endophytes (Khan *et al*., 2012).



Descriptions:

a. Gaeumannomyces graminis	*e. Fusarium oxyporum*	i. *Dothiodeomycetes* sp
b. Meyerozime guillierrmondii	*f. Fusarium xeratoplasticum*	*j. Psendopestalotiopsis thea*
c. Bipolaris setariae	*g. Gaeumannomyces amomi*	*k. Phialemonium dimorphosporum*
d. *Trichoderma virens*	h. *Trichoderma longibraciatum*	l. *Starmerella bombicola*

Fig. 2. Graminae Root-Fungal Endophyte

B. Pathogenic Test

From the twelve (12) endophytic fungi, the pathogenity test was done to obtain the potential isolates as the trigger of growth of upland rice plants. Selection is done by growing the seeds of rice that has been sterile on the media that has been overgrown with mushrooms (approximately 14 days) on the twelve mushrooms. Mushrooms that are able to germinate and germinate normally, the fungus is a fungus that can be used next test. Isolates of endophytic fungi that are not endophytic fungi will show seeds that do not germinate even rot and dry. Seeds that are not able to germinate in the assumption that the fungus is a pathogenic fungus that inhibits seed germination and the isolate is not used for further tests. From twelve (12) the fungus is potential as endophytic fungus because all do not show inhibition of growth of rice seed in petri dish. Plants do not show symptoms of falling sprouts and stem base rot. This is because the endophytic fungus is not a pathogen and depends on the host so that the plant is not infected and does not hurt. The inability of the endophytic fungus causes symptoms of the disease under the endophytic fungus to have no or no gene loss for pathogenicity.

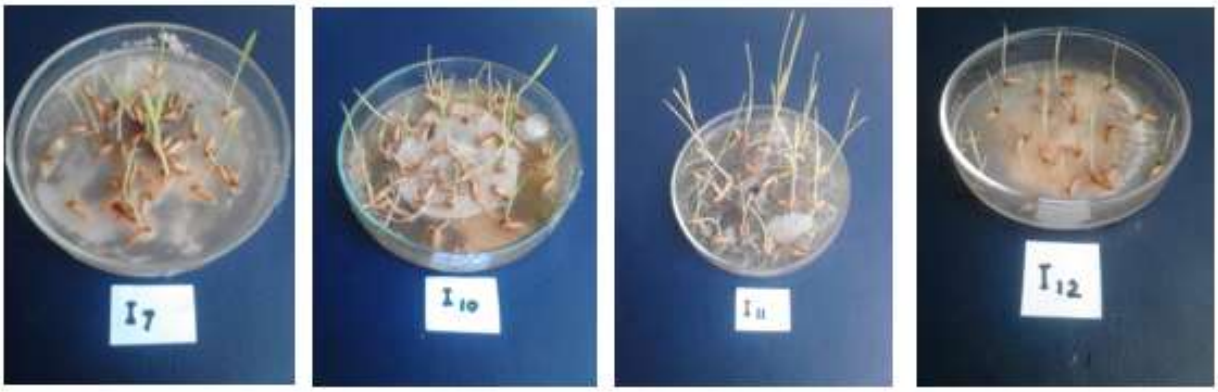


Fig. 3. Pathogenic test of rice seed

IV. CONCLUSION

Gramine root endophytes have been isolated and identified molecularly. Endophytic fungi include: *Gaeumannomyces graminis, Meyerozyme guilermondii, Bipolaris setariae, Hipocrea virens, Fusarium oxyporium, Fusarium solani, Gaeumamomyces amomi, Trichoderma longibraticum, Dothiodeomycetes sp, Pseudopestaliopsis theae, Phialemonium dimorphosporum, Starmelella bombicola*. Of the twelve (12) fungi all have potential as endophytic fungus because they do not show inhibition of growth of upland rice seed in petri dish through pathogenic test.

REFERENCES

Angelini P, Rubini A, Gigante D, Reale L, Pagiotti R, Venanzoni R, 2013. The Endophytic fungal comunities asocciated with the leaves and root of comon reads (*Phragmites australis*) in Lake Trasimeno (Perugia Italy) in declining and healthy stands. Fungal Ecol. 30:1-11.

Arnold, A.E. and Here, A.E. (2003). Canopy cover and leaf age affect colonization by tropical fungal endophytes : Ecological pattern and process in *Theobroma cacao* (malvaceae). Mycologia, 95(3): 388-98.

Barnet, H.L dan B.B. Hunter. 1960. *Illustrated Genera of Imperfect Fungi*. Brgess Publishing Company. USA. P 75.

Carrol, G. 1988. *Fungal Endophytes in Stem and Leaves : From laten Pathogen to Mutualistic Symbiont*. Ecology, 62: 2-9.

Cohen, S.D., 2006. Host selectivity and genetic variation of *Discula umbrinella* isolates from two oak species: analyses of intergenic spacer region sequences of ribosomal DNA. *Microbial Ecology* 52, 463-469.

Here, E.A., Mejia L.C., Kyllo, D.A., Rojas E., Maynard Z., Butler A., and Bael, S.A.V., (2007). Ecological implications of Anti-pathogen Effects of Tropical Fungal Endophytes and Mycorrhizae. Ecology, 88 (3): 550-558.

Hubbard, M.J., Germida, and V. Vujanovic, (2012). Fungal endophytes improve wheat seed germination under heat and drought stress, *Botany* 90: 137-149.

Kogel, K.H., Franken, P., and Huckkelhoven, R., (2006). Endophyte or Parasite-what decides?Current Opinion in Plant Biology. 9:358-363.

Lehtonen, P., Helander, M., Saikkonen, K., (2005). Are endophyte-mediated effects on herbivores conditional on soil nutriens? *Ocologia* 142: 38-45.

Nakagiri A, 2005. Preservation of fungi and freezing method. In: Workshop and Preservation of Microorganisms. Biotechnology Center-NITE and Research and Development Center for Biotechnology-LIPI, Cibinong 17-18, Oktober 2005.

Narisawa, K., Ohki, T. and Hashiba, T. (2000). Suppresion of clubroot and Verticilium yellows in Chinese Cabbage in the field by the root endophytic fungus, *Heteroconium chaetospira*. Plant Pathology, 49: 141-146.

Qodri M, Johri S, Shah BA, Khajuria A, Shidiq T, Lattoo SK, Abidin MZ, Riyaz-Ul-Hassan S, 2013. Identification and biactive potential of endophytic fungal isolated from selected plants of the Western Himalayas. Springer Plus 2 (8):1-14.

Rodriguez, R.J., White, J.F., Arnold, A.E., and Redman, R.S., (2009). Fungal endopyhtes : Diversity and Functional Roles. *The New Phytologis*t. 182 (2): 314-30.

Safrida, Yuni. 2012. *Isolasi dan Karakteristik Bakteri Berpotensi Probiotik pada Ikan Kembung (Rastrelliger* sp.) Jurnal. Universitas Syiah Kuala, Aceh.

Varvas T, Kasekamp K, Kulman B, 2013. Preliminary study of endophytic fungi in timothy (*Phleum pratense*) in Estonia. Acta Mycologica 48 (1):41-49.

Xiong ZQ, Yang YY, Zhao N, Whang Y. 2013. Diversity of endophytic fungi and sreening of fungal paclitaxel producer from Anglojap yew, *Taxus media.* BMC Microbial 13 (71):2-10.

D.16

ACTIVITY OF SOIL MICROORGANISMS DURING THE GROWTH OF SWEET CORN (*Zea mays saccharata Sturt*) IN SECOND PLANTING TIME WITH THE APPLICATION OF COMBINATION ORGANONITROFOS, INORGANIC FERTILIZERS, AND BIOCHAR

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ABSTRACT

Efforts to increase the production of sweet corn can be done with the application of fertilizers, either inorganic, organic orits combination. In addition, the application of soil amendments such as biochar is also expected to improve soil fertility that will indirectly increase the production of sweet corn. Organonitrophos fertilizer is an organic fertilizer developed by lecturers of Faculty of Agriculture, University of Lampung. The research was aimed to study effect the combination of organonitrophos, and inorganic fertilizers, biochar and the interaction between fertilizer combination and biochar on soil respiration and soil microbial biomass.The research was conducted in the Integrated Field Laboratory of Lampung University using 6x2 factorial in a Randomized Block Design with 3 replications. The first factor was six levels combination of organonitrophos and inorganic fertilizers (P_0, P_1, P_2, P_3, P_4, and P_5). The second factor was two levels of biochar dosage (B_0 and B_1). Data was analyzed by Analysis of Variance and followed by the Least Significant Difference (LSD)Test at 5% level. The observed variables were soil microorganism activity likely soil respiration and soil microbial biomass. The results showed that P_3B_1treatment (300 kg Urea ha^{-1}, 125 kg SP-36 ha^{-1}, 100 kg KCl ha^{-1} + 2500 kg organoitrophosha^{-1}) was the highest soil respiration at of 60 days after planting (DAP). P_5treatment (5000 kg Organonitrophosha^{-1}) has the highest soil microbial biomasscompared to other treatments at 60 and 90 DAP. B_1 treatment (5000 kg biocharha^{-1}) has higher soil respiration and soil microbial biomasscompared to treatment (0 kg biochar ha^{-1}. There was an interaction between combination of organonitrophos and inorganic fertilizers and biochar on soil respiration at 90 DAP. However, there was no interaction between fertilizer combinationand biochar on soil microbial biomass.

Keywords: Fertilizer Combination, Organonitrophos, Biochar, Soil Respiration, Soil Microbial Biomass.

I. INTRODUCTION

In Indonesia, corn is a commodity in the world's most important food crop after rice. One of the obstacles that cause the low corn production in Lampung is a type of soil that is the land of Ultisol which is dominated by the sandy fraction and has undergone further weathering. This land is also poor nutrient and mineral deposits such as P, Ca, Mg, Na, and K, high levels of Al, low cation exchange capacity, and be sensitive to erosion(Joon and Suriadikara, 2006). Based on the soil conditions, soil fertility improvement is needed. One of the efforts to improve the fertility of the soil by fertilizing, good organic fertilizers, inorganic fertilizers or a combination of both.

One type of organic fertilizer that can be used is the fertilizer alternative Organonitrofos (Nugroho *et al*., 2012). Organonitrofos fertilizer is made from cow dung and 70-80% 20-30% phosphate rocks, with the addition of microbial N fastening system and solvent P. But the results of the latest fertilizer formulations Organonitrofos is made from a mixture of cow dung and chicken manure, dolomite, industrial solid waste ash, MSG (Monosodium Glutamate) and with the addition of microbial N and P fastening system. In addition to fertilizers, to improve Ultisol soil fertility, especially to improve the quality of the biological materials of soil, refining soil material can be used such as biochar. Biochar is a carbonaceous material derived from biomass such as wood as well as the rest of the results of the processing plant that is heated in a container with little or no air (Lehman and

Joseph, 2009). Research by Sukartono *et. al*, (2014), indicating that any change of soil physical properties on the map of the land who is given the application of biomass (manure, biochar, and straw). Granting of biochar to soil potentially increase levels of C-soil, water retention and nutrient elements in the soil. Gani (2009) States that ' biochar ' applications much more effectively improve the retention of nutrients to plants than any other organic material, such as compost or manure.

The content of organic matter in the soil is essential towards the nature of the physical, chemical or biological soil which will affect the levels of soil fertility. One of the biological properties of the soil is the presence of microorganisms in the soil. The activity of the microorganisms can be observed through the rate of respiration and microbial biomass carbon (C-mic) ground. Soil respiration is defined as the sum of all the metabolic activities that generate CO_2 or produce O_2 absorption from the soil (Ragil, 2009). The soil which is containing high organic materials has the number of microorganisms which is also high because the soil contains the substrate that can support the life of the microorganism (Azizah et. al., 2007). Biomass of soil microorganisms represent a portion of the total fraction of carbon and nitrogen in the soil but is relatively easy to change so that the amount of activity and the quality of the microbial biomass a factor in controlling the amount of C and N is mineralized (Kirana, 2010).

Granting of rice husk biochar with a combination of Organonitrofos fertilizer and chemical fertilizers are expected to improve the nature of the physical, chemical, and biological soil, increasing the absorption of nutrient elements by plants, as well as knowing their effectiveness in increasing the production of corn plants. This research is the second season of research that aims to study the influence of the combination of chemical fertilizer and organonitrofos fertilizer, biochar and the interaction between a combination of fertilizer and soil microorganisms activity against biochar namely respiration and soil microbial biomass carbon (C-mic).

II. MATERIALS AND METHODS

The research carried out in Lapang Terpadu Laboratory of Lampung University use factorial 6x2 in randomized block design with 3 repetitions. The first factor is 6 level fertilizer combinations (Table 1). The second factor is 2 level dosage *biochar* (Table 2). Analysis of data with ANOVA and LSD 5%. The observed variable issoil microorganism activity i.e. soil respiration and biomass respiration of soil microorganisms (C-mic).

Table 1. Combination fertilizer OP and Inorganic

Treatment	Combination fertilizer		Dose fertilizer			
	OP	Inorganik	OP (kg ha^{-1})	Urea (kg ha^{-1})	SP-36 (kg ha^{-1})	KCl (kg ha^{-1})
P_0	0	0	0	0	0	0
P_1	0	100	0	600	250	200
P_2	25	75	1250	450	187,5	150
P_3	50	50	2500	300	125	100
P_4	75	25	3750	150	62,5	50
P_5	100	0	5000			

Table 2. Dose of *Biochar*

treatment	Biochar (%)	Dose of Biochar (kg ha^{-1})
B0	0	0
B1	100	5000

The results of the analysis of organonitrofos fertilizers used contain N-and P-available is very high, K-high totals, as well as a neutral soil pH, can be seen in table 3.

Table 3. The results of the chemical analysis of Ultisol soil at Gedong Meneng, organonitrofos and Biochar before treatment.

Type analysis	*Biochar*	Soil a Start	Organonitrofos	Criteria
N-total (%)	0,76 (ST)	0,28 (S)	1,13	very high
P-total (%)	-	-	5,58	very high
K-total (%)	-	-	0,68	high
P-available (ppm)	26,83 (ST)	6,9 (R)		
K-dd (%)	1588,0 (ST)	0,453 (S)		
C-organic (%)	14,65 (ST)	1,76 (R)	9,52	very high
KTK (me 100 g^{-1})	-	6,4 (R)		
pH	7,9 (AA)	6,47 (AM)	5,69	Netral

Source criteria: balittanah, (2005).

Map of corn measuring 3 x 2 m distance between the swaths of corn is 50 cm. Corn planted seeds as much as 2 for each hole with a distance of planting 70 x 25 cm. next after 6 days done thinning so a healthy growing plant remained. Chemical fertilizer (KCl and SP-36) and ½ dosage urea given 2 weeks after planting the seed of corn (in accordance with the respective treatment). Applications of urea (the remaining ½ dosage) the rest is done at the end of the vegetative (panicles start out). Chemical fertilization is done by at 5 cm deep in tugal.

Soil sampling for soil respiration observation and C-mic ground performed at 0, 15, 30, 60 and 90 DAP (harvest). Soil samples were taken using the drill ground at a depth of 0-10 cm. Each swath is taken from 5 points then the soil sampling is compiledand stored in the refrigerator. The main variable is the respiration of the soil with the method of 1981 Verstraete (Franzluebbers et al., 1995) and C-Mic ground with Fumigation-Incubation Method (Jenkinson and Powlson, 1976).

Supporting variable is the analysis of the ground early and late i.e. water content (Volumetric method), pH (electrometric method), the C-organic (Walkley and Black method), N-total (Kjeldahl method), P-available (method of Bray), soil Temperature (measured by Soil Temperature Tester) and K-dd (method of NH_4-Ac).

III. RESULTS AND DISCUSSION

Changes of soil properties after the second growing season Corn Harvest the results of the analysis of the soil at the moment of harvest (table 4), an increase in the content of P-available significantly on the treatment of P2B1 (75% of inorganic fertilizer and 25% Organonitrofos + ' Biochar '), on the analysis of the initial P-content of soil available for 6.9 ppm increased to 49.71 ppm. In addition, an increase in the content of K-dd at the treatment P4B1 significantly (25% chemical fertilizers and 75% Organonitrofos + Biochar).

Table 4. The results of the chemical analysis of soil Building Ultisol Meneng with Organonitrofos fertilization treatment, Biochar and inorganic fertilizers when harvesting.

Treatment	N-total (%)	P-available (ppm)	K-dd (%)	C-Organic (%)	KTK (me 100g^{-1})	pH
P_0B_0	0,13	2,43 (R)	0,42 (SR)	1,12	6,12	6,30
P_1B_0	0,11	1,52 (R)	0,30 (SR)	0,94	8,90	5,83
P_2B_0	0,15	10,66 (S)	0,56 (S)	1,46	6,63	6,26
P_3B_0	0,16	45,44 (ST)	0,88 (T)	1,55	7,15	6,41
P_4B_0	0,11	1,91 (R)	0,32 (SR)	0,96	8,90	6,22
P_5B_0	0,18	25,62 (ST)	0,71 (T)	1,72	10,13	6,36
P_0B_1	0,11	1,61 (R)	0,58 (S)	1,21	8,05	6,17
P_1B_1	0,16	2,51 (R)	0,55 (S)	1,31	6,90	6,05
P_2B_1	0,12	49,71 (ST)	0,72 (T)	1,32	7,25	6,23
P_3B_1	0,22	30,70 (ST)	0,63 (T)	1,72	6,85	6,30
P_4B_1	0,17	36,52 (ST)	0,81 (T)	1,88	6,86	6,32
P_5B_1	0,12	12,50 (ST)	0,59 (S)	1,55	7,94	6,55

Information :

P_0 = without fertilizer
P_1 = 100% chemical fertilizer
P_2 = 75% chemical fertilizer and 25% Organonitrofos
P_3 = 50% chemical fertilizers and 50% Organonitrofos
P_4 = 25% chemical fertilizerand 75% Organonitrofos
P_5 = 100% Organonitrofos
B_0 = without biochar
R= low
S= medium
T= high

On the analysis of the early soil, the content of K-dd of 0.453% increase to 0.81%. However, the nutrient content of N-total decline throughout treatment. At the time of initial soil analysis, the content of N-total of 0.28% decreases ranged from 0.11- 0.22%. This is in line with the statement (1983) Koswara that corn plants take N all its growth. Nitrogen absorbed during the growth of the plant until the maturation of seeds, so this plant requires the availability of N continuously on all stadia growth until the formation of the seed. The results of the analysis of the soil pH unchanged meaning. Analysis of the ground early, the value soil pH 6.47 (rather acerbic), after the application organonitrofos, chemical fertilizers, and biochar soil pH values ranging from 6.17- 6.55 criteria somewhat sour. The results of the research of Nisa (2010) shows that the ground has given the biochar 10 tons ha-1 which can increase the soil pH from 6.78 became 7.40 or ride 9.14%.

The influence of giving the combination of Organonitrofos Fertilizer and Inorganic Fertilizer with the addition of Biochar against Soil Respiration on the analysis of the spectrum (table 5) indicates that the combination treatment of manure and fertilizer organonitrofos inorganic gives a real influence against soil respiration at a time when corn plants were 0 and 90 HST. However, the addition of biochar does not give any significant effect on the soil respiration during plant growth of corn. There is an interaction between a combination of fertilizer (OP and inorganic) when corn was 90 DAP.

The dynamic changes of soil respiration during corn growth is presented in Fig. 1. Fig. 1 shows that the respiration of the soil has decreased at the beginning to plant corn was 15 HST. It is alleged the available nutrients used for plant growth of corn. Organic and inorganic fertilizers are added to the land has not experienced the decomposition process to the maximum, so the available nutrient elements in soils by soil microorganisms contested. So competition between soil microorganisms and soil microorganisms partly reduced the population.

Table 5. A summary analysis of the range of soil respiration due to the granting of a combination of organonitrofos and chemical fertilizers with the addition of biochar.

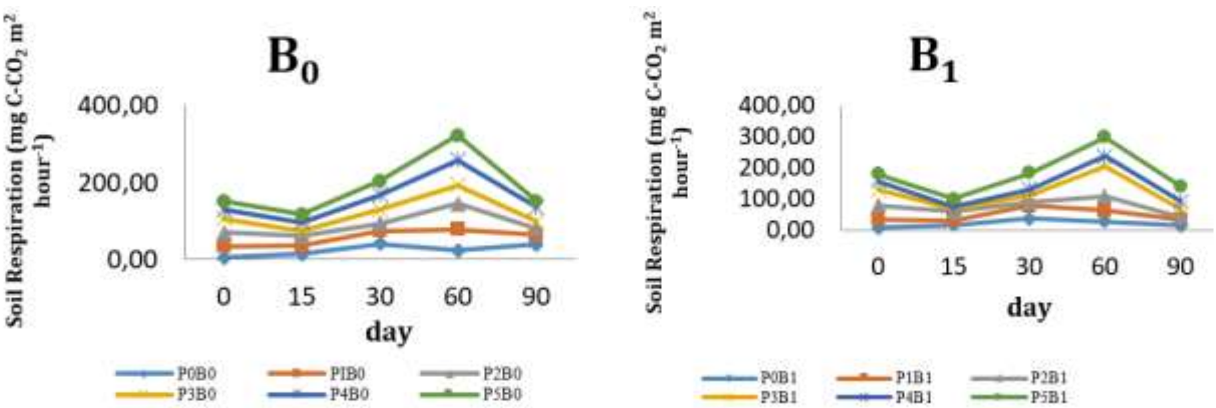
Sources of Diversity	Soil Respiration (kg C-CO_2 ha^{-1} day^{-1})				
	days after planting (DAP)				
	0	15	30	60	90
fertilizers	*	tn	tn	tn	*
Biochar	*	tn	tn	tn	tn
Interaction	tn	tn	tn	tn	*

Information: days after planting (DAP), * = significance at P<0,05, ** = significance at P<0,01, tn = significance'n

Soil respiration increased after that corn was on 60 HST. Soil respiration was increasing along with the growth of corn plants during the vegetative end. At that time the development of the roots already maximized so that roots can issue the exudate. This root exudate can be used as an energy source for soil microorganisms and some of the roots are also experiencing a death. So can undergo decomposition and utilized by the microorganisms of soil. Soil respiration decreased again at a time when corn plants were 90 HST. This is because the nutrient elements required by plants is already reduced in number in the ground. Nutrient elements are not only used for plant growth but used as an energy source for soil microorganisms.

Highest respiration at a time when corn plants aged 60 HST namely treatment P_3B_1 (300 kg.ha^{-1} of urea, 125 kg SP-36 ha^{-1}, 100 kg.ha^{-1} + KCl fertilizer organonitrofos 2500 kg.ha^{-1} + 5000 kg.ha^{-1}) and lowest respiration namely P_0B_0 treatment (control). Meanwhile, treatmentP_3B_0 (300 kg.ha^{-1} of Urea, 125 kg SP-36 ha^{-1}, 100 kg.ha^{-1} + KCl fertilizer organonitrofos 2500 kg.ha^{-1}) has a higher respiration compared to treatment P_1B_0 (600 kg.ha^{-1} Urea, 250 kg SP-36 ha-^{1} , 200 kg ha^{-1}KCl). It is alleged by balanced fertilization accompanied with the usage of soil refiner such as biochar which can meet the needs of plant nutrient corn and as a source of energy for the microorganisms. This is in line with the results of the experiment and Antonius Agustiyani (2011) that the highest soil respiration activity obtained in combination treatment of chemical fertilizers (inorganic) 140 kg.ha^{-1} of urea, 200 kg.ha^{-1} TSP + 130 kg.ha^{-1} of KCl and a liquid organic fertilizer 40 liters.ha^{-1}.

At the time of the corn plant was 90 HST (harvest), there was an interaction between the giving of the combination organonitrofos and inorganic fertilizer with the addition of biochar against soil respiration.It is alleged the granting of organonitrofos and inorganic fertilizer with the addition of biochar can provide enough nutrient for plant growth of corn as well as the result of the decomposition of the organic material can be used as an energy source for soil microorganisms. Influence the awarding of a combination Organonitrofos Fertilizer and Inorganic Fertilizer with the addition of Biochar soil microbial biomass carbon (C-mic). the summary results of the analysis range C-mik grant of land by the combination of organonitrofos fertilizer and chemical fertilizers with the addition of biochar can be seen in Table 7.



Information :

P_0 = without fertilizer
P_1 = 100% chemical fertilizer
P_2 = 75% chemical fertilizer and 25% Organonitrofos
P_3 = 50% chemical fertilizers and 50% Organonitrofos
P_4 = 25% chemical fertilizer and 75% Organonitrofos
P_5 = 100% Organonitrofos
B_0 = without biochar

Fig. 1. Dynamics of soil respiration at the treatment without biochar (top) and treatment with biochar during growth of corn plants

Table 6. Interaction between treatment of chemical fertilizers and Organitrofos with biochar against soil respiration at a time when corn plants was on 90 HST

Biochar	fertilizers					
	P_0	P_1	P_2	P_3	P_4	P_5
B_0	6,24 (a)	4,00 (ab)	6,09 (a)	3,96 (c)	2,82 (c)	4,89 (c)
B_1	5,02 (a)	4,06 (a)	3,94 (c)	4,59 (ab)	5,00 (c)	6,58 (a)

Information :

P_0 = without fertilizer

P_1 = 100% chemical fertilizer

P_2 = 75% chemical fertilizer and 25% Organonitrofos

P_3 = 50% chemical fertilizers and 50% Organonitrofos

P_4 = 25% chemical fertilizer and 75% Organonitrofos

P_5 = 100% Organonitrofos

B_0 = without biochar

The same letter is not significantly different based on 5% BNT test. Small letters are read horizontally, capital letters are read vertically

Table 7. A summary of the analysis of the spectrum of C-mic ground due to the granting of a combination of organonitrofos and chemical fertilizers with the addition of biochar.

Sources of Diversity	soil microbial biomass carbon (mg CO_2-C kg^{-1})				
	days after planting (DAP)				
	0	15	30	60	90
Fertilizer (P)	*	*	tn	*	*
Biochar (B)	*	*	*	*	*
Interaction	tn	tn	tn	tn	tn

Information: days after planting (DAP), * = significance at P<0,05, ** = significance at P<0,01, tn = significance'n

Table 8. Influence the awarding of a combination of fertilizer and organonitrofos fertilizer on soil C-Mic (mg CO_2-C kg^{-1}) during growth of corn.

Treatment of fertilizer combination	C-mic (mg CO_2-C kg^{-1})			
	0 DAP	15 DAP	60 DAP	90 DAP
P_0 without fertilizer	33,42 a	36,44 a	72,00 a	41,08 b
P_1 (OP 0% + 100% chemical fertilizer)	43,61 b	50,78 bc	83,95 b	39,03 a
P_2 (Op 25% + 75% chemical fertilizer)	46,61 b	42,54 b	86,39 b	37,66 a
P_3 (OP 50% + 50% chemical fertilizers)	46,88 b	44,34 b	91,03 c	42,88 b
P_4 (OP 75% + 25% chemical fertilizers)	58,20 c	30,71 a	90,78 c	50,64 bc
P_5 (OP 100% + 0% chemical fertilizers)	51,95 c	48,00 b	94,15 c	49,56 b
BNT	7,55	4,26	8,16	8,53

Table 9. The influence of Biochar against C-MIC (mg CO_2-C $kg^{-1)}$ during growth of corn

Combination treatment of biochar	C-mik (mg CO_2-C kg^{-1})				
	0 DAP	15 DAP	30 DAP	60 DAP	90 DAP
B_0	41,53a	31,60 a	28,03 a	81,45	38,91 a
B_1	51,90b	52,67 b	37,16 b	91,32 b	48,03 b
BNT	4,36	4,26	5,58	4,71	4,93

C-mic ground during growth of corn plants, in General, has increased with increasing doses of fertilizer Organonitrofos. C-mik at the treatment of 5000 kg biochar ha^{-1} (B_1) which is higher compared to without biochar (B_0).There is no interaction between the granting of organonitrofos and chemical fertilizers with the addition of biochar against C-mic ground.This is supposedly a combination of organonitrofos with the addition of biochar fertilizer already comply in providing a source of energy and a habitat for microorganisms of the soil so that the value C-mic ground increase. Because the content of organic matter affects soil microorganisms and activation of the population. The higher soil organic matter than C-mic ground will also increase (Iswandi and Bangun, 1995). Kimetu *et al.,* (2008) concludes that the granting of biochar to soil degraded showed a benefit of biochar-related soil water availability and soil microbial dynamics.

Treatment of single or combination of inorganic fertilizer fertilizers and inorganic organonitrofos have C-mik which is higher than that for the control. It is alleged the Urea fertilizer application 600 kg ha^{-1}dapat increase the biomass of soil microorganisms. According to Handayanto and Hairiah (2007), that not only the plants that need N, microorganism also need N in the form of ammonium ions (NH_4 +). The higher elements of N in the soil then the total microorganisms are increasingly high.

After the corn was 90 DAP C-mik has decreased. It is suspected that there are microorganisms in the soil is already diminished population. in this phase, the most microbial population began to see death as it uses nutrients as energy which is began to run out so that it will lead to a decrease in the number of microbes. In this phase the cell count of the dead more than the living cell number (Volk and Wheeler, 1993).

Soil Respiration correlation test and C-mic ground with soil Organic C, Total N soil, and soil pH, soil Temperature, Total N, P, and K of Seed corn. Test results correlation between soil respirations by Soil organic c, total N-soil, soil, temperature, soil pH Ground water levels, P-available, total N, P, and K of Maize seeds are presented in Table 10.

Table 10. The coefficient of correlation between the properties of the soil by soil respiration and C-mic ground

Correlation test	R
C-organic with soil respiration	0,25^{tn}
C-organic with soil microbial biomass carbon	0,77*
N-Total with soil respiration	-0,04^{tn}
N-total with soil microbial biomass carbon	0,45 ^{tn}
pH with soil respiration	0,49^{tn}
pH with soil microbial biomass carbon	0,60*
Soil temperature with soil respiration	-0,18^{tn}
Total N with soil respiration	0,90*
Total P with soil respiration	0,88*
Total K with soil respiration	0,87*
P-available with soil microbial biomass carbon	0,69*
Soil moisture with soil microbial biomass carbon	0,41 ^{tn}
Soil temperature with soil microbial biomass carbon	-0,27 ^{tn}

Information: * = significance at P<0,05, ** = significance at P<0,01, tn = significance'n

There are real correlations between total N, P, and K maize seeds and soil respiration (table 1). The research of Yupitasari (2013) in the second growing season (rainy season) shows that a combination of fertilizer Organonitrofos with inorganic fertilizers with a dose of 100 kg ha^{-1}, urea 50 kg SP-36 ha^{-1}, 50 kg ha^{-1}, KCl 1,000 kg ha^{-1} Organonitrofos significantly improve plant, number of branches, uptake of nutrients N, P, and K of plants and fruit, and the production of tomato plants.

Furthermore, there is a real correlation between C-mic ground with organic soil, C-P-available, and soil pH (table 10). This shows that the treatment of manure and inorganic fertilizers organonitrofos with the addition of biochar can increase the availability of P in soil solution so that it was able to increase the uptake of P by the plant. Nutrient source P fertilizer is derived from Organonitrofos (derived from rock phosphate and cow dung) containing a very high P nutrients namely 3.4% and also fertilizer SP-36.

IV. CONCLUSION

1. At the beginning of the corn plant growth, soil respiration decreased hingga15 HST. Then the soil respiration increased to corn plants aged 60 DAP, and thereafter decreased soil respiration back to corn plants was 90 DAP. Dynamics of respiration for the given or not given the biochar.
2. C-mic ground during growth of corn plants in General has increased with increasing doses of fertilizer Organonitrofos. C-mik soil with biochar application 5000 kg ha^{-1} (B_1) higher than without biochar (B_0).

REFERENCES

Anjani, D. J. 2013. Uji Efektivitas pupuk organonitrofos dan kombinasinya dengan pupuk anorganik terhadap pertumbuhan dan produksi tanaman tomat (*Lycopersicum escullatumnill*) di tanah ultisol gedung meneng.*Skripsi*.Universitas lampung.Bandar lampung.80 hlm.

Antonius, S and Agustiyani, D. 2011. Pengaruh Pupuk Organik Hayati yang Mengandung Mikroba Bermanfaat Terhadap Pertumbuhan dan Hasil Panen Tanaman Semangka serta Sifat Biokimia Tanahnya pada Percobaan Lapangan di Malinau-Kalimantan Timur. *Penel Hayati*: 16 (203–206).

Azizah, R., Subagyo, dan E. Rosanti. 2007. Pengaruh Kadar Air terhadap Laju Respirasi Tanah tambak Pada penggunaan Katul Padi Sebagai Priming Agent. *Ilmu Kelautan* 12 (2) : 67-72.

Balittanah.litbang.deptan.co.id . 2005. Diakses tanggal 12 Januari 2016.

Franzluebbers, A.J., D.A. Zuberer, and F.M. Hons. 1995. Comparison of microbiological methods for evaluating quality and fertility of soil. *Biology and Fertility of Soil*. 19:135-140.

Gani, A. 2009.*Biochar* Penyelamat Lingkungan. Balai Besar Penelitian Tanaman Padi. *Warta Penelitian dan Pengembangan Pertanian*. 31: 15-16.

Handayanto, E. Dan K. Hairiah. 2007. Biologi Tanh (Ekologi dan Makrobiologi Tanah). PT Raja Grafindo Persada. Jakarta. 166 hlm.

Iswandi, A., dan P. Bangun. 1995. Mikroorganisme Tanah dari Budidaya Pertanian Olah Tanah Minimum. Faperta IPB. BALITAN Bogor.

Kimetu, J., H.J Lehmann, S. Ngoze, D. Mugendi, J. Kinyangi, S. Riha, L. Verchot, J. Recha and A. Pell. 2008. Reversibility of soil productivty decline with organic matter of differing quality along a degradation gradient. Ecosystem, in press.

Kirana, A. 2010.Pengaruh Sistem Olah Tanah Konservasi Jang Panjang terhadap Biomassa Karbon Mikroorganisme Tanah (C-mik) dan Produktifitas Tanaman Jangung di Tanah Ultisol.*Skripsi*.Unila.63 hlm.

Koswara.J., 1983.Jagung.Jurusan agronomi.Fak. Pertanian IPB. Bogor. 50 hlm.

Lazuardhy, A. M. 2012. Pengaruh Pemberian Kombinasi Pupuk Organonitrofos dan Pupuk Kimia dengan Penambahan *Biochar* terhadap Respirasi Tanah selama pertanaman Jagung (*Zea mays* L.).*Skripsi*.Universitas lampung.Lampung. 75hlm.

Lehmann J and S Joseph. 2009*. Biochar for Environmental Management: An Introduction*. Science and Technology (Johannes Lehmann and Stephen Joseph *Eds*.).First published by Earthscan in the UK and USA in 2009.

Nisa, K. 2010. Pengaruh Pemupukan NPK dn Biochar terhadap Sifat Kimia Tanah, Serapan Hara dan Hasil Tanaman Padi Sawah. *Thesis*.Banda ceh. Universitas Syiah Kuala.

Nugroho, S.G., dermiati, J. Lumbanraja, S. Triyono, dan H. Ismoyo. 2012. Optimum Ratio of Fresh manure And Grain of Phosphate Rock Mixture in a Formulated Compost for Organomineral NP Fertilizer. *J. Tropical Soil*. 17 (2) : 121-128.

Prasetyo, B. H. dan D.A. Suriadikarta. 2006. Karakteristik, Potensi, dan Teknologi Pengelolaan Tanah Ultisol Untuk Pengembangan Pertanian Lahan Kering di Indonesia. *J. Litbang Pertanian* 25(2) : 39-40.

Ragil.2009. http://cahtanah.blogspot.com.Diakses tanggal 12 Januari 2016.

Soepardi, G. 1983. Sifat dan Ciri Tanah. Fakultas Pertanian. Institut Pertanian Bogor. Bogor. 591 hlm.

Sukartono, Suwardji, Mulyati, Baharuddin dan T. Wulan. 2014. Modifikasi Aplikasi Biomassa pada Pertanaman Ubi Kayu di Tanah Lempung Berpasir (Sandy Loam) Lahan Kering Lombok Utara.*Buana Sains* 14 (1) : 47-54.

Yupitasari, M. 2013. Pengaruh pupuk Organonitrofos dan Kombinasinya denganPupuk Kimia terhadap Pertumbuhan, Serapan Hara, dan Produksi Tanaman Tomat (*Lycopersicum esculentum)* pada Musim Tanam Kedua.*Skripsi*.94 hlm.

Volk, W. A., and M. F. Wheeler. 1993. *Mikrobiologi Dasar.* Erlangga. Jakarta. 396 hlm.

D.17

THE SHIFTING OF WEED COMPOSITION AT SOME PLANT SPACING SETTINGS AND THE PROPORTION OF INORGANIC NITROGEN AND COMPOST NITROGEN OF WHEAT CROP

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ABSTRACT

Wheat cultivation has a bright prospect in the future. To be able to provide high production, wheat crop needs fertilizer as nutrient suppliers and plant spacing settings that may affect the growth rate of weeds and the crop yields. Distance in tight lines accelerates the critical period of crops with weeds. This happens as the response of crops and weeds in utilizing the growing space and the growth factors available. This study aimed to analyze the shifting of weed composition at some plant spacing settings and the proportion of inorganic nitrogen with compost nitrogen of wheat crop. The research was conducted in Sirapu Village, Semangga District, Merauke Regency. The weed observation method was done by employing vegetation analysis at the age of 21 and 35 DAP using sample plot based on the plant spacing settings (25cm x 10 cm, 25 cm x 15 cm, and 25cm x 20 cm) with the size of 50 cm x 60 cm. The vegetation analysis was carried out by removing the existing weeds in the sample plots and identified using various means i.e. consulting them to weed experts and matching them with the illustrations on weed atlas. The weeds were then counted individually, washed and dried with oven at 80 °C, then weighed the dry weight. The variables obtained in the vegetation analysis included the density, the occurrence (frequency), and the land tenure (dominance). The results showed that narrowing the distance in rows from 15 cm to 10 cm and widening the distance in rows from 15 cm to 20 cm did not change the composition of weed species, while widening distance in rows from 10 cm to 20 cm changed the composition of weed species. Plant spacing of 25 cm x 10 cm and of 25 cm x 15 cm showed that the dry weight of weed was not significantly different and each was lower than the one of 25 cm x 10 cm was. This indicated that the narrower the spacing in the line was, the more depressed the weed growth would be, resulting in lower dry weight.

Keywords : plant spacing, nitrogen proportion, weed composition, wheat.

I. INTRODUCTION

Wheat crop (*Triticum aestivum* L.) is one of the main commodities that dominate the top position of trade of agricultural products and nutrition of the world. This is because wheat is the main ingredient of bread makers, the most popular types of food in the world, and other types of food that most of the world's population needs. Like other plants, to obtain a high production of planting distance arrangement and balanced fertilization must be considered in order to avoid competition between plants and between plants and weeds.

Dense spacing will increase the competitiveness of plants to weeds because plant canopies inhibit light emission to the soil surface so that weed growth becomes obstructed, as well as the evaporation rate can be suppressed (Dad Resiworo 1992). However, at a distance of planting that is too narrow may be cultivated plants will give relatively less result because of competition between plants itself. Therefore, an optimum spacing is required to obtain maximum results.

Provision of fertilizer is an important thing in increasing production. In addition to improving the harvest quantitatively can also improve the quality of the plant. One of the essential nutrients that are often added in fertilization is nitrogen. Nitrogen that plants need can be obtained from inorganic fertilizer and organic fertilizer. However, the excessive use of inorganic fertilizers has caused many problems related to the production, efficiency, price, and income of farmers. Compost is an organic material such as rice bran, husk and animal waste that has been decomposed by microorganisms that can be utilized to improve soil properties. Compost fertilizer can increase the availability of foodstuffs and nutrients for plants including elements of N. Utilization of compost fertilizer as substitution of some artificial chemical fertilizers in the cultivation of wheat crops is expected to increase production, reduce dependence on the use of artificial chemical fertilizers, reduce production costs, and improve soil conditions . The use of inorganic fertilizers is known to increase productivity, but if done continuously can damage the soil fertility of both physical, chemical and biological, in addition, nutrients given are easily lost due to volatilation and rainwater pouring. It is therefore necessary to apply nitrogen fertilizer with the right combination of inorganic and organic fertilizers to provide the best growth and yield of wheat.

The distance between rows is followed by the distance in the varied rows, the density variation and the number of plant population will be obtained. Setting the distance in the line is one of the cultivation techniques that affect the growth rate of weeds and crop yields to be achieved. Distance in tight lines accelerates the critical period of crops with weeds. This happens as the response of crops and weeds in utilizing the growing space and the growth factors available. Plant biomass will increase with increasingly narrowed distance in rows to a certain extent. Narrowing the distance in rows to a certain extent is expected to suppress weed growth.

A decrease in row spacing often results in decreased weed biomass (Andersson, 1986; Putnam et al., 1992; Teich et al., 1993; Murphy et al., 1996) and higher yields (Putnam et al., 1992; Murphy et al., 1996), but in some cases there is no effect on yield (Vander Vorst et al., 1983; Teich et al., 1993). Increasing crop density usually results in decreased weed biomass (Radford et al., 1980; Samuel & Guest, 1990; Blackshaw, 1993; Murphy et al., 1996; Doll, 1997). Furthermore, the clumped pattern reduces the potential for increasing weed suppression with higher crop densities, because increasing crop density within rows increases intraspecific competition within the crop population more than it increases competition with the weeds (Weiner et al., 2001).

This study aims to analyze the shifting of weed composition at some plant spacing and the balance of inorganic nitrogen fertilizer with compost nitrogen in wheat crop. From this research is expected to know the distance of planting and balance of inorganic fertilizer and appropriate compost, so it can suppress the growth of weeds and losses caused by weeds can be pressed as small as possible which will ultimately be obtained higher grain yield.

II. MATERIALS AND METHODS

This study was conducted using field experiments. The research was conducted in Sirapu Village, Semangga District, Merauke Regency. The implementation of this research took place from September to December 2016. The materials used in this research are wheat varieties of Dewata, urea fertilizer, SP-36, KCl, compost fertilizer, darmafur. The tools used are plow, hoe, ruler, roll meter, scissors, gembor, digital scales, oven, lux meter, seed counter, backer glass and thermometer. The weed observation method was done by employing vegetation analysis at the age of 21 and 35 DAP using sample plot based on the plant spacing settings (25cm x 10 cm, 25 cm x 15 cm, and 25cm x 20 cm) with the size of 50 cm x 60 cm. The vegetation analysis was carried out by removing the existing weeds in the sample plots and identified using various means i.e. consulting them to weed experts and matching them with the illustrations on weed atlas. The weeds were then counted individually, washed and dried with oven at 80 °C, then weighed the dry weight. Absolute and relative weed densities, frequencies and dominance of each weed type were recorded to compute sum dominance ratio (SDR). The major or dominant weed species were determined by computing SDR values (Pablico dan Moody 1983) as follows:

$$\textit{SDR of a sp.} = \frac{relative\ density + relative\ frequency + relative\ dominance}{3} \quad (1)$$

Relative density, relative frequency and relative dominance were measured from the following:

$$\textit{Relative density of a sp.} = \frac{Absolute\ density\ of\ a\ sp.}{Total\ absolute\ density\ of\ all\ spp.} \quad (2)$$

$$\textit{Relative dominance of a sp.} = \frac{Absolute\ dominance\ of\ a\ sp.}{Total\ absolute\ dominance\ of\ all\ spp.} \quad (3)$$

$$\textit{Relative frequency of a sp.} = \frac{Absolute\ frequency\ value\ of\ a\ sp.}{Total\ absolute\ frequency\ value\ of\ all\ spp.} \quad (4)$$

Community coefficient (C). Community coefficient was computed as suggested by Tjitrosoedirdjo *et al*. (1984) Where:

$$C = \frac{2W}{A+B} x\ 100\% \quad (5)$$

Where :

C = community coefficient,
W = total of the lowest SDR value of all species from each community
A = total of all SDR values from the first community and
B = total of all SDR values from the second community.

If the C value is more than 75% then the two comparable communities are considered has a similar degree of composition.

III. RESULTS AND DISCUSSION

A. The composition of weed species prior to soil treatment

The results of weed vegetation analysis before the cultivation of soil obtained by Summed Dominance Ratio (SDR) of each type of weed are listed in Table 1. In Table 1 it appears that there are only 3 types of weeds that come from the group of grasses and sedges growing before the tillage. The highest SDR that is 75,49% seen in block II is weed of class of rumputan, that is alang-alang (*Imperata cylindrica*). *Imperata* breed generatively by seed and vegetatively by rhizomes. This plant is a very large seed producer, reaching 3000 seeds per plant and spread by winds so it is possible to spread and dominate the areas far enough. Alang-alang seeds have no dormancy and have a sprout gain of 95% and will germinate within a week after harvest (Aguilar, 1992). Imperata has a nutrient needs level that is low enough so as to grow well in areas that are not fertile, sandy soil and swamp (Suryaningtyas et al., 1996).

The value of weed community coefficient (C) between blocks I and II was 94.83%, between blocks I and III 96.44%, and between blocks II and III 95.03%. The inter-treatment block has a C value greater than 75 percent, meaning that the community in the experimental field is quite homogeneous (the vegetation is not different), so it is appropriate for weed-related studies (Tjitrosoedirdjo et al., 1984). A community is a group of organisms that consists of a number of different species simultaneously occupying the same habitat and interacting with each other.

Table 1. SDR value (%) of various types of weeds prior to soil treatment

Weed species	Block			Average
	I	II	III	
Sedges				
Fimbristylis littoralis	16,89	16,78	13,53	15,73
Grasses				
Imperata cylindrica	70,22	75,49	73,78	73,16
Imperata exaltata	12,90	7,72	12,69	11,10
Total	100,01	99,99	100,00	100,00
comunity coefficien (C)				
C I - II	94,83%			
C II - III		95,03%		
C I - III			96,44%	

The weed type SDR shows the dominant level of a weed species in an area. SDR type of weeds ≥ 50% indicate the weed is increasingly dominating (Tjitrosoedirdjo et al., 1984). The result of weed vegetation analysis shows that dominating the experimental field is Imperata cylindrica weed which is weeds with SDR 73,16%, this is because the research field used is reed *Imperata*.

B. Weed type composition after treatment

1. The composition of weed species in plants aged 21 DAP

The effect of plant spacing on each inorganic nitrogen fertilizer counterpart with compost nitrogen to the growing number of weeds is seen to change from the original before the soil processing is dominated by the type of grasses (alang-alang), after the treatment becomes dominated by the type of sedges. This change is caused at the time of processing rhizome ground reeds cleaned. Processing of the soil is done 3 weeks after the grass clearance so that when the cultivation of the soil is done, the reeds are in the new leaf forming phase. According Suryaningtyas (1996), tillage will cut rhizoma reeds in the soil and drain the food reserves in it so that the reed will quickly die.

The weed composition that grows on the planting distance of 25 cm x 10 cm, 25 cm x 15 cm, and 25 cm x 20 cm on various inorganic nitrogen fertilizer composite and compost nitrogen shows the highest SDR value possessed by the type of weed *Fimbristylis littoralis*. Types of weeds that are also found are *Echinochloa colonum* from grasses group, whereas from the wide leaf group that is *Physalis alba* and *Grangea modepatana*. These three types of weeds are found in very small amounts to have a much smaller SDR than the weeds of the faction (*Fimbristylis littoralis*) (Table 2).

Table 2 shows that widening the distance in rows from 10 cm to 20 cm and from 15 cm to 20 cm in the balance treatment without urea and compost fertilizers and a 100% urea balance treatment alters the weed type composition. This can be seen from the value of community coefficient (C) <75%. The widening spacing from 25 cm x 10 cm to plant spacing of 25 cm x 20 cm in the treatment of urea without compost with urea and the balance of urea 100% of its C value was 74.23% and 60.17% respectively. While widening spacing from 25 cm x 15 cm to spacing of 25 cm x 20 cm on the balance treatment without urea fertilizer with compost and urea balance treatment 100% of its C value is 74.23% and 73.32% respectively. In the treatment of other fertilizer, widening spacing from 25 cm x 10 cm to 25 cm x 20 cm shows the change of weed composition, it is seen from its C value

<75%. While the value of C obtained from narrowing spacing 25 cm x 15 cm to 25 cm x 10 cm showed no change in weed composition (> 75%).

Table 2. Weed type composition at age 21 DAP

Weed species	SDR % Planting Distance		
	25 cm x 10 cm	25 cm x 15 cm	25 cm x 20 cm
K0+U0			
Sedges			
Fimbristylis littoralis	100	93,83	74,23
Grasses			
Echinochloa colonum	0	6,17	0
Brodleaf weeds			
Physalis alba	0	0	14,44
Ludwigia peruviana	0	0	11,33
comunity coefficien (C)	J_1 - J_2 93,83%	J_2 - J_3 74,23%	J_1 - J_3 74,23%
K0+U100			
Sedges			
Fimbristylis littoralis	100	86,85	60,17
Grasses			
Echinochloa colonum	0	7,18	15,32
Brodleaf weeds			
Physalis alba	0	5,97	24,51
comunity coefficien (C)	J_1 - J_2 86,85%	J_2 - J_3 73,32%	J_1 - J_3 60,17%
K25+U75			
Sedges			
Fimbristylis littoralis	100	83,46	74,14
Grasses			
Echinochloa colonum	0	16,54	19,27
Brodleaf weeds			
Physalis alba	0	0	6,59
comunity coefficien (C)	J_1 - J_2 83,46%	J_2 - J_3 90,68%	J_1 - J_3 74,14%
K50+U50			
Sedges			
Fimbristylis littoralis	100	93,81	75,11
Fimbristylis autumnalis	0	6,19	19,36
Grasses			
Echinochloa colonum	0	0	5,53
comunity coefficien (C)	J_1 - J_2 93,81%	J_2 - J_3 81,3%	J_1 - J_3 75,11%
K75+U25			
Sedges			
Fimbristylis littoralis	100	77,04	73,56
Grasses			
Echinochloa colonum	0	22,96	20,16
Brodleaf weeds			
Grangea modespatana	0	0	6,28
comunity coefficien (C)	J_1 - J_2 77,04%	J_2 - J_3 93,72%	J_1 - J_3 73,56%
K100+U0			
Sedges			
Fimbristylis littoralis	100	93,77	75,08
Brodleaf weeds			
Physalis alba	0	6,23	24,92
comunity coefficien (C)	J_1 - J_2 93,77%	J_2 - J_3 81,31%	J_1 - J_3 75,08%

The highest SDR value of 100% is dominated by *Fimbristylis littoralis* weeds at 25 cm x 10 cm spacing. *Fimbristylis littoralis* is an annual and annual technological weed that breeds with seedlings and seeds. This weed has a morphology of leaves that resemble a cylindrical rod and can reach a height of more than 1 meter. This causes even though grown in the planting area is quite dense plants, weeds are still able to survive and develop very quickly because it is not constrained by shade factor. Weeds of the grasses group with the highest SDR value are *Echinochloa colonum* with SDR value of 22.96% found in planting distance treatment 25 cm x 15 cm with urea 25% nitrogen balance with compost 75% nitrogen. For wide leaf weed which has the highest SDR value is *Physalis alba* with SDR value 24,92% which is in planting distance treatment 25 cm x 20 cm with balance of 100% compost nitrogen.

Changes in spacing seem to greatly affect the composition of weed species. The width of the clumps in the row causes the growing number of weeds to be more diverse. This is strongly supported by the availability of growing spaces for weeds in the area with wider plant spacing. The availability of light for weeds will be related to plant growth. Rapid plant growth and quick leaves covering the soil surface can suppress weed growth. Wheat crops with high LAI at early growth can suppress weeds due to shading so the need for light for weed growth can be suppressed.

2. *The composition of weed species in plants aged 35 DAP*

The result of vegetation analysis at 35 DAP showed that weeds still dominate the plantation area, it can be seen from the SDR value which is very high in each treatment. The highest SDR of weeds was owned by *Fimbristylis littoralis* at planting distance of 25 cm x 10 cm with urea 75% nitrogen and 25% compost nitrogen, with SDR value of 88.97%. As for weeds, the highest SDR was found in *Echinochloa colonum* at planting distance treatment of 25 cm x 20 cm with 100% urea nitrogen balance and in wide leaf weeds on *Ludwigia peruviana* at plant spacing treatment of 25 cm x 20 cm with urea nitrogen balance of 50% and Compost 50% with SDR values 24.08% and 20.76% (Table 2) respectively.

The presence of weeds at 35 DAP was slightly changed compared to 21 DAP observations. Weeds of the class of sedges that at the observation age 21 DAP represented only by *Fimbristylis littoralis* and *Fimbristylis autumnalis*, at 35 DAP observation found also *Fimbristylis meliaceae*. There are also wide leaf weeds other than *Physalis alba* found in 21 DAP observations, namely *Ludwigia peruviana*, *Urena lobata*, and *Heliotropium indicum*.

Table 3 shows that the widening of clump spacing in rows from 10 cm to 20 cm in all treatments of dosage of nitrogen fertilizer with compost obtained C <75%. This shows that changes in plant spacing become wider resulting in changes in the composition of weeds. Meanwhile, the change of clump distance in rows from 10 cm to 15 and from 15 cm to 20 cm in all fertilizer treatment showed no change in weed composition, as seen from its C value> 75%.

C. *Total weed dry weight*

Results of the total weed dryness analysis of 21 and 35 hst at various plant spacing and the balance of inorganic nitrogen fertilizer with compost nitrogen can be seen in Table 4.

The results of weed dry weight analysis at the age of 21 and 35 hst showed that between planting treatments was significantly different to weed dry weight, whereas the fertilizers were not significantly different (Table 3). Fingerprints showed no interaction between plant spacing treatment and the balance of inorganic nitrogen fertilizer with compost nitrogen to weed dry weight.

Plant spacing of 25 cm x 10 cm and 25 cm x 15 cm shows weed dry weight is not significantly different and each lower than the plant spacing of 25 cm x 10 cm. This indicates that the more narrow the spacing in the line, the weed growth becomes more depressed, resulting in lower dry weight.

According to Sukman and Yakup (1995), planting with spacing is very rare to provide opportunities for weeds to grow freely. Increased crop density increases the shade effect on weeds thereby reducing growth and reproduction. Degradation of plant density from the usual plant spacing of 25 cm x 25 cm to 15 cm x 25 cm was able to reduce weed growth by more than 30% and correlated increased with soybean crop yield. According to Olsen (2005), increases in crop density and spatial uniformity can increase weed suppression and grain yield. A reduction in the degree of spatial aggregation may be sufficient to give major improvements in weed suppression. If this is correct, a reduction in the degree of spatial aggregation may be sufficient to give major improvements in weed suppression. This can be achieved through a combination of reduced row spacing and increased uniformity within the rows. A high degree of uniformity seems to have small but significant positive effects on yield, however. While we have demonstrated the benefits of increased uniformity, the optimum degree of uniformity will depend on the costs of increasing uniformity in the field.

Dry weed weight is a balance between taking CO2 through photosynthesis by releasing CO2 through respiration. According to Hoffman et al. (1998), the top soil layer contains more weed seed reserves than the sub soil layer, so that the soil depth, the less the weed seeds will be. If soil top layer soil is used then weeds will grow more than the soil sub layer soil.

Table 3. Weed type composition at age 35 DAP

Weed species	SDR % Planting Distance 25 cm x 10 cm	25 cm x 15 cm	25 cm x 20 cm
K0+U0			
Sedges			
Fimbristylis littoralis	82,65	78,70	66,97
Fimbristylis meliaceae	17,35	5,68	4,39
Grasses			
Echinochloa colonum	0,00	15,62	14,93
Brodleaf weeds			
Physalis alba	0,00	0,00	4,91
Urena lobata	0,00	0,00	8,80
comunity coefficien (C)	J_1 - J_2 84,38%	J_2 - J_3 86,29%	J_1 - J_3 71,36%
K0+U100			
Sedges			
Fimbristylis littoralis	65,16	69,51	44,51
Fimbristylis meliaceae	13,33	7,60	11,71
Grasses			
Echinochloa colonum	0,00	15,56	24,08
Brodleaf weeds			
Physalis alba	5,67	7,33	19,71
Ludwigia peruviana	15,83	0,00	0,00
comunity coefficien (C)	J_1 - J_2 78,44%	J_2 - J_3 79,12%	J_1 - J_3 61,89%
K25+U75			
Sedges			
Fimbristylis littoralis	88,97	75,43	69,58
Fimbristylis meliaceae	11,03	7,16	5,18
Grasses			
Echinochloa colonum	0,00	7,36	15,31
Brodleaf weeds			
Physalis alba	0,00	10,05	9,93
comunity coefficien (C)	J_1 - J_2 82,59%	J_2 - J_3 92,05%	J_1 - J_3 74,71%
K50+U50			
Sedges			
Fimbristylis littoralis	74,64	72,46	66,89
Fimbristylis meliaceae	18,87	11,16	0,00
Cyperus rotundus	0,00	9,71	0,00
Grasses			
Echinochloa colonum	6,49	6,67	12,34
Brodleaf weeds			
Ludwigia peruviana	0,00	0,00	20,76
comunity coefficien (C)	J_1 - J_2 90,11%	J_2 - J_3 73,56%	J_1 - J_3 73,38%
K75+U25			
Sedges			
Fimbristylis littoralis	68,20	88,45	83,30
Fimbristylis meliaceae	14,75	11,55	5,97
Grasses			
Echinochloa colonum	6,17	0,00	0,00
Brodleaf weeds			
Physalis alba	10,88	0,00	0,00
Heliotropium indicum	0,00	0,00	10,73
comunity coefficien (C)	J_1 - J_2 79,75%	J_2 - J_3 89,27%	J_1 - J_3 74,17%

Table 3. Continued

K100+U0			
Sedges			
Fimbristylis littoralis	78,39	87,88	63,36
Fimbristylis meliaceae	10,09	0,00	0,00
Grasses			
Echinochloa colonum	5,93	12,12	16,80
Brodleaf weeds			
Physalis alba	0,00	0,00	19,83
Urena lobata	5,58	0,00	0,00
comunity coefficien (C)	J_1 - J_2 84,32%	J_2 - J_3 75,48%	J_1 - J_3 69,29%

Table 4. Dry weed weight (g / 0.30 m2) at plant spacing (cm) and inorganic nitrogen fertilizer balance with compost nitrogen.

Observation time	Fertilizer balance	Planting Distance			Avarage
		25 cm x 10 cm	25 cm x 15 cm	25 cm x 20 cm	
21 DAP	K0+U0	3,65	4,82	6,95	5,14 a
	K0+U100	4,80	5,74	9,39	6,64 a
	K25+U75	3,93	6,22	7,00	5,72 a
	K50+U50	4,98	5,44	8,07	6,16 a
	K75+U25	4,92	7,75	8,38	7,02 a
	K100+U0	6,11	6,92	8,35	7,13 a
	Average	4,73 q	6,15 q	8,02 p	(-)
35 DAP	K0+U0	3,24	3,95	6,24	4,48 ab
	K0+U100	4,01	4,90	6,36	5,09 ab
	K25+U75	2,77	3,65	5,95	4,12 b
	K50+U50	3,29	4,96	6,68	4,98 ab
	K75+U25	4,36	4,59	7,16	5,37 ab
	K100+U0	5,13	6,49	8,30	6,64 a
	Average	3,80 q	4,76 q	6,78 p	(-)

Description: Figures followed by the same letter in a column show no significant difference according to Duncan 5% Duncan Multiple Test.

IV. CONCLUSION

Distance in rows on each of the counterparts of inorganic nitrogen fertilizer with compost nitrogen have an effect on weed composition. Narrowing the distance in rows from 15 cm to 10 cm or widening the distance in rows from 15 cm to 20 cm does not alter the composition of weed species. Widening distance in rows from 10 cm to 20 cm changes the composition of weed species.

REFERENCES

Aguilar, N.O. 1992. *Imperata cylindrica* (L.) Raeuschel. P140 – 142). *In*: Mannetje and Jones (Eds). Prosea: Plant Resources of South - East Asia, Forages. Bogor.

Andersson B (1986) Influence of crop density and spacing on weed competition and grain yield in wheat and barley. In: Proceedings 1986 European Weed Research Society Symposium, Economic Weed Control. Stuttgart-Hohenheim, 121–128.

Dad Resiworo J.S. 1992. Pengendalian gulma dengan pengaturan jarak tanam dan cara penyiangan pada pertanaman kedelai. Prosiding Konferensi Himpunan Ilmu Gulma Indonesia. Ujung Pandang. Hal. 247-250.

Doll H (1997) The ability of barley to compete with weeds. Biological Agriculture and Horticulture 14, 43–51.

Haryadi, S.S. 1983. *Pengantar Agronomi*. Gramedia. Jakarta.

Murphy SD, Yakubu Y, Weise SF & Swanton CJ (1996) Effect of planting patterns and inter-row cultivation on competition between corn (Zea mays) and late emerging weeds. Weed Science 44, 856–870.

Olsen J, Kristensen L, Weiner J, Griepentrog HW. 2005. Increased density and spatial uniformity increase weed suppression by spring wheat. European Weed Research Society Weed Research 2005 45, 316-321.

Pablico, P.P. and K. Moody. 1983. Sampling of weeds and vegetation analysis. Lecture prepared for participants attending the integrated pest management training course held at the International Rice Research Institute, 15 August-24 November 1983. Los Banos, Laguna, Philippines.

Putnam DH, Wright D, Field LA & Ayisi KK (1992) Seed yield and water-use efficiency of white lupin as influenced by irrigation, row spacing, and weeds. Agronomy Journal 84,557–563.

Radford BJ, Wilson BJ, Cartledge O & Watkins FB (1980) Effects of wheat seeding rate on wild oat competition. Australian Journal of Experimental Agriculture and Animal Husbandry 20, 77–81.

Samuel AM & Guest SJ (1990) Effect of seed rates and within crop cultivations in organic winter wheat. In: Crop Protection in Organic and Low Input Agriculture: Options for Reducing Agrochemical Usage (ed. RJ Unwin), 49–54. British Crop Protection Council, Farnham, UK.

Sukman, Y. dan Yakup. 1995. *Gulma dan Teknik Pengendaliannya*. PT Raja Grafindo Persada. Jakarta.

Suryaningtyas, H., A. Gunawan, dan A. Gozali. 1996. *Pengelolaan Alang-alang di Lahan Petani*. Pusat Penelitian Karet, Balai Penelitian Sembawa. 47 hal.

Teich AH, Smid A, Welacky T & Hamil A (1993) Row-spacing and seed-rate effects on winter wheat in Ontario. Canadian Journal of Plant Science 73, 31–35.

Tjitrosoedirdjo, S., I.H. Utomo, dan J. Wiroatmojo (Ed). 1984. *Pengelolaan Gulma di Perkebunan*. PT. Gramedia. Jakarta.

Vander Vorst PB, Wicks GA & Burnside OC (1983) Weed control in a winter wheat-corn-ecofarming rotation. Agronomy Journal 75, 507–511.

Weiner J, Griepentrog H-W & Kristensen L (2001) Suppression of weeds by spring wheat Triticum aestivum increases with crop density and spatial uniformity. Journal of Applied Ecology 38, 784–790.

D.18

THE EFFECT OF RATION BASED OF THE FERMENTED PALM OIL BY PRODUCT AND ZN-LYSINATE ON THE PERFORMANCE AND DIGESTIBILITY GOAT

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ABSTRACT

The objectives of this research were to find out: the influence of fermented palm by product based ration to digestibility of dry material and organic material, and the performance (feed consumption and daily gain) of goats. There are nine goats which consist of 3 treatments and 3 replications. Some treatments which are tested in this research are R1 = control ration (15% king grass and 85% concentrate consists of cassava waste, tofu waste, rice brand, molasses, urea, premix), R2 = fermented palm oil by product based ration (*cassava waste, rice brand,* mollases, urea, premix + palm leaves, and palm kernel meal), R3= R2 + Zn-lysinate (40 ppm). The results of this research are: first, the R1 treatment results the digestibility of dry material and organic material as well as the best performance; second, The digestibility of dry material and organic material on R2 treatment is higher than R3 treatment; and the third, the R3 treatment results the better performance rather than R2 treatment. The additional of Zn-lisinat influence the performance of goats.

Keywords : palm oil by product, Zn-lysinate, digestibility, ferformance

I. INTRODUCTION

Goat was one of ruminant that has potential to develop to support availability of animal protein in Indonesia. Feed was one of the essential factors to support livestock production. Potential feeds resources were leguminous. However, there were competition utilization of leguminous between human and animals, therefore we need alternative feed. Feed alternative that could be used as feed was potential by product.

Utilization of palm oil by product need to be optimalize because they contain highs crude fiber and low crude protein. The palm oil by product consisted of leaf midrib and palm cake. The constrain utilization of palm oil by product could reduce the processing and add some feed supplement. There were many processing agriculture product to improve their utilization.

Fermentation was biological processing that used to improve nutrition value of agriculture by product because the fermentation process support chemicals processed of organic material (Mandels dan Parizek, 1990). Meanwhile, supplement Zn Organic in ration could be support growth of rumen microbial and improve livestock performance (Muhtarudin *et al*., 2003).

II. MATERIALS AND METHODS

The research design which was used was random block design, weight gain was based. There are nine cattle which consist of 3 treatments and 3 replications. Some treatments which are tested in this research are: R1 = control ration (15% king grass and 85% concentrate consists of cassava waste, waste tofu, rice brand, molasses, urea, premix), R2 = fermented palm oil by product based ration (*cassava waste, rice brand,* mollases, urea, premix + palm leaves, and palm kernel meal), R3= R2 + Zn-lysinate (40 ppm). Parameters of this research consisted :

A. Fecal collection to Digestibility

Fecal collection during five day. Is collected to calculated value of dry matter digestibility and organic matter digestibility. The calculation dry matter and organic matter digestibility used method total collection (Tillman et al., 1991)

B. Ration consumption

Ration consumption was calculated by subtraction among of ration that gives by residuals of rations. The consumption which was measured during 24 hours residuals of rations was weighed on 07.00—08.00 PM (Mathius et al. 2002).

C. Daily Gain

Daily gain was calculated by formula i. e.:

$$\text{Daily gain (kg)} = \frac{(W2 - W1)}{(t2 - t1)} \quad (1)$$

Information:
W1 = early weight of animals (kg)
W2 = late weight of animals (kg)
t1 = early observation (day)
t2 = late observation (day)

Body weight was measured once a month to evaluated giving of ration body weight was done at 07.30—08.30 p.m.

Nutrient content of treatment ration can be seen on the table 1. The data observation were analyzed of variance (ANOVA) on 5% of parametric test and or 1% and continued with LSD (least significant different).

Table 1. Nutrient content of treatment ration

Ration		Nutrient content of treatment ration (%)					
		DM	CP	CF	EE	Ash	BETN
	F	17,67	12,29	24,42	1,83	17,87	43,60
R1	C	68,38	18,02	11,14	8,37	7,68	54,81
Total (15% F+85% C		60,77	17,16	13,13	7,39	9,20	53,13
	F	35,66	8,20	43,84	4,94	10,81	32,21
R2 and R3	C	55,55	16,63	12,76	5.66	18,1	46,85
Total (15% F+85% C)		52,57	15,37	17,42	5,55	17,00	44,65

Explanation:
DM = dry matter;
C P= crude protein;
C F = crude fiber;
EE= ether extract;
N N M = Non nitrogen material;
F= forage;
C= concentrate.

Resources: Analysis of feed laboratory, Departement of Animals Husbandry, Agriculture Faculty, Lampung University (2017).

III. RESULTS AND DISCUSSION

A. Effect treatments on dry matter and organic matter digestibility

Based on the analysis of variants showed that treatment had significant effect ($P<0.05$) on dry matter digestibility based on least significant different test (LSD). R1 treatments had higher digestibility compared to R2 and R3. The R1 treatment had better nutrient than R2 and R3 treatments, The R1 treatment had more protein, low of crude fiber, and ash. Tillman (1998) said that nutrient, digestibility had strong correlation with their chemical composition (content of protein, crude fiber, and ash.

Organic matter digestibility of rations was resulted from subtraction between organic matter consumption and organic matter in faces. The rate value of organic matter at R1 treatment was higher than R2 and R3 treatment. Sutardi (1990) said that the improvement of organic matter digestibility was the same with the improvement of dry matter digestibility.

B. Effect treatments on ration consumption

Based on the analysis of variants showed that the treatment had significant effect ($P<0.05$) to ration consumption. According to least significant test ($P<0.05$) showed that R1 treatment had higher ration consumption compare to R2 treatment (Tabel 1). R2 and R3 treatment which is consisted of palm oil by product have less palatable. So, utilization of palm oil by product was decresing palatable of rations. Suwigyo (2004) said that different kind of ration composition would be supported by different palatability and nutrient contents. Different nutrient content in rations especially crude fiber, resulted R1 treatment had more consumption than another treatment (R2 and R3). Ration that had high of crude fiber could make degradability in rumen slow.

Furthermore, it caused the decreasing of feed consumption. Soebarinoto (1991) statement said that one of the characteristic of agriculture by product was high of lignocelluloses content in rations. It caused the differences on the digestive by ruminant.

In Table 1, it is showed that goat consumption at R2 treatment (consisted of palm oil by product) had lower consumption than other treatments. Midrib of palm oil plant influenced the difficulties of consumption. Furthermore, it caused its palatability decreased (Hassan and Ishak, 1991). According to Ravindran and Blair (1992), palm cake had less palatability as feed, because of physical characteristic of palm cake. In table 2 also showed that R3 treatments had more consumption than R2 treatment. This matter was influenced by the supplementation of Zn-lysinate in R3. Zn-lysinate would be degraded into lysine and Zn, so lysine was used by rumen microorganism to improve digestibility. Church (1983) said that microbial growth in rumen would be optimal if their entire precursor were available. The rate of consumption in this research was up to 1460.42 g/animal/day. Saragih (2014) reported that the ration which contain palm oil by product had the consumption was up to 421.35 g/animal/day. Other statement was by Ismoyo and Widyaningrum (2008) they said different time period of giving between concentrate and forage resulted rations consumption was up to 719.67 g/animal/day. Hartanto (2004) said that the supplementation of organic Zn on kacang goat had resulted ration consumption was up to 387.47 g/animal/day. Based on all of the statement above, it is showed that the processing of palm oil by product, different of time period in rations, utilization of mineral had different respond of ration consumption.

C. Effect treatments on goat daily gain

Daily gain was parameter to evaluate goat performance and also to evaluate quality of rations. The rate of daily gain was presented at table 2. The highest of daily gain happened at R1 and the lowest at R2 treatment. That matter had correlation with consumption parameter. According Tanuwiria et al (2006), said that nutrient that is consumed is needed to maintenance, production, and reproduction of animals. Parakkasi (1999) also said that daily gain was influenced by feed consumption. Sutama and Budiarsana (1996) reported that daily gain of ettawa grade was up to 48.3 g/animals/day (age of goat was 12 month).

Table 2. The effect treatment to digestibility and performance

Parameter	Ration Treatment		
	R1	R2	R3
Dry matter digestibility (%)	70.86[a]	58.31[b]	50.81[c]
Organic matter digestibility (%)	74.77[a]	64.38[b]	55.49 [c]
Ration consumption (g/animals/day)	1460.42[a]	933.29[b]	1038.53[a]
Dail gain (kg/animals/day)	0.12[a]	0.7[b]	0.10[a]

Explanation:
lower case with different superscript on the same line show the significant different ($p<0,05$)

R1 = control ration (15% king grass and 85% concentrate consists of cassava waste, tofu waste, rice brand, molasses, urea, premix),

R2 = fermented palm oil by product based ration (*cassava waste, rice brand,* mollases, urea, premix + palm leaves, and palm kernel meal),

R3 = R2 + Zn-lysinate (40 ppm).

IV. CONCLUSION

The results of this research are: first, the R1 treatment results the digestibility of dry material and organic material as well as the best performance; second, The digestibility of dry material and organic material on R2 treatment is higher than R3 treatment; and the third, the R3 treatment results the better performance rather than R2 treatment. The additional of Zn-lisinat influence the performance of goats.

REFERENCES

Chruch, D.C. 1983. Digestive Pysiology and Nutrition of Ruminant. Vol 1. 2 Rd. Corvali. Oregon. USA

Mandels and R. Parizek. 1990. Enchanced Cellulose Production by Mutant of *Trichoderma Viride.* J. Appl. Microbiol

Hartanto, I. 2004. Pengaruh Penggunaan Zn Organik dalam Ransum Terhadap Performans *Feedlot* Kambing Kacang Jantan. Skripsi. Jurusan Peternakan, Fakultas Pertanian, Universitas Lampung. Lampung

Hartati, E. 1998. Suplementasi Minyak Lemuru dan Seng ke dalam Ransum yang Mengandung Silase *Pod Kakao* dan Urea untuk Memacu Pertumbuhan Sapi *Holstein* Jantan. Disertasi. Program Pascasarjana. Institut Pertanian Bogor. Bogor

Hasan, A.O. and M. Ishada. 1991. Effect of Water, Mollases, and Urea Addition on Oil Palm Frond Sillage Quality, Fermentation, and Palatability Proceedings of Third International Symposium on The Nutrition of Herbivora. Penang

Iswoyo dan Widiyaningrum. 2008. Pengaruh Jarak Waktu Pemberian Pakan Konsentrat dan Hijauan Terhadap Produktivitas Kambing Peranakan Etawa Lepas Sapih. Jurnal Ilmiah Ilmu Peternakan. Sumber Rejo, Vol 11 Nomor 2

I.W., I.B. Gaga, dan I.K. Sutama. 2002. Kebutuhan Kambing Peranakan Etawa Jantan Muda akan Energi dan Protein Kasar, Konsumsi, Kecernaan, Ketersediaan, dan Pemanfaatan Nutrien. Fakultas Peternakan, Universitas Udayana. Denpasar

Muhtarudin, Liman, dan Y. Widodo. 2003. Pembuatan dan Penggunaan Zn-Proteinat dalam Ransum untuk Meningkatkan Nilai Hayati Dedak Gandum dan Optimalisasi Bioproses dalam Pencernaan Ternak Kambing. Jurnal Penelitian Pertanian Terapan. Lampung

Parakkasi, A. 1999. Ilmu Nutrisi dan Makanan Ternak Ruminansia. Universitas Indonesia

Ravindran V. and R. Blair. 1992. Feed Resources for Poultry Production in Asia and The Pasific II. Plant Protein Sourrces World's. Sci. J. 48: 206-231

Saragih, H. 2014. Penggunaan Limbah Perkebunan untuk Pengembangan Ternak Kambing. Jurnal Penelitian Peternakan. Medan, Vol 4 Nomor 1

Soebarinoto, S. Chuzaemi, dan Mashudi. l99l. Ilmu Gizi Ruminansia. Universitas Brawijaya. Animal Husbandry Project. Malang

Sutardi, T.1980. Landasan Ilmu Nutrisi I. Departemen Ilmu Makanan Ternak, Fakultas Peternakan, Institut Pertanian Bogor, Bogor

Sutama, I.K. dan I.G.M. Budiarsana. 1996. Kambing PE Penghasil Susu sebagai Sumber Pertumbuhan Baru Sub-sektor Peternakan dan Veteriner. Prosiding Seminar Nasional Peternakan dan Veteriner. Departemen Pertanian. Bogor

Suwignyo, B. 2004. Sektor Peternakan Komoditi Utama Penggerak Perekonomian. Cyber News. Suara Merdeka. Yogyakarta

Tanuwiria, W., Garnida, dan I.Y. Asmara. 2006. Pengaruh Tingkat Protein dalam Ransum terhadap Performan Entok Lokal pada periode pertumbuhan. Seminar Nasional Teknologi Peternakan dan Veterinerr. Universitas Padjadjaran. Bandung.

D.19

CORN CROP WASTE PRODUCT ABSORPTION of N, P, and Ca at VARIOUS ALTITUDES IN THE WEST JAVA

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ABSTRACT

Corn straw as a corn crop waste was widely available and could be a major source for increasing livestock productivity. Corn crop waste was one of ruminant feed available in the country. Research on " N, P, and Ca nutrient uptake of corn crops at various altitudes in West Java" was conducted on August 14, 2016 to 24 August 2016 located on the highland (> 700 m asl), medium plains (400-700 M asl), and in low land (<400 m asl). Sampling was conducted for six replications. This study was aimed to determine the effect of altitude and to obtain the highest yield on nutrient uptake of N, P, and Ca of the corn crop waste. Experimental method used in this research was Randomized Complete Block Design (RCB). The variables observed were nutrient uptake of Nitrogen (N), Phosphorus (P), and Calcium (Ca). The data set was tested using the analysis of variance and followed by using the Duncan's multiple range tests to determine the differences between treatments. The results showed that the Nitrogen uptake of corn plant waste on the medium plain was higher than in the highlands and lowlands. The nutrient uptake of P in corn wastes was the same at various altitudes, whereas the uptake of Ca in medium plains was higher than in the Highland but the same as the lowlands. The uptake of calcium in the highlands was similar to the lowlands.

Keywords: Corn Plant Waste, Nutrient Absorption, Altitudes, N, P, Ca.

I. INTRODUCTION

Corn crop is very suitable to be developed in tropical climate like in Indonesia, because the plant is a C4 plant that requires direct sunlight. In addition, corn is also easy to grow, has spread in Indonesia with various types of soil and easy maintenance, so many land farmers was planted with corn crops. Corn is very useful as food, vegetable (babycorn), snack (popcorn), bioethanol, non-oil export materials, feed ingredients and raw materials for animal feed industry.

According to Syafruddin (2010), corn as a food crop is likely to be a source of work and income for farmers, as well as to support rural food security programs. Corn can be one of the food source of carbohydrate after paddy, also as raw material of food industry and animal feed. This is supported by Pakasi et.al. (2011), which states that corn is a potential commodity to be developed because it is a source of carbohydrates and protein. In addition, corn has the potential as one of agricultural commodities for the second most important food after rice and as animal feed and as industrial raw materials. The demand for corn continues to increase in line with the improvement of people's economic standard and the advancement of livestock feed industry so it is required the efforts to increase production through human resources and natural resources, land availability and yield potential and technology (Pakasi et al., 2011).

Availability of forage feed for ruminants is still very limited, especially in the dry season, so farmers use fibrous food derived from food crop waste (Retnani, et.al., 2009). One of agricultural waste is corn waste, especially in the form of stems, leaves, cobs reaches 1.5 times the weight of seed. This means that every 8 tons of seeds per ha then it is obtained 12 tons of waste that can be used as feed ruminant, that can be given directly or through Fermentation or pretreatment. Corn straw is an agricultural waste that is found in rural areas evenly on dry land. Agricultural products such as corn straw if mixed with other feed ingredients that have complete nutrient content will produce a rational and cheap feeding arrangement. Corn straw is the remnant of corn crops after the seeds are harvested and can be fed to livestock, both fresh and dry. Utilization of corn straw as animal feed has been done mainly for cattle, goats, and sheep (Directorate of Ruminant Livestock Livestock 2006). The potential of corn crop waste can be used as raw material for the manufacture of complete feed as an effort to reduce the consumption of forage (Maryono and Romjali 2007). The number of leaves of maize plants ranges from 10 to 18 leaflets (Subekti et.al., 2010).

Factors that affect the growth and development of corn crops are climate factors, one of them is the height of the place (low, medium and high). The climatic elements such as radiation, temperature, humidity and rainfall are greatly affecting crop productivity (Whiteman et al., 1974). According to Rustiani (2015), the height of the place is divided into three parts namely lowland (<400 m asl), medium land (400-700 m) asl and highlands (> 700 m asl).

Corn plants absorbed nitrogen relatively more than the absorption of phosphorous and potassium nutrients, although the way the accumulation is almost the same. In the early stages of corn crops, the accumulated growth of P is slow and increases rapidly after 4 weeks of age. Accumulation of P reaches 35% of all required when panicles or male flowers come out and continue to rise until the time of harvest (Sutoro et.al., 1998). This is in accordance with the opinion of Horner (2008) which states that corn plants desperately need nitrogen which is a macro nutrient in large quantities, if the needs are fulfilled then the growth is fast and the plant is able to absorb P more effective. Saifuddin (1993) argues that adequate calcium in plant tissue cells makes plant cells more selective in absorbing plant nutrients. The Calcium in soils in addition to the need for plant productivity through the roots is absorbed in the form of Ca ++, is also a cation that helps raise soil pH, this increase the nutrient uptake for plant growth and development.

II. MATERIALS AND METHODS

The research was conducted in May 2016 until June 2016, by using a survey method with multistage sampling technique. First stage was to determine the district area using purposive sampling with consideration: the potential of feed biomass, planting area and production capacity, density of livestock, land use whose data sets were basically derived from statistical documents (secondary data) available in the region of West Java. The next stage was to determine the region of the selected district. Finally the sampling was carried out by gathering primary data.

The data obtained from the research results were analyzed using Randomized Complete Block Design (RCB) with factorial arrangement. Single factor consisting three levels with 3 replicates each was implemented. The data set was then analyzed by using Analysis of Variance, and then followed by using Duncan's multiple-range test to determine the significant difference. The treatments levels were:

P1 = Plateau (> 700 mdpl)
P2 = Medium plain (500-700 mdpl)
P3 = Lowland (<500 mdpl)

Samples taken from each studied site consisted of six samples, so the total sample of corn waste taken was 18 samples. The cut sample is inserted into the sample paper after being weighed fresh and recorded, then fed into the oven to determine its dry weight. After the sample has dried, the sample was weighed and analyzed for N, P, and Ca. The absorption of N, P and Ca is obtained from the multiplication of dry matter and the content of each nutrient.

III. RESULTS AND DISCUSSION

Table 1. The Effect of Altitudes on Nutrient Uptake of N, P and Ca of Corn Waste at Various Altitude in West Java

Altitudes	Corn Crop Waste Mineral Content (g/plant)		
	Nitrogen intake	Phosphor intake	Calcium intake
P1 (Plateu/highland)	86,31 b	12,67 a	23,13 b
P2 (Medium plain)	187,81 a	14,51 a	45,70 a
P3 (Lowland)	118,15 b	20,32 a	30,96 ab

Notes: The different letters at a column shows the difference different.

The results showed that the absorption of corn plant waste on nitrogen in medium plains (187.81 g/plant) was higher than in the highlands and lowlands. Nitrogen uptake of corn plant waste in highlands (86.31 g/plant) and lowland (118.15 g /plant) was not significantly different. This is due to the medium plains is a suitable condition for corn crops, resulting in the highest Nitrogen Absorption. This is in accordance to Gardner et.al. (1985) stated that plant growth is affected by genetic factor and environment factors such as topography i.e. the elevation. According to Hodge et.al.(2000), plant ability to absorb Nitrogen from soil depends on environment, soil type and plant species. Almost 50-70% of Nitrogen source from soil cannot be absorbed by plant. According to Arif et.al (2014) that nitrogen plays a major role in the formation of plant tissue compared with other nutrients. This happens because nitrogen is very important in the formation of amino acids, proteins, nucleic acids and phytochrome.

The nutrient uptake of P in maize wastes is similar in highland (12.67 g / plant), medium plain (14.51 g / plant) and lowland (20.32 g / plant). According to Husain et.al. (2016), the absorption of Nitrogen and Phosphor affected the total Nitrogen and Phosphor content of maize leaves. Wasonga (2008) research states that at varied P conditions in the soil, give the same P absorption of corn crop. In plants, P is an important constituent of adenosine triphosphate (ATP) which directly plays a role in the process of storage and transfer of associated energy in the metabolic processes of plants (Doberman and Fairhurst, 2000). Added by Taiz and Zeiger (2002) phosphorus also acts as a constituent of metabolites and complex compounds as activators and cofactors or constituents of enzymes.

In Ca uptake in moderate plains (45.70 g / plant) was higher than in the highlands (23.13 g / plant) and similar or not significantly different in lowland (30.96 g / plant). The uptake of calcium in the highlands is similar to the lowlands

Overall in the medium plains, corn plants can be efficient in the absorption of nutrients, especially N, P and Ca, so it is very supportive for growth and productivity. The light factor has an important role for plant growth. Corn crops like direct sunlight but with moderately low temperatures (on medium plains). High temperatures (low altitudes) or low temperatures (on high plains) are incompatible with corn crops. It is in accordance with Mussadiq (2012) opinion that hybrid corn plantations found in high plains with high humidity, have longer planting times to accumulate enough heat, so plants are slower to mature and agronomically and nutritionally lower than in the plains Medium.

IV. CONCLUSION

A. *Conclusion*

Corn crop waste at medium plains (400-700 m dpl) in the West Java reaches the best Nitrogen, Phosphor and Calcium uptake. The Nitrogen uptake reaches 187,81 g/plant, the Phosphor uptake reaches 14,51 g/plant and Calcium uptake reaches 45,70 g/plant.

B. *Suggestion*

This research should be continued for making the ration feed and should be utilized for ruminant.

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REFERENCES

Arif, A., A.N.Sugiharto dan E. Widaryanto.2014. Pengaruh umur transplanting benih dan pemberian berbagai macam pupuk nitrogen terhadap pertumbuhan dan hasil tanaman jagung manis (Zea mays L Saccharata sturt). Jurnal Produksi Tanaman. 2(1): 2-8.

Direktorat Budidaya Ternak Ruminansia. 2006. Limbah Tanaman Sebagai Pakan Ruminansia, Jakarta.

Dobermann, A. & T. Faihurst. 2000. Rice, Nutrient Disorders and Nutrient Management. Manila: IRRI and Potash & Phosphate Institute of Canada.

Gardner, F.P., Pearce, R.B., Mitchell, R.L. 1985. Phisiology of Crop Plant. Iowa State University Press. Ames.

Hodge A, D.Robinson, and A.Fitter.2000. Are microorganisms more effective than plants at competing for nitrogen. Trends in Plant Science. 5:304-308.

Horner, E.R.2008. The effect of nitrogen application timing on plant available phosphorus. Thesis. Graduate School of the Ohio State University.USA.

Husain, B., K.Dawar, I Khan, and A.Abbas. 2016. Effect of various level of N,P fertilizers on maze (*Zea mays* L.) under different moisture condition. International.Journal of Agronomy and .Agricultural Research (IJAAR). 8(2):54-66.

Maryono dan E. Romjali. 2007. Petunjuk teknis teknologi inovasi pakan murah untuk usaha pembibitan sapi potong. Pusat Penelitian dqn Pengembangan Peternakan.

Mussadiq, Z. 2012. Performance of Forage Maize at High Latitudes:Plant Development, Agronomy and nutritive Value. Thesis. Swedish University of Agricultural Sciences Umea.

Retnani, Y. W. Widiarti, I. Amiroh, L.Herawati, dan K.B. Satoto. 2009. Daya simpan dan palatabilitas wafer ransum komplit pucuk dan ampas tebu untuk sapi pedet. Media Peternakan 32(2):130-136.

Rustiani, U.S. 2015. Keragaman dan Pemetaan Penyebab Penyakit Bulai Jagung di 13 Provinsi Indonesia. Disertasi. Sekolah Pascasarjana.Institut Pertanian Bogor. Bogor.

Sari N.P., T.I.Santoso dan S. Mawardi.2013. Sebaran tingkat kesuburan tanah pada perkebunan rakyat Kopi Arabika di dataran tinggi Ijen-Raung menurut ketinggian tempat dan tanaman penaung. Pelita Perkebunan. 29(2):93-107.

Saifuddin, S. 1993. Kesuburan dan Pemupukan Tanah Pertanian. CV. Pustaka Buana, Bandung

Syafruddin.2010. Modifikasi Sistem Pertanaman Jagung dan Pengolahan Brangkasan untuk Meningkatkan Pendapatan Petani di Lahan Kering. Balai Pengkajian Teknologi Pertanian Sulawesi Tengah.

Subekti, N.A, Syafrudin, R. Efendi, dan S. Sunarti. 2010. Morfologi Tanaman dan Fase Pertumbuhan Jagung. Balai Penelitian Tanaman Serealia Maros. http://balitsereal. litbang.deptan.go.id/ ind/bjagung/empat.pdf

Sutoro., Yoyo, S dan Iskandar. 1988. Budidaya Tanaman Jagung.Dalam Subandi, M. S dan A.Widjono. *Jagung*. Balai Penelitian Tanaman Pangan. Bogor

Taiz, L., and Zeiger. 2002. Plant Physiologi. Massachusetts: Sinauer Associates Inc. Publisher

Wasonga, C.J., D.O.Sigunga and A.O. Musandu. 2008. Phosphorus requirements by maize varieties in different soil types of Western Kenya. African Crop Science Journal. 16(2):161-173.
Whiteman, P.C., L.R.Humphreys, N.H. Monteith, A.H. Hoult, P.M.Bryand and J.C. Slater. 1974. A Course Manual in Tropical Pasture Science. Printed and Bound by Watson Ferguson and Co. Ltd. Brisbone.

D.20

POTENTIAL OF LIQUID SMOKE FROM AGRICULTURAL WASTE MATERIAL AS NATURAL PESTICIDE

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ABSTRACT

The use of synthetic pesticides unwise, cause pest and disease problems of plant have become so complex that negatively impact the environment and on the other pest resisitensi and pest resurgence. Quite high negative impact on the use of synthetic pesticides, encouraging efforts to pursue the use of natural pesticides as an alternative to synthetic pesticides. One of the natural pesticides that can be used is liquid smoke. Liquid smoke is a result of condensation or condensation of vapor of combustion (pyrolysis) of agricultural waste materials that contains lignin, cellulose, hemicellulose and other carbon compounds. Chemical compounds in the liquid smoke is generally dominated by phenols and organic acids. Phenol is the result of pyrolysis of lignin instrumental in giving flavor and acts as an antioxidant to inhibit the oxidation process when liquid smoke is applied. Organic acids such as acetic acid which is the result of the pyrolysis of cellulose and hemicellulose acts as an antibacterial. From various studies it is known that liquid smoke is more potent as a fungicide, while potential as insecticides only repel insect pests not killed. Characteristics of liquid smoke both levels and types of compounds are changing in every production of liquid smoke despite using the same raw materials. Thus the toxic power of liquid smoke as a natural pesticide unstable. However, the liquid smoke can be used as an alternative solution for controlling pests and plant diseases to avoid environmental pollution.

Keywords : Liquid Smoke, natural pesticides, pests, diseases, plant.

I. INTRODUCTION

The growing use of synthetic pesticides are considered practical by farmers and lovers of plants to prevent the plants from pests, it turns out to have negative impacts large enough for humans and the environment. According to the World Healt Organization (WHO) noted that worldwide pesticide poisoning occurs between was 1-5 million of people annually, mostly (80%) occur in developing countries [1].

The negative impact of the use of synthetic pesticides is increasing pest resistance to pesticides, increased costs of care due to the high price of pesticides and the use of less precise can cause toxicity for humans and ecosystems in the environment becomes unstable / unbalanced. Quite high negative impact on the use of synthetic pesticide was encouraging efforts to pursue the utilization of natural pesticides as an alternative to synthetic pesticides.

In general, a natural pesticide is a pesticide that basic ingredients derived from plants. The biodegradable pesticides in nature, so it does not pollute the environment and are relatively safe for humans and livestock, because the residuals are easily lost. One of the natural pesticides that can be used is liquid smoke. Liquid smoke is categorized as botanical pesticides, because originating from sewage plants is treated with the technique pyrolysis [2]. This paper discusses the use of liquid smoke as a natural pesticide in terms of the various results of research on controlling pests and plant diseases.

II. DEFINITIONS OF LIQUID SMOKE

Liquid smoke obtained from condentation by the pyrolysis process of wood constituents such as cellulose, hemi-cellulose and lignin. Liquid smoke could also mean the result of cooling and liquefaction of smoke from burned materials in a sealed tube. The smoke initially solid particles into a liquid cooled and then it is called by the name of liquid smoke. Liquid smoke could also mean the result of cooling and liquefaction of smoke from burned materials in a sealed tube [3]. Liquid smoke is a complex system consisting of a dispersed liquid phase and gas as a dispersing medium. Liquid smoke is produced by the incomplete combustion involving decomposition reaction constituent polymers into an organic compound with low molecular weight due to heat effect which includes oxidation, polymerization and condensation [4]. The use of liquid smoke, among others is as a food preservative, wood preservatives, freeze sap, pesticides and fertilizers [5].

III. PROCESS OF MAKING LIQUID SMOKE

Simple liquid smoke maker, in the form of a drum furnace for combustion and a drum filled with water to soak smoke pipe (Fig.1 & 2). Pyrolysis reactor can be made of stainless steel pipe, equipped with tar catcher and aset of condensation tools. The reactor serves to burn raw materials. The ingredients for making liquid smoke are woody materials or other plant parts such as coconut shell, wood waste, rice husk, stems of sago plant, sago waste, palm shell, rubber wood, sawmill and others. The ingredients are inserted into the drum as a pyrolysis furnace, then burned. After the fire is smoldering and smoky, each ingredient is inserted all then closed for pyrolysis.

The process of pyrolysis needs to long time. Smoke will come out of the container and enter the condenser that is submerged in a water bath, which finally issued the liquid from the condensation that is accommodated in the container. The heating is terminated until no liquid smoke drips in the container. The obtained liquid is a heterogeneous mixture of liquid smoke with tar. The liquid is then allowed to stand for a week to allow tar and other insoluble compounds to settle, then filtered, and this results in grade 3 liquid smoke [6], [7], [8].

Fig. 1 Drum furnace with pipe the smoke is elongated straight

Fig. 2 Drum furnace with spiral smoke drainpipe

IV. CHARACTERISTIC OF LIQUID SMOKE

Characteristics of liquid smoke in the form of rendement, color, pH value, total content of acid, total content of phenol and total carbonyl are influenced by raw materials and furnace model used. From different raw materials and furnace models will produce different characteristics and properties [9], [10]. The amount of liquid smoke rendement produced in the pyrolysis process depends on the type of raw materials used [11]. The condensation system during the pyrolysis process also affects the rendement of liquid smoke. Various research results reported liquid smoke rendement of various raw materials ranged from 4.95% - 52.64%, with temperatures ranging from 40ºC - 500ºC (Table 1). Liquid Smoke Rendement is never stable. Although the raw materials are the same, they always produce different rendemen in each pyrolysis process. This is likely influenced by the rate of heating, particle size, type and composition of the raw materials [2].

The resulting yield is also influenced by the content of lignin and cellulose, where the material containing high lignin content, the liquid smoke yield is also high [12]. The pH of liquid smoke ranged from 2.70-4.50 (Table 1). The lower the pH of liquid smoke the higher the quality of the liquid smoke. Liquid smoke with low pH acts as an antibacterial and antioxidant [13]. Its color of liquid smoke is yellow light brown - reddish brown - brown blackish (Fig.3).

Table 1. Characteristics of liquid smoke from various research results.

Raw material	Pyrolysis Temperature (ºC)	Rendement results (%)	The pH of liquid smoke produced	Reference
Coconut shell	160	13,12	4,00	[15]
Rice husk	160	12,63	3,80	[15]
Waste of wood shavings	160	10.80	3,00	[15]
Palm oil shells	500	29,59 34,88 52,02	- -	[14]
Palm oil shells	500	52,64	-	[2]
Palm oil shells	400	39,20	-	[28]
Wastes of mahogany & jackfruit	400-450	5,64	3,20	[9]
Sengon wood waste + sengon skin	400-450	4,95	3,80	[9]
Sengon wood waste without sengon skin	400-450	5,27	4,50	[9]
Black Bamboo	40 – 45	6,00	2,70	[10]
Spot Bamboo	40 – 45	5,20	2,80	[10]
Betung Bamboo	40 – 45	24,00	3,36	[10]
Sago waste	400	33,74	-	[7]
Sago palm stem shell	400	44,14	-	[7]
Pine sawdust	110	10,92	3,45	[11]
Pine sawdust	200	14,46	3,30	[11]
Pine sawdust	300	11,99	3,07	[11]
Pine sawdust	400	11,32	3,21	[11]

V. CHEMICAL COMPOSITION OF LIQUID SMOKE

To know the chemical compounds in liquid smoke are identified with the technical GC-MS. In general, chemical compounds in liquid smoke are dominated by phenols and organic acids (acetic acid) [14], [15]. Phenol which is the result of pyrolysis of lignin plays a role in giving flavor and acts as an antioxidant in inhibiting oxidation process when liquid smoke is applied. Organic acids such as acetic acid which are the result of pyrolysis of cellulose and hemicellulose act as antibacterial [10], [12], [16]. Levels of phenol and acetic acid in liquid smoke vary depending on the raw materials used. From the results of the research the content of phenol in liquid smoke ranged from 3.03% -46.01% (Table 2). Phenol and its derivatives serve to prevent pests and plant diseases [9], [17].

Table 2. The content of chemical compounds of phenol and its derivatives in the liquid smoke of various raw materials from various researchs result.

Raw material	Fenol (%)	Reference
Coconut shell	20,41	[15]
Coconut shell	26,13	[8]
Rice husk	12,39	[15]
Waste of wood shavings	20,18	[15]
Palm oil shells	11,68	[2]
Palm oil shells	46,01	[14]
Coconut husk	3,03	[16]
Sago waste	13,06	[7]
The bark of the sago plant	10,53	[7]
Black Bamboo	29,87	[10]
Spot Bamboo	30,36	[10]
Betung Bamboo	30,62	[10]

Fig. 3 Color of liquid smoke (Grade 3)

The content of the chemical compounds in the liquid smoke is very dependent on the type of material used, it is very influenced by the ratio of cellulose, hemicellulose and lignin content [7]. Most of the compounds contained in liquid smoke are semi-polar, meaning that liquid smoke is a water-soluble fume [2]. The content of organic acids in liquid smoke from various research results ranged from 5.44% -72.22% (Table 3). Organic acids in liquid smoke serve to accelerate plant growth and prevention of plant diseases [10].

Table 3. Chemical content of acetic acid in liquid smoke from various raw materials from various research results

Raw material	organic acid (%)	Reference
Coconut shell	53,00	[15]
Coconut shell	51,17	[8]
Rice husk	72,22	[15]
Waste of wood shavings	52,87	[15]
Palm oil shells	30,02	[2]
Palm oil shells	44,00	14
Coconut husk	9,22	[16]
The bark of the sago plant	5,44	[7]
Black Bamboo	31,27	[10]
Spot Bamboo	23,13	[10]
Betung Bamboo	56,39	[10]

VI. LIQUID SMOKE AS INSECTICIDE

Some research results show that liquid smoke formulation can be categorized as a natural insecticide, with concentration of 3 m /l give effect to pest of rice bug (*Leptocorisa oratorius*), can push the pest to the economic threshold value and act as repellent [18]. Mixing and fuming application of 5 ml of w/v as a pest insect repellent on 200 g of maize on the storage could increase the number of the dead maize weevil (*Sitophilus zeamais*) and reduce the damage maize kernel [19]. Reference [2], stated that liquid smoke as antifeedant to *Plutella xylostella* caterpillar, this is indicated by the value of EI50 (Effective Inhibitor) of 67.39709 at a liquid smoke concentration of 1.00% (w/v). The higher the value of EI50 from the probit analysis, were the more potentially a fraction as a biopesticide [2]. However, research results [20], stated that liquid smoke solution made from coconut shell at effective concentrations of 3% and 22% is a weak to moderate antifeedant inhibitor to the larvae of *Crocidolomia pavonana*. Liquid smoke is a low toxic levels, according to the LC50 (Lethal Concentration 50%) value of Nezara viridula of 42.85 to 55.08% equivalent to 428,500 ppm - 550,800 ppm [22]. This Criteria is based on a determined of category of EPA (Environmental Protection Agency) (Table 4).

Table 4. Criteria for levels of toxicity of LC_{50} values

No.	Level of toxicity	LC_{50} value (ppm)
1.	Low	> 100
2.	Medium	10 – 100
3.	High	1 – 10
4.	Very toxic	< 1

Source: [21]

Liquid smoke with concentration dose of 1.5% able to suppress the attack of grayak caterpillar, pod borer and sucker pod on soybean plants respectively by 25,11%; 56.64%; 83.98% compared to controls [15]. Seeing the results of LC 50 from the liquid smoke is very high, that is> 40%, it means that the application of liquid smoke applied in the field with a dose of <10% is only exorcising insect pests, rather than killing [22].

VII. LIQUID SMOKE AS FUNGICIDE

Liquid smoke can be used as a natural fungicide, with a concentration of 0.11% can inhibit the growth of *Phytophthora sp*. until 50% [23]. The research results [24], liquid smoke with a concentration of 0.5% able to suppress the attack *Phytophthora sp*. up to 63.87% and 52.28% for curly disease in pepper plants compared with controls. The research results [25], liquid smoke from palm shells capable of inhibiting the growth of fungus of *Ganoderma sp*. Liquid smoke also effectively inhibits anthracnose and fusarium wilt on cucumber host plants with 100% inhibitory at 0.5% concentration; 1% and 5%, but liquid smoke 5% concentration causes necrosis of cucumber leaf [26]. Meanwhile, according to reference [27], a concentration level of 12.5% is feasible to develop into doses of applications where this concentration level of neutral liquid smoke is non-toxic to plants.

VIII. CONCLUSION

1. From various studies it is known that liquid smoke is more potent as a fungicide, while potential as insecticides only repel insect pests instead of killing.
2. Characteristics of liquid smoke both levels and types of chemical compounds are always changing in every production of liquid smoke despite using the same raw materials. Thus the toxic power of liquid smoke as a natural pesticide unstable. However, the liquid smoke can be used as an alternative solution for controlling pests and plant diseases to avoid the impact of environmental pollution.

REFERENCES

[1] M. Mahmudah, N.E. Wahyuningsih dan O. Setyani. Kajian Keracunan Pestisida Pada Istri Petani Bawang Merah di Desa Kedunguter Kecamatan Brebes Kabupaten Brebes. Media Kesehatan Masyarakat Indonesia, Vol. 11 (1). pp. 65-70. April 2012.

[2] I.Khaldun, dan A.G. Haji. Potensi Asap Cair Hasil Pirolisis Cangkang Kelapa Sawit Sebagai Biopestisida Antifeedant. Seminar Nasional Sains & Teknologi III. 18-19 Oktober 2010. Lembaga Penelitian-Universitas Lampung. pp. 547-557.

[3] Muhakka, A. Napoleon, dan Hidayatul Isti'adah. Pengaruh Pemberian Asap Cair Terhadap Pertumbuhan Rumput Raja (*Pennesetum purpuleophoides*). Pastura Vol. 3 (1). pp. 30-34. 2013.

[4] E. P. Darmadji. Teknologi Asap Cair dan Aplikasinya Pada Pangan dan Hasil Pertanian. Universitas Gajah Mada. Yogyakarta. 2009.

[5] Alpian, T.A. Prayitno, J.P.G. Sutapa, dan Budiadi. Kualitas Asap Cair Batang Gelam (Melaleuca sp.). Jurnal Penelitian Hasil Hutan. Vol.32 (2). pp. 83-92. Juni 2014.

[6] Anonimous. (2013) Teknik Membuat Asap Cair. Jimat Indonesia. Available: https://www.facebook.com/Jimat.Indonesia/posts/...9 .

[7] R. B. Aditria, Cahyono, dan F. Swastawati. Identifikasi Komponen Penyusun Asap Cair dari Ampas Sagu dan Kulit Batang sagu (Metroxylon sagu Rottb) Serta Penentuan Senyawa Fenolat Total dan Aktifitas Antioksidan. Chem Info. Vol. 1 (1). pp. 240-246. 2013.

[8] J. Towaha, A. Aunillah, E.H. Purwanto. Pemanfaatan Asap Cair Kayu Karet dan Tempurung Kelapa untuk Penanganan Polusi Udara pada Lump. Buletin Ristri 4 (1). pp. 69-78. Maret 2013.

[9] S.Komarayati, Gusmailina dan G. Pari. Produksi Cuka Kayu Hasil Modifikasi Tungku Arang Terpadu. Jurnal Penelitian Hasil Hutan. Vol. 29 (3). pp. 234-247. 2011.

[10] S.Komarayati, dan S. Wibowo. Karakteristik Asap Cair Dari Tiga Jenis Bambu. Jurnal Penelitian Hasil Hutan. Vol. 33 (2). pp. 167-174. Juni 2015.

[11] M.Wijaya, E. Noor, T.T. Irawadi dan G. Pari. Perubahan Suhu Pirolisis Terhadap Struktur Kimia Asap Cair Dari Serbuk Gergaji Kayu Pinus. Jurnal Ilmu dan Teknologi Hasil Hutan 1 (2). pp. 73-77. 2008.

[12] S.Wibowo. Karakteristik Asap Cair Tempurung Nyamplung. Jurnal Penelitian Hasil Hutan. Vol. 30 (3). pp. 218-227. September. 2012.

[13] S.Komarayati, I. Anggraeni dan G. Pari. Pemanfaatan Cuka Kayu Sebagai Pencegah Hama/Penyakit Tanaman. Prosiding Seminar Nasional Kesehatan Hutan dan Kesehatan Pengusahaan Hutan Untuk Produktivitas Hutan. Bogor. 2012. pp. 221-228.

[14] Haji, A.G. 2013. Komponen Kimia Asap Cair Hasil Pirolisis Limbah Pada Kelapa Sawit. Jurnal Rekayasa Kimia dan Lingkungan. Vol. 9 (3): 109-116.

[15] D.R. Mustikawati, N. Mulyanti dan R. Wylis Arief. Study Effectiveness of Liquid Smoke As A Natural Insecticide For Maint Pest Control of Soybean Crops. International Journal of Sciences: Basic and Applied Research (IJSBAR). Vol. 30 (1). pp. 237-245. 2016.

[16] Mappiratu. Kajian Teknologi Produksi Asap Cair dari Sabut Kelapa. Media Litbang Sulteng 2 (2). pp.104-109. Desember 2009.

[17] Rakhmi. (2014) Pengaruh Liquid Smoke Terhadap Pertumbuhan Tanaman. Available: https://jurnalilmuhayat.wordpress.com/2014/10/08

[18] R.S. Santoso. Asap Cair Sabut Kelapa Sebagai Repelan Bagi Hama Padi Walang Sangit (Leptocorisa oratorius). Jurnal Sainsmat Vol. IV (2). pp. 81-86. September 2015.

[19] B. Rahmat, D. Pangesti, D. Natawijaya and D. Sufyadi. Generation of wood waste Vinegar and Its Effectiviness as a Plant Growth Regulator and Pest Insect Repellent. BioResources 9 (4). pp. 6350-6360. 2014.

[20] Wiyantono dan E. W. Minarni. Kajian Potensi Asap Cair Dalam Mengendalikan Ulat Krop Kubis, *Crocidolomia pavonana*. Jurnal Pembangunan Pedesaan Vol. 9 (1). pp. 50-56. April-Juli 2009.

[21] I.Kinasih, S.Ateng dan N.R. Roma. Uji Toksisitas Ekstrak Daun Babadotan (Ageratum conyzoides Linn) Terhadap Ikan Mas (Cyprinus carpio Linn.) Sebagai Organisme Non-Target. Edisi Agustus VII (2). pp. 121-132. 2013.

[22] D.R. Mustikawati. Toxicity Test of Liquid Smoke Against Green Stink Bugs (*Nezara viridula*). Makalah disampaikan pada International Conference on Sustainable Agriculture. Yogyakarta, 17-19 Januari 2017.

[23] E. Pangestu, S. Iman, Supriyanto. Uji Penggunaan Asap Cair Tempurung Kelapa Dalam Pengendalian E *Phytophthora sp.* Penyebab Penyakit Busuk Buah Kakao Secara *In Vitro*. Jurnal Perkebunan & Lahan Tropika. Vol. 4 (2). pp. 39-44. Desember 2014.

[24] D.R. Mustikawati. Effect of Plant Growth Promoting Rhizobacteria (PGPR) and Liquid Smoke Against Diseases Attacks and Growth of Pepper (*Piper nigrum* L.). International Journal of Sciences: Basic and Applied Research (IJSBAR). Vol. 31 (3). pp. 145-155. 2017.

[25] Thamrin. Efek Asap Cair Cangkang Kelapa Sawit Terhadap Jamur *Ganoderma sp*. Pada Kayu Kelapa Sawit. Jurnal Sains Kimia. Vol. 11 (1). pp. 9-14. 2007.

[26] I. Aisyah, N. Juli dan G. Pari. Pemanfaatan Asap Cair Tempurung Kelapa Untuk Mengendalikan Cendawan Penyebab Penyakit Antraknosa dan Layu Fusarium pada Ketimun. Jurnal Penelitian Hasil Hutan. Vol. 31 (2). pp. 170-178. Juni 2013.

[27] F.X. Wagiman, A. Ardiansyah and Witjaksono. Activity of Coconut-Shell Liquid-Smoke as an Insecticide on The Rice Brown Planthopper (Nilaparvata lugens). ARPN Journal of Agricultural and Biological Science. Vol.9 (9). pp. 293-296. September 2014.

[28] M. Halim, P. Darmadji, dan R. Indrati. Fraksinasi dan Identifikasi Senyawa Folatil Asap Cair Cangkang Sawit. Agritech. Vol. 16 (3). pp. 117-123. 2004

D.21

PADDY YIELDS INCREASING EFFORTS BY FERTILIZER DOSING TECHNOLOGY IN THREE SUB-DISTRICT PADDY PRODUCER CENTRE IN TULANG BAWANG BARAT DISTRICT

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ABSTRACT

The field experiment was conducted to test and find the right package fertilization technology in rice crops that produce optimal growth and production. The experiment was conducted in 3 (three) centers of rice production of Tulang Bawang Barat District, namely Sub-District Tumijajar (Tiuh Daya Asri), Sub-District Tulang Bawang Tengah (Tiuh Pulung Kencana), and Sub-District Tulang Bawang Udik (Tiuh Marga Kencana) started from November 2016 to February 2017. The experimental design used a complete randomized design with 3 replications. The treatment was fertilizer technology package consisting of 4 (four) packages that was applied to 2 (two) rice varieties, Cimelati and Mapan 05. There are 8 (eight) treatment combinations which are: (1) Farmers Fertilization using Cimelati Varieties (200 kg Urea / ha, 200 kg SP36/ha without KCl fertilizer), (2) Unila Recommended fertilization using Cimelati Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha), (3) Farmers Fertilization using Mapan 05 Varieties (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer), (4) Unila Recommended fertilization using Mapan 05 Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha), (5) Farmers Fertilization using Cimelati Varieties++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG), (6) Unila Recommended fertilization using Cimelati Varieties ++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha +*Plant Catalys and* BMG) , (7) Farmers Fertilization using Mapan 05 varieties ++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG), and (8) Unila Recommended fertilization using Mapan 05 Varieties ++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha + *Plant Catalys and* BMG).

The results show that Unila Recommended fertilization using Mapan 05 Varieties ++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha + *Plant Catalys and* BMG) resulted the highest yield of dry grain harvest of 7.48 tons/ha. Unila Recommended Fertilization dose increase the productivity of Cimelati Varieties from 4.9 tons/ha to 5.97 tons/ha. Unila Recommended Fertilization dose increase the productivity of Mapan 05 Varieties from 5. 69 tons/ha to 7.04 tons/ha. Unila Recommended Fertilization dose with BMG and plan catalyst addition increase the productivity of Cimelati Varieties from 5.03 tons/ha to 6.41 tons/ha. Unila Recommended Fertilization dose with BMG and plant catalyst addition increase the productivity of Mapan 05 Varieties from 5. 68 tons/ha to 7.48 tons/ha.

Keywords : paddy, fertilization, productivity

I. INTRODUCTION

Agriculture Ministry of Indonesia through the Directorate General of Food Crops set the target of rice production in 2017 amounted to 78,132,000 tons of rice dry grain (GKG), it increase amount of 1,906,000 tons of GKG if it is compared to the year 2016 (Dirjen Tanaman Pangan, 2017). To meet the production targets, the Directorate General of Food Crops will implement operational steps to increase rice production by: (1) Increasing plant area and (2) Increasing productivity.

Efforts to increase planting area are carried out through : (a) utilization of existing raw land, (b) new land/paddy field printing, (c) land optimization, (d) utilization of abandoned land, (e) sustainable land conservation, and) intercropping cultivation pattern on plantation and forestry fields. While efforts to increase productivity one of them is done through Integrated Crop Management Application Movement (GP-P TT) (Dirjen Tanaman Pangan, 2017).

Lampung Province in 2016 produces 4,020,420 tons GKG with productivity of 50.46 quintal/ha, placed Lampung on seventh position after East Java, West Java, Central Java, South Sulawesi, South Sumatera and North Sumatra (Badan Pusat Statistik, 2017). In 2017, Lampung Province is targeted by the Ministry of Agriculture to produce rice for 4,401,188 tons of GKG. To achieve the production target, all rice production centers in Lampung Province must work optimally by running programs and activities including Tulang Bawang Barat District.

The area of raw land for food crop agriculture in Tulang Bawang Barat Regency in 2015 reached 11.298,6 ha consisting of irrigated rice field and rainfed rice field, while the harvested area reaches 18,747 ha with production of 90,171,04 ton, there is an increase of production equal to 4,193 ton or 4,6 percent if it was compared to 2014. Although there is an increase in production, but in fact the productivity of rice crops in Tulang Bawang Barat District is still relatively low at 4.8 ton/ha (BPS Kabupaten Tulang Bawang Barat, 2016) and it is still lower than the productivity of Lampung Province in 2015 of 5,15 ton/ha and the national productivity of 2015; 5,34 ton/ha (Badan Pusat Statistik, 2017). The low productivity is caused by many factors, one of which is the low level of soil fertility in Tulang Bawang Barat and land suitability classes is marginal soil (Dinas Pertanian Kabupaten Tulang Bawang Barat, 2016). That mean the land require more intensive treatment.

The research was conducted by agriculture unit of Tulang Bawang Barat District in cooperation with Agriculture Faculty of University of Lampung in three rice production centers in Tulang Bawang Barat namely Tumijajar Subdistrict (23 sample points), Tulang Bawang Tengah Subdistrict (17 sample points), and Tulang Bawang Udik Subdistrict (11 sample points). Initial research of soil nutrient content shows that the average nutrient content of N, P, K is low (R) to very low (SR). Therefore, in order to increase the productivity of rice in Tulang Bawang Barat regency is needed a deep study, one of which required the right fertilizer technology package that can give a positive influence so that the productivity of rice can be improved.

In this study, University of Lampung (Unila) recommends a fertilizer technology package that has been studied in depth by considering several aspects including soil fertility level, the nutrients need of rice crops, especially N, P, and K, and fertilizer efficiency. Unila's recommendation fertilizer technology package will be compared with the local farmer's fertilization method, then it will be applied to two varieties of rice that is non hybrid variety (Cimelati Varieties) and hybrid rice variety (Mapan Variety 05).

II. MATERIALS AND METHODS

A field experiment was conducted in 3 (three) centers of rice production Tulang Bawang Barat, namely Tumijajar Subdistrict (Tiuh daya Asri), Tulang Bawang Tengah Subdistrict (Tiuh Pulung Kencana), and Tulang Bawang Udik Subdistrict (Tiuh Marga Kencana) starting in November 2016 until February 2017.

The experimental design was used a complete randomized design with 3 replications. The treatment was fertilizer technology package consisting of 4 (four) packages that was applied to 2 (two) rice varieties, Cimelati and Mapan 05. There are 8 (eight) treatment combinations which are: (1) Farmers Fertilization using Cimelati Varieties (200 kg Urea / ha, 200 kg SP36/ha without KCl fertilizer), (2) Unila Recommended fertilization using Cimelati Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha), (3) Farmers Fertilization using Mapan 05 Varieties (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer), (4) Unila Recommended fertilization using Mapan 05 Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha), (5) Farmers Fertilization using Cimelati Varieties++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + Plant Catalys and BMG), (6) Unila Recommended fertilization using Cimelati Varieties ++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha +Plant Catalys and BMG) , (7) Farmers Fertilization using Mapan 05 varieties ++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + Plant Catalys and BMG), and (8) Unila Recommended fertilization using Mapan 05 V arieties ++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha + Plant Catalys and BMG).

Field experiment in each sub-district was conducted on 1 ha of land. Then the land is divided by eight with a barrier of bunds to obtain eight experimental plots with a size of 1,250 m^2 where the application of each treatment placed. SP36 and KCl fertilizers were applied at one time before planting rice. Urea fertilizer is applied twice, half the dose at planting time and the rest is applied when the rice plants enter the phase of primordia. Plant catalyst with a dose of 5 kg / ha was applied simultaneously on one day before planting with application of SP36 and KCl fertilizer by spraying it to land until it immersed. BMG (biological fertilizer) with a dose of 4 liters / ha also applied simultaneously on one day before planting by sprayed onto the land evenly. Rice planting in the field is done by legowo 2: 1 row system with plant spacing 50 x (25 x 15) cm. Age of seed used is 15 days after sowing. Planting is done with 2 seeds per planting hole.

The response variables observed in this experiment with statistically analyzed data are (1) the number of tillers per hill, (2) the number of productive tillers per hill, and (3) the production of dry rice harvest per hectare. The data were analyzed by varian analysis (anova) of complete randomized design, and continued with the Least Significant Difference test (LSD) at 5% level.

III. RESULTS AND DISCUSSION

The result showed that the treatment had significant effect on the number of tillers. The results of the least significant difference (LSD) of treatments effect on number of tillers are presented in Table 1.

Table 1. Number of tillers of rice plants due to the effect of treatment in dose fertilization technology

Treatment	Average Number of Tillers
A	15.60 d
B	23.33 a
C	18.43 bcd
D	23.00 a
E	19.40 bc
F	21.33 ab
G	17.67 cd
H	24.00 a

LSD (0.05) = 3.207

Description: The numbers followed by the same letter are not significantly different according to the LSD test at 5%

Treatments:
A = Farmers Fertilization using Cimelati V arieties (200 kg Urea / ha, 200 kg SP36 / ha without KCl fertilizer)
B = Unila Recommended fertilization using Cimelati Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha)
C = Farmers Fertilization using Mapan 05 Varieties (200 kg Urea/ha, 200 kg SP36/ha, without KCl fertilizer)
D = Unila Recommended fertilization using Mapan 05 Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha)
E = Farmers Fertilization using Cimelati Varieties++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG)
F = Unila Recommended fertilization using Cimelati Varieties++ (500 kg Urea/ha, 400 kg SP36 / ha, 250 kg KCl/ha + *Plant Catalys and* BMG)
G = Farmers Fertilization using Mapan 05 varieties ++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG)
H = Unila Recommended fertilization using Mapan 05 V arieties ++ (500 kg Urea/ha, 400 kg, SP36/ha, 250 kg KCl / ha + *Plant Catalys and* BMG).

Table 1 shows that the fertilization recommendation dose from unila significantly increased the number of rice tillers, either on Cimelati Varieties or on Mapan Variety 05 when compared with fertilization dose done by farmers. In general, the treatment of fertilizer recommendation from unila resulted in the highest number of tillers of rice crops which is average of 24,00 tillers produced by Mapan Variety 05.
The result of variance analysis showed that the treatment had significant effect on the number of productive tillers . The results of the least significant difference test (LSD) of treatment on the number of productive tillers are presented in Table 2.

Table 2. Number of productive tillers of rice plants due to the effect of dose fertilization technology

Treatment	Average Number of Earning Chicks
A	13.57 d
B	21.67 a
C	16.20 bcd
D	21.67 a
E	17.77 bc
F	19.00 ab
G	15.33 cd
H	22.00 a

BNT (0.05) = 3.26

Description: The numbers followed by the same letter are not significantly different according to the LSD test at 5%

Treatments:
A = Farmers Fertilization using Cimelati V arieties (200 kg Urea / ha, 200 kg SP36 / ha without KCl fertilizer)
B = Unila Recommended fertilization using Cimelati Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha)
C = Farmers Fertilization using Mapan 05 Varieties (200 kg Urea/ha, 200 kg SP36/ha, without KCl fertilizer)
D = Unila Recommended fertilization using Mapan 05 Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha)
E = Farmers Fertilization using Cimelati Varieties++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG)

F = Unila Recommended fertilization using Cimelati Varieties++ (500 kg Urea/ha, 400 kg SP36 / ha, 250 kg KCl/ha + *Plant Catalys and* BMG)
G = Farmers Fertilization using Mapan 05 varieties ++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG)
H = Unila Recommended fertilization using Mapan 05 V arieties ++ (500 kg Urea/ha, 400 kg, SP36/ha, 250 kg KCl / ha + *Plant Catalys and* BMG).

Table 2 shows that the treatment of fertilizer recommendations from unila significantly increased the number of productive tillers of rice crops that were produced when compared to the farmer's way of fertilization, either on Cimelati Varieties or on Mapan Variety 05. Treatment B (Unila Recommended fertilization using Cimelati Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha) resulted significantly different in average number of higher productive tillers (21.67 seedlings) compared to Farmers Fertilization using Cimelati Varieties (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer) which produces only 13.57 of productive tillers of saplings. Likewise, Mapan Varieties 05, Treatment H (Unila Recommended fertilization using Mapan 05 V arieties ++ (500 kg U rea / ha, 400 kg SP36 / ha, 250 kg KCl / ha + *Plant Catalys and* BMG) was significantly different, higher average number of productive tillers (22.00 tillers) compared to Treatment G (Farmers Fertilization using Mapan 05 varieties ++ (200 kg Urea / ha, 200 kg SP36 / ha without fertilizer KCl + *Plant Catalys and* BMG)) which produces only 15.33 productive tillers.

Table 2 also shows that Mapan Variety 05 significantly produces higher number of productive tillers than Cimelati Varieties with the same fertilizer dose treatment. This is because the Mapan Variety 05 is a hybrid variety that genetically has one advantage over the non-hybrid varieties (Cimelati) that has more number of productive tillers (Balai Besar Penelitian Tanaman Padi, 2017).

The result of variance analysts indicated that the treatment had a significant effect on the production of dry grain harvest per hectare. The results of the least significant difference test (LSD) of the treatment effect on dry paddy yield per hectare are presented in Table 3.

Table 3 shows that the treatment of fertilizer recommendation from unila significantly increased the production of harvested dried grain (GKP) per hectare when compared to Farmers Fertilization way, the treatment of H (Unila Recommended fertilization using Mapan 05 V arieties ++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha + *Plant Catalys and* BMG) resulted highest yield of dry grain harvest of 7.48 ton / ha, higher than other treatment except treatment D (Unila Recommended fertilization using Mapan 05 Varieties (500 kg Urea/ha, 400 kg SP36 / ha, 250 kg KCl / ha) resulting dry crop yield of 7.04 tons / ha.

The results of this all study indicate that the treatment of fertilizer recommendation from Unila has a better effect because the doses given more precisely and balanced. Balanced fertilization will positively affect the growth and development of the rice plant which will eventually increase the production of grain produced. According to Balai Besar Penelitian Tanaman Padi (2015), the concept of balanced fertilization is giving a number of fertilizer to achieve the availability of balanced and optimum essential nutrients into the ground to enhancing productivity and quality of agricultural products; increase fertilizer efficiency; enhancing soil fertility and soil conservation; and avoid environmental pollution and poisoning plants. Balanced Fertilization Principle is fertilizing with four precisely: (1) Proper Dose is in accordance with the status of soil nutrients, crop needs, and yield targets; (2) On Time, nutrients are available when plants require in large quantities; (3) Precise Placement of fertilizers in locations where plants can effectively access nutrients; (4) Exact Type/Form, that is formula of fertilizer according to soil condition and requirement of plant.

Table 3. Dried Harvest Grain Production due to the effect of dose fertilization technology

Treatment	Replication			Average
	Tulang Bawang Udik	Tulang Bawang Tengah	Tumijajar	
	.... ton/ha			
A	5.46	4.17	5.07	4.90 e
B	6.27	5.74	5.90	5.97 c
C	6.10	5.44	5.54	5.69 cd
D	7.33	6.79	6.99	7.04 ab
E	5.26	4.44	5.38	5.03 de
F	6.70	5.96	6.58	6.41 bc
G	6.00	5.38	5.68	5.68 cd
H	8.10	7.02	7.31	7.48 a

LSD (0.05) = 0.762

Description: The numbers followed by the same letter are not significantly different according to the LSD test at 5%

Treatments:
A = Farmers Fertilization using Cimelati V arieties (200 kg Urea / ha, 200 kg SP36 / ha without KCl fertilizer)
B = Unila Recommended fertilization using Cimelati Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha)

C = Farmers Fertilization using Mapan 05 Varieties (200 kg Urea/ha, 200 kg SP36/ha, without KCl fertilizer)
D = Unila Recommended fertilization using Mapan 05 Varieties (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha)
E = Farmers Fertilization using Cimelati Varieties++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG)
F = Unila Recommended fertilization using Cimelati Varieties++ (500 kg Urea/ha, 400 kg SP36 / ha, 250 kg KCl/ha + *Plant Catalys and* BMG)
G = Farmers Fertilization using Mapan 05 varieties ++ (200 kg Urea/ha, 200 kg SP36/ha without KCl fertilizer + *Plant Catalys and* BMG)
H = Unila Recommended fertilization using Mapan 05 V arieties ++ (500 kg Urea/ha, 400 kg, SP36/ha, 250 kg KCl / ha + *Plant Catalys and* BMG).

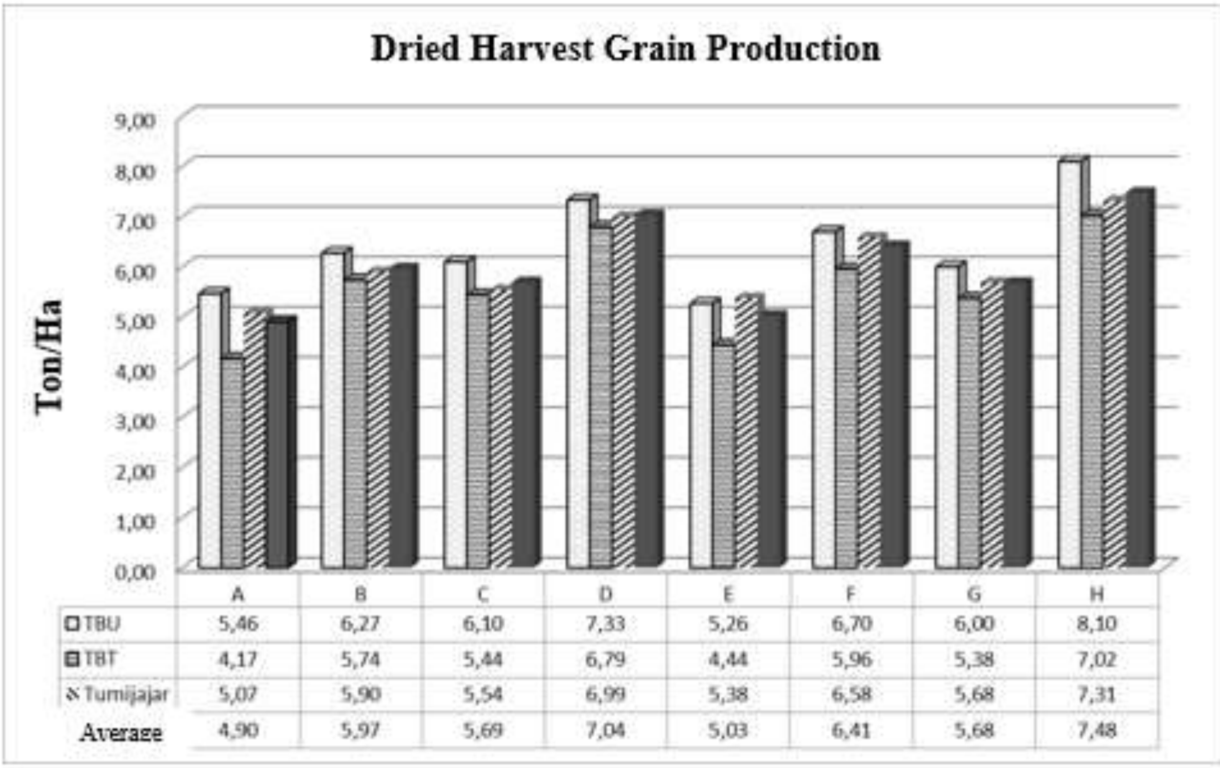

Fig. 1. Average Harvest Dry Harvest (GKP) per Hectare according to Sub-District

Table 4. Comparison of Dried Harvest Grain Production (GKP) between Cimelati Varieties and Mapan 05 Variety in same fertilization dose

No	Treatment	Varieties	
		Cimelati	Mapan 05
		---------- ton / ha ------------	
1	Farmers Fertilization (200 Kg Urea / ha, 200 Kg SP36 / ha, 0 Kg KCl / ha)	4 , 90	5 , 69
2	Unila Recommended fertilization (500 Kg Urea/ha, 400 Kg SP36 / ha, 250 Kg KCl / ha)	5 , 97	7 , 04
3	Farmers Fertilization ++ (200 Kg Urea / ha, 200 Kg SP36 / ha, 0 Kg KCl / ha + Plant Catalys and BMG)	5 , 03	5 , 68
4	Unila Recommended fertilization ++ (500 Kg Urea / ha, 400 Kg SP36 / ha, 250 Kg KCl / ha + *Plant Catalys and BMG*)	6 , 41	7 , 48

Table 4 shows that the Mapan 05 Variety significantly resulted higher yield of Dried Harvest Grain Production (GKP) at the same fertilizer dosage, either on Unila recommendation fertilizer treatment or on farmer's way treatment. This fact proves that Mapan 05 Variety which is a genetically hybrid varieties has a higher potential in grain production. In accordance with the opinion by Balai Besar Penelitian Tanaman Padi (2017) that hybrid varieties have advantages such as (1) higher yields than inbred superior rice yields; (2) Have better vigor and have good competitiveness with weeds; (3) Advantages of physiological aspects, such as wider rooting activity, wider photosynthetic area, lower respiratory intensity and higher assimilate translocation; and (4) Advantages in some morphological characteristics such as stronger root system, more tillers, more grain per panicle, and higher content of grain weight at 1.000 grains.

Table 4 also shows that Unila Recommended Fertilization dose increase the productivity of Cimelati Varieties from 4.9 tons/ha to 5, 97 tons/ha (increased 21.84%). Unila Recommended Fertilization dose increase the yield productivity of Mapan 05 Varieties from 5,69 tons/ha to 7 , 04 tons/ha (increased 23.73%). Unila Recommended Fertilization dose with plant catalyst and BMG addition increase the yield productivity of Cimelati Varieties from 5.03 tons/ha to 6,41 tons/ha (increased 27.44%). Unila Recommended Fertilization dose with BMG and plant catalyst addition increase the yield productivit y of Mapan 05 Varieties from 5,68 tons/ha to 7,48 tons/ha (increased 31.69%).

IV. CONCLUSION

The results of the experiment showed that :

1. Unila Recommended fertilization using Mapan 05 Varieties++ (500 kg Urea/ha, 400 kg SP36/ha, 250 kg KCl/ha + Plant Catalys and BMG) resulted highest yield of dry grain harvest of 7.48 tons/ha.
2. Unila Recommended Fertilization dose increase the productivity of Cimelati Varieties from 4.9 tons/ha to 5.97 tons/ha.
3. Unila Recommended Fertilization dose increase the productivit y of Mapan 05 Varieties from 5.69 tons/ha to 7.04 tons/ha .
4. Unila Recommended Fertilization dose with BMG and plant catalyst addition increase the productivity of Cimelati Varieties from 5.03 tons/ha to 6.41 tons/ha .
5. Unila Recommended Fertilization dose with BMG and plant catalyst addition increase the productivity of Mapan 05 Varieties from 5.68 tons/ha to 7.48 tons/ha.

REFERENCES

Badan Pusat Statistik. 2017. Production and productivity of rice by province. Retrieved on December 24, 2017 from http://www.pertanian.go.id/Data5tahun/TP-ARAM%20II%202017(pdf)/20-ProdPadi.pdf.

Balai Besar Penelitian Tanaman Padi. 2017. The advantages of hybrid rice. Agency for Agricultural Research and Development Ministry of Agriculture Republic of Indonesia. Jakarta. Retrieved on December 24, 2017 from http://bbpadi.litbang.pertanian.go.id/index.php/tahukah-anda/193-advantages-padi-hibrida .

Balai Besar Penelitian Tanaman Padi. 2015. Application of Balanced Fertilization on Specific Location. Agency for Agricultural Research and Development Ministry of Agriculture Republic of Indonesia. Jakarta. Retrieved on December 24,2017. From http://bbpadi.litbang,pertanian.go.id/index.php/berita/info-teknologi/content/197-application-fertilization-balanced-specific-location .

BPS Kabupaten Tulang Bawang Barat. 2016. Tulang Bawang Barat In Figures 2016. Panaragan.

Dinas Pertanian Kabupaten Tulang Bawang Barat. 2016. Study of Land Suitability and Soil Fertility in Rice Production Center of Tulang Bawang Barat Regency. Cooperation of Local Government of Regency of Tulang Bawang Barat with Faculty of Agriculture University of Lampung.

Direktorat Jenderal Tanaman Pangan. 2017. Production, Harvested Area, and Rice Productivity in Indonesia Year 2013-2017 *) . Retrieved on December 24, 2017 from http://www.pertanian.go.id/ ap_pages/mod/datatp.

D.22

THE USE OF BACTERIA *Coryne bacterium* ANTAGONISTS AS PREVENTIVE ACTIONS TO REDUCE MAIN DISEASES IN RICE

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ABSTRACT

Tactics technical culture (cultural or ecological management control) is a tactic to manipulate the environment to create a mismatch pests in an environment by interfering with the reproductive cycle, eliminate food, and make the environment more suitable for the development of natural enemies. One of the biological agents that can be used is Coryne bacterium. Coryne bacterium (Corin) is a natural biological agents (biological pesticides) -based antagonists Coryne bacterium bacteria are highly effective for controlling major diseases in rice plants. This assessment will be carried out on the use of corine to protect plants by using a randomized block design with 3 treatments, without the use of corine A., B. Use coine with a frequency of 15 days, C. The use of corine with a frequency of once every 30 days. The results showed that the use of Corin with a frequency of 15 days can reduce blast disease of approximately 45.82% and approximately 50.2% crackle disease compared with no use of Corin. Corin for use with frequency of 30 days only suppress the disease tersbut < 20%. Corin has no effect on natural enemy performance in rice cultivation.

Keywords : *Coryne bacterium*, disease, rice.

I. INTRODUCTION

The principle of integrated pest control in general is to integrate various control measures such as control of technical culture, superior varieties, and natural enemies [1]. A cultural control or ecological management tactic is the tactic of manipulating the environment to create a pest incompatibility in an environment by disrupting the reproductive cycle, eliminating food, and making the environment more suited to natural enemy developments. Although it is classified as old, technical culture method is still effective in suppressing the level of pest attacks and is widely accepted in the implementation of IPM technology. A cultural control or ecological management tactic is the tactic of manipulating the environment to create a pest incompatibility in an environment by disrupting the reproductive cycle, eliminating food, and making the environment more suited to natural enemy developments. One of the biological agents that can be used Coryne bacterium. Coryne bacterium (Corin) is a natural biological agent (biological pesticide) bacterium-based antagonist Coryne bacterium that is very effective for controlling major diseases in rice plants.

Control of pathogens with antagonistic microbes can be produced from one or more antagonistic mechanisms depending on the type of antagonistic microbe. Direct effects on pathogens include competition for colonization at the site of infection, carbon competition and nitrogen source, iron competition through the production of iron-chelating compounds or siderophores, antimicrobial compounds such as antibiotics and HCN, degradation of pathogenic germination factors or pathogenicity and parasitism factors. These factors can coincide with indirect mechanisms, including nutrient repairs and damage compensation, changes in root system anatomy, microbial changes in the rhizosphere and activation of plant resistance mechanisms [2].

Corrin is a natural biological agent (biological pesticide) bacteria-based antagonist corynebacterium that is very effective for controlling major diseases in rice plants. Corrin can control bacterial leaf blight disease (HDB) or rice crunch disease, orange leaf blight / Bacterial Red Stripe (BRS), Blast / Pyricularia Oryzae and leaf spot / Cercospora. The use of corin in harmony with agricultural objectives to be achieved is a sustainable agriculture system.

Sustainable agriculture systems are the long-term goal of IPM with the goal of achieving high production, quality products, protection and upgrading of land, water and other resources, developing a thriving village economy, and a better life for farm families and farming communities in general. This will only be realized in the next few decades as sustainable agriculture has so far not yet had a model or alternative in relation to economically viable farming [3]. This assessment will be carried out corine use on rice plants to protect plants from infectious diseases.

II. MATERIALS AND METHODS

Corine-making techniques at farm level:

A. Materials

One tube stater Coryne, 15 kg potatoes, 150 grams of white sugar, clean water.

B. Procedure

Potatoes as much as 15 kg cleaned his skin from the ground, then peeled. Potatoes that have been peeled in small pieces of approximately 1x2 cm. After that the cut potatoes are boiled with 5 liters of water until the potatoes are cooked and extracts. Then the potatoes are lifted and then into boiled water is put white sugar 150 gram, then stirred for 30 minutes, then the liquid is removed and move into a closed container such as rigen or bottle aqua galo, and closed tightly. After the cold liquid then insert the isolate (stater) of one tube Coryne bacterium into the liquid.

Gallon of mineral water with potato extract and bacterial isolate Corine (coryne bacterium) is then incubated or bred for several days. If in this culture the aquarium aerator is only done for 4 days, but if mixing or mixing done manually by shaking the container (gallon of water or rigen) used then it takes longer incubation time that is more or less 15 days. This propagation result is ready for use.

C. Application mode

Coryne bacterium prevents non-treat therefore application is performed while the plant has not been attacked. The concentration used is 100-200 ml / spray tank 14-17 liters (0.5-1 glass aqua / spray tank). This mixture of bacteria should not be mixed with chemical pesticides. Because the corine bacteria of living beings will die if mixed with chemical pesticides. Cultures are applied on the morning before 9 o'clock. Can also be sprayed in the afternoon after 4 o'clock. But keep in mind do not apply corine bacteria when the day will rain. Spray evenly on all parts of the rice plant. This solution is applied when the rice plants are 15 hst, 30 hst according to the treatment. Experiments were conducted on the farmers of the father (Surip, with an area of approximately 0.25 ha, the varieties used were Impari 10. The design used was a complete randomized block design with the following treatments:

The applied treatment is frequency of use of corrin that is:

1. Use of Corrine with frequency of 15 days one time (T1).
2. Use of Corrine with frequency of 30 days once (T2).
3. Without corin treatment (T3)

Observations were made on 30 plant samples. Observations were made on the intensity of major disease events in rice plants, major natural enemy populations and number of tillers of rice plants.

III. RESULTS AND DISCUSSION

The observation result showed that the main disease intensity data found in rice plants were as follows:

Table 1. Intensity of major disease attack of rice plants with two techniques of giving corin at Impari 10 varieties at age 85 day after planting (DAP).

Observation	Major diseases (Intensity)	
	Kresek (bacterial leaf blight)	Blast
T1	10.37 a	11.01 a
T2	19.21 b	24.32 b
T3	20.50 b	24.22 b

Description: The number followed by the same letter in the same column is not significantly different at the 5% level by t test

The table above shows the observations at 85 day after planting (DAP), observations have been started from the plant age 40, 55 and 70 DAP. At observations 40 and 55, and 70 DAP, there was no difference between the three treatments against the major disease intensity in rice plants, namely bacterial and blast spots. This is because the intensity of bacteria and pathogenic fungus is not too high so that the antagonistic fungus work is still able to suppress fungi / bacterial pathogens either with the use of corin 15 days once or 30 days once. In nature the antagonists need time to multiply so they are able to compete with the fungus / pathogenic bacteria, because the higher the antagonistic fungi population the ability to prevent the development of pathogenic fungi is also higher [4; 5].

The difference is seen in the age of 85 DAP, it is seen that at 15 days of corin use (T1) the major stresses of kresek and blast disease are much less (10.37 and 11.01%) than in others with more than 20%. It appears that corin antagonist bacteria are capable of defeating plant pathogenic bacteria present in rice plants. The development of antagonistic bacteria is quite good in rice cultivation is seen in Fig. 1 and 2 below.

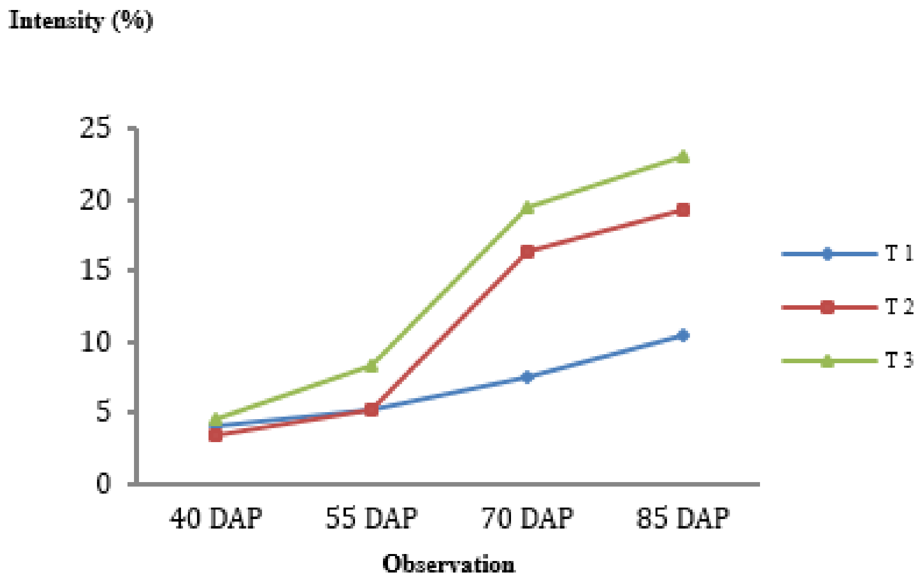

Fig. 1. The development of kresek (BLB) disease at 4 times observation

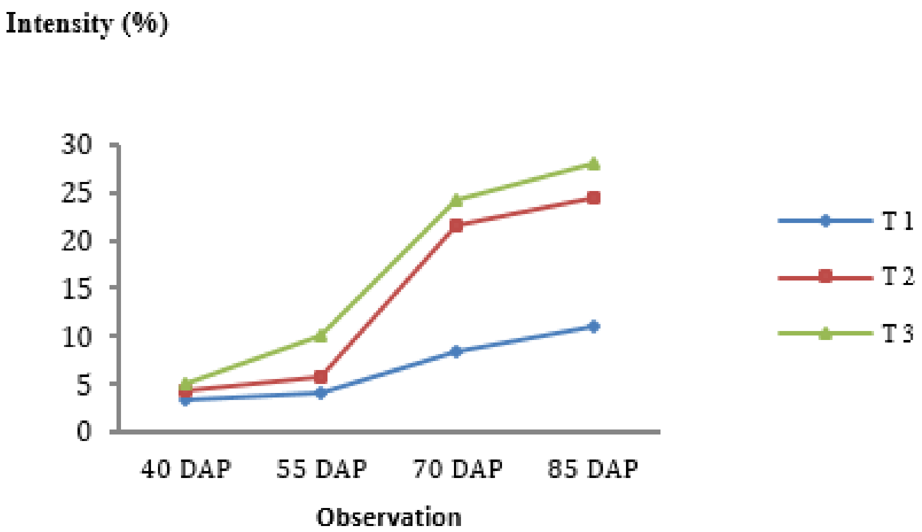

Fig. 2. Blast disease progression in 4 observations

The increasing age of the plant, the presence of pathogens, as well as corin biological agents are also developing. It is seen that in the 70 and 85 days after planting observation there was a difference in intensity of attack of two main diseases of rice plants in both treatment of Corrine. From the picture above shows that in the treatment of corrine 15 days one time, the intensity of the two major diseases both spots bacteria and blast is lower than the use of 30 days (Fig. 1). It can be said that the more intensive use of Corrine is able to reduce the development of plant pathogens. Antagonistic bacteria are capable of developing faster than plant pathogens [6]. The ability of these antagonistic bacteria is compatible with eco-friendly plant disease control systems and that support sustainable agriculture. This control is often referred to as biological control which aims to reduce the use of synthetic pesticides that affect the environment and food. Utilization of microbes or microbial products for plant disease control and to increase crop production is an integral part of sustainable agriculture [7]. Fungus / antagonistic bacteria are usually isolated from soil untouched by both cultivation practices and chemicals. This soil is called a suppressive soil. Fungi / bacteria isolated from suppressive soils have great potential to be utilized as biological agents [8; 9]. One of them is Corryne bacterium.

From this study also observed the existence of natural enemies that exist in rice plants. The results of the dominant natural enemy observations found are as follows.

Table 2. Major natural enemy populations of rice crops with two techniques of giving corin on Impari 10 variety varieties.

Observation	Average population (tail)	
	Spider	Paederus sp
T1	1.93 a	1.60 a
T2	1.81 a	1.30 a
T3	1,75 a	1.21 a

Description: The number followed by the same letter in the same column is not significantly different at the 5% level by t test.

Observation of the main natural enemies of rice crops, spiders and orders Coleoptera Paederus sp. Showed that antagonistic bacteria had no significant effect on the presence of natural enemies in the field (Table 2). This shows that antagonistic bacteria are safe against the environment, especially the natural enemies that surround them. According to [10], natural enemies have an enormous share in environmentally sound agricultural development because their pest control is high and does not have a negative impact on the environment. It appears that using a microorganism antagonist such as bacterial coryne would be complementary to complement the work of natural enemies.

In four observations the natural enemies were quite good until the rice plants reached the generative phase. Although not significantly different but in the treatment of corin use twice a month will make more natural enemies spider and Paederus sp better (Fig. 3 and 4).

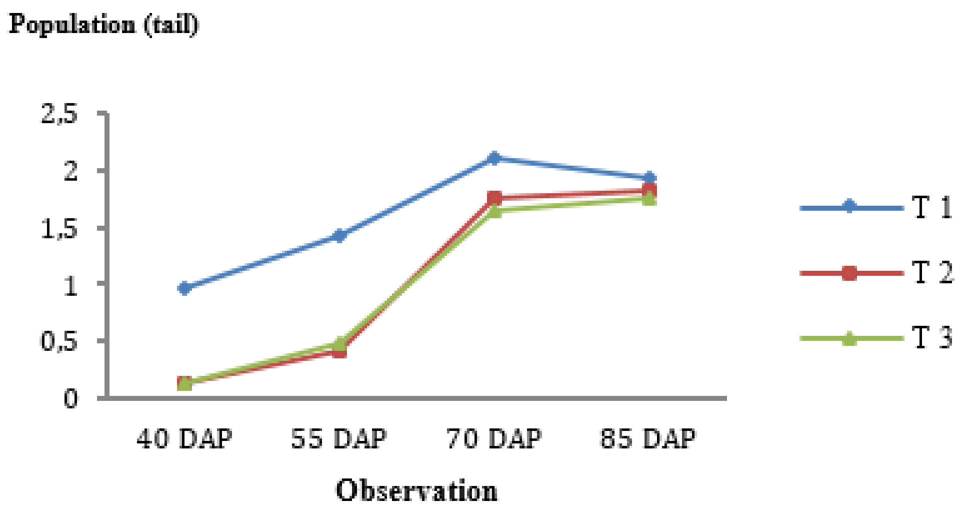

Fig. 3. The development of spider's natural enemies at 4 times observation

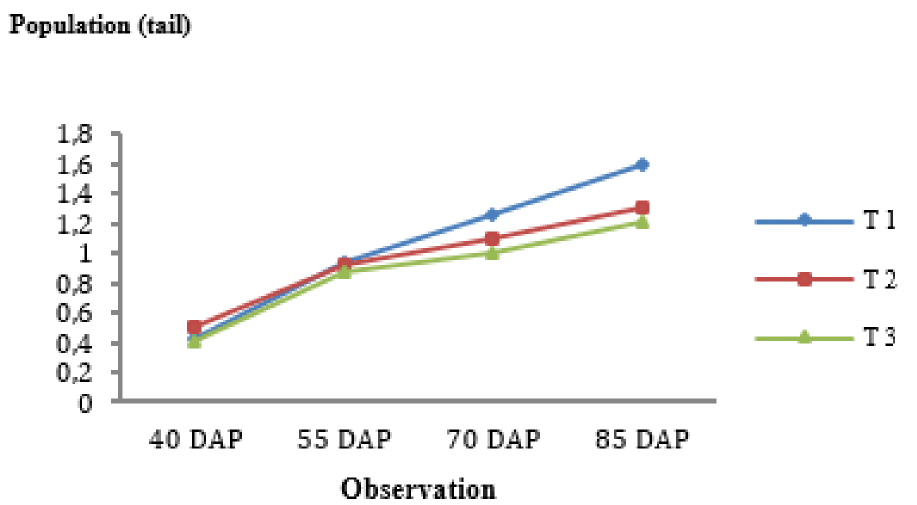

Fig. 4. The development of natural enemies Paederus sp at 4 times observation

According [11], biological control has advantages that is: (1). Safe means not cause environmental pollution and poisoning in humans and livestock, (2). Does not cause pest resistance, (3). Natural enemies work selectively against their host or prey so as not to interfere with other useful organisms, and (4). Permanent for a long period of time. So it can be said that the use of corin is harmless both the environment and other useful organisms.

Likewise with observation of vegetative growth of plants that is number of tillers (Table 3) it appears that from statistical analysis there is no difference in the number of tillers of rice if treated with Corrine either 15 days or 30 days. However, from observational data it is seen that with the use of corin 2 times a month, the number of tillers are also higher than without corin. It is seen that the use of corin causes the root area to be more capable of developing than without the use of corin. This is caused by the presence of antagonistic organisms, thereby reducing infections and other diseases, especially in the root areas of rice plants.

Also suspected by the use of corin will stimulate the growth of other useful organisms such as decomposing bacteria that cause the soil around the roots more fertile than those not treated with corin.

Table 3. Number of tillers of rice plants with two techniques of giving corin on Impari 10 variety varieties.

Observation	Average tillers		
	T1	T2	T3
40 DAP	15.40 a	15.03 a	14.21 a
55 DAP	15.20 a	15.10 a	14.73 a
70 DAP	15.20 a	15.12 a	14.42 a
85 DAP	15.21 a	15.15 a	14.87 a

Description: The number followed by the same letter in the same column is not significantly different at the 5% level by t test.

IV. CONCLUSION

The use of corin with a frequency of 15 days can reduce blast disease approximately 45.82%, and kresek disease about 50.2% compared with without the use of corin. For the use of corin with a frequency of 30 days only just suppress the disease tersbut <20%. The use of corin does not affect the performance of natural enemies in rice cultivation.

REFERENCES

[1] SE. Baehaki, "Teknik pengendalian wereng coklat terpadu", Prosiding Simposium Penerapan PHT tahun 1992, Balai Penelitian Tanaman Pangan Sukamandi. hlm. 39-49.

[2] JM. Barea, M.J. Poso, R. Azcon and C. A. Aguilar, "Microbial co-operation in the rhizosphere", *Journal of Experimental Botany*. Pp. 1-18, 2005.

[3] R. Earles, "Sustainable agriculture: An introduction", ATTRA-National Sustainable, 2002.

[4] S. Dawar, S. Hayat, M. Anis and M.J. Zaki, "Effect of Seed Coating Material In The Effi cacy of Microbail Aantagonists For The Control of Root Rot Fungi On Okra And Sunfl ower", *Pak. J. Bot*, 40(3): 1269-1278, 2008.

[5] CT. Lo, "General mechanisms of action of microbial biocontrol agents", Plant Pathology Bulletin, 7:155-166, 1998.

[6] JM. Whipps, "Microbial interactions and biocontrol in the rhizosphere", *Journal of Experimental Botany*, 52: 487-511, 2001.

[7] WM. Haggag, and H. A.L. A. Muhamed, "Biotechnological Aspects of Microorganisms Used in Plant Biological Control", *American-Eurasian Journal of Sustainable Agriculture*, 1(1): 7-12, 2007.

[8] A. Westphal, and J.O. Becker, "Components of soil suppressiveness against Heterodera schachii", Soil Biology and Biotechnology. 33: 9-16, 2001.

[9] ASY. Ting, S. Meon, K. Jugah and A.R. Anuar, "Effect of artifi cially induced suppressive soil on Fusarium wilt", Info Musa, 12(1): 33-34, 2009.

[10] R. Rukmana, dan Sugandi, "Hama Tanaman dan Teknik Pengendaliannya", Kanisius, Yogyakarta, 2002.

[11] Jumar, "Entomologi Pertanian", Rineka Cipta, Jakarta, 2000.

D.23

PERFORMANCE OF GROWTH, DISEASE, AND PRODUCTION OF HOT CHILI BY APPLYING SUSTAINABLE AQUACULTURE

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ABSTRACT

Hot chili is a horticultural commodity that is excellent for farmers. During this way of cultivation at farmers' emphasis on the use of chemicals, especially in controlling the pest / disease, so it will have a negative impact on the environment and increase production costs. Therefore in this study will be carried out assessments with application of chili cultivation innovation of environmentally friendly with zero-one-methodological approach, ie a comparison between treatment technologies that are environmentally friendly innovations (A) and technology of farmers (P). It do at the same season. The results showed that the vegetative growth of the plants between treatment A and P not significant where the average height of the plants ranged from 90-100 cm, as well as canopy width ranging between 55-65 cm. However, if viewed from the production, the treatment A result of 0.80 kg / tree (+ 11.6 tons / ha) significantly different from the treatment of farmers (P) is 0.65 kg / ha (8.2 tons / ha). A treatment can increase the profit of about 33,33%.

Keywords : eco-friendly cultivation, growth, diseases, production.

I. INTRODUCTION

The main commodities of vegetable crops in Lampung Province are chili, onion, cabbage, pouch, potatoes and carrots. For fruit plants of the main fruit types in Lampung are mango, durian, orange, banana, papaya and pineapple. Commodities with the highest production achievement in 2013 were chili (34,706 ton), banana (984,298 ton) and pineapple (722,621 ton) [1]. Lampung Province is one of the locations of red chili agribusiness development outside Java island. This potential is supported by the extent of paddy fields and dry land that can be used for hot chili. Production centers of hot chili in Lampung Province are Pesawaran, East Lampung and Central Lampung.

Green chili farming activities are closely linked to the control of plant pest organisms that could potentially cause yield loss on both strategic commodities. By law, pest control in Indonesian hot chili is based on the concept of Integrated Pest Management (IPM), as stated in Law no. 12 of 1992 on Plant Cultivation System and Law no. 13 of 2010 on Horticulture. The concept of IPM is the best choice in the control of chilli and onions, because it is a combination, or synergy of various control techniques initiated by the collection of information on plant conditions and analysis of the condition before it is decided the implementation of the control. Pest control by using Biological Agents is a key component and plays an important role in supporting the achievement of sustainable agricultural development system. According to [2], natural enemies as part of agroecosystems have a decisive role in the regulation and control of pest populations. The principle of population management in one community at a certain level is interrelated. Until now in general, chilli farmers control pest only rely on chemical pesticides. It can cause environmental damage, kill useful organisms, and cause resistance and resurgence to pests. Various technological innovations hot chili cultivation and pest control / disease have been produced by Balitsa ranging from ecosystem management, balanced fertilization, maintenance to harvest [3]. Healthy chili and onion growth is more resistant to pest attack, so it is absolutely necessary to meet the requirements of plant growth, ranging from seed selection, soil processing, balanced fertilization, irrigation and other plant maintenance techniques. Simultaneous cropping and crop rotation following the local growing season, intercropping, sorjan system is an effective pest control strategy. Because it can naturally break the cycle of development of pests in the tropics such as chilli centers and onions in open-season Indonesia (biological activity occurs throughout the year) [4].

This technological innovation has largely not reached the farmers. Despite knowing it not often farmers are reluctant to apply it. Therefore, the application of environmentally friendly innovation technology at the farm level needs to prove its superiority compared to the farmers technology.

II. MATERIALS AND METHODS

A. Location And Time

Activities was been implemented in April-December 2015, in Simpang Kanan Village, Sumberejo Sub-district, Tanggamus Regency with 0.5 ha area.

B. Experimental design

The method of implementing a demonstration technology of 0.5 (half) ha is zero-one-approach, comparing the activities of eco-friendly technology innovation package (A) and farmer technology (P). It do at the same season using Kitaro varieties. Treatment was done as many as 4 replications. The main emphasis is on pest and disease control, for technology innovation control is the following manner:

Pest Control: (1) Fruit Flies by: (a) Installing 40 Metil Equinol ME) traps per ha at 15-21 Days after planting (DAP). A total of 0.9 ml ME was injected into a cotton tied with a perforated plastic trap bottle (0.5 to 1.0 cm in size) on the 4 sides, and filled with water up to 1/3 - ½ bottle contents, (b) Monitor each 3-5 days to 20 plants before using insecticide. If caught 10 flies / traps or if damage of more than 20% or more of 2-3 pieces of chilli fell per plant, then sprayed liquid and vegetable smoke insecticides according to recommended dosage, and (c) Collect and destroy infected fruit, (2) Thrips And other small insects by (a) Using 40 pieces / ha of yellow lace trap from can of rectangle (length 30 cm, width 15 cm, height 10 cm) or piece of paralon (10 cm diameter, length 15 cm) inside painted yellow and smeared with dilute wood glue or vaseline at planting time, and (b) Monitor every 3-5 days on 20 plants before use insecticide. If there are 2 thrips / leaves or damage from thrips attack more than 15% per plant, then sprayed insecticide according to recommended dosage. If damage of <15% per plant, then cut the sick and destroyed, (3) *Spodoptera* sp by (a) Destroying the egg / larvae of *Spodoptera litura*, (b) Monitoring every 5-7 days to 20 plants before use insecticide. If the leaf damage is greater than 12.50% per plant, then sprayed insecticide according to recommended dosage. (4) Aphids by (a) Using a yellow traps (40 pieces / ha) at planting time.

The yellow trap is made of rectangular cans or paralon pieces (10 cm in diameter and 15 cm long), the interior is painted in yellow, and smeared with diluted wood glue or vaseline, and (b) Perform regular monitoring (every 7 days) 20 plants before using insecticides. If dense population 3 aphids per young leaf, then spraying of insecticides according to recommended dosage.

Disease control: (1) Withered by (a) improving drainage (maintaining the height of the ridges and waterways), keeping the soil pH (adding Dolomite), preventing root placement, and spraying fungicide as recommended if each bed has been found more than 10% Withered. (2) Curling by: (a) Selecting seedlings planted in a nursery (if the seeds show curling symptoms, the seeds are not planted in the garden), (b) Pruning when the plants are 10-15 (DAP), (c) Using the trap as many as 40 pieces / ha at the time of planting, (d) Periodic monitoring (every 7 days) to 20 sample plants / beds before using insecticides. If the density of the population is 3 thrip / young leaves or damage caused by trips attack more than 15% per plant, then sprayed insecticide according to recommended dosage. If the damage is less than 15% per plant, then the affected part is cut and destroyed, and (e) Planting corn crops at around chili plants (planting a triangle system) as a barrier; (3) Anthracnose by: (a) Planting tolerant varieties, (b) Pruning the affected parts of the plant and destroying it, (c) Avoiding the growing season when harvest falls in the rainy season, (d) Setting the spacing to regulate the moisture / climate Micro, and (e) Monitoring every 7 days on 20 plants / beds. If there are more than 10% of sick plants, then sprayed fungicide as recommended; (4) Yellow Virus by: (a) Destroying the source of infection (sick plants and weeds are known from monitoring every 3 days, young plants aged up to 30 DAP are attacked immediately destroyed and embroidered with healthy plants, gardens should be clean weed), (b) Soil preparation and balanced fertilization (20 tons of pure + 100 kg Urea + 400 kg ZA +150 kg TSP + 150 kg KCl Tabur per ha, use Silver plastic mulch), (c) If young plants under 30 DAP develop viral over 10% and at the same time find adult mites fly as well as egg and larval colonies, red chilli plants are soon eradicated, (d)) and planting 3-5 rows of plants (e) Use of cow urine pesticide, liquid assumptions and vegetable pesticides, if necessary use chemical toxins with active ingredients Bifenthrin, Buprofezin, Imidacloprid, Fenpropathin, Endosulfan (Applaud), Cyfluthrin, Amitraz , Deltamethrin, Permethrin, and Asefat.

For farmers' technology, pest control (*Bemesia* spp.), *Spodoptera* sp caterpillar, fruit fly, thrips, aphids, antraknosa or Patek (local language) that usually arise during the 8th harvest, and sickness is done in a way Spraying pesticides (insecticides + fungicides) to all red chili plants in the morning (before sunrise when dew is present in the plant part). Pesticides used are: Insecticides Confidor: soil caterpillars and crickets, Insecticides Bistok: soil caterpillars and crickets, Insenticides Regent: fruit fly, Furadan Insecticide: caterpillars and aphids and Fungicides Antracol: patek disease. Spraying is done every 3-10 days. Pesticide administration schedule is: (a) First month : every 10 days, (b) Second month : every 5 days, and (c) Third month : every week. Total application of pesticides is 24-36 times/seasson. The dosage used is 2 kg of fungicide + 2 liter insecticide + 2 liter growth regulator/ ha. The use of pesticides is always changing.

III. RESULTS AND DISCUSSION

The observation result shows that there is a difference between vegetative observation component of chilli plant between the treatment of environmentally friendly innovation and farmer technology (Table 1).

Table 1. Vegetation observation, disease, and natural enemies of chilli plants on the treatment of innovation packages and technology of farmers, in Simpang Kanan Village, Sumberejo, Tanggamus.

Observation	Farmer technology	Innovation package
Plant height at harvest (cm)	90.80 a	99.04 a
Canopy width	55.75 a	65.25 a
Number of branches	8.45 a	9.08 a
Yellow viral diseases (%)	32.48 a	11.50 b
antraknose (%)	25.31 a	10.09 b
Natural enemies		
- Spider (tail)	0.16 a	1.69 b
- Coccinellidae (tail)	0.23 a	1.87 b

The number on each line followed by the same letter is not significantly different according to the t test at the 5% level.

According to data from table 1, it can be seen that vegetative growth of pepper plants (plant height, canopy width and number of branches) did not different significantly between farmer's treatment and innovation package treatment. Treatment of farmers who use chemical fertilizers with a high enough dose is not able to produce better growth compared to the use of organic fertilizers and chemical fertilizers fewer additions. This is also in accordance with research from [5], the use of organic materials in the Florida area is able to maintain the results of red chili as good as if using chemical fertilizers. It can be said that by using organic materials both fertilization and in the maintenance of hot chili plants will be able to maintain the production level of hot chili while preserving the environment.

The use of excessive chemicals both as fertilizer and pesticide affects the presence of other insects and organisms that are planted. This is seen in the existence of pests and diseases that occur in the crop of chili. From table 1, it can be seen that the percentage of yellow and anthracnose virus disease is higher in the treatment of farmers (32.48% and 25.32%) compared with the treatment of innovation (11.50% and 10.09%), suspected intensive pesticide use Stimulates faster pest breeding and higher growth of other intruder organisms. However, the use of pesticides will also reduce existing natural enemies planted, as more natural enemies are killed by intensive use of pesticides. This is shown in Table 1, where from observation, it is known that the number of dominant natural enemies (spiders and coccinellidae) caught on the treatment of farmers (the use of high pesticides) is less than 0.16 and 0.23 is significantly different than the treatment of innovation package The number of naturally occurring enemies caught is higher ie 1.69 and 1.87. Research on the use of organic materials to control pests and diseases in these plants has also been investigated by [6], who said that by using plant extracts to control pests and diseases in the cabbage can reduce the natural mortal death 10-55%.

The results of vegetative growth of chili plants and the level of pests and diseases, it can be estimated the results to be obtained on the plant. This is also seen in the observations in Table 2 below.

Table 2. Average number of fruit, fruit weight and amount of chili production on Innovation package, and farmer technology, in Simpang Kanan Village, Sumberejo, Tanggamus.

Observation	Farmer technology	Innovation package
Number of fruits / plants	170.39 a	200.89 b
The weight of fruit / plant (gr)	800.76 a	1,500.02 b
Production (ton / ha)	8.20 a	11.60 b

The number on each line followed by the same letter is not significantly different according to the t test at the 5% level.

The data above shows that the number of fruit, fruit weight and chili production in the innovation package is higher and significantly different than that of farmers, it can generally be said that with the use of innovation package can increase production by approximately 33.33%. [7] suggest that certain features of a growth are influenced by genotype while others are influenced by the environment. The high yield of a variety due to the varieties has been able to adapt to the environment. Therefore, although genetically there are varieties that have high yield potential, but the results are also influenced by environmental conditions. [8] states that a plant will flourish if needed nutrients are sufficiently available in a form suitable for absorption.

The use of organic materials more than the way farmers cause environmental conditions in the treatment of innovation systems can grow better than the way farmers who use high chemicals. Continuous use of inorganic fertilizers can lead to accumulation of chemicals in the soil causing soils to become contaminated and less favorable for plant growth [9]. According to research [10], said that organic materials can also improve soil properties, so it is also that can support the growth of red chili so that its production is much better.

When viewed in terms of farming system farming using farming packages can also increase farmers' income because the inputs used are lower than the way farmers. Read more simple analysis of red chili farming system between farmer's treatment and innovation package are as follows:

Table 3. Chili production on package treatment Innovation and technology of farmers, changes in the use of the number of production facilities and technological advantages of farmers and Innovation packages, in Simpang Kanan Village, Sumberejo, Tanggamus

Description	Farmer Technology	Innovation package	% change (+ / -)
Number of fruits /plant	170.39	200.89	+ 17.90
Yellow viral	32.48	11.50	- 64.59
Antraknosa diseases	25.31	10.09	- 60.13
Natural enemies			
- Spider (tail)	0.16	1.69	+ 965.25
- Coccinellidae (tail)	0.23	1.87	+ 713.04
Input costs (000)	35,380	34,230	- 3. 25
Labor costs (000)	9,500	11,500	+ 21.05
Rent the land (000)	1,700	1,700	-
Total cost (000)	46,580	47,430	+ 1.82
Production (kg/ha)	8,200	11,600	+ 41.46
Total income(000)	123,000	174,000	+ 41.46
Total profit (000)	76,420	126,570	+ 65.62
Increased profitability (000) with innovation technology			50.15
Average price of chili Rp. 15.000.-			

Table 3, it is known that by treatment of planting by using innovation package can decrease the main disease about> 60%, and increase the existence of natural enemies more than 700%. With fewer pests and diseases in the use of innovation packages, it is the result of the production of chili plants. From the observation shows that the number of fruits per plant increased approximately 17.90%, as well as total production of about 41.46%. Due to the incidence of insect pests and diseases, farmers apply chemical insecticides to improve yields. They use insecticides indiscriminately, thereby reducing biodiversity by causing useful animal deaths such as bees and butterflies that pollinate flowers [11], and soil organisms that improve soil structure. In addition, the use of insecticides indiscriminately poses a health risk to farmers [12]. With more eco-friendly cultivation using organic materials can reduce the use of chemical imput, it will also preserve the environment and reduce the impact of chemicals on the environment, especially natural enemies and humans. From a simple farming analysis it is seen that the use of environmentally friendly cropping systems can increase profits by more than 50% compared to farmers.

IV. CONCLUSION

The results showed that vegetative growth between plants A and P was not significantly different where the average height of plants ranged from 90-100 cm, as well as the canopy width ranging from 55-65 cm. However, when viewed from the production, in the treatment of A obtained 0.80 kg / tree (+ 11,6 tons / ha) significantly different from the farmer (P) treatment is 0.65 kg / tree (8.2 tons / ha). Treatment A can increase production by about 33.33%, and increase profits by more than 60%.

REFERENCES

[1] BPS. Lampung Dalam Angka 2014, Badan Pusat Statistik Provinsi Lampung.

[2] Untung, "Pengantar Pengelolaan Hama Terpadu", Gajah Mada University Press. Yogyakarta, 2006.

[3] W. Setiawati, BK. Udiarto, A. Muharam, "Pengenalan dan pengendalian hama-hama penting pada tanaman cabai merah", Balai Penelitian Tanaman Sayuran, Pusat Penelitian dan Pengembangan Hortikuluta, Badan Penelitian dan Pengembangan Pertanian, Lembang-Bandung, 2005, 55 hal.

[4] (http://hortikultura.pertanian.go.id/wp-content/uploads/2016. Usaha Tani Cabai dan Bawang Merah Ramah Lingkungan

[5] JC. Legaspi, C. Gardner, G. Queeley, N. Leppla J. Cuda, and C. Benjamin, "Effect of Organic and Chemical Fertilizers on Growth and Yield of Hot Pepper, and Insect Pests and Their Natural Enemies", *Jurnal Subtropica Plant Science*, 59:75-84, 2007

[6] PK. Baidoo & MB. Mochiah, "Comparing the Effectiveness of Garlic (Allium sativum L.) and Hot Pepper (Capsicum frutescens L.) in the Management of the Major Pests of Cabbage Brassica oleracea (L.)", *Jurnal Sustainable Agricultural Research,* Vol. 5, No. 2; 83-91, 2016.

[7] FP. Gardner, R. B. Pearce dan R.L. Mitchell, "Fisiologi Tana-man Budidaya", Universitas Indonesia, Jakarta. 427 hlm, 1991.
[8] S. Simamora, "Meningkatkan Kualitas Kompos", Agromedia, Jakarta, 2006.
[9] C. Reinjtjes, B. Haverkort, dan Waters-Bayer, "Pertanian Masa Depan", Kanisius, Jakarta, 1999.
[10] D. Arbiwati, "Kajian peranan beberapa macam kompos gulma air terhadap agregasi tanah inseptisol kasar dan vertisol serta pertumbuhan tanaman jagung, Tesis, Program Pasca Sarjana, 2000, UGM, Yogyakarta.
[11] MA. Angbanyere., & PK. Baidoo. 2014. The effect of pollinators and pollination on fruit set and yield of okra, Abelmoschus esculentus (L.) Moench) in the forest region of Ghana. *American Journal of Experimental Agriculture*, 4(9), 985-995. http://dx.doi.org/ 10.9734/AJEA/2014/7472
[12] BR. Critchley. 1995. Manual for the Integrated Pest Management of Diseases, Insects, Nematodes and Weeds of Garden eggs, okra onion, pepper and tomato in Brong Ahafo, Ghana. Natural Resource Institute (NRI), UK. 234-247.

E

ENERGY

E.1

ISOLATION OF CELLULASE ENZYME FROM COW RUMEN TO HYDROLYZE NYPA MIDRIB IN PRODUCING BIO-ETHANOL

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ABSTRACT

Indonesia is rich in various source of bioenergy, one of them is nypa (*Nypa fruticans* Wurmb). Nypa sap from fruit stalk contains total sugar about 13.3%, nypa midrib has also a high content of cellulose, i.e about 42.22%. Therefore, nypa can be used to produce bioethanol. Nypa midrib offers an advantages as bioethanol feedstock because it is not as food. The first stage in making bioethanol from cellulose is hydrolysis process. This can be done in two ways, namely (1) hydrolysis using acid and high temperature and (2) hydrolysis using cellulase enzyme. The second stage is fermentation process to produce bioethanol by using an alcohol-tolerant microbe. The objective of the study was to find an enzyme from cow rumen for cellulose hydrolysis of nypa midrib, while the long-term goal of the research was to produce second-generation bioethanol from cellulose of nypa midrib. Cellulase enzyme was produced in this experiment and then it was used for hydrolysing nypa midrib cellulose. The hydrolyzate was fermented by using microbes to produce bioethanol. The experiment results showed that cellulase enzyme isolated from *Bos taurus* cow rumen could optimally worked in the range of pH 5-6 and temperature 40 ^{o}C. In average, cellulase enzyme activity was 0.2644 IU/ml at 0.386 absorbance while specific enzyme activity was 7.7936 µmol/mg at 0.648 absorbance.

Keywords : nypa midrib, cellulose, bioethanol.

I. INTRODUCTION

Indonesia has abundance of nypa plants (*Nypa fruticans* Wurmb). The plants can provide raw material for producing bioethanol. Nypa palm produces a very high yield of sugar-rich sap. The stalk contains about 13.3% [1], while nypa midrib contains about 42.22% [2]. The nypa sap has been used as raw material for producing bioethanol. However, the nypa midrib has not been used for producing bioethanol as it contains lignin which causes difficulties in extracting the sugar. In comparison with the sap, the nypa midrid has an advantage in producing bioethanol because it is usually not used for food. Potency of the nypa midrib should be explored for producing bioethanol by solving the problem of lignin existance in the midrib.

Hydrolisis is an important stage in bioconversion process of biomass using catalyst into bioethanol. The process is addressed to degrade cellulose into simple sugar which includes cellobiose or glucose [3]. Hydrolysis of cellulose can be done biologically, chemically, and enzymatically. The most promising method for cellulose hydrolysis is by using cellulose enzyme. Reference [4] Sandi (2016) reported that implementation of 7% sulfuric acid (H_2SO_4) in hydrolisis of sea weed reduces sugar content of about 45.01%. Reference [5] found that 1.2% reducing sugar can be produced from nypa midrib by using 2M H_2SO_4 during 4 hours hydrolisis process. Reference [6] mentions that enzymatic hydrolisis using cellulase enzyme gives higher yield and more environment friendly compare to the use of acid catalist. The catalytic action of an enzyme, its activity, is measured by determining the increase in the reaction rate under precisely defined conditions [7]. Cellulose enzyme can break β-1,4-D-glicoside bound to produce oligosacharide and glucose [8]. Cellulose can be used as raw material in fermentation to produce ethanol because the cellulose contains more than 10.000 unit of glucose. The glucose can be converted into simple sugar. By fermentation process using bacteria or fungi, ethanol can be produced from the simple sugar.

Cow rumen could be a potential source of cellulase enzyme. The enzyme is easier to be isolated from the cow rumen than that of bacteria or fungi. However, characteristic of the enzyme in degrading cellulose into glucose has not yet widely investigated. Therefore, this research was conducted to know the enzym activity in various temperarture and pH condition, and to know its soluble protein content.

II. MATERIALS AND METHODS

A. Material and tools

Material used in the experiment includes cow rumen liquid, ammonium sulfate, phosphate buffer pH 7.0, citric acid, Disodium phosphate dihydrate, Natrium dihydrogen phosphate, Boric acid, Sodium tetraborate decahydrate, Trisodium citrate, Dinitrosalicylic acid (DNS), paper filter *Whatman* no. 01, NaOH, Sodium potassium tartrate phenol, Sodium metabisulfite, glucose, coomassie blue G-250, ethanol, H_3PO_4, Bovine Serum Albumin (BSA), and aquadest. To conduct experiment the following tools are used: *sentrifuge*, *magnetic stirer, water bath*, spectrophotometer, cool storage, analytic balance, and glass-wares.

Observed variables comprised activity and characteristic of enzyme. The enzyme characteristic were observed in various temperature and pH.

B. Measurement method

1. Preparation of enzyme from liquid rumen

Rumen sample was gained from 3-5 imported cows slaugthered in RPH (slaughterhouse) Sokaraja, Banyumas. Liquid from rumen was taken by filtration in low temperature. The liquid was sentrifuged (10.000 rpm in 10 minutes at 4°C temperature) to separate supernatan from cells and microbe cell content [9]. The supernatan was than used as rough enzyme source.

2. Determination of ammonium sulphate percentage

Ammonium sulphate in some concentration level (40%, 50%, 60%, and 70%) was added into the supernatan and the mixture was stirred by using magnetic stirer in about 1 hour. Afterwards, the mixture was stored at 4°C storage for 12 hours.

3. Isolation of enzyme

After gaining optimum ammonium sulphate precentage, the rough enzyme was re-sentrifuged (10.000 rpm in 15 minutes at 4 °C). Enzym sediment was then taken and dilluted in phosphate buffer pH 7.0 with ratio 10:1 (sediment from 100 ml supernatan dilluted in 10 ml buffer fosfat pH 7.0) without purification. The dilluted enzyme was then stored in cool storage for further measurements (activity and characteristic of enzyme).

4. Enzyme activity test

FP-ase method and complete cellulose activity test were used in the enzyme activity test. Analysis of the cellulose activity was conducted by using filter paper Whatman no. 1 ukuran 1 x 6 cm (50 mg). Determination of the enzyme activity value was done as follows: 0.5 ml sample and 1 ml buffer pH were filtered and then the mixture were incubated at 48°C for 1 hour. Afterwards, 3 ml DNS reagent was added to the mixture and it was then heated on Boiling water bath for 5 minutes. Reducing sugar was measured using spectrophotometer at 515 nm wavelength. One unit of enzyme activity was defined as quantity of enzym to produce 1 mg of glucose per minute [10]. Value of enzyme activity influences production of gula pereduksi during the activity. Cellulase activity can be define by the following formula:

$$\text{FP-ase enzyme unit (IU/mL)} = (\text{mg glucose x } 0.0925)/\text{mL} \quad (1)$$

The following steps were follow to produce glucose standard curve: Basic standard glucose 1 mg / ml was diluted to make a series of glucose standard with concentration of 0.02 – 0.5 mg/mL. Each 0.5 mL of standard was poured into reaction tube and then 3 mL DNS was added. Afterwards, it was heated on boiling water bath for 5 minutes and then it was cooled. Standard of absorbance was measured using spectrophotometer at 515 nm wavelengths. Results of the measurement was then used to produce the glucose standard curve.

1. Optimum pH

Determination of optimum pH was conducted by adding buffer at various pH (in a range 5-9) to the rough enzyme, and then the mixture was incubated at 37°C for 10 minutes. Cellulase activity test was done by using 3.5-dinitrosalicylic acid (DNS) acid method and it was based on quantity of reducing sugar as the result of cellulase hydrolisis [11].

2. Optimum Temperature

To find optimum temperature for enzyme activity, the enzyme was incubated at optimum pH and temperatures of 30, 40, 50, and 60°C in 0.05 M buffer fosfat for 10 minutes.

3. Soluble protein content test

Measurement of protein content of cellulase enzyme used Bradford method [10]. For this purpose, 0.1 ml of rough enzyme extract sample was mixed with 5 ml of Bradfort reagent. Absorbance of the mixture was measured by spectrophotometer at 595 nm wavelength. Standard curve was made by using bovine serum albumin (BSA) at a range of 25 - 200 mg/ml. Spesific activity of cellulase can be calculate using the following formula:

$$\text{Specific activity} = \text{enzyme activity}/\text{protein concentration} \quad (2)$$

Experimental results was analysed using descriptive and quantitative method.

III. RESULTS AND DISCUSSION

Cow rumen is rich of amino acid, vitamin, and mineral [12]. Rumen liquid contains various microbes such as bacteria, protozoa, and fungi; the rumen liquid produces enzyme for degrading plant fiber. According to [12], microbes in cow rumen have better capability in degrading organic material and cellulose in comparison to buffalo rumen microbes. Cow rumen liquid is potential to be used as inoculant since it is rich of *fermentable nutrient*, microbes, and fiber degrading enzyme [13].

Among ammonium sulphate treatment applied in the experiment, ammonium sulphate of 70% concentration resulted the highest yield of supernatan. In this research, the supernatan was used in cellulase enzyme activity test. Before subjected to temperature and pH treatments, activity of amylase enzym can be seen in Table 1. We found that greater absorbance value indicates higher activity of the enzyme.

Tabel 1. Activity of cellulase enzyme before treatments.

Repetition-1		Repetition-2		Repetition-3	
Absorbance	Enzyme Activity (IU/ml)	Absorbance	Enzyme Activity (IU/ml)	Absorbance	Enzyme Activity (IU/ml)
0.374	0.2521	0.382	0.2576	0.403	**0.2720**

Enzyme activity is highly influenced by several factors such as temperature, pH, substrate concentration, and inhibitors. In this research, temperature treatments were applied to find the highest activity of amilase enzyme. Results of the experiment indicated that the highest enzyme activity was found at 40^{o}C. It can be seen in Table 2 that the average of enzyme activity is 0.2623 (IU/ml).

Reference [14] reported that optimum temperature for cellulose enzyme is 39 ^{o}C whereas enzyme activity is 306.35 μmol/ml and specific enzyme activity is 10.87 μmol/mg. The optimum temperature of 39 ^{o}C was also reported for cellulase of cow rumen and liquid cow rumen [16]; [15] found the optimum temperature of cellulase enzyme from cow rumen was 39 ^{o}C. Higher temperature will cause reaction rate to decraese as the enzyme will be denaturated at high temperature [17].

Considering influence of pH to enzyme activity, Reference [18] mentioned that most enzyme activity works at maximum rate at neutral pH. In this research was found that optimum pH was below neutral pH. It can be seen in Table 3 that the high enzyme activity was observed at pH 5 (repetition 2) and pH 6 (repetition 3). This results agrees with finding by [16] where in fiber hydrohidrolisis by cellulase enzyme occurs at pH 4.5 to pH 6.5 and at higher pH will decrease to 40%. Reference [14] also reported similar results where optimum pH for cellulase enzyme was 5.4. At this pH, the enzyme activity was 311.64 μmol/ml and specific enzyme activity was 11.06 μmol/mg. The enzyme activity will decrease at higher pH.

At optimum activity of cellulase enzyme, production of glucose will be maximum. It was found in this research that optimum specific activity of cellulase enzyme was 7.7936 μmol/mg. It is lower than the result reported by [14] where the specific activity of enzyme was 11.06 μmol/mg.

Enzymatic hydrolysis is a deconstruction process of complex polymer into its monomer components by using enzyme. The enzymatic hydrolysis has several advantages in comparison to acid hydrolysis, such as no degradation of sugar resulted in the hydrolysis, softer process condition (low temperature and neutral pH), potential to get higher yield, and lower maintenance cost as no corosive material involved [19]. Application of enzymatic hydrolysis by using cow rumen enzyme is believed to give higher sugar yield than that of acid hydrolysis.

Table 2. Activity of cellulase enzyme at various temperature condition

Temperature (^{o}C)	Repetition-1		Repetition-2		Repetition-3	
	Absorbance	Enzyme Activity (IU/ml)	Absorbance	Enzyme Activity (IU/ml)	Absorbance	Enzyme Activity (IU/ml)
30	0.318	0.2111	0.272	0.1823	0.354	0.2384
40	0.392	**0.2644**	0.273	0.1830	0.386	0.2603
50	0.314	0.2110	0.269	0.1802	0.384	0.2589
60	0.310	0.2083	0.275	0.1843	0.313	0.2103

Table 3. Activity of cellulase enzyme at various pH condition

pH	Repetition-1		Repetition-2		Repetition-3	
	Absorbance	Enzyme Activity (IU/ml)	Absorbance	Enzyme Activity (IU/ml)	Absorbance	Enzyme Activity (IU/ml)
5	0.405	0.2733	**0.542**	**0.3671**	0.391	0.2637
6	0.370	0.2494	0.440	0.2973	0.459	0.3103
7	0.339	0.2282	0.448	0.3028	0.403	0.2720
8	0.328	0.2210	0.467	0.3158	0.394	0.2658
9	0.291	0.1953	0.416	0.2809	0.370	0.2494

Table 4. Specific activity of cellulase enzyme.

I		II		III	
Absorbance	Specific Enzyme Activity (μmol/mg)	Absorbance	Specific Enzyme Activity (μmol/mg)	Absorbance	Specific Enzyme Activity (μmol/mg)
0.651	4.3919	0.811	0.1956	0.648	**7.7936**

IV. CONCLUSION

1. Average cellulase enzyme activity at no temperature and pH treatments was 0.2260 IU/ml at 0.403 absorbance
2. Optimum temperature for the activity amilase enzyme was 40°C where the level of activity was 0.2644 IU/ml at 0.386 absorbance.
3. Optimum pH for the activity cellulase enzyme was pH 5 where the level of activity was 0.3671 IU/ml at 0.542 absorbance.
4. Specific activity of cow rumen cellulase enzyme was 7.7936 μmol/mg at 0.648 absorbance.

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REFERENCES

[1] W. Trisasiwi, A. Asnani and R. Setyawati, "Optimization of bacterial dose and incubation time on ethanol fermentation of nipa for biofuel energy", 3rd International Conference on Mathematics and Natural Sciences ICMNS, Bandung, pp 403-418, 23-25 November 2010. (Conference Paper)

[2] A.E. Akpakpan, U.D. Akpabio, B.O. Ogunsile and U.M. Eduok, "Influence of cooking variables on the soda and soda-ethanol pulping of *Nypa fruticans* petioles". Australian Journal of Basic and Applied Sciences, 5(12):1202-1208, 2011.

[3] C. A. V. Askarieh, F.B.D. Daniel, G.P.L. Fitz, G.J. Holto, N.J. Pilkington and J.H. Rees. 2000. The chemical and microbial degradation of cellulose in the near field of a repository for radioactive wastes. *Waste Management*. Vol 20: 93-106, 2000.

[4] Y.A. Sandi, W.S. Rita, and Y. Ciawi, Seaweed (*Gracilaria* sp.) Hydrolysis Using Enzyme and Acid Catalysts for Making Bioethanol. Journal of Chemistry, Udayana University, vol. 10: 7-14, 2016.

[5] W. Trisasiwi, G. Wijonarko, A. Margiwiyatno and K.P. Aji, The influence of sulfuric acid's concentration and hydrolysis time period to reducing sugar on bioethanol production from nipa palm fronds, National Seminar on Agricultural Engineering to Support Food Self-Reliance Based on Local Wisdom, Padang, 4-5 November, 2016. (Conference Paper)

[6] M. Galbe and G. Zacchi. Pretreatment of Lignocellulosic Meterials for Efficient Bioethanol Production. Adv Biochem Engin/Biotechnol. *vol* 108: 41-65, 2007.

[7] J. Koolman and K-H. Roehm, Color Atlas of Biochemistry. 2nd Ed. Thieme, Stuttgart, New York, 2005.

[8] Y.H.P. Zhang, M.E. Himmel and J.R. Mielenz, Outlook for cellulase improvement: screening and selection strategies. *Biotech Adv* 24:452-481, 2006.

[9] A. Budiansyah, K.G. Resmi, M.T. Wiryawan, Y. Soehartono, Widyastuti dan N. Ramli, Isolation and Characterization of Carbohydrase Enzyme from Rumen Cow Liquid from Animal Cutting House. *Media Peternakan,* April 2010. Vol. 33 No. 1. Pp: 36-43.

[10] T. Irawadi, *Cellulase*, Inter-University Center of Biotechnology, Bogor Agricultural University, Bogor, 1990.

[11] D.S. Wardhani, Evaluation of Activity Stability Cellulase Enzyme from Sheep's Rumen Fluid, *Thesis*, Bogor Agricultural University, Bogor 2012.

[12] S. Puppo, S. Bartocci, S. Terramoccia and F. Grandon. 2002. Rumen microbial counts and in vivo digestibility in buffaloes and cattle given different diets. *Animal Sci*. 75, Issue 2, October 2002 pp: 323-329.

[13] I.M. Mudita, I.G.L.O. Cakra, A.A.P.P. Wibawa and N.W. Siti, The Use of Rumen Liquid as Alternative Bioinoculant Plus Material and Its Utilization in Optimalization of Development of Waste Based Environment Based Ranch. The Udayana Research Report of the Leading Grant, Udayana University, Denpasar. 2009.

[14] H. Setyoko and B. Utami, Isolation and Characterization of the Cellulase Enzyme Rumen Cattle Fluid for Biomass Hydrolysis. *Proceeding Biology Education Conference* (ISSN: 2528-5742). Vol 13(1) 2016, pp: 863-867.
[15] Y.J. Lee, B.K. Kim, B.H. Lee, K.I. Jo, N.K. Lee, CH. Chung, Y.C. Lee and J.W. Lee. Purification and Characterization of Cellulose Produced by *Bacillus amyloliquefaciens* DL-3 Utilizing Rice Hull. *Biores*. *Technol*. 99, pp: 378-386. 2008.
[16] D.P. Morgavi,, K.A. Bauchemin, V.L. Nsereko, L.M. Rode, A.D. Iwaasa, W.Z. Yang, T.A. McAlister and Y. Wang. Synergy between Ruminal Fibrolytic Enzymes and Enzymes from *Trichoderma longibrachiatum. J. Dairy* Sci. 83, pp: 1310-1321. 2000.
[17] E. Fitriani, Activity of Enzyme Carboxymethyl Cellulase *Bacillus pumilus* Strain 55 at Various Incubation Temperature. *Thesis*. Bogor Agricultural Institute, Bogor. 2003.
[18] B.D. Hames and N.M. Hooper. *Biochemistry: The Instant Notes. 2nd edition*. Springer-Verlag, Berlin. 2000.
[19] M.J. Taherzadeh and K, Karimi. *Acid-based hydrolysis processes for ethanol from lignocellulosic materials: a review, Bioresources* 2(3), pp: 472-499. 2007.

E.2

ENERGY EFFICIENCY ESTIMATION IN RICE STORAGING WITH VARIATIONS' TECHNOLOGY AND GETTING THE BEST QUALITY RICE IN PLASTIC SACKS

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ABSTRACT

The storaging energy refers to this study is the storage of rice that has been packed with plastic sacks 5 kgs, 10 kgs, 25 kgs and 50 kgs to the storaging area which has a good air circulation, so that rice that has been packaged not easily in a maximum period of 2 months.

Average energy storaging of Small Capacity of Rice Milling Factory (SCRMF) is 10,45 kJ/day with average load capacity is 1,721,05 kg/day which consists of human energy (handling) is 10,45 kJ/day with average load capacity 1,721,05 kg/day, and not found Eeergy storaging engine. Average energy storaging of Medium Capacity of Rice Milling Factory (MCRMF) is 10,45 kJ/day with average load capacity is 3,099,16 kg/day which consist of human energy is handling about 10,45 kJ/day with average load capacity is 3,099,16 kg/day, and not found energy storaging machine. Average energy storaging of Large Capacity of Rice Milling Factory (LCRMF) is 29,78 kJ/day with load capacity is 4,585,78 kg/day which consist of human energy as handling is 10,45 kJ/day with load capacity is 4,585,78 kg/day, storaging machine is 19.33 kJ/day with load capacity is 1,959,09 kg/day, average of diesel fuel is 1,47 liter/hour.

Conclusion from comparison is average of storaging energy SCRMF about 10,45 kJ/day equal to average of storaging energy of MCRMF, average of storaging energy SCRMF and MCRMF less than average of storaging energy LCRMF is 29,78 kJ/day.

Keywords: Energy Storaging, Energy Eficienccy, SCRMF, MCRMF, LCRMF.

I. INTRODUCTION

A. Background and Problems

Aspects of post-harvest handling to the storage process need to be taken seriously in an effort to increase production, because the climatic conditions especially during the rainy season will greatly affect the yield of grain drying, whether it concerns the yield and grain quality. The development of grain drying technology will inevitably have to be done, to increase the optimal quality of grain production. Farmers in Indonesia, in drying the grain still rely on sunlight.

Storage energy still uses human energy in the storage process to the warehouse. Human energy of Rice Capacity of Rice Milling Factory (SCRMF) is still valued with cheap services (main) and human energy of Medium Capacity of Rice Milling Factory (MCRMF) and Large Capacity of Rice Milling Factory is handling (LCRMF) as complementary. Rice Milling Factory (RMF) operationalization has not utilized energy optimization in accordance with standard engine specifications. Inefficient energy risks always occur, and this needs to be addressed in the future.

RMF in 2010 has reached 108,512 units with a cumulative capacity of 109.5 million tons per year (Patiwiri, 2006). National rice production is only 60.3 million tons, equivalent to 39.2 million tons of rice with conversion factor from rice to 65% rice. This has caused many rice milling units to work under the installed capacity. This symptom has actually occurred since 2003, it is estimated that only 40% of rice mills are operating at full capacity (Thahir, 2010).

B. Research Objectives

1. To obtain comparative energy storage data on SCRMF, MCRMF and LCRMF related to storage technology and to obtain quality rice with plastic storage.
2. To analyze the energy efficiency of SCRMF, MCRMF and LCRMF which is related to packing and storage technology and to get rice quality with plastic storage.
3. To know the efficient type of storage energy so it can be considered in the storage of rice and rice technology storage of good quality in plastic storage at RMF in the future.

C. Framework

Saving of diesel usage by utilizing husk (rice seed coat) as energy source of Diesel Power Factory (DPF). Six kilograms of husk can be converted into energy equivalent to one liter of diesel. The use of husk also reduces air pollution. Renewable energy which is an energy that will not run out and more environmentally friendly as biomass energy becomes very important to be developed for energy crises and environmental damage due to pollution can be avoided. DPF 100 kilowatts if operated using pure diesel then per kilowatt hour requires 0.30 liters of diesel fuel. If operated using rice husk, the DFD requires only 0.06 liters of diesel per kilowatt. Solar is still needed but can be saved up to 80 percent.

The use of diesel husk is very suitable to be applied in Indonesia, especially rice mill. Because, rice mills always produce chaff that had been thrown away. Rice mills also have to pay to clear the chaff. Gasification units are made, so the husk can be used as an energy source because the price of a gasification unit of Rp 425 million (LIPI, 2010).

Based on the number of machines and the daily capability of grinding rice, the rice milling unit is classified into LCRMF is larger than 2.00 ton / h, MCRMF is 1.00 - 1.99 ton, SCRMF 0.60 - 0.99 ton / hour, and RMF is smaller 0.60 ton / hour milled rice. In this era was introduced to storage of byproducts, ranging from utilization of composite flour, rice bran, and husk (Thahir, 2010).

D. Hypothesis

Energy storage at LCRMF is more efficient compared to operational energy in SCRMF and MCRMF.

II. LITERATURE

A. Storage

Before consumption or sale, rice is stored for a certain period of time. Storage with good technique can extend the shelf life and prevent damage to rice. Rice storage generally uses packaging, which serves as a container, protects rice from contamination, and facilitates transportation. Storage in packaging made of polypropylene and high density polyethylene extends the shelf life of rice and is better than sacks and plastic bags. Storage of rice using the base of the board which is about 20 cm from the floor (Setyono, 2010).

B. Energy of Rice Mill

Energy is defined as the ability to do business or work. In conducting its activities, the living things in the world need energy. Until now, the existence of energy is being questioned because energy is a commodity not found substitution and can not be recycled. Agriculture is a series of activities aimed at changing the forms of energy that can not be eaten into forms of biomass such as carbohydrates, proteins, livestock and so forth.

With the addition of a separator in the Horse Power or HP configuration there is an increase in yield of 0.9% and the addition of paddy cleaner and machine tools (pads cleaner) and separator in the HP configuration there is an increase yield of 1.9%. This increase is certainly larger, when compared with the average yield produced on other small rice mills 61%. A simple configuration commonly owned by KDP, which accounts for more than 6% of the whole Indonesian rice milling industry, is refined from Husker-Polisher to Cleaner-Husker-Polisher or Cleaner-Husker-Separator-Polisher, with an increase in rice yield of 0.9 % - 1.9% quantitatively can be secured around 450,000 - 950,000 tons of rice. This analysis is based on a 2010 study that 65% of KDP grind 70% of the total national milled capacity (Budiharti, et al., 2010).

C. Fuel

Fuel is a chemical compound that can generate energy through chemical changes. Fuel becomes a source of energy processing machine, both in cultivation and harvest. Fifty-year-olds have 80% energy capacity from 25 years of age, while 60-year-olds have an energy capacity of 60% from 25 years of age. Classification of workload on human labor 20 - 50 years old to perform activities on some workload conditions. Each stage of the process deals load capacity is 4,585,78 kg/day, storage machine is 19.33 kJ/day with load capacity 1,959.09 kg/day, the average of 1.47 liter/hour diesel fuel.

III. RESULTS AND DISCUSSION

A. Storage Energy of Rice Milling Mill

The storage energy referred to in this study is the storage of rice that has been packed with plastic sacks 5kgs, 10 kgs, 25 kgs and 50 kgs to the storage area which has a board with good air circulation, so that rice that has been packaged not easily decay in a maximum period of 2 months.

B. SCRMF

Average energy storage of SCRMF is 10,45 kJ / kg with average load capacity 1,721,05 kg/day which consist of: human energy (handling) 10,45 kJ/day with average load capacity 1,721,05 kg/day, and not found energy storage engine.

C. *MCRMF*

Average energy storage of MCRMF is 10,45 kJ / kg with average load capacity 3,099,16 kg/day which consist of: human energy is handling 10,45 kJ/day with average load capacity 3,099,16 kg/day, and no energy storage machine can be found.

D. LCRMF

Average energy storage of LCRMF is 29,78 kJ/ kg with load capacity 4,585,78 kg/day which consist of: mean of human energy as handling 10,45 kJ/kg.

Conclusion of comparison: average of storage energy SCRMF 10,45 kJ/day equal to average of storage energy of MCRMF, average of storage energy SCRMF and MCRMF smaller than average energy storage LCRMF 29,78 kJ/day.

The conclusion of the comparison of operational energy in RMF can be seen, where the average operational energy of SCRMF (224.69 kJ/day) is smaller than MCRMF (249.24 kJ/day), and less than LCRMF (287.17 kJ/day).

E. Energy Efficiency of RMF

Energy efficiency referred to in this research is the less energy spent/used, it means will be more efficient in operation of RMF.

F. Average Load Capacity

The average capacity of SCRMF load (4,539.33 kg/day), MCRMF (3,513.09 kg/day), and LCRMF (5,811.34 kg/day).

The hypothesis is rejected, that based on the calculation of SCRMF is more efficient even the percentage of operating expenses reached 127.99%.

IV. CONCLUSION

A. Conclusion

The average storage energy of SCRMF is 10.45 kJ/day is the same as the average storage energy of MCRMF 10.45 kJ/day. The average energy storage of SCRMF and MCRMF is smaller than the average storage energy of LCRMF is 29.78 kJ/day.

The average energy efficiency of SCRMF is 224.69 kJ/day is smaller than the average of MCRMF is energy efficiency of 249.24 kJ/day. The average energy efficiency of MCRMF is 249,24 kJ/day is lower than the average energy efficiency of LCRMF is 287,17 kJ/day.

B. Suggestion

The comparison of average storage energy in SCRMF, MCRMF and LCRMF obtained from this research should be taken into consideration in the operationalization of RMF in the future. Because of concern is the average energy storage just as a complement.

SCRMF uses the smallest energy compared to MCRMF with its operational expense of 86.96% and LCRMF with its operational cost only 37.40%. MCRMF and LCRMF have not used energy optimally or not full capacity.

REFERENCES

Abdullah, K. 2010. Energy and Electricity of Agriculture. JICA-DGHE / IPB Project /ADAET. IPB. Bogor.

Adang K. 2010. Workload Analysis of ICHI Polisher Machine Operator On Rice Milling Process Based on Recommended Weight Limit (RWL) As Efforts to Increase Productivity and Safety, Oration Scientific, Department of Engineering and Industrial Management, Faculty of Engineering, University of Pasundan Bandung.

Chamsing, A., V.M. Salokhe, and G. Singh. 2010. Energy Comsumption Analysis For Selected Crops in Different Regions of Thailand. Agricultural Engineering International: CIGR Ejournal, Volume VIII page 120.

Cervinka, V. 2010. Fuel and Energy Efficiency in Handbooks of Energy Utilization in Agricultural. Pimentel, D. CRC. Press, Inc. Boca Raton. Florida. USA.

Fluck, R.C. 2010. Energy in Florida Agriculture, downloadable matter, Http://edis.ifas.ufl.edu/EH/EH 17900.pdf. Retrieved on May 24th 2012.

Indonesian Institute of Sciences (LIPI), 2010. Replacing Solar, Sekam can be changed to PLTD Source, http://www.energi.lipi.go.id. Media Indonesia (September 1, 2003). Retrieved on May 20, 2012.

Indriyani, Tamrin, Rangga Azhari, 2012. Tesis. Analisis Energi Operasional pada Pabrik Penggilingan Padi (Kapasitas Kecil, Menengah dan Besar), Magister Teknologi Industri Pertanian, Fakultas Pertanian Universitas Lampung.

Setyono A. 2010. Repair of Postharvest Technology In Pressing Efforts Loss of Rice Results. Journal of Agricultural Innovation Development Center Large Rice Research. Subang.

Singh, H., D. Mishra, and N.M. Nahar. 2002. Energy Use Pattern in Production Agriculture of Typical Village in Arid Zone India - Part I. Energy. Convers. Manag.

Thahir R. 2010. Revitalization of Rice Milling Through Innovation of Slaughtering, Supporting Rice Self-Sufficiency and Facing Global Competition, Agricultural Research and Development Agency, Professorship Oration Professor of Research Technology Field Processing Technology (Technology Postharvest) Department of Agriculture. IPB. Bogor.

E.3

KINETICS OF BIODIESEL PRODUCTION FROM WASTE COOKING OIL THROUGH MICROWAVE-ASSISTED TRANSESTRIFICATION REACTION

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ABSTRACT

Kinetics parameter is required to determine the production of biodiesel in certain circumstances. This study aims at determining the kinetics parameters of biodiesel production through transesterification assisted by microwaves. This research was conducted using used cooking oil derived from street vendors of fried around the University of Lampung. The chemicals used are methanol (technical) and NaOH (pa). The study was conducted with a molar ratio of 1: 4 and with a combination of three levels of temperature (45°C, 50°C and 55°C) and a five-level of reaction time (2 minutes, 3 minutes, 4 minutes, and 5 minutes). Results showed that the highest biodiesel yield amounted to 66.8% at the time of 6 minutes and a temperature of 55°C. The result of the calculation produces the value of the reaction rate constant (k), which increases with temperature, ie. 0.0609 per minute at a temperature of 45°C, 0.047 per minute at 50°C, and 0.0291 per minute at 55°C. The calculation resulted that the value of activation energy (E_a) of 63.94 kJ/mol with a value for the collision frequency constant (A) was 8.38(10^9) per second.

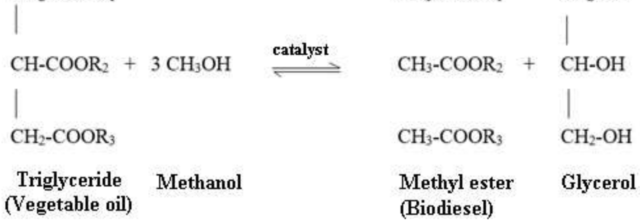
Keywords : biodiesel, microwaves, waste cooking oil, yield, reaction rate, activation energy.

I. INTRODUCTION

Fulfillment of energy derived from petroleum has received a very serious attention. Not only because of the greenhouse effect resulting from CO2 emissions it produces, but also because of the world's petroleum reserves are getting limited. The depletion of petroleum reserves is marked by the surge of crude oil prices in the world market [1]. This situation has caused researchers and the government think hard in preventing energy scarcity. One effort to reduce the need for transportation fuels is to create alternative fuels, such as biodiesel and bioethanol and look for other sources of renewable energy. Biodiesel is one type of fuel produced from vegetable oil or animal fat through a process called transesterification with the help of alcohol and catalyst [2].

Indonesia is one of the tropical countries that has various types of biodiesel raw materials, including palm oil, waste frying oil, rubber seed oil, jatropha curcas, and so on. Biodiesel production potential from palm oil reached 438,876 thousand barrels, cooking oil 45,515 thousand barrels, and rubber seed oil 3,989.7 thousand barrels. Using biodiesel for supplement Indonesia will be able to overcome the energy crisis until the year 2101 [3.

Biodiesel is generally made through a transesterification reaction using an alkaline catalyst. This reaction is faster to form methyl esters (biodiesel) than the esterification reaction using acid catalyst [1, 4]. In addition to biodiesel, the reaction will also produce a by-product of glycerine [5]. This by-product can be utilized for other purposes, such as cosmetic ingredients, soap and others [6]. According to Hikmah and Zuliyan [7] the transesterification reaction of triglycerides to methyl esters can be presented as follows:



Temperature is an important parameter in the reaction. However, heat transfer in the conventional transesterification reaction is slow due to convection and conduction. The microwave applications can accelerate the heat transfer process because microwaves can propagate through the liquid so that the heating process will take place more effectively and the biodiesel process can be done in a shorter time [8]. The use of microwaves in biodiesel production can convert waste frying oil into biodiesel faster, when compared to conventional methods [9].

The reaction kinetic analyses the rate of chemical reaction. Reaction rate is the change of reactant or product concentration over a unit of time. Kinetics of transesterification reactions are required to predict the reaction results at a given time and condition. The purpose of this study is to determine the effect of temperature and reaction time in biodiesel production and to determine kinetic parameters for transesterification of used cooking oil assisted by microwaves.

II. MATERIALS AND METHODS

A. Materials and Equipment

Materials used in this experiment include waste frying oil (WFO), methanol (technical grade), NaOH (p.a), and aquades. Waste oil is obtained from fried stuffs traders around the University of Lampung. The WFO is filtered using a tea strainer to separate solid particles. Characteristic of WFO and biodiesel to determine the acid number, free fatty acid content, and fatty acid composition is conducted in the Lab. of Agricultural Product Processing, Faculty of Agriculture, University of Lampung. The tools used in this research are microwave oven, spatula, burette, analytical balance, pycnometer glass for mass type analysis, condenser, small mixer with 300 rpm for stirring, Erlenmeyer, beaker glass, thermometer, rubber bulb, spatula, falling ball viscometer to measure the viscosity of the resulted biodiesel.

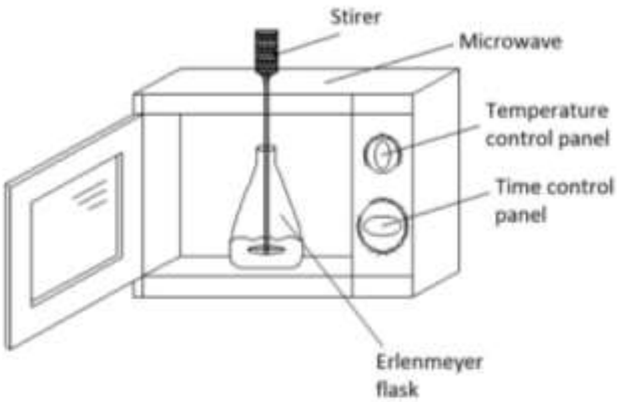


Fig. 1 Biodiesel processing with the aid of microwave.

B. Experimental Design

The treatments in this research are temperature variation and duration of heating. Each consists of three levels for temperature (45, 50, and 55°C) and five for duration (2, 3, 4, and 5 min). The process of biodiesel synthesis with the help of microwave is shown in Fig. 1. The transesterification reaction uses a molar ratio between WFO and methanol of 1: 4. The process of biodiesel production begins with the preparation of a methoxide solution by mixing 0.5 g NaOH into 18 ml of methanol and stir it until all NaOH particles dissolve. This solution is then poured into a 500 ml Erlenmeyer flask that has been filled with 100 ml of cooking oil. The flask is then fed into the microwave in the very middle position. The microwave is turned on for a pre-setting time and the power intensity is adjusted to achieve the desired reaction temperature. At the same time the mini mixer is turned on to stir the WFO.

The reaction result is allowed for 24 hours to rest. Biodiesel is separated from glycerol and washed several times until it is clean (marked by clean wastewater). The yield of biodiesel is calculated using the following equation:

$$\text{Yield} = \frac{\text{Mass of biodisel after washing (g)}}{\text{Mass of WFO (g)}} \times 100\% \tag{1}$$

C. Analysis

Kinetics of transesterification reaction refer to Kusdiana and Saka [10]. In this case, transesterification is considered to be a first order reaction and is a function of non-biodiesel concentration (uME) and reaction temperature. The uME components include triglycerides, diglycerides, mono-glycerides, and unreacted free fatty acids (FFA). The reaction rate is expressed as:

$$\text{Rate} = -\frac{d[uME]}{dt} \tag{2}$$

$$-\frac{d[uME]}{dt} = k\,[uME] \tag{3}$$

At a time t = 0 uME concentration is [uME_0] and at t = t is [uME_t], where [uME_o] > [uME_t]. Integration of Eq. (2) from uME_0 to uME_t and t = 0 to t = t produces:

$$-\int_{uME_0}^{uME_t} \frac{d[uME]}{[uME]} = k\int_0^t dt \tag{4}$$

$$-\ln\left(\frac{[uME_t]}{[uME_0]}\right) = kt \tag{5}$$

Assuming that before a reaction occurs, biodiesel component in the WFO can be neglected, it follows that:

$$\frac{[uME_t]}{[uME_0]} = 1 - \text{Yield} \tag{6}$$

The plot of Eq. (5) with t as abscissa and the negative value of natural logarithm of [uME_o]/[uME_t] as an ordinate can be used to determine the value of the reaction rate constant k at a certain temperature. Values of this constant at different temperatures are then used to determine the value of the global activation energy (E_a) of the transesterification reaction using the Arrhenius equation:

$$k = A\exp(-E_a/RT) \tag{7}$$

or

$$\ln(k) = \ln(A) - (E_a/\mathrm{R})\left(\frac{1}{T}\right) \tag{8}$$

where A is constant for molecular collision frequency, R is ideal gas constant (8.314472 J/mol.K), and T is the absolute temperature.

III. RESULTS AND DISCUSSION

A. WFO Characteristics

Table 1 shows the characteristics of used cooking oil used in this study. It is seen that the cooking oil is quite viscous with high viscosity (61.75 cSt). But the cooking oil has free fatty acid content or FFA (free fatty acids) is quite low (1.43%), so the process of making biodiesel can be performed through direct transesterification reaction.

Table 1. Font sizes for papers characteristics of used cooking oil used in this study

Parameter	Value
Density (g/ml)	0.912
Viskosity (cSt) 30°C	61.75
FFA (%)	1.43
Acid number	0.7199
Fatty acids:	
Methyl Laurate	0.75
Methyl Myristate	1.58
Methyl Palmitate	42.84
Methyl Linoleat	12.43
Methyl Oleat	35.71
Methyl Stearat	5.15
Unknown	1.54

B. Biodiesel Yield

Table 2 shows the yield of biodiesel resulting from a combination of treating the temperature and duration of the reaction. The resulting biodiesel has a density of between 0.86 - 0.87 g/ml (according to SNI), and viscosity 3,79 - 5,53 cSt (according to SNI). The results showed that the higher the temperature of the higher the biodiesel yield produced. Likewise, the longer the reaction time the higher the yield of biodiesel. The highest yield was produced at 55°C and 6 minutes (66.77%). This non-optimum yield is due to several factors, such as the quality of methanol and NaOH, and the molar ratio used.

Table 2. The yield of biodiesel

T (°C)	Time (Min)	Yield (%)	$-\ln\frac{[uME_t]}{[uME_0]} = -\ln(1-\text{Yield})$
	2	33.44	0.41
45	3	33.45	0.45
	4	38.15	0.51
	5	47.78	0.59
	2	38.29	0.40
50	3	42.84	0.50
	4	44.95	0.53
	5	47.84	0.55
	2	34.40	0.42
55	3	35.33	0.44
	4	36.34	0.46
	5	45.65	0.51

Based on the theory the longer the reaction time, the possibility of contact between substances the greater so that will result in a large conversion [11]. Biodiesel yield is also influenced by the ratio of triglycerides to methanol and oven power intensity. Majid [12] found the ratio of triglyceride concentration to methanol which resulted in optimum biodiesel conversion was 1: 6. They also report initially that biodiesel yields will increase with greater power and heating time, but when optimum heating power and time has been reached, the biodiesel yields will decrease.

C. Reaction Rate (k)

Based on the data in Table 2, the rate constant of the reaction can be calculated by making the plot as given in Fig. 2, where the rate constants constant is a linear line gradient. The results show that the higher the reaction temperature the reaction rate constant will increase. This happens because with the higher reaction temperature, the reaction rate is also increasing [13]. Salamah [14] states that the higher the temperature, the movement rate of each molecule will be faster, so that the frequency of collisions between molecules will be faster, so that the frequency of collisions between molecules will increase and the reaction becomes faster. The relation data between reaction temperature and reaction rate constant are shown in Table 3.

Table 3. Relation of temperature and reaction rate constant

Temperature T (°C)	1/T (K^{-1})	K ($minute^{-1}$)	ln k
45	0.003143	0.059	-2.83
50	0.003095	0.094	-2.36
55	0.003047	0.096	-2.34

D. Activation Energy

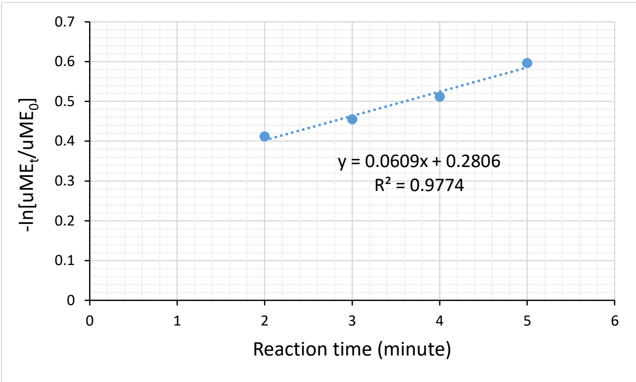
The activation energy can show how easy or difficult the reaction is, in theory if a reaction has a smaller activation energy will tend to react more quickly and easily than a reaction with a larger activation energy that tends to react more difficult and longer [15]. The greater the value of the reaction rate constant, the reaction will take place quickly. The faster a reaction allows for large collisions of particle with a relatively short time and lower energy levels so that the balance will be achieved at a faster time.

Based on Eq. (7) then the activation energy (Ea) can be obtained by plotting 1/T as the abscissa versus ln(k) as ordinate. In this case the slope of the linear line is the value of Ea/R. From Table 3, we can make a plot as given in Fig. 3 so it can be used to determine the value of each parameter on the proposed kinetic model. From Fig. 3, we get the following mathematical equations:

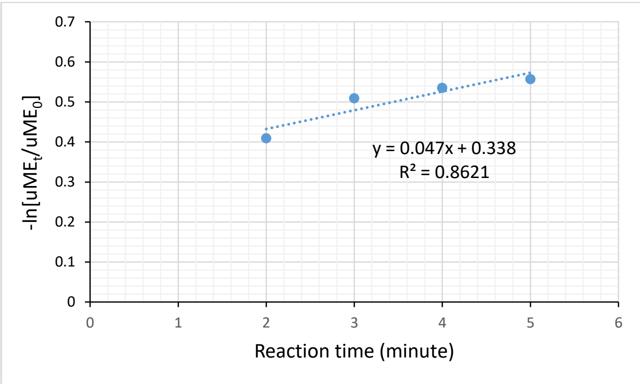
$$\ln k = 13.28 - 5101\left(\frac{1}{T}\right) \tag{9}$$

By substituting the above equation in the previous equation, the value of A = 8.38(10^9) s^{-1} and E_a is 63.94 kJ/mol. Therefore the resulting kinetic equation can be presented as:

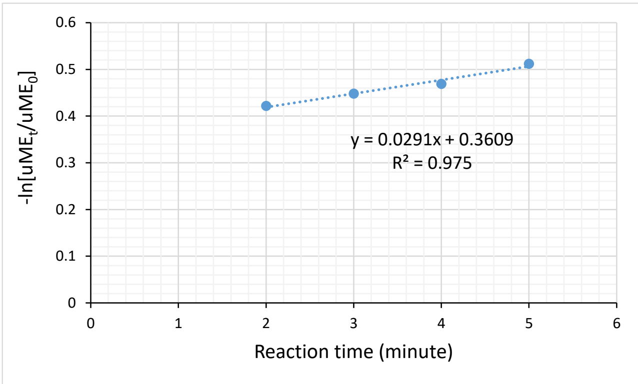
$$k = 8.38(10^9)\ \exp(-63941/RT) \tag{10}$$



(a)



(b)



(c)

Fig. 2. Relationship of time and –ln[uME_t/uME_0] at reaction temperature of 45°C (a), 50°C (b) and 55°C (c).

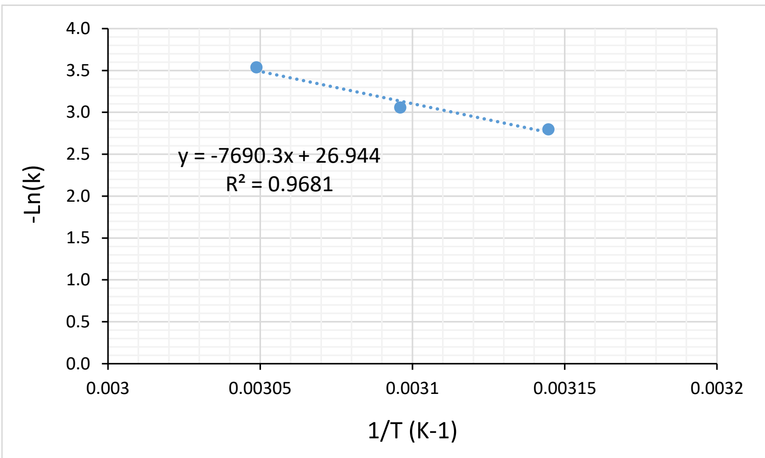


Fig. 3. Plot of 1/T and ln(k)

The activation energy obtained from this study is considerably high when compared to the activation energy of biodiesel production using different oils and heating systems as given in Table 4. This is probably because at the start of the reaction the oil is not preheated to the desired temperature, but starting from the lowest temperature (room temperature). Therefore, the reaction requires a large enough energy to start.

Table 4. Energy activation of biodiesel reactions

Feedstock	Reaction Condition	E_a (kJ/mol)	Reference
UCO	MR 1:4, t = 2-6 min, T 45-55°C, microwave aided	63.94	This work
Kapok seed oil	MR 1:3, t 60 -120 min, T 40, 70, 90°C, conventional.	10.39	[14]
Pongamia oil	MR 1:6, T, 30-70°C, conventional	41. 57	[18]
Cotton seed oil	MR 1:6, T 30 - 70°C, conventional	23. 69	[18]
Jatropha seed oil	MR 1:6, conventional, T 40-60°C	41.94	[16]
Jatropha seed oil	MR 1:9, T 100-140°C, t 120 min (interval 15 min)	17.54	[17]
Nyamplung seed oil	MR 1:6, T 29, 45, 60, 70°C t 0-30 min, conventional	16.25	[19]
Palm oil	MR 1:6, T 30, 40, 60 C, t 10-30 min, static mixing reactor	71.83	[20]

IV. CONCLUSION

The results showed that the yield of biodiesel ranged from 33.45 to 66.77%. The highest yield is at 55°C and reaction time is 6 minutes. The results showed that the higher the reaction temperature the greater the rate of the reaction rate constant (k). The k values were 0.0609, 0.047, and 0.0291 per minute, respectively obtained for temperatures of 45, 50 and 55°C. The value of activation energy (E_a) of transesterification reaction of used cooking oil with the help of microwave is 63.94 kJ/mol.

ACKNOWLEDGEMENT

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REFERENCES

[1] J. Karman. *Teknologi dan Proses Pengolahan Biomasa*. Alfabeta. Bandung. 128 pp. 2012.

[2] W. Dharsono and Y.S. Oktari. Proses Pembuatan Biodisel dari Dedak dan Metanol dengan Esterifikasi In Situ. Skripsi. Jurusan Teknik Kimia, FakultasTeknik, Universitas Diponegoro. Semarang, 2010.

[3] P. Kuncahyo, A. Z. M. Fathallah, and Semin. Analisa prediksi potensi bahan baku biodisel sebagai suplemen bahan bakar motor diesel di Indonesia. *Jurnal Teknik Pomits*, vol. 2(1), pp. B62-B66, 2013.

[4] J. V. Gerpen. Biodiesel processing and production. *Fuel Processing Technology*, vol 86, pp. 1097-1107, 2005.

[5] S. Jaichandar and K. Annamalai. The status of biodiesel as an alternative fuel for diesel engine - An overview. *Journal of Sustainable Energy and Evironment*, vol. 2, pp. 71-75, 2011.

[6] M. Syamsudin, 2010. *Membuat Sendiri Biodisel* (*Bahan Bakar Alternatif Pengganti Solar*). Lily Publisher, Yogyakarta, 46 pp.

[7] M. N. Hikmah and Zuliyan. Pembuatan metil ester (biodisel) dari minyak dedak dan metanol dengan proses esterifikasi dan transesterifikasi. Skripsi. Jurusan Teknik Kimia, Universitas Diponegoro. 2010.

[8] T. M. Barnard, N. E. Leadbeater, M. B. Boucher, L. M. Stencel, and B.A. Wihite. Countinus-flow preparation of biodisel using micro-wave heating. *Energy and Fuel*, vol. 21(3), pp. 177-1781, 2007

[9] A. Haryanto, U. Silviana, S..Triyono, and S. Prabawa. Produksi biodiesel dari transesterifikasi minyak jelantah dengan bantuan gelombang mikro: Pengaruh intensitas daya dan waktu reaksi terhadap rendemen dan karakteristik biodiesel. *Agritech*, vol. 35(2), pp. 234-240, 2015.

[10] D. Kusdiana and S. Saka. Kinetic of transesterification in rapeseed oil to biodisesel fuel as treated in supercritical methanol. *Fuel*, vol. 80, pp. 693-698, 2001.

[11] Susilowati. Biodisel dari minyak biji kapuk dengan katalis zeolit. *Jurnal Teknik Kimia*, vol. 1(1), pp. 10-14, 2006.

[12] A. A. Majid, D. Prasetyo, and Y. C. Danarto. Pembuatan biodisel dari minyak jelantah dengan menggunakan iradiasi gelombang mikro. Simposium Nasional RAPI XI FT UMS: K15-K21, 2012.

[13] H. Satriadi. Kinetika reaksi esterifikasi gliserol dan asam asetat menjadi triacetin menggunakan katalis asam sulfat. *Teknik*, vol. 36 (2), pp. 75-80, 2015.

[14] S. Salamah. Kinetika reaksi esterifikasi minyak jelantah biji Kapuk pada pembuatan biodisel. *Chemica*, vol. 1(1), pp. 11-18, 2014.

[15] A. Z. Rahman and I. G. M. Sanjaya. Rasionalisasi jalur sintesis laevifonal dari trans-resveratol dengan menggunakan teori fungsional kerapatan (DFT). *UNESA Journal of Chemistry*, vol. 1(1), pp. 1-9, 2012.

[16] L. Buchori and S. B. Sasongko. Kinetika transesterifikasi biodisel jarak pagar. *Teknik*, vol. 33(2), pp. 52-57, 2012.

[17] H Rustamaji, S. Heri, and B. Arief. Permodelan dan simulasi kinetika reaksi alkoholisis minyak jarak pagar (*Jatropha curcas*) dengan katalisator zikornia tersufatasi. *Jurnal Rekayasa Proses*, vol. 4(1), pp. 19-24, 2010.

[18] N. Jaya and B. K. Selvan. Comparative study on kinetic parameters for tranesterification of pongamia and cotton seed oil. *International Journal of ChemTech Research*, vol. 6(10), pp. 4475-4479, 2014.

[19] Sahirman, A. Suryani, D. Mangunwidjaja, Sukardi, and R. Sudrajat. Kinetika reaksi transesterifikasi minyak biji Nyamplung (*Calophyllum inophyllum*) pada proses produksi biodiesel. *Jurnal Penelitian dan Hutan*, vol. 27(3), pp. 201-212, 2008.

[20] S. Penggabean. Analisis kinetika reaksi tranesterifikasi pada produksi biodiesel secara katalitik dengan static mixing reactor. (*Thesis*). Teknik Mesin Pertanian dan Pangan, Institut Pertanian Bogor. 2011.

E.4

PHYSICAL DIMENSION OF OIL PALM FRESH FRUIT BUNCH AT MINERAL AND PEAT LAND

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ABSTRACT

Oil palm Fresh Fruit Bunch (FFB) transportation needs big power resources, i.e truck bin capacity. The efficient loading and arrangement of FFB in truck bin contributed financial performance to the oil palm plantation company. Today, most of FFB placement in truck bin are randomly arranged. In order to optimize the truck bin capacity, the information about FFB characteristics were needed. This research studied about the FFB characteristics, which were: shape, dimension, and volume. The FFB sphericity and bulk density (BD) resulted from the research can be used to develop the model of FFB arrangement in the truck bin. The method used were measuring sphericity and BD of FFB from mineral land as well as peat land. The data were statisticaly analized using T test. Mineral land's FFB were bigger than peat land's FFB. The length, width, weght and volume of mineral land's FFB were 56,9 cm; 32,0 cm; 17,9 kg; and 12,6 lt respectively, while of peat land's were 44,0 cm; 29,7 cm; 12,2 kg; and 7,7 lt. FFB of peat land were more round than of mineral land, with sphericity value 0.97. BD of FFB were not different between from mineral land or peat land.

Keywords: sphericity, oil palm, fresh fruit bunch, spesific volume, transportation.

I. INTRODUCTION

Oil palm Fresh Fruit Bunch (FFB) harvesting and transportation's goal was delivering the FFB as much as possible with the minimum quality degradation [1]. Transporting FFB from field to palm oil mill (POM) is important, because it's delay influenced processing, POM capacity, and final oil quality [1]. Information about physical and mechanical properties of FFB is important as references in designing transportation, sortation, and grading devices [2], because harvesting, transportation and processing activities are interrelated and may interfere the next quality [3; 4].

In transportation activities, FFB should be arranged in truck bin properly so that the capacity reach optimum and the damage minimum [5]. Randomly FFB stacking cause some losses space and potentialy increase friction (pressure) among FFB. Physical properties of FFB need to be known in order to design the FFB arrangement in truck bin. [6] observed physical and mechanical properties of Dura and Tenera oil palm variety, in term of dimension, volume weight, density, and porosity. This research was aimed to observe and compare the FFB physisal propeties, i.e.: size, bulk density, and sphericity between in mineral land and peat land.

II. MATERIALS AND METHODS

The material used as objects in this research was oil palm FFB. The observations were done at Instiper's oil palm field, Ungaran, Central Java, and at private company's field, Riau province. Parameters measured were; length, width, weght and volume of FFB that harvested in mineral land and peat land. Those data were used to calculate bulk density, and sphericity. Beside land type, the treatments applied was also oil palm trees age, i.e 4, 8 and 14 years. Data were analyzed using T test and Anova.

III. RESULTS AND DISCUSSION

An oil palm FFB has 15-30 kg weight, consists of 600-2000 fruitlets that attach to bunch stalk [7]. The bunches' shapes was ovate with 50 cm length and 35 cm width. While the fruitlets has oval shape, with 2-5 cm length and 3-30 gr weights [8]. FFB transportation capacity and the effort to maintain FFB integrity was important, because they related with the goal of harvesting and transportation. The losses should be minimized. [9] found that time factor was important in relation with quality degradation, so the transportation efficiency must be optimized. One of methods to improve transportation performance was in truck bin FFB arrangement. Then, the information about FFB's shape and bulk density from this research may contibute to the arrangement design.

A. FFB Sphericity

The sphericity was ratio between smallest circle diameter and the outer diameter of the material. Sphericity = 1 means the material was sphere.

Table 1. FFB sphericity at various maturity levels

Maturity level	Length (cm)	Width (cm)	Height (cm)	sphericity
1	37.7	35.8	28.5	0.80
2	34.5	32.7	22.5	0.69
3	39.3	35.3	22.3	0.63

Table 1 showed that FFB sphericity was different with the level of maturity. The lower the maturity level, more sphere the FFB. The older FFB grew more oval. This was because the FFB grew bigger between the leaf midribs, it was in a bind. The data was similar to [6] result that the sphericity of the fresh dura variety were found to be 0.71 and 0.68, respectively, while that of the fresh tenera was 0.64 and 0.57%, respectively.

B. FFB Dimension and Volume

Data presented in Table 2. showed that length and width of FFB increased with increasing trees age. The increase in the length and width of FFB in mineral land was higher than in peatland, indicated that mineral land was more fertile than peat land [10]. The increase in volume of young to teenage trees was higher than the older one. Again, mineral land showed better performance than peat land in term of volume increase.

Table 2. FFB dimensions, harvested from mineral land and peat land' planted trees

Land type	Age (years)	length (cm)	Width (cm)	Weigh (kg)	Vol (lt)
Mineral	4	35,2	25,2	6,6	3,2
Mineral	8	55,3	33,7	17,0	12,8
Mineral	14	80.2	37,0	30,0	21,8
average		*56,9*	*32,0*	*17,9*	*12,6*
Peatland	4	34,3	24,3	6,2	3,6
Peatland	8	42,8	31,2	11,0	8,0
Peatland	14	54,8	33,6	19,5	11,6
average		*44,0*	*29,7*	*12,2*	*7,7*

C. FFB sphericity dan Bulk Densityof Mineral and Peatland

The FFB's shape tends to sphere with the age. The older the trees, it will have more sphere FFB (Table 4). It was because at the older trees, the distance between leaf midribe was bigger, then the FFB may grew toward the width rather than toward the length. Instead of measued FFB, [9] observed the sphericity of oil palm fruitlets, and found that as the age increased from 20 to 50 years, the sphericity of Dura cultivars increased from 0.80 to 0.87, while that of Tenera fruitlets decreased from 0.81 to 0.64.

While comparation of this parameter between at mineral and peatland showed that FFB of peatland was more sphere than of mineral land. It might be because the FFB grow at mineral land faster than at peatland, especially at long side.

Table 3. FFB sphericity and bulk volume, arvested from mineral land and peat land planted trees

Land type	Age (years)	Sphericity	Bulk volume (kg/lt)
Mineral	4	0,92	2,11
Mineral	8	0,98	1,34
Mineral	14	0,82	1,39
average		*0,91*	*1,61*
Peatland	4	0.96	1,87
Peatland	8	0,98	1,38
Peatland	14	0,98	1,69
average		*0,97*	*1,65*

The FFB bulk volume as can be seen at Table 3, was not different between of mineral land and peatland. Although there was different in FFB weight and volume, the ratio between mass and volume was same. It means that the truck bin capacity will not differ while transporting mineral's or peatland's FFB.

But due to the difference in their dimensions and sphericity, there will be different space among FFB. This should be studied further by in truck bin FFB arrangement modelling, in order to optimize the transportation capacity, as [12] stated the knowledge about agricultural product phisical properties increase the possibilities to design better quality processing technology, including low loss rates and more efficient operating rates.

IV. CONCLUSION

1. The lower the maturity level, more sphere the FFB
2. The older the trees, it will have more sphere FFB.
3. The increase in the length and width of FFB in mineral land was higher than in peatland.
4. FFB of peatland was more sphere than of mineral land.

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REFERENCES

[1] Fauzi, Y., Widyastuti, Y.E, Satyawibawa, I. and Paeru, R.H. *Kelapa Sawit*. Penerbit Swadaya, Jakarta. 2012.
[2] Davies, R.M. Physical and Mechanical Properties Of Palm Fruit, Kernel and Nut. *Journal of Agricultural Technology 8*(7): 2147-2156. 2012.
[3] Risza, Suyatno. *Kelapa Sawit, Upaya Peningkatan Produktivitas*. Penerbit Kanisius, Yogyakarta. 2008.
[4] Pahan, Iyung. *Manajemen Agribisnis Kelapa Sawit Dari Hulu Hingga Hilir*. Penebar Swadaya, Jakarta. 2010.
[5] Krisdiarto, A.W. dan Sutiarso, L. 2016. Influence of plantation road quality and FFB position in truck bin to oil palm transportation. *Agritech*, 35 (3).
[6] Owolarafe, O.K., Olabige, M.T., Faborode, M.O. Physical and mechanical properties of two varieties of fresh oil palm fruit. *Journal of Food Engineering 78 : 1228–1232.* 2007.
[7] Pardamean, M. *Panduan Lengkap Pengelolaan Kebun dan Pabrik Kelapa Sawit*. Agro Media Pustaka, Jakarta. 2008.
[8] Corley, R.H.V., and Tinker, P.B. *The Oil Palm*. Blackwell Science Ltd. Malden, USA.p.47. 2003.
[9] Krisdiarto, A.W., Soetiarso, L. and Widodo, K.H. Optimasi kualitas tandan buah segar kelapa sawit dalam proses panen-angkut menggunakan model dinamis. *Agritech*, 37 (1). 2017.
[10] Mangoensoekarjo, S. dan Tojib, A.T. Manajemen Budidaya Kelapa Sawit. In Mangoensoekarjo, S and Semangun, H (ed). *Manajemen Agribisnis Kelapa Sawit*. Gadjah Mada University Press, Yogyakarta. 2008.
[11] Morakinyo, T. A., and A. I. Bamgboye. Effects of Age on Some Physical Properties of Oil Palm Fruitlets. *Agric Eng Int: CIGR Journal 17*(3): 342-352. 2015.
[12] Purwantana, Bambang. Sifat Fisik Bahan Pertanian. Lecture dictate. Agricultural & Biosystem Engineering Dept, FTP-UGM. Not published. 2008.

E.5

FEASIBILITY STUDY OF PLANT MICROBIAL FUEL CELL TECHNOLOGY IN INDONESIA'S RURAL AREA

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ABSTRACT

Seven points two million families are having no access to electricity services now in Indonesia's rural area. Mostly, people are using traditional kerosene lantern to obtained light. Apparently, the light output of kerosene lamp is minuscule, also harmful to the environment and human health. Hence, we would like to propose a possible green energy, plant microbial fuel cell (P-MFC), to generate electricity in the isolated district. P-MFC is a sustainable and renewable energy which take advantages of photosynthesis process of a plant and bacteria to transform the sunlight into electricity. Moreover, P-MFC is non-destructive, non-food compete, and applicable in the wetlands area and rice paddy field. The study focuses on the current development of P-MFC and reviews three main paradigms. Firstly, the effect of rhizodeposition and photosynthesis processes to plants in producing electricity. Secondly, the current development of P-MFC design and its power generation. And lastly, the potential to implement P-MFC in Indonesia's rural area.

Keywords : plant microbial fuel cell, bioenergy, light, rural area, Indonesia.

I. INTRODUCTION

The great Thomas Edison narrative that "we will make electricity so cheap that only the rich will burn candles" is nearly right, especially to a current significant development of industrialisation. But, he didn't anticipate the perplexity of millions of people who still have lack access to electricity. However, IEA projected that today hundreds of billions of people worldwide are still left behind without proper energy service where mostly located in developing countries (IEA 2016). In more detail, four out of five people with no access to electricity are live in South Asia and sub-Saharan Africa (Mahapatra, Chanakya, and Dasappa 2009).

Nowadays, most of the inhabitants in non-electrified rural area are using candles, car batteries, diesel generator and kerosene lamp for lighting. Seven million of household or equal to 12% of Indonesian are still using kerosene for cooking and lighting which equal to 1.9 Mt of kerosene liquid (Permadi, Sofyan, and Kim Oanh 2017). Moreover, this high energy needs of fuel source are predicted to keep increase by 30% at 2040 where hundreds of people are projected to be still left behind without proper energy service (IEA 2016). However, excessive use of fossil fuel to generate light is regarded to bring a devastating consequence on the environment. Many believe that this nonrenewable energy fuel is the leading source of world's global warming pollution, such as climate change, resource depletion, pollution, toxicity, and diversity loss. The worst influence is a direct bearing on human health (Gates, Trauger, and Czech 2014). Hence, high production of energy derived from renewable and sustainable energy is needed to develop.

Renewable energy needs are projected to increase in the future and will replace the position of fossil fuel. Moreover, some environmental and economic advantages of renewable energy transition were measured. But, Pimentel (2014) in his book stated that several issues are rising due to the prerequisite of a large scale power generation from biofuels technology, such as competition for food and feed, also land opposition for agricultural, forestry, urbanisation and wildlife activities. With this intention, we considered Plant-Microbial Fuel Cell (P-MFC) as one of possible solution since this technology is non-destructive, renewable, and non-land/food compete (Strik et al. 2008).

II. DEVELOPMENT OF P-MFC

On 1910, a botanist named Potter implanted the idea of the possibility of electricity generation by microbes (Potter 1911). Unfortunately, his idea didn't reach a lot of attention. After two decades, the technology recognised and welcomed by the researchers because its state of arts of converting wastage into energy without any damaging effect on the environment (zero footprints). In the long run, many improvement and advancement were made within the Microbial Fuel Cell (MFC) technology. And one of the current innovation is by applying MFC onto plants which are known as Plant Microbial Fuel Cell (P-MFC). The idea of P-MFC was to incorporate a plant at an anode section as the source of food uptake for the bacteria (substrate).

This technology is a collaboration between many discipline areas differing from the study of microbes, bio-electrochemical, plants, environment, biosystem and other engineering areas., The focal point of plant science is to understand the adaptation of the rhizodeposition due to the choice of suitable plants upon their morphology and physiology point of view. The microbial study is required due to the factor of microbial strain chosen in the rhizosphere-soil consortium to study better electrically active microbes. Next, the environmental engineering is necessary to familiarise with the wastewater treatment approach of heavy metals removal and organics degradations. Chemical engineering is favourable for its possible fabrications of electrodes which are cost effective, and less toxic. Electrical engineering is necessary to know the possible stacking to maximise the power output. Then, biosystem engineering is comprised in the interconnection of living and non-living components to reach an understanding of P-MFC as a biosystem for the production of biomass and bioenergy (Nitisoravut and Regmi 2017).

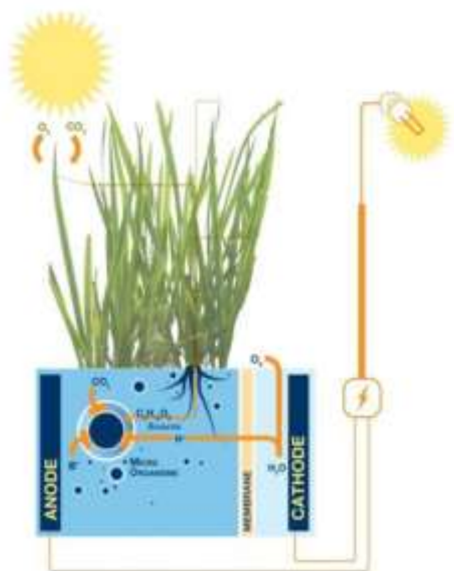

Fig. 1. Overview of Plant-Microbial Fuel Cell (Strik et al. 2008)

P-MFC is a novel technology for energy generation which takes advantages from living plants to generate electricity (Fig. 1). It was proven to produce electricity in 2007 (Strik et al. 2008) by a demonstration using Reed mannagrass. Then it was being introduced in 2008. Moreover, P-MFC harvested the energy in situ without affecting any harm to the environment. To point out, the only side product of P-MFC is pure water that resulted from a simultaneous electron flows through the external circuit within the system.

P-MFC holds a naturally occurred process which leads it to be fully sustainable and renewable. Sunlight and carbon dioxide are two important matters to support the photosynthesis of the plant. Plants utilise solar energy to produce biomass with the help of chlorophyll pigments within the green parts of it leaves. However, only 40% of the energy used by the plants for its biological growth. The remaining half of it then exudates to the rhizosphere which resulted in the form of organic carbon; such as carbohydrate and glucose. Next, the organic matter is exploited by the microbe state which presents in the soil around the root to break it down become electrons, proton, and carbon dioxide. Lastly, this process could trigger the production of electricity after the electron flows from the anode to the cathode through a load, then the electricity produced is so called "bioelectricity."

In general, P-MFC needs a submerged anaerobic area to proceed the ions exchange from the anode to the cathode. Hence, this technology is projected to implement in a natural wetland area and to couple it with a rice paddy field. We could obtain two benefits by this implementation; additional values of wetlands function, and electricity production.

III. PHOTOSYNTHESIS PATHWAY AND RHIZODEPOTISION OF PLANTS USED IN P-MFC

The choices plant of PMFC gives a significant power output difference. Two factors contributed to this effect is probably rhizodeposition and photosynthesis. Plants are classified into three categories based on their photosynthetic pathways, namely; C3, C4 and CAM (crassulacean acid-metabolism). Plants didn't store all of the solar energy within their biomass due to energy losses through the photosynthesis process. A significant loss occurs mostly to outside photosynthetically active spectrum, reflection, and other limitation (Fig. 2). Hence, C4 plants efficacy is higher than other plants because of its ability to restrict photorespiration.

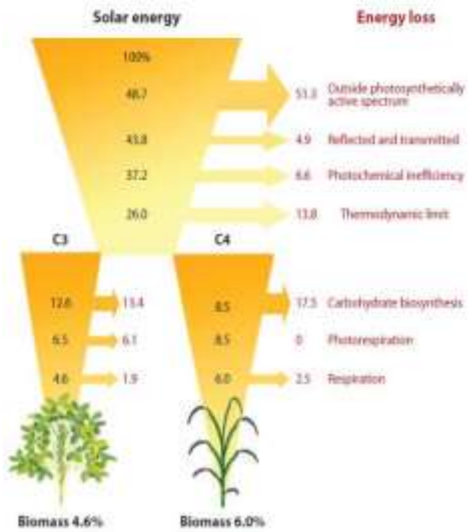

Fig. 2. Solar energy convertion to C3 and C4 plants (Zhu, Long, and Ort 2010)

Understanding the photosynthetic pathways of a plant is necessary for choosing the plants for PMFC. The conversion efficiency of C3 plants is estimated around 4.6%, while C4 is estimated to be 6%. This efficiency matter means that C4 plants are projected to produce more bioelectricity in the application of PMFC. Some advantages of choosing C4 over C3 in PMFC technology are:

1. C4 plants can grow well in hot and dry ambient.
2. Theoretically more efficient to absorb solar energy (6 % over 4.6 %).
3. Higher photosynthesis efficiency leads to a higher rhizodeposition. Hence, more rhizodeposition in C4 plants is available for microbes and fuel production.

Moreover, crassulacean acid metabolism or CAM plants are dissents from C3 and C4 plants due to its characteristic of inhabiting a dry and arid area. The CAM names come from its plant family names, the Crassulaceae. CAM plants have an ability to uptake CO2 during the night, hence lead to water collection within their leaves. Furthermore, CAM plants grow slower than C3 and C4 which resulted in less biomass production. However, challenges are present to do further research on the prospect of CAM as a plant driver in PMFC.

Plants residues in the form of organic matter then exudate from the live roots. The secretion from the roots brings out the carbon based organic matter, such as glucose and organic acids. These organic compound can be easily used as a substrate in the rhizosphere by the microbes. From the total input of the organic compound, organic rhizodeposition could provide 30-40%. Hence, organic matter from plant roots holds a significant role in the rhizosphere.

Fig. 3 *Spartina anglica* plant (Sloth 2003).

Spartina anglica (Fig. 3) and *Glyceria maxima* are two most used kinds of grass in the current research of PMFC, and both of them belong to C4 class plant. Moreover, Oryza sativa is the most popular food crop being studied so far, and its belong to C3 plant. The power output of *S. anglica* reaches a better performance than the latter two in almost every study being carried (Helder et al. 2013, Helder et al. 2010, Timmers et al. 2010).

IV. DEVELOPMENT OF P-MFC DESIGN AND ITS POWER GENERATION

Three types of PMFC design recently studied are flat plat, tubular, and roof top (modular). Flat plat and tubular design are mostly used on the lab scale. On the other hand, the roof top system or commercially known as the modular design (plant-e.com) is initially aimed as a green roof garden to decrease the effect of dense population in the urban area. None of them is reportedly applied yet in the natural area. *Text Font of Entire Document*

Fig 4. Three types of P-MFC models; A. Tubular, B. Modular, and C. Flat plat (source: Wetser (2016) and plant-e.com)

Table 1. Overview of PMFC development

MFC Fabrication		Plant Types (Pathways)	Operating condition	Sub-strate	Max. power density (mW/m^2)	Reference
Anode	Cathode					
Graphite felt		O. *sativa* (C3)	Rice field	Soil/fertilizer	80	Ueoka et al. (2016)
Graphite granules		O. *sativa* (C3)	Greenhouse	Hoagland solution [a]	33	Schamphelaire et al. (2008)
Graphite granule	Graphite felt	G. *maxima* (C3)	Climate chamber	Hoagland solution	67	Strik et al. (2008)
Graphite felt		C. *involucratus* (C3)	Ambient condition	Lotus soil, wastewater	5.9	Klaisongkram and Holasut (2015)
Raphite rod	Graphite felt	A. *anomola* (C4)	Climate chamber	Hoagland solution	22	Helder et al. (2010)
Graphite plate		P. *setaceum*	Ambient condition	Red soil	163	Deng, Chen, and Zhao (2012)
Graphite felt		S. *anglica*	Climate chamber	Nitrate less ammonium rich medium	679 (PGA [b])	Wetser et al. (2015)

[a] Hoagland solution : rich nutrient solution for plant growth
[b] PGA : Plant Growth Area (total area of plants root within the reactor).

The system cost of PMFC reactor is consist of each anode and cathode 8.5%, reactor 68.5%, spacer (membrane) 11%, mediator 1.4%, and collector 2.7% (Deng, Chen, and Zhao 2012). The anode and cathode used in the experiment were mostly a carbon based material with electrical conductivity, for example; carbon felt, graphite felt, carbon fibre, graphite rod, etc. A spacer is needed to separate the anode and the cathode physically, preventing a short circuit. The spacer is preferably non-conductive and small (to reduce the ionic and transport losses). Moreover, the mediator is the section where the PMFC being put on, for example in modular type; it is set in a black plastic box, while in a flat plat design, thin glass is occupied. A current collector is needed to harvest the electricity generation, for example; titanium wire, gold wire and aluminium wire.

V. POWER POTENTIAL OF P-MFC IN INDONESIA'S RURAL AREA

P-MFC needs an anaerobic state which only possible in a submerged area. Two kinds of an immersed area which has a potential for PMFC application in Indonesia are rice paddy field and natural wetlands such as peatland or marsh. The total area of rice paddy field in Indonesia is 8.114.829 ha (BPS 2017), while the total of a natural wetland, especially peatland, is around 6 million ha (Sari 2012). Moreover, wetland methane emission could give an estimation to the national potential power generation of the PMFC. Therefore, particular data of each wetland type is required to get the ultimate potential power. In this estimation, we only consider rice paddy field and peatland area, while of course other wetland area such marshes and swamps also present.

The electricity potential calculation is based on the ability of electrochemically active bacteria to outcompete the methanogens as an electron donor. Consequently, the methane is not released to the atmosphere but used for electricity production. The power generation is calculated using equation 1 (Wetser, 2016).

$$P=JnFU/Mt \tag{1}$$

Where P is the estimated power (Tera Watts), J is methane production (Tg yr -1), n is the number of electrons in acetate redoks reaction (8)*, F is the Faraday constant (96485 A s mol -1), U is the PMFC voltage (assumed to be 0.6 V), M is methane molar mass (16 g/mol), and t is total of seconds in a year (s/year). *Acetate is assumed to be the organic materials degraded by the microbe in this calculation.

$$P\ total=P\ rice\ field+P\ wetland \tag{2}$$

According to Khalil et al. (2008), methane emission from rice paddy field is nearly 30 mg/m^2/hr which is equal to 21.3 Tg/year in national level. Furthermore, methane emission in natural wetland according to IPCC report is around 1260 kg/ha/yr or equal to 7.56 Tg/year. The power potential from each submerged area is calculated separately. Then, the total power potential is determined by summing the potential from rice paddy field and peatland (Equation 2) which equal to 26,512 Mega Watt/year (Table 2).

Table 2. Power production estimation from Rice paddy field and Peatland

Wetland type	Area (million ha)	Methane Emission (Tg/yr)	Estimated power production (MW/yr)
Rice Paddy Field	8.1	21.3	1,957.9
Peatland	6.0	7.56	6,938.9
Total power			26,512.9

Additionally, P-MFC needs a high ambient temperature for the plant to grow.. The fact that the location of Indonesia next to the equator line gives it a relatively high temperature and humidity. Data from Meteorological Station (BMKG) shows that the maximum temperature in 2015 reaches 39.5 ^{O}C and the lowest is 17.0^{O}C. Where the average normal temperature is around 27 ^{O}C (BPS 2017). However, the lab scale P-MFC's use an artificial temperature between 23 and 27 ^{O}C (mostly 25 ^{O}C) because the plant is assumed to grow under this condition (Strik et al. 2008, Timmers et al. 2012, 2013).

Solar irradiation value is another notable ambient condition to support the photosynthesis process of the plants in P-MFC. Kouzuma, Kaku, and Watanabe (2014) found out that PMFC electricity production was dependent to sunlight (due to photoshyntesis and root exudates). However, the average solar irradiation value in Indonesia is quite high which is around 170 - 200 W/m2 (solargis.com). As a comparison, in The Western Europe area (the location of the previous research), the average solar radiation is about 150 W/m2 (Strik et al. 2008). While the favoured condition for the plants (rice paddy and marsh species) is 170 W/m2 (Deng, Chen, and Zhao 2012). Hence, Indonesia's ambient condition is favourable for PMFC application.

VI. CONCLUSION

This preliminary study presents the potential of applying newly emerged technology, plant microbial fuel cell (PMFC), in Indonesia's rural areas. Some factors influencing the performance of the technology have been explained regarding plant types, and operational condition. The climate condition of Indonesia as a tropical country is favourable for PMFC application, concerning local temperature and solar irradiation value. The power output potential of this technology in rice paddy fields and natural wetlands is estimated to be around 26,512.9 MW/year. This energy production is projected to serve the needy people as a new electricity/light source around the isolated areas.

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REFERENCES

BPS. 2017. Statistical yearbook of Indonesia. edited by Badan Pusat Statistik. Jakarta: BPS-Statistics Indonesia.

Deng, Huan, Zheng Chen, and Feng Zhao. 2012. "Energy from Plants and Microorganisms: Progress in Plant–Microbial Fuel Cells." ChemSusChem 5 (6):1006-1011. doi: 10.1002/cssc.201100257.

Gates, J. Edward, David L. Trauger, and Brian Czech. 2014. "Envisioning an Alternative Future." In Peak Oil, Economic Growth, and Wildlife Conservation, edited by J. Edward Gates, David L. Trauger and Brian Czech, 317-339. New York, NY: Springer New York.

Helder, M., D. P. B. T. B. Strik, H. V. M. Hamelers, A. J. Kuhn, C. Blok, and C. J. N. Buisman. 2010. "Concurrent bio-electricity and biomass production in three Plant-Microbial Fuel Cells using Spartina anglica, Arundinella anomala and Arundo donax." Bioresource Technology 101 (10):3541-3547. doi: http://dx.doi.org/10.1016/j.biortech.2009.12.124.

Helder, Marjolein, David P. B. T. B. Strik, Ruud A. Timmers, Sanne M. T. Raes, Hubertus V. M. Hamelers, and Cees J. N. Buisman. 2013. "Resilience of roof-top Plant-Microbial Fuel Cells during Dutch winter." Biomass and Bioenergy 51:1-7. doi: http://dx.doi.org/10.1016/j.biombioe.2012.10.011.

IEA. 2016. "World Energy Outlook 2016." IEA. /https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExecutiveSummaryEnglish.pdf.

Khalil, MAK, Martha J Shearer, RA Rasmussen, Changlin Duan, and Lixin Ren. 2008. "Production, oxidation, and emissions of methane from rice fields in China." Journal of Geophysical Research: Biogeosciences 113 (G3).

Klaisongkram, Nuttawut, and Kanyarat Holasut. 2015. "Electricity Generation of Plant Microbial Fuel Cell (PMFC) using Cyperus Involucratus R." Engineering and Applied Science Research 42 (1):117-124.

Kouzuma, Atsushi, Nobuo Kaku, and Kazuya Watanabe. 2014. "Microbial electricity generation in rice paddy fields: recent advances and perspectives in rhizosphere microbial fuel cells." Applied microbiology and biotechnology 98 (23):9521-9526.

Mahapatra, Sadhan, H. N. Chanakya, and S. Dasappa. 2009. "Evaluation of various energy devices for domestic lighting in India: Technology, economics and CO2 emissions." Energy for Sustainable Development 13 (4):271-279. doi: http://doi.org/10.1016/j.esd.2009.10.005.

Nitisoravut, Rachnarin, and Roshan Regmi. 2017. "Plant microbial fuel cells: A promising biosystems engineering." Renewable and Sustainable Energy Reviews 76:81-89. doi: http://doi.org/10.1016/j.rser.2017.03.064.

Permadi, Didin Agustian, Asep Sofyan, and Nguyen Thi Kim Oanh. 2017. "Assessment of emissions of greenhouse gases and air pollutants in Indonesia and impacts of national policy for elimination of kerosene use in cooking." Atmospheric Environment 154:82-94. doi: http://doi.org/10.1016/j.atmosenv.2017.01.041.

Pimentel, David. 2014. "Implications for the Economy and Environment of Alternatives to Fossil-Fuel Energy." In Peak Oil, Economic Growth, and Wildlife Conservation, edited by J. Edward Gates, David L. Trauger and Brian Czech, 63-82. New York, NY: Springer New York.

Potter, M. C. C. Full publication date Sep. 1911. "Electrical Effects Accompanying the Decomposition of Organic Compounds." Proceedings of the Royal Society of London. Series B, Containing Papers of a Biological Character 84 (571):260-276.

Sari, Eli Nur Nirmala 2012. "Facts about Peatland in Indonesia." Accessed 17 July 2017. http://180.235.150.225/iccc/index.php/en/lib/article/peatland/191-facts-about-peatland-in-indonesia.

Schamphelaire, Liesje De, Leen Van Den Bossche, Hai Son Dang, Monica Höfte, Nico Boon, Korneel Rabaey, and Willy Verstraete. 2008. "Microbial fuel cells generating electricity from rhizodeposits of rice plants." Environmental Science & Technology 42 (8):3053-3058.

Sloth, Niels. 2003. "Common Cord-Grass (Spartina anglica)." Accessed 17 July 2017. http://www.biopix.dk/.

Strik, David P. B. T. B., H. V. M. Hamelers, Jan F. H. Snel, and Cees J. N. Buisman. 2008. "Green electricity production with living plants and bacteria in a fuel cell." International Journal of Energy Research 32 (9):870-876. doi: 10.1002/er.1397.

Timmers, Ruud A, David PBTB Strik, Hubertus VM Hamelers, and Cees JN Buisman. 2010. "Long-term performance of a plant microbial fuel cell with Spartina anglica." Applied microbiology and biotechnology 86 (3):973-981.

Timmers, Ruud A., David P. B. T. B. Strik, Hubertus V. M. Hamelers, and Cees J. N. Buisman. 2012. "Characterization of the internal resistance of a plant microbial fuel cell." Electrochimica Acta 72:165-171. doi: http://doi.org/10.1016/j.electacta.2012.04.023.

Timmers, Ruud A., David P. B. T. B. Strik, Hubertus V. M. Hamelers, and Cees J. N. Buisman. 2013. "Electricity generation by a novel design tubular plant microbial fuel cell." Biomass and Bioenergy 51:60-67. doi: http://doi.org/10.1016/j.biombioe.2013.01.002.

Ueoka, Nagayoshi, Naoko Sese, Mayu Sue, Atsushi Kouzuma, and Kazuya Watanabe. 2016. "Sizes of Anode and Cathode Affect Electricity Generation in Rice Paddy-Field Microbial Fuel Cells." Journal of Sustainable Bioenergy Systems 6 (01):10.

Wetser, Koen. 2016. Electricity from Wetland: Technology assessment of the tubular Plant Microbial Fuel Cell with an integrated biocatode, PhD thesis, Wageningen University. Wageningen, NL. PhD thesis.

Wetser, Koen, Emilius Sudirjo, Cees J. N. Buisman, and David P. B. T. B. Strik. 2015. "Electricity generation by a plant microbial fuel cell with an integrated oxygen reducing biocathode." Applied Energy 137:151-157. doi: http://dx.doi.org/10.1016/j.apenergy.2014.10.006.

Zhu, Xin-Guang, Stephen P Long, and Donald R Ort. 2010. "Improving photosynthetic efficiency for greater yield." Annual review of plant biology 61:235-261.

E.6

ENERGY AUDITING IN CPO (CRUDE PALM OIL) PRODUCTION PROCESS

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ABSTRACT

CPO (crude palm oil) is very important raw material for several industries in the world. Besides that, CPO also one of the most potential raw material for bio-diesel production in the world. CPO demand in internasional market has been increasing significantly since many countries need to change their energy resources by using "more greener" resources such as bio-diesel. Concerning on environmental impact, producing a "green product" is important and a must. As raw material of many kind products, CPO should be proven as a "green product" too. Energy auditing in CPO production process is strongly needed, since it will be help to provide data for 'green product evaluation' such as energy resources or energy supply system, efficiency of energy usages on each production stage, and waste utilization. In the other side, improvement of the production system will reduce production cost and increasing competitiveness market.

This paper presents the result of energy auditing in several palm estates and CPO factories in Indonesia. Auditing conducted from the stages of palm cultivation in the field, transportation of palm to the factory, and the stages of palm processing to produce CPO in the factory plant. The result of auditing shows that energy needed in CPO production system are heat energy, mechanical energy, and electricity. Most of those energy demand was fulfilled by biomass waste (of the processing stages) as primary energy source. Specific energy to produce 1 kg CPO are varies among the range of 13.4 MJ – 17.5 MJ. The wide range of specific energy indicate that the production process having high possibility to be improved for more efficient on energy usages.

Keywords : energy auditing, green product.

I. INTRODUCTION

CPO (*crude palm oil*) is crude oil that produced by extraction process of palm bunches. CPO is a primary product. This crude oil will be processed as raw material of many kind products, such as cooking oil, margarine, soap, shampoo, and many other products, included bio-diesel. Indonesia is one of the biggest CPO producer in the world, beside Malaysia. Palm plantation area and CPO factory mostly located in Sumatera and Kalimantan (Borneo) island. Only about 25-30 % of the total CPO absorbed by local industries, the other was exported.

Increasing of CPO demand in the international market caused by both of increasing of industries based on CPO and also goodwill of many countries on using more greener products and more greener energy resources such as bio-diesel. Energy auditing in CPO production process is strongly needed, since it will be help to provide data for 'green product evaluation' such as energy resources or energy supply system, efficiency of energy usages on each production stage, and waste utilization.

This paper present the result of energy auditing in several palm estates and CPO factories in Indonesia. Some analysis of the data can be done to evaluate the production process from many views angle, such as energy aspect (such as energy conservation, energy resources and supply system, potential energy resources), environmental aspect (such as waste utilization, waste potential, emission), economics aspect (such as production cost analysis, product development) or management aspect. Based on those analysis some improvement can be done to make CPO from Indonesia more competitive in the international market.

II. MATERIALS AND METHODS

Auditing conducted on all stages of palm cultivation in the field, transportation of palm to the factory, and all stages of palm processing to produce CPO in the factory plant.

The audit method is macro audit following with detailed audit. Walk-through audit has been taken in the certain time (one week or more, depend on the system and condition) for macro audit purpose. Those audit conducted on all stages of CPO production chain, start from palm cultivation system included harvesting, transportation system (from the plant site to the CPO factory), and CPO production system (processing of palm to produce CPO) in the factory.

Detailed audit has been done only on the stage or unit which was detected un-efficient, not secure, or consuming huge amount of energy. To take the data, we assume that each stage can be separated from the stages before and after. So, we can calculate as one system alone. But, in this paper, only result of detailed audit on energy supply system will be reported.

Only energy input which was directly related with CPO production activities will be accounted. Thus, energy usage for housing, office and other public services will not audited. In this audit, all of energy input, both of direct or indirect input, will be calculated as input energy to the production system. Due to the limited data about energy specific of almost all of machines and equipment, embodied energy of all machines and equipment were not calculate. The same case also happened for pesticide and energy input from the sun in the photosynthesis process. Indirect energy input from fertilizer was calculated based on data from some references.

III. RESULTS AND DISCUSSION

A. CPO production stages

CPO production stages starting from palm cultivation in the plantation area to the palm processing to produce crude palm oil (CPO) in the factory, presented in the Fig. 1 below.

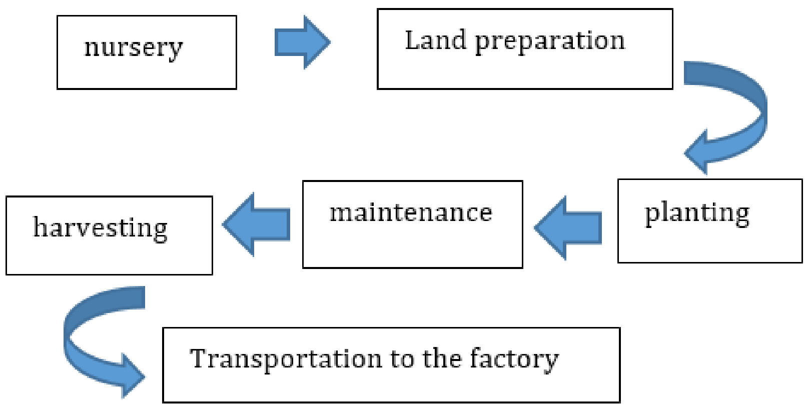

Fig 1. Stages of palm cultivation and harvesting

Fruit palm bunches (FPB) which were harvested, will be transported to the factory, and processed in some stages to produce crude palm oil (CPO). The processing stages presented in the Fig. 2 below.

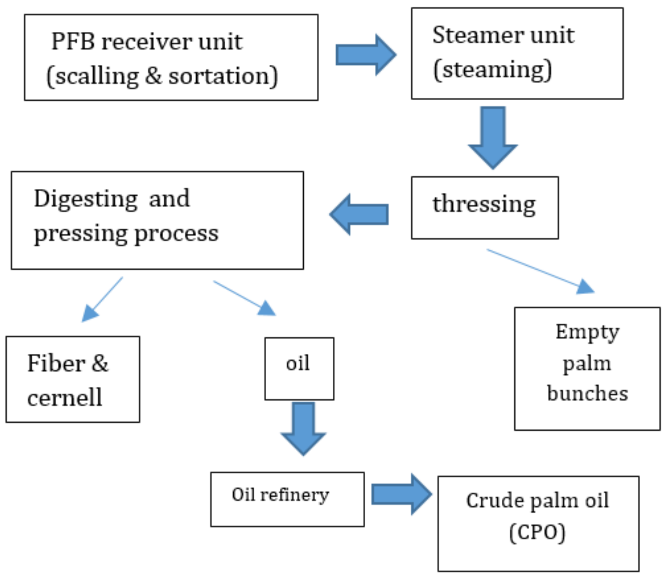

Fig. 2 Palm processing stages to produce CPO

B. Energy demand for CPO production

Result of energy auditing in all location shows that most energy (70% - 90% of the total energy demand) was consumed by the palm processing in the factory plant. Energy demand in the cultivation stages was vary in the range of 10% - 30%, due to the local situation which will be influencing maintenance activities needed such as nursery method, land preparation, planting activities, kind and amount of fertilizer or pesticide, etc. Condition of land or plantation area also influencing energy demand for harvesting and transportation FPB activities. Table 1 and Table 2 are presenting the result of auditing energy in several CPO producer.

Specific energy of CPO is defined as "total energy input, both of direct and indirect input, to produce certain amount of CPO (MJ/kg CPO or MJ/ton CPO). Based on the data in Table 2, we can see that specific energy to produce CPO are vary among the location. Even though all of the producer using the same kind of energy resources, but none of them using same amount of primary energy input. Energy resources which has been used in the CPO production are diesel oil, biomass waste (fiber and palm shell), and electricity as direct energy input, and fertilizer as indirect energy input. Human (biologic) energy is using as both of direct and indirect energy input. As mentioned above, indirect energy input such as sun irradiation for plant photosynthesis, pesticide, and embodied energy of all machines and equipment were not audited due to the limited data or references.

Table 1. Energy demand for CPO production in some producer, based on the production process stages *)

	PTPN IV, Adolina, North Sumatra	PTPN VIII, Lebak, Banten	PT Condong Garut, West Java	PTPN VII, Rejosari, Lampung
Processing capacity (ton FPB /hour)	30	60	20	25
specific energy (MJ/kg CPO)	**13.4106**	**16.678**	**17.560**	**15.755**
Palm cultivation (%)	27.74	5.94	34.07	32.56
Harvesting (%)	0.04	0.03	0.04	0.19
Transportation (%)	4.58	2.91	1.73	1.4
Processing to produce CPO (%)	59.11	80.69	(+ utility) 64.16	(+utility) 65.85
Utility (%)	8.53	10.43		

*) processed from some references

Data shows that biomass (fiber & palm shell), which was produced as waste of the CPO production process, is the dominant primary energy resources to fulfill all of energy demand in the CPO production chain. The biomass waste were used as energy source for boiler system to produce steam , which was needed in the main first processing stages (Fig. 2) and help the process in almost of all processing stages.

In the utility section, the steam produced by the boiler system, not only use directly for processing activities, but also used to generate electricity by using steam turbine & generator unit. The electricity was used in the production process as energy source to operate motor/machines/equipment and lighting in the factory. In this auditing, electricity which was produced by steam turbine will be defined as secondary energy resources, and not calculated in the specific energy calculation, since it has been calculated as its origin form (= biomass for boiler fuel). Data about electricity usages in this auditing was presented in order to provide information about all form of energy needed in each production stages, origin resource of each kind of energy, and also amount of electricity which should be supplied. Information about amount of electricity demand is very important for "(energy supply) buffer system" planning. Diesel generator is the common buffer system which has been used to provide electricity in the almost all of CPO producer in Indonesia.

Table 2. Energy demand for CPO production in some producer, based on the primary energy input share *).

	PTPN IV, Adolina, North Sumatera	PTPN VIII, Lebak, Banten	PT Condong Garut, West Java	PTPN VII, Rejosari, Lampung
Specific energy (MJ/kg CPO)	**13.4106**	**16.678**	**17.560**	**15.755**
Diesel /solar (%)	3.22	2.47	3.92	4.57
Biomass (%)	77.63	95.28	61.97	62.96
Fertilizer (%)	16.60	2.09	11.09	31.26
Biologic/ human (%)	2.55	0.16	23.02	1.2

*) processed from some references

Diesel oil was used as fuel for trucks in the transportation activities (transported FPB from the plantation area to the CPO factory) and fuel of some equipment in the plant maintenance activities. In some cases, diesel oil also used as fuel for electricity generator in the utility section, whenever any trouble occurred.

Fertilizer is indirect input energy, given in a certain time (periodically) to the plant, both of the plant in the growing period and in also in the productive period. Calculation was based on the embodied energy of each kind fertilizer, total area (Ha), and amount of FPB harvested per Ha. Embodied energy of each kind of fertilizer was calculated based on data from some references about fertilizer production system and energy demand.

Table 3. Energy demand for CPO production in some CPO producer, based on final energy used*)

	PTPN IV, Adolina, North Sumatera	PTPN VIII, Lebak, Banten	PT Condong Garut, West Java
Specific energy (MJ/kg CPO)	**13.4106**	**16.678**	**17.560**
Diesel /solar (%)	4.5	2.8	3.61
Electricity (%)	3.3	5.0	0.8
Steam (%)	64.3	86.1	52.58
Fertilizer (%)	24.2	5.7	13.98

*) based on some references

Since biomass having main role as primary energy resources, and it used as fuel for boiler system which also having main role to supply almost all of energy needed in the production processing plant in the CPO factory, detailed audit should be taken on all part of the system (boiler system, steam distribution, and power generation unit). Result of detailed audit in the boiler system shows that boiler system in all location were very poor (less than 60%), except in PT Condong Garut which achieve 67%. It's because they still using old version technology, while new technology which able to produce super- heated steam could reach performance higher than 70% efficiency.

Wide range of specific energy (meaning high energy elasticity), indicate that production process in all CPO producer which has been audited, are low on energy efficiency. Some improvement should be done in order to reduce environmental impact (by air pollution produced from fuel combustion, and heat lost radiation), and also production cost. Chance to energy conservation can be done by improvement in the boiler system (increasing efficiency), steam distribution (reducing heat lost & steam leak), and also improvement on steam turbine & generator unit. In some location, un-efficient of human activities also recognized and need to be improved.

Table 4. Result of scheculed audit (5 years) in PT Condong Garut , only in the processing stages (in the factory), not included cultivation, harvesting and transportation from plantation area to the CPO factory

Auditing time	Researcher	Real capacity (ton FPB per day)	Rendemen (%)	Content of fiber and palm shell (%)	Specific energy (MJ/kg CPO)
1999	Alfra	**)	**)	**)	37.198
2003	Mutiara	70.3	17.52	12.49 and 6.5	14.49
2008	Wibowo	87	18.92	20.7 and 4.4	22.77
2013	Tisah Afiatul I	81	20.08	12.01 and 6.01	10.88

**) no data ; source : Tisah (2013)

One of the purpose of energy auditing is improvement to get better condition. Auditing should be taken again after improvement has been done, as evaluation weather the improvement successful or not. Result of auditing in PT Condong Garut which has been done periodically in every 5 years (Table 4), shows that the improvement not so successfully increasing performance of CPO production system. It indicate that improvement sometimes could not be done partially. But it is big challenges for the investor to do that. The same case also found in tea production system in Indonesia. One of the problem on increasing performance is raw material. Uncertainly amount of raw material will be influence significantly to the total energy efficiency since the system not working in the optimum capacity. Other problem are climate and nature condition which will be influencing quality of harvesting product which will be send to the factory as raw material. It also influencing waste composition and at the end influencing amount of fuel or fiber and palm shell to be burnt.

IV. CONCLUSION

Result of auditing shows that energy demand for CPO production are vary and specific for every location, depend on the condition when auditing has been taken. Periodically audit in the same location also showing the same fact. The differences caused by the differences of condition when the audit activities done, such as real processing capacity and machines & equipment condition.

Result of energy auditing in 4 location (CPO producer) shows that specific energy (total energy demand) to produce CPO is vary among 13.4 MJ/kg CPO – 17.5 MJ/kg CPO, and fiber & palm shell (which is the waste of processing) is the main primary energy resources (60%-95%) in those production system.

64% - 90% of the total energy input were consumed in the factory, using for processing palm to CPO and provide energy (steam and electricity) that needed in the whole processing stages and factory operation. Energy needed for the production chain is heat energy (steam), electricity, diesel oil, and indirect energy from fertilizer, and biologic/human energy.

Wide range of specific energy (meaning high energy elasticity), indicate that production process in all CPO producer which has been audited, are low on energy efficiency. Some improvement should be done in order to reduce environmental impact (by air pollution produced from fuel combustion, and heat lost radiation), and also production cost. Some efforts for energy conservation can be done by improvement in the boiler system (increasing efficiency), steam distribution (reducing heat lost & steam leak), and also improvement on steam turbine & generator unit. In some location, un-efficient of human activities also recognized and need to be improved.

REFERENCES

[1] Agustina, Sri Endah. 2010. Energy auditing on tea production system in some tea estates in Java island, Indonesia. Paper presented in Tri University Int'l Join Seminar & Symposium, Chiang-Mai, Thailand

[2] Inayah, Tisah Afiatul. 2013. Auidt energy pada proses produksi CPO di PMKS PT Condong Garut, Jawa Barat. IPB. Bogor.

[3] Natasha, Kristen. 2013. Audit energy pada proses produksi CPO di PTPN IV unit usaha Adolina Sumatera Utara. IPB, Bogor.

[4] Siregar, Ranto Ricardo. 2013. Audit energy pada proses produksi CPO di pabrik kelapa sawit Kertajaya PTPN VIII, Lebak –Banten. IPB, Bogor

E.7

LIFE CYCLE ENERGY ANALYSIS OF OIL PALM PLANTATION SYSTEM FOR BIODIESEL PRODUCTION IN ACEH PROVINCE

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ABSTRACT

Oil palm (Elaeis guineensis) has been main feed stock for biodiesel production in Indonesia special in Aceh province. The most reliable alternative for substitution of the fossil fuel is biodiesel. As one of the world's largest CPO producer in the world, Indonesia uses CPO to produce biodiesel. Scientific approach through Life Cycle Assessment (LCA) can be used as a tool to do energy analysis. The condition and energy analysis used in this study are expected to provide more comprehensive assessment on biodiesel production. The objective of this research is to calculate and analyze the consumption of renewable energy, non-renewable energy, fossil energy and see the relationship of net energy balance (NEB), net energy ratio (NER), and renewable index (RI) at each scenario to obtain optimum result which reflects the condition of oil palm plantation process. Energy consumption for producing biodiesel from oil palm was found that pre-harvest activity was higher compared to post harvest activity. The largest energy consumption for biodiesel production from cradle to gate is is fertilizing sub-process i.e. 19,850.00 MJ/ton-BDF. The total value of energy consumption before stable productivity for oil palm is 51.831,17 MJ/ton-BDF.

Keywords : energy, life cycle assessment, oil palm, biodiesel.

I. INTRODUCTION

Energy sector plays an important role for Indonesia in achieving its economic development goal. Indonesia is still heavily dependent on fossil based energy, which is accounted for more than 90% of its energy mix (including oil, gas and coal). Biodiesel is one of the biofuel being developed and used intensively in Indonesia. Biodiesel can be produced from various oil borne plants, such as palm oil, jatropha curcas, rapeseed, soybean, etc.

The Indonesia produced biodiesel mainly from palm oil. Beside environmental, energy process becomes the most important issue in biodiesel production. Even though the source of the energy is considered as carbon neutral, the production path can emit various environmentally hazardous gasses. Appropriate method to analyze aforementioned problems is Life Cycle Assessment (LCA) which complies with the International Organization for Standardization (ISO).

LCA has been widely used by America and Europe for other organic materials. Besides for emission analysis, LCA is also designed to analyse all aspects related with energy. LCA is a systematic process which comprises identification, measurement, and assessment of environmental impact caused by a product during its life cycle process or activity [1]. By using particular criteria, LCA can be a method on deciding whether one certain product has better qualification than others based on particular perspective [2].

LCI is one of four stages of LCA which have important role to conduct the assessment. The result generated from LCA is highly influenced by the validity and sufficiency of data inventory of the object being assessed. In Aceh Province case, the data access that can be used in this LCA study is very limited. Number of LCA study on Indonesian biodiesel production come up with different result. This difference could be due to data inconsistency and did not present the actual condition found in the field.

The condition and energy analysis used in this study are expected to provide more comprehensive assessment on biodiesel production. The objective of this research is to calculate and analysis the consumption of renewable energy, non-renewable energy, fossil energy and see the relationship of net energy balance (NEB), net energy ratio (NER), and renewable index (RI) at each scenario to obtain optimum result which reflects the condition of oil palm plantation process. From this research We will found the emission distribution for planting, harvesting and post-harvesting of palm oil? Which stage has significant effect? What kind of material input is the most siqnificant ? And then We will know how are the energy consumption, net energy balance, net energy ratio, and renewable index of biodiesel production from oil palm oil to produced biodiesel ?

II. MATERIALS AND METHODS

A. Boundary of Research

The system boundary for LCA study is shown in Fig.1, where cradle to gate consists of eight sub-processes. The functional unit (FU) of this study is one ton of biodiesel fuel (BDF). LCI analysis was performed based on data collected from palm oil plantation in Aceh Province. Each stage of analysis and calculations was carried out before and after the plants yield the usable fruits.

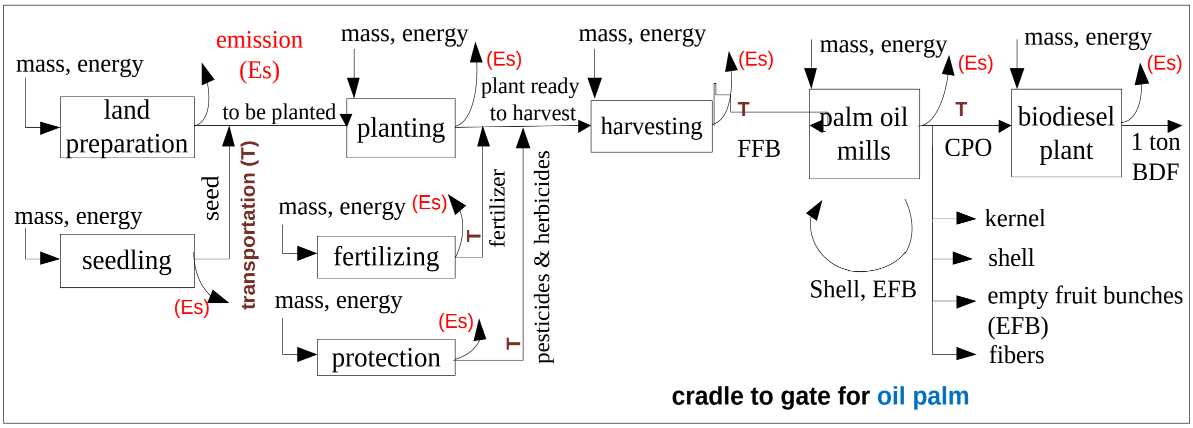

Fig.1. The system boundary of this study

B. Place and Time

The research was conducted in Laboratory of Energy and Instrumentation, Department of Agricultural Engineering, Faculty of Agricultural, Syiah Kuala Universty and collected data in oil palm plantation in Aceh Province. The research was accomplished from August 2016 up to April 2017.

C. Data Source and Research Boundaries

The data source was obtained from primary data and secondary data of numerous national and international publications from various countries. Using primary data from PTPN 1 Lhoksukon-Aceh Timur, and private company national in Aceh Province, i.e.: PT.SPS 1 and 2 in Nagan Raya, PT.Soxfindo in Nagan Raya, PT.Kurnia Tanah Subur in Meulaboh, PT.PKS in Biureun, and oil palm plantation from people, , i.e.: Kabupaten Nagan Raya, Kabupaten Aceh Barat, Kabupaten Aceh Timur, Kabupaten Biureun, dan Kabupaten Lhoksemumawe.

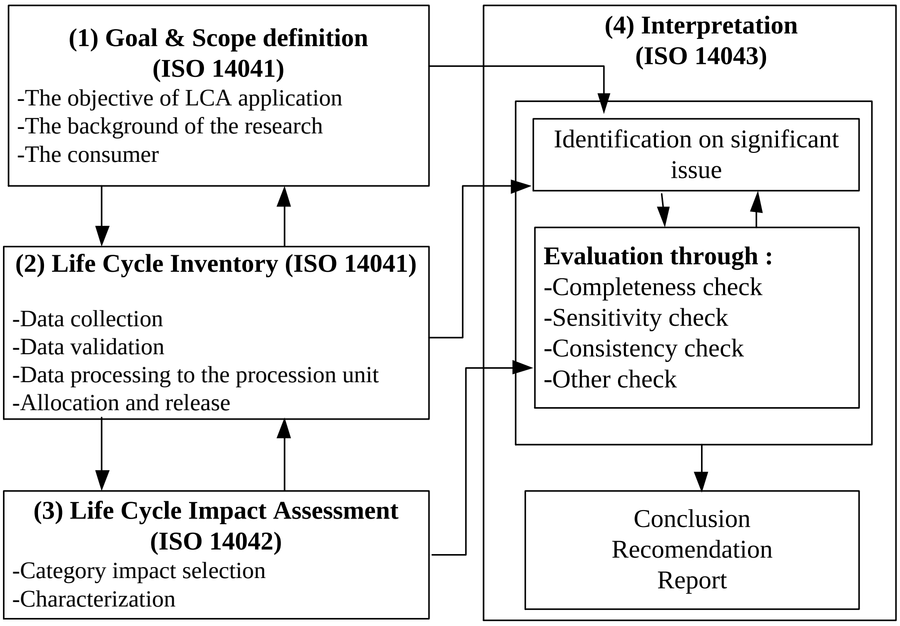

Fig.2. Four stages involved in LCA

Four stages involved in LCA are shown in Fig.2. LCA is a life cycle assessment of a product from its existence until its extinction. However, in regard with the limitation of data, time and accessibility, and the objective, this research is limited to these conditions :

1. This study is branded with "cradle to gate" life cycle assessment, which is from land preparation up to the biodiesel production.
2. The data used for analysis with in the range of seed preparation to harvesting is secondary data from numerous sources, which presents the typical Aceh Province oil palm plantation activity.
3. The biodiesel production from oil palm involve some processing activities from land preparation, seedling, planting, fertilizing, protection, harvesting, palm oil mill, and biodiesel production. The biodiesel production is processed under catalytic reaction.
4. Data analysis is carried out to analyze the energy consumption, net energy balance, renewable index and energy ratio.

D. Calculation of NEB, NER and RI

By products generated from biodiesel processing should be maximally used for energy source during biodiesel process. James (2006) said that the amount of energy required for the production of biodiesel is relative to the energy content [3]. This hypothesis can be evaluated with the net energy balance (NEB) as shown in Eq. 1.

$$NEB : E_{bdf} - (E_{ff} + E_{fo}) \tag{1}$$

Where :

E_{bdf} : energy content of biodiesel fuel

E_{ff} : energy content of fossil fuel

E_{fo} : other fossils as a source of energy used during the entire production cycle.

The potential impact value and energy required by each process (energy produced by fuel) is summed to obtain the total value of the entire process, from the handling of pre-harvest, harvest and post-harvest, and until the biodiesel is produced. In this research, the concept of energy balance is that the incoming energy is equal to the amount of stored energy and energy leaving the system, i.e. Eq. 2.

$$Energy_{input} = Energy_{stored} + Energy_{output} \tag{2}$$

In the context of biodiesel processing which is being studied, the energy balance is as Eq. 3.

$$Energy_{input} = Energy_{process} + Energy_{output} \tag{3}$$

If input energy is described into sub system as shown in Fig.1, the equation is as follow is Eq. 4.

$$\underbrace{Energy_{input}}_{E_{in}} = \underbrace{Energy_{CPO}}_{E_1} + \underbrace{Energy_{MeOH} + Energy_{NaOH}}_{E_2} \tag{4}$$

The energy process is performed from preparation-transesterification-washing and so on to form biodiesel (E_{pr}).

$$\begin{aligned} E_{pr} &= Energy_{fossil} + Energy_{non-fossil} + Energy_{electricity} \\ &+ Energy_{mechanical} + Energy_{thermal} \end{aligned} \tag{5}$$

The energy output consists of :

$$\underbrace{Energy_{output}}_{E_{out}} = \underbrace{Energy_{biodiesel}}_{E_{out\_target}} + \underbrace{Energy_{glyerol} + Energy_{MeOH\_residual}}_{E_{out\_residual}} \tag{6}$$

If catalyst (NaOH) can be recycled 100% and calculated methanol is used so there is no residual methanol, the equation is as follow:

$$Energy_{input} = Energy_{CPO} \tag{7}$$

The energy output is:

$$Energy_{output} = Energy_{biodiesel} + Energy_{glycerol} \tag{8}$$

Based on the above mentioned equations, it can be described three energy parameters for biodiesel production and feasibility, i.e.:

$$Net\ Energy\ Ratio = \frac{Energy_{output}}{Energy_{input}} \tag{9}$$

$$Net\ Energy\ Balance = Energy_{output} - Energy_{process} \tag{10}$$

$$\mathrm{Re}newable\ Index = \frac{Energy_{renewable}}{Energy_{process}} \leq 1 \quad (11)$$

III. RESULTS AND DISCUSSION

A. Inventory Data

Life cycle inventory (LCI) involves collecting all necessary environmental burden data to meet the objectives of the research. The main key in the inventory phase is data collection. It usually relates the number of primary data, secondary data which obtained from national and international journal, student field practice report on palm oil, undergraduate thesis, graduate thesis, relevant research report, and also publication released from national private plantation companies. The biodiesel has marked an increased acceptance in the global market as an environmentally friendly diesel fuel [2]. LCI was conducted based on input-output analysis of mass and energy at each production line, as shown in Fig. 1. Overall averaged data (primary and secondary data) is has collected [3, 4, 5, 6, 7, 8, 9]. Data inventory shows that production of small holder's palm oil plantation is around 10 tons FFB per ha per year. While private estate with better seedling, maintenance and fertilization produces approximately 30 tons FFB per ha per year, with average yield about 20 tons FFB per ha per year. During stable production, palm oil can produce biodiesel up to 4 tons per ha per year. Pleanjai et al. said that 6-7 tons FFB (yield 15.38 %) or 1.14 tons of CPO (yield 87.7 %) is needed in order to produce 1 ton of biodiesel [10]. Palm oil consumes high nutrient from mineral fertilizer in Southeast Asia (Hardter & Fairhurst, 2003 in [11]). Fertilizer is used to produce and maintain high productivity. This is usually conducted through applying such amount of fertilizers-based nitrogen-NPK (ammonium nitrate), ammonium sulfate and urea. Detail description of eight sub-processes involved in LCI for palm oil is shown in Table 1. Collected data of material and energy used for 1 ton BDF production of oil palm is shown in Table 2.

Table 1. The detail description of life cycle on biodiesel production from oil palm in Aceh Province

Input activities	Component	Oil palm
(1) Land preparation	Early land uses	Primer & skunder forest
	Soil fertility	Fertile
	Tree, diameter > 60 cm	26-100 trees/ha
	Tree, diameter > 30 cm	Approx. 2500 trees/ha
	Coarse grass	10-30 groups/m^2
	Soil tillage	Effective soil depth 50-150 cm
	Plant above the soil surface	Nuts
(2) Seedling	Seedling time	12 months
	Seedling source	Seed
(3) Planting	Plants width space	9 x 9 x 9 m
	Number of plants	136/ha
	Number of hole	50 x 40 x 40 cm
(4) Fertilizing	Fertilizer compound	N,P,K,Mg,B, organic fertilizer
	Intensity	Very intensive
(5) Protection	Plant pest	Many kinds of pest presents
(6) Harvesting	Start to produce	30 months
	Production on stable productivity	8 tons seed/ha
	Edible/non-edible	Edible
(7) Palm oil mills or Extraction oil	Production of crude oil	By milling
	Value of FFA	<2
	Ratio of FFB to crude oil	21%
	Produced biomass	Empty bunch, fruit fiber, shell, palm kernel
(8) Biodiesel production	Reaction of biodiesel production	Transesterification
	Ratio of crude oil to biodiesel fuel	92%
	Biodiesel source	Pulp, kernel
	Catalyst	Alkali

Table 2. Mass and energy used for 1 ton BDF from oil palm

Process	Mass and Energy	Unit	Oil palm
(1) Land preparation	Herbicide	kg	0.861
	Diesel fuel for toppling & clearing	L	0.703
(2) Seedling	Fungicides	kg	-
	Insecticides	kg	0.00018
	Chemical fertilizer Urea 0.2 %	kg	0.00492
	Organic fertilizer	kg	8.367
	Kieserite ($MgSO_4$)	kg	2.008
	Urea	kg	0.00007
	Herbicide	kg	0.974
	Dolomite	kg	2.949
	Compound fertilizer	kg	4.686
	Electricity for Pump Water	kWh	0.436
	Pesticides	kg	0.004
	Transportation by diesel fuel for truck 5 tons	L	1.004
(3) Planting	TSP/SP36	kg	13.387
	Rock Phosphate	kg	22.887
(4) Fertilizing (for five years)	Compound fertilizer	kg	9.844
	Rock Phosphate	kg	252.492
	ZA/Urea	kg	279.464
	HGF Borate	kg	3.347
	TSP/SP36	kg	117.140
	MOP (K)/KCl	kg	245.995
	Kieserit	kg	184.078
	HGF Borate	kg	3.347
(5) Protection (for five years)	Herbicide	kg	56.317
	Insecticides (liquid & powder)	kg	1.323
	Pesticides	kg	0.801
	Diesel for power sprayer & fogging	L	0.554
(6) Harvesting	Diesel fuel for truck 10 ton	L	5.027
(7) Palm oil mills vs Oil extraction	Electricity from grid	kWh	34.392
	Steam consumption	kg	1325.39
	Water consumption	m^3	3.968
	PAC	kg	0.125
	Flokulon	kg	0.00053
	NaOH	kg	0.107
	H_2SO_4/HCl	kg	0.109
	Tanin Consentrate	kg	0.045
	Poly Perse BWT 302	kg	0.045
	Alkaly BWT 402	kg	0.043
	Shell consumption	kg	133.862
	Transportation by diesel fuel for truck 10 tons	L	2.540
(8) Biodiesel production	Methanol	ton	0.269
	Electricity from grid	kWh	15.645
	NaOH	ton	0.080
	Water consumption	L	1700.68
	Diesel fuel for Boiler	L	14.00

B. Impact Assessment of Energy Consumption

Evaluation of impact assessment was carried out using data produced in inventory data and MiLCA-JEMAI (Multiple Interface Life Cycle Assessment-Japan Environmental Management Association for Industry) version 1.1.2.5 for data processing.

Fig. 3 show that energy consumption for oil palm. The largest energy consumption for oil palm is fertilization sub-process i.e. 19 850.00 MJ/ton-BDF-CPO. The total value of energy consumption before stable production for oil palm is 51,831.17 MJ/ton-BDF-CPO. Fig. 8 shows that oil palm energy consumption during land preparation, seedling, planting, fertilizing, protection, harvesting, palm oil mills, and biodiesel production is 0.33 %, 0.49 %, 0.78 %, 36.60 %, 12.47 %, 0.85 %, 16.04 %, and 32.45 %, respectively. The percentation of proportion of each stage including pre-harvest, harvest and post-harvest is 50.66 %, 0.85 %, and 48.9 %, respectively. James et al. explained that the amount of energy required to produce biodiesel is relative to the energy content [3]. This is due to renewable energy characteristic on the feedstock it self, such as palm oil, where the waste still can be used as a source of energy during processing and it also because most agriculture energy analyst believes that solar energy is freely provided. Table 3 shows the proportion of each stage which comprises pre-harvest, harvesting and post-harvest.

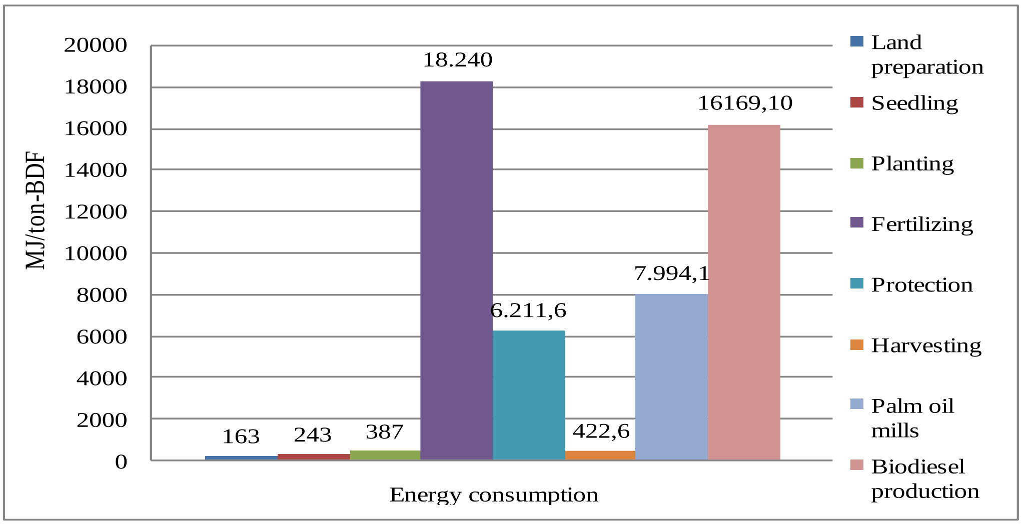

Fig. 3. The energy consumption value of oil palm before stable production (1-5 year)

Table 3. Energy consumption percentage for LCA of oil palm from cradle to gate

Input activities	Percentage (%)
	Palm oil
Pre-harvest	50.66
Harvesting	0.85
Post-harvest	48.49

C. Net Energy Balance, Net Energy Ratio, and Renewable Index

Fig. 4 shows the NEB value of BDF-CPO throughout its life cycle. NEB value is the result of output energy values substracted by energy processes. The output energy consists of BDF-CPO energy added with glycerol energy, while the energy process consists of fossil energy added with renewable energy which is calculated from the beginning of the process until the biodiesel is produced in accordance with the limits in this experiment. According to the NEB value, it can be seen that the value during initial production is still negative, because the production is not as high as the energy process used. The NEB value will become positive as the production increases due to the production energy in the form of produced biodiesel has become higher than the energy process during biodiesel production. The positive value of NEB means that there is energy surplus during the production process which presents good sustainability.

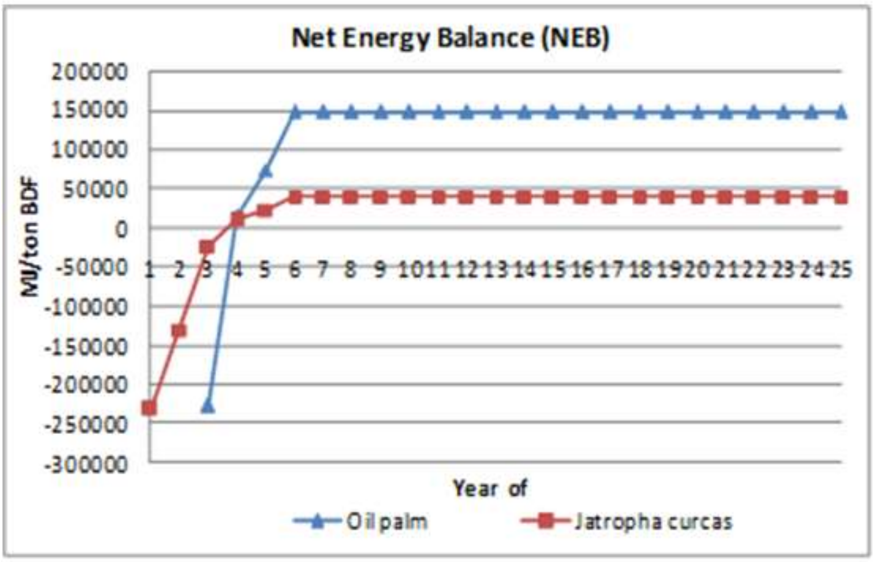

Fig. 4. The NEB value of BDF-CPO throughout its life cycle (1-25years)

Fig. 5 shows NER value for oil palm i.e. 1.041. NER value is derived from the value of energy output that consists of energy BDF-CPO added with glycerol energy and divided with energy input that consists of CPO energy. It turns that NER value appears to be constant value due to increased output value will increase the input value, although the NER value can reach higher value if the produced biomass energy is calculated as output energy.

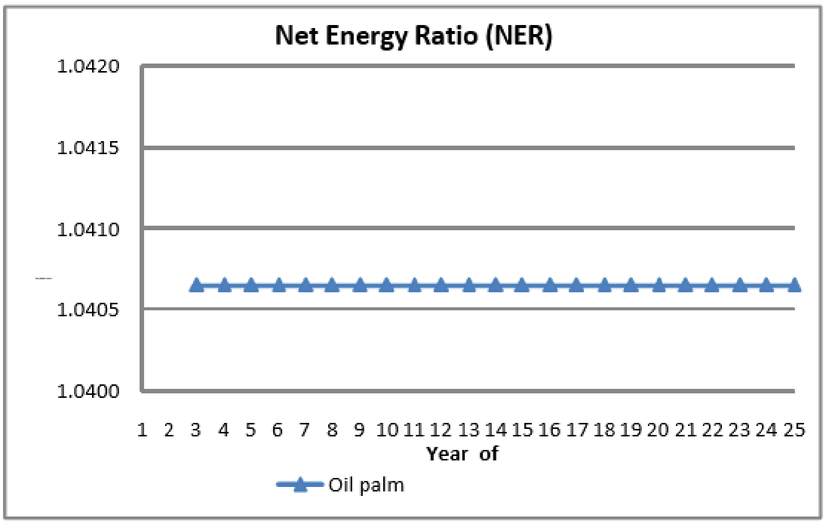

Fig. 5. The NER value of BDF-CPO throughout its life cycle (1-25 years)

Fig. 6 shows RI value of palm oil. RI is an indicator of renewable energy amount used in the biodiesel production. If RI increases or closes to one mean that more of renewable energy used in this process. In other words, if more fossil energy used in the process means that RI value should be increased to perform environmental friendly of biodiesel production. Siregar (2013) said that biodiesel from crude jatropha curcas oil had lower fossil energy used during its life cycle than the palm oil. The increasing number of oil palm will increase fossil fuel consumption including the diesel fuel consumption in boiler. This condition can be anticipated by using biomass produced by biodiesel during its production in boiler.

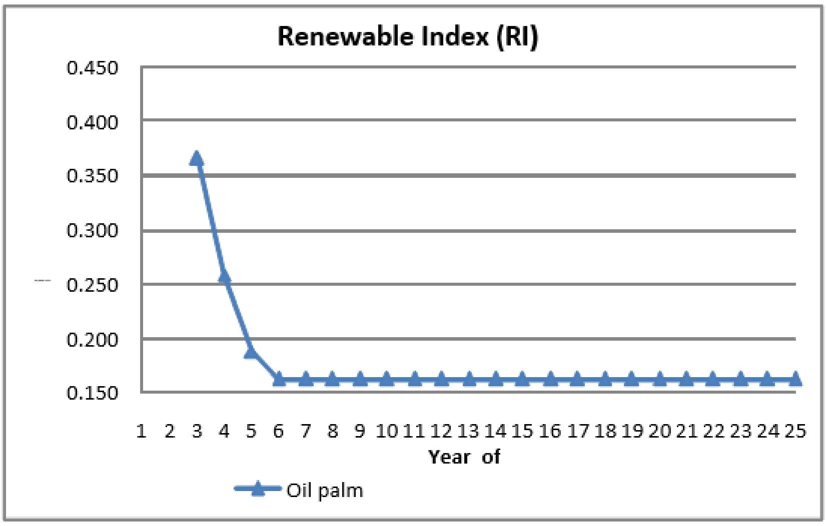

Fig. 6. The RI value of BDF-CPO throughout its life cycle (1-25 years)

Fossil fuel has negative NEB, the second law of thermodynamic says that if energy does not enter or leave the system then the potential energy will always be lower than the initial state. In the conversion of crude oil into gasoline, Net Energy Ratio (NER) is determined as the energy output divided by the energy input of gasoline. The NER value is less than one (= <1). NEB and NER are two methods for evaluating the sustainability of biofuels since energy crisis in 1970's (U.S. Department of Energy, 1980). Lam et al. (2009) said that the ratio of energy output and energy input on palm oil based biodiesel is 2.27 [12]. Stout (1990) in James (2006) states that NEB value of biofuel is positive due to renewable energy inherent in the raw materials, the waste can still be used as an energy source in the treatment process, and because most of agricultural energy analysts realize that the sun energy is freely captured by biomass [3]. It is believed that the fuel with higher NEB is said to have more efficient energy. If the NEB has low value, the biofuel will have low production efficiency or equal to higher load environment and higher resource consumption for fuel production.

Thus, NEB can be used as the first approach in measuring environmental sustainability of biofuel. Besides of emission and environmental impact, the other focus relies on energy consumption process. Besides of that energy, biomass used in boiler is also considered as renewable. Renewable energy percentage of all required energy is called renewability. If waste is also used as fuel for production process, the net energy production can be calculated.

If the required value of the energy input per unit mass is higher than the heating value of produced fuel or has low efficiency, it appears that the technology is not appropriate to produce related fuel. It means that new technology should be developed or modificated. This might occur also in energy input using fossil fuel or non-fossil fuel because if everything is converted into the energy per unit mass or MJ/kg it will have similar analysis. However, if non-fossil fuel is derived from processing material, the efficiency calculation will use available energy input. For example, this condition occurs when palm oil bunch is used for broiler.

Renewable index (RI) presents the value of renewable energy in the biodiesel production process path. If compared to energy from fossil, higher RI means that the development process on this biodiesel is getting better or more sustain.

IV. CONCLUSION

1. Energy consumption for producing biodiesel from oil palm was found that pre-harvest activity was higher compared to post harvest activity.
2. The largest energy consumption for biodiesel production from cradle to gate is is fertilizing sub-process i.e. 19,850.00 MJ/ton-BDF. The total value of energy consumption before stable productivity for oil palm is 51,831.17 MJ/ton-BDF.
3. The NEB value of oil palm is 146,948.08. The RI value of oil palm is 0.162, and NER value for oil palm i.e. 1.041 .

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REFERENCES

[1] Cowell SJ. 1999. Use of Environmental Life Cycle Assessment to Evaluate Alternatif Agricultural Production Systems, Proceeding 52nd Plant Protection Conference: 40-44. New Zealand. http://www.hortnet.co.nz. (Accessed January 19, 2017).

[2] Searcy C. 2000. An Introduction to Life Cycle Assessment.http://www.i-clps.com/lca/. (Accessed 20 April 2017).

[3] James A.D, Shapouri H, Wang M, Assessment of Biofuels. Renewables-Based Technology: Sustainability Assessment. John Wiley & Sons, Ltd. ISBN: 0-470-02241-8.2006.

[4] Alamsyah R, *Studi Proses Mekanisme Pengadukan Dengan Metode Static-Mixer Untuk Meningkatkan Efisiensi Transesterifikasi Minyak Sawit Menjadi Biodiesel*, Disertasi. Pascasarjana. IPB. Bogor.2010. [Bahasa Indonesia]

[5] Pahan I, *Panduan lengkap kelapa sawit-manajemen agribisnis dari hulu hingga hilir*. Depok : Penebar Swadaya. 2011.[Bahasa Indonesia]

[6] Lubis R.E, Widanarko A, *Buku Pintar Kelapa Sawit*.Agromedia. Jakarta.2011. [Bahasa Indonesia]

[7] Wicke B, Sikkema R, Dornburg V, Faaij A, Exploring land use changes and the role of palm oil production in Indonesia and Malaysia, Elsevier : Land Use Policy, 1 June, 2010.

[8] Pardamean M, *Sukses Membuka Kebun dan Pabrik Kelapa Sawit*. Penebar Swadaya. Depok, Jakarta.2011. [Bahasa Indonesia]

[9] Siregar K, Tambunan AH, Irwanto AK, Wirawan SS, Araki T, A Comparison of Life Cycle Inventory of Pre-harvest, Production of Crude Oil, and Biodiesel Production on Jatropha curcas and Palm Oil as A Feedstock for Biodiesel in Indonesia. Proceeding of Ecobalance 2012 conference,Yokohama 21 – 24 November 2012, Japan. 2012.

[10] Pleanjai S, Gheewala S.H, and Garivait S, Environmental Evaluation of Biodiesel Production from Palm Oil in a Life Cycle Perspective.Asian J. Energy Environmental, 8 (2007) 15-32

[11] Siregar, K., Tambunan,A.H., Irwanto,A.K., Wirawan,S.S., Tetsuya,A. 2013. Comparison of Emission and Energy for Biodiesel Production from Oil Palm (Elaeis guineensis) and Jatropha Curcas (Jatropha curcas L.) Based on Life Cycle Assessment (LCA) in Indonesia, Dissertation. Bogor Agricultural University.

[12] Lam MK, Lee TK, Mohamed AR. 2009. Life Cycle Assessment for The Production of Biodiesel: A Case Study in Malaysia for Palm Oil versus Jatropha Oil.Society of Chemical Industry and John Wiley & Sons, Ltd, 5 October 2009.

E.8

PROCESS ANALYSIS OF RAW PALM OIL MILL EFFLUENT USING SINGLE FEEDING SYSTEM

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ABSTRACT

Palm Oil Mill Effluent (POME) can be classified into three types of waste: liquid, solid , and gas.Generally the liquid waste of palm oil millcontains are dissolved solids and suspended colloids, residues, and high levels of oil.If the liquid waste is directly discharged into river is very potential to environment pollute so the need for processing. The purpose of this research is to monitor and evaluate the processing of Waste Water Treatment Installation (WWTI). Fresh liquid waste (raw material) was tested for its quality characteristics using pH, BOD, COD, oil & fat levels, amonia levels, and TSS parameter. Monitoring processs to find out fluctuations with pH, VFA, TA, and VFA/TA measurements. The characteristic of the palm oil mill effluents were on average are pH 3,71, BOD 18,529, COD 58,540, oils and fats 2,593 Mg/L, Amonia 73 Mg/L, and Total Suspended Solid (TSS) 18,750 Mg/L. The result of Raw Oil Palm Mill Effluent monitoring on anaerobic processing with single system of feeding is very helpful to the process of degradation of organic material, by mixing the old waste with fresh waste, pH value average is 7,3, VFA value average is 274 mg/L, and value of TA 4.355 mg/L. The ratio of VFA/ TA was 0,07, it acceptable when the standard is under 0,2.

Keywords : Anaerobic, effluent, liquid waste, palm oil mill, single feeding.

I. INTRODUCTION

According to World Wild Foundation (WWF) Indonesia 2013 Indonesia was produced 47,6% oil *palm (Elaeis guineensis Jacq)* from total of palm oil production in the world with total production of Crude Palm Oil (CPO) with 26 million ton [1].

Mostly palm oil mill in Indonesia process Fresh Fruit Bunches (FFB) from 1200-1800 tons each day with palm oil mill capacity around 45-90 tons FFB each hour and duration of the processing around 20 hours each day ([2], [3]).

The processing of palm oil requires steam around 1 m^3 of water each ton FFB, is used for boiling, pressing, as well keeping the oil temperature in the tank of sterilization and storage tank [4]. The three main sources of Palm oil mill effluent (POME) generated from a palm oil mill are condensate from steriliser, sludge, hydrocyclone or claybath wastewater ([5], [6], [7]). In the palm oil mill processing, about 50% (0.75 cubic meters) of the water source eventually became POME, the other 50% turn out to be used water [8].

The growing demand for palm oil has caused a substantial increase of POME [9]. POME contains are minerals, carbohydrates, fibres, protein, remains of oil etc [6]. POME is generally treated using a series of shallow and large ponds (Biological treatment systems). The pool can't be so deep, the volume of a very large reaction can be done by increasing the surface area.

Characteristics of POME are high-temperature (80–90 °C) [10] with acidic (pH between 4 and 5), brownish, [11] dissolved solids containing, suspended colloid and oil residues with high COD (Chemical Oxygen Demand) contents [12]. If the liquid waste directly discharged into the water is potentially polluting the environment, so it must be processed first before removal. These wastes has been processed or digested in the waste treatment plant according to the Indonesian Ministry of Environment Regulation No. 5 Year 2014 [13].

POME to be applied, must be processed or treated, with BOD (Biological Oxygen Demand) value between range 3,500-5,000 m /L, and pH about 6,2-7,2. Treatment and disposal of oily wastewater, like POME is presently one of the serious environmental problems contributors [14]. The POME ponding system contained a cooling/grid pond, four stages of anaerobic ponds and aerobic ponds [15] with Hydraulic Retention Time (HRT) for the ponding system is 45–60 days [11]. The open pond system is presently used to treat the POME because the open pond system is cheap and less maintenance required [9].

In this research, waste treatment was done by using single feeding systems, that is waste treatment with sequential or serial drainage from cooling pond, mixing pond, anaerobic pons, and aerobic pond or contact pond. Unlike the single feeding system, multiple feeding is a random waste treatment systems, the waste stream does not have to be sequential or parallel. The advantages of single feeding system is the operation is easy, do not need a complex control system, and regularly. But this system has weaknesses, among others: it takes long hydraulic retention time, many nutrient nutrients that participate decompose so many missing nutrients, cannot suitable for land application as fertilizer [7].

The study focuses on the inputs and outputs of the anaerobic of POME with single feeding system. The purpose of this research are to monitor and evaluate the processing of Waste Water Treatment Installation (WWTI) with single feeding system especially on pH, TA (Total Alkalinity), and VFA (Volatile fatty acid).

II. MATERIALS AND METHODS

A. Vanue and Times

The research was conducted at one of the palm oil mill owned by a private company in Sampit, Central Kalimantan, Indonesia, which was done on July-October 2016.

B. Equipment and Materials

PH meter, measuring cylinder, erlenmeyer, breaker glass, methyl orange indikator-460-S0260 (special indicator), Alkalinity Titrant (S 0226), H_2SO_4, NaOH, and POME.

C. Data Collection

The analysis of POME treatment in open ponds was carried out using information from POME treatment at the palm oil company [13]. Data collected in this study are pH, TA (Total Alkalinity), and VFA (Volatile fatty acid) each taken on cooling pond, anaerobic pond 1, anaerobic pond 2, anaerobic pond 3, anaerobic pond 4, and contact pond. In (Fig. 1) shows all sampling points in this study.

The Biological Oxygen Demand was determined by manometric method and Chemical oxygen Demand determined using (COD meter) [16].

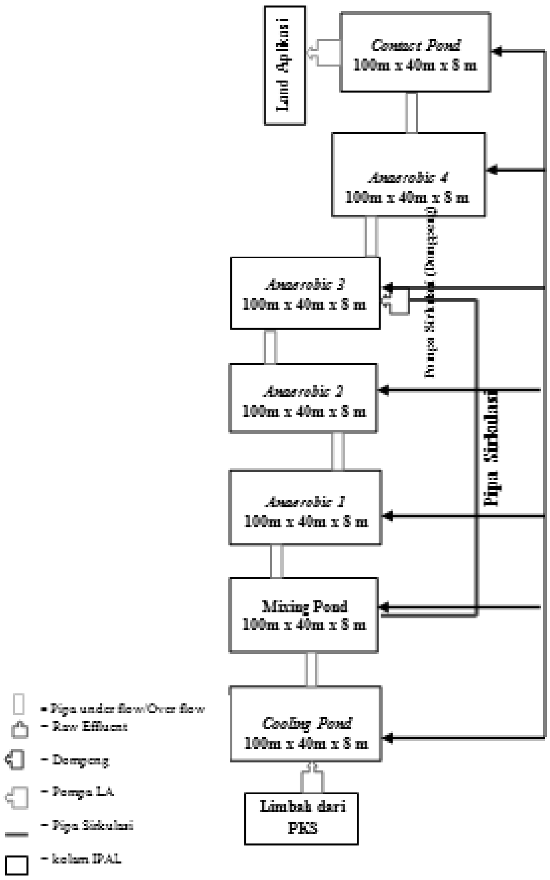

Fig. 1. Layout of treatment pond Palm Oil Mill Effluent (POME)

D. Analytical Methods

The data collected was analyzed graphical methods [17] according to standard methods for the examination of wastewater [18]. Graphical analysis was used to find correlation between independent factor, such as Total Alkalinity and pH, Volatile Fatty Acid and pH, as well Total Alkalinity / Volatile Fatty Acid and pH.

III. RESULTS AND DISCUSSION

A. Characteristics of Palm Oil Mill Effluent (POME)

The wastewater content produced by the palm oil mill from the results of the average BOD yield analysis of 18,529 mg/L, which is in the high category, the BOD content is the result of measuring the amount of oxygen that require the bacteria to degrade the organic components present in water or waste water within five days by aerobic decomposition microorganisms in a volume water at 20 °C [7].

Closely related to BOD is COD, in the waste material not all organic chemicals can be broken down by microorganisms rapidly so that the need for COD testing. Therefore, COD test result will be higher than BOD test, the value of the average test result is 58,540 mg / L.

Table 1. Physicochemical Characteristics of Raw Effluent

Month	pH	BOD (mg/l)	COD (mg/l)	Oil & Grease (mg/L)	Ammonia (mg/L)	TSS (mg/L)
April	3,69	18.138	57.378	1,243	49	15.900
May	3,84	17.533	60.903	2,284	63	15.100
June	3,34	22.571	63.463	3,052	70	17.650
July	3,72	16.626	51.148	4,075	56	25.000
August	3,97	17.775	59.807	2,309	126	20.100
Σ	3,71	18.529	58.540	2,593	73	18.750

The analysis of oil and grease content in palm oil plant was also high which is on average 2,593 ml / L. This results in a relatively stable organic compound and is difficult to break down by bacteria. The presence of TSS in a high state, then turbidity will increase and this decreases the quality of waste. The threshold value for the TSS parameter is 100 ml/L. If the factory-issued TSS exceeds 100 ml/L, then this can pollute the environment. In the results of the analysis of the quality of palm oil waste this average value per month is 18.750 mg/L.

B. pH

pH is essential parameter that used to show strength of an effluent under anaerobic condition, and it as well parameter in evaluating the acidity and alkalinity of water, wastewater and or effluents [6].

At (Fig 2) shows fluctuations in pH quality in each pond with liquid wastes fed by a single feeding system method and handling it using anaerobic system. The pH time on the cooling pond increases. Cooling pond has a pH standard between 3,5 – 4,0, while during the observation process is obtained an average of 4,23. It close to maximum standard, the cooling pond can work well.

The same condition occurs in the mixing pond has increased pH. Mixing pond has a pH standard of 5,0 to 6,5, while the observation is 5,90. The increase and decrease in pH of the mixing pond can also be influenced by the development of decomposing bacteria, if the bacteria are weakened then the raw waste feed is slowed or stopped. The pH time at anaerobic pond 1 to 4 has increased. Anaerobic ponds 1 to 4 had a pH standard of 6,8 7,5, while observations were obtained on average at 6,84, 7,29, 7,54, and 7,70 in each pool. The pH rising conditions continue to occur until the contact pond. The pH standard in the contact pond is 7,5-8,0, the pH conditions in which data obtained pH in the contact pond was averaged 7,89.

C. Total Alkalinity

The fluctuation graphs raised at (Fig.3) TA values are in the range of 3,558 - 5,760 mg / L and the average value is 4,355 mg / L while the minimum performance standard is 3,500 mg / L. Alkalinity related with water hardness, the presence of calcium (Ca) and magnesium (Mg) ions in the water will result in the hardness of the water.

TA (Total Alkalinity) in anaerobic pool 1-4 then made a linear equation for anaerobic 1 that is $y = 28{,}189x + 3659{,}2$ with $R^2 = 0{,}1211$. The anaerobic linear equation 2 is $y = 26{,}353x + 3631$ with $R^2 = 0{,}2083$, whereas for the anaerobic linear equation 3-4 is $y = 93{,}416x + 4317{,}5$ with $R^2 = 0{,}3882$ and $y = 55{,}178x + 481{,}4$ With $R^2 = 0{,}1876$.

D. Volatile Fatty Acid

VFA measurements aim to determine the saturation level of microorganisms to degrade organic material from polymer form into simpler monomers in the acidogenesis process. In this case the necessity of controlling the feeding of them when VFA value of less than 500 mg / L then the feed is made in full, if the value of VFA in the range of 500-750 mg/L then it can only feed with a share of 50%, the value of VFA in the range of 750 - 1000 mg/L then the portion of the feed is allowed only by 25% and when the value of VFA exceed 1000 mg/L then feeding the microorganisms suspended in the sense that it is no longer decompose the organic material to convert into acids such as formiat acid, acetic acid and propionic acid. From the observation value of VFA is 143 323 mg/L with an average yield of 274 mg/L. The higher concentration of volatile acids will increase hydrogen ion and decrease the value of alkalinity so that the system cannot do buffer and degradation of organic material began to be inhibited resulting in decreasing pH value. The measurement results in an anaerobic VFA 1-4 presented in (Fig.4), based on the graph linear equations made for anaerobic 1 is y = 14,769x + 119,5 with R^2 = 0,6183. Anaerobic exponential equation 2 is y = -0,8601x + 292,92 with R^2 = 0,0085, while for anaerobic 3-4 linear equations is y = 2,8392x + 267,88 with R^2 = 0,0592 and y = 2,6538x + 287,67 with R^2 = 0,1451.

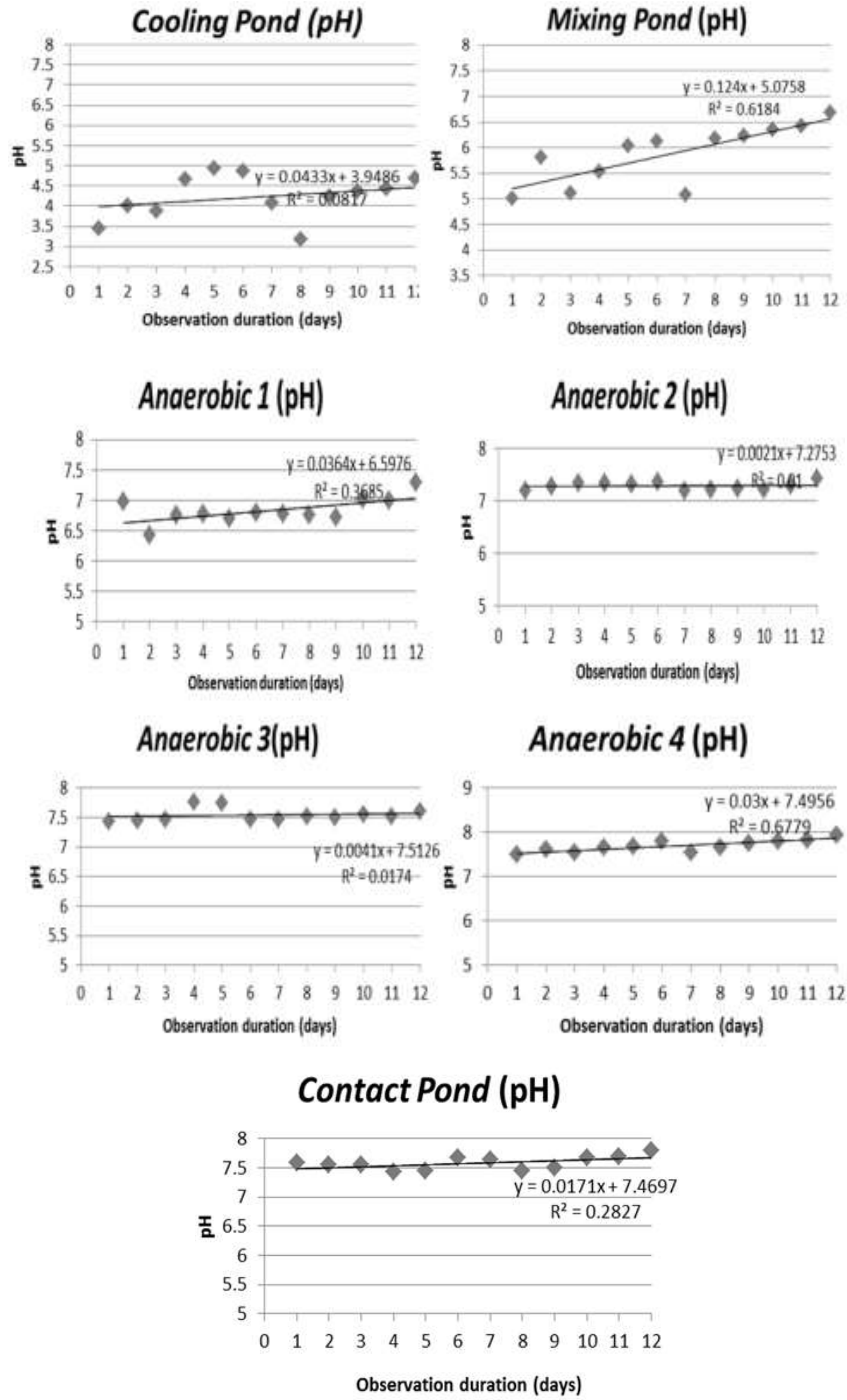

Fig. 2 Graph of pH fluctuations in each ponds

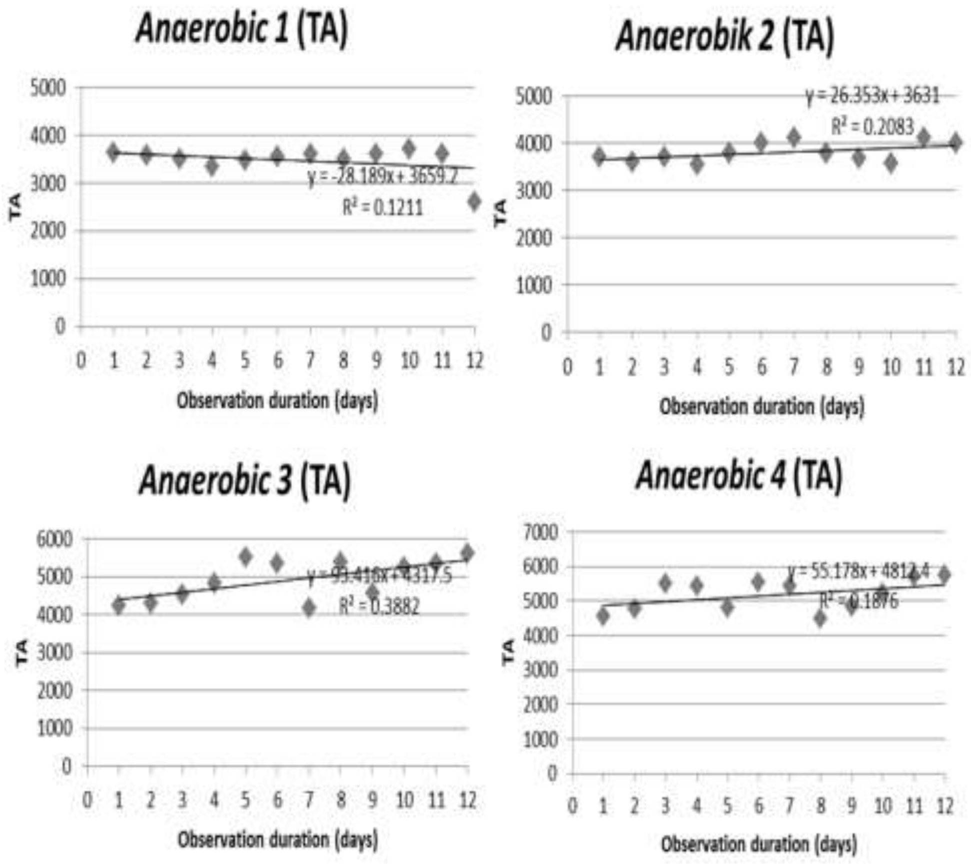

Fig. 3 Graph of TA fluctuations in each aerobic ponds

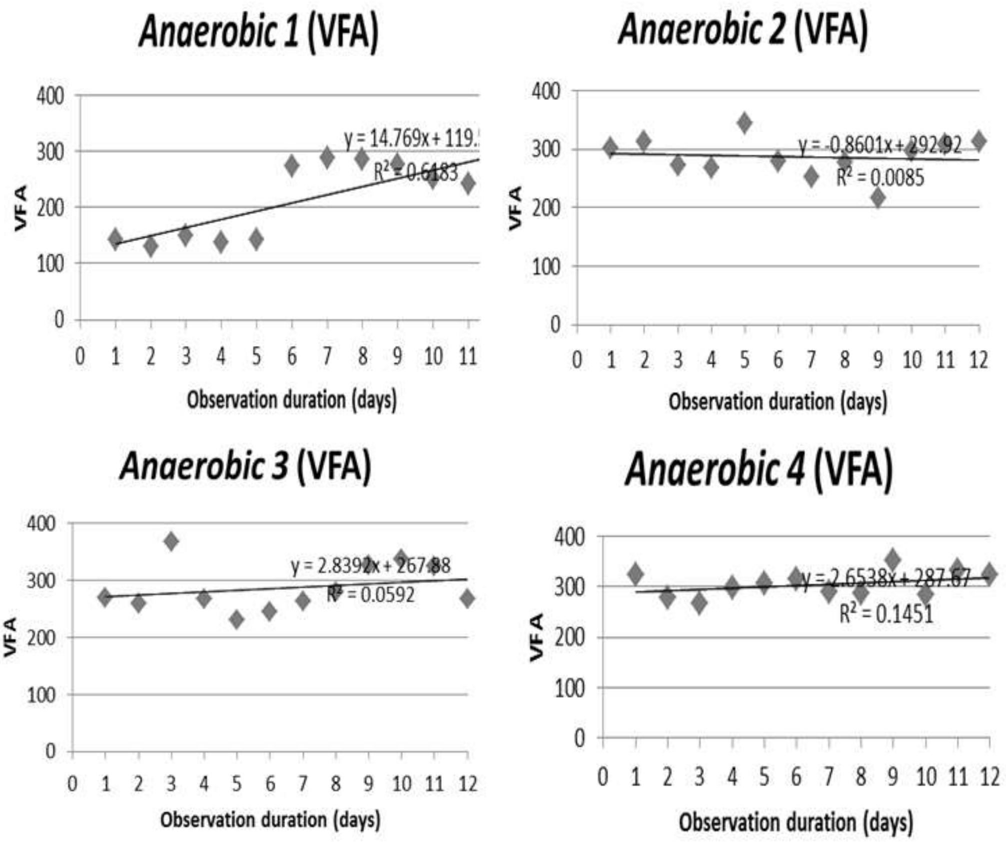

Fig. 4 Graph of VFA fluctuations in each aerobic ponds

E. TA and pH Correlation

The strong correlation relationship between the increase of pH value which impact on the increase of TA value, at (Fig.5) tested the relationship between TA and pH, exponential expression y = 206,94e0,4131x with R^2 = 0,6879. The increasing pH also affects the increase of TA value. The graph of pH relationship with TA is seen in the anaerobic process. The pH condition is already in the standard and the value of TA also has largely met the standard number indicating the waste treatment process was running well.

F. VFA and pH Correlation

The correlation relationship between the increase of pH value has an impact on the increase of VFA value, which made exponential equation y = 10,32e0,4432x with R^2 = 0,4097 and graph presented in (Fig.6). The increasing pH also affects the increase of VFA value. The graph of pH relationship with VFA is seen in the anaerobic process. Most of the pH is above 7 (pH> 7) which indicates the process of degradation of organic material goes well with marked by the increase of pH and offset by the small value of VFA.

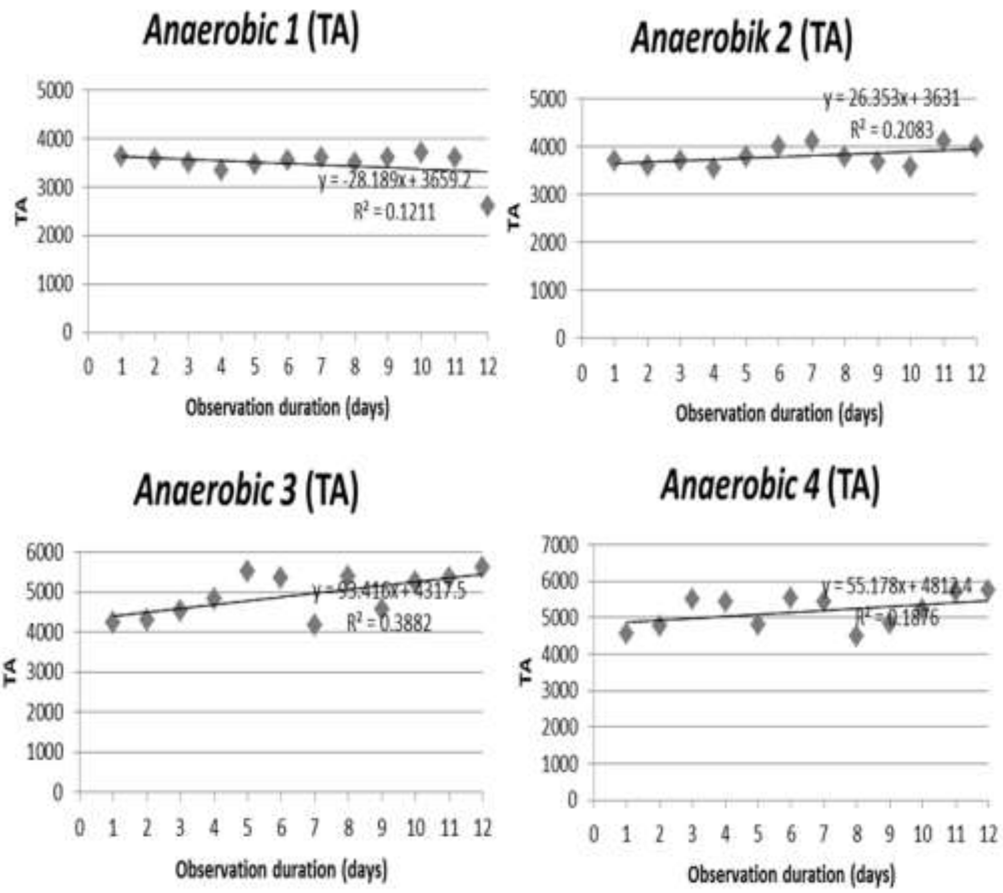

Fig. 5. Graph of TA and pH Correlation

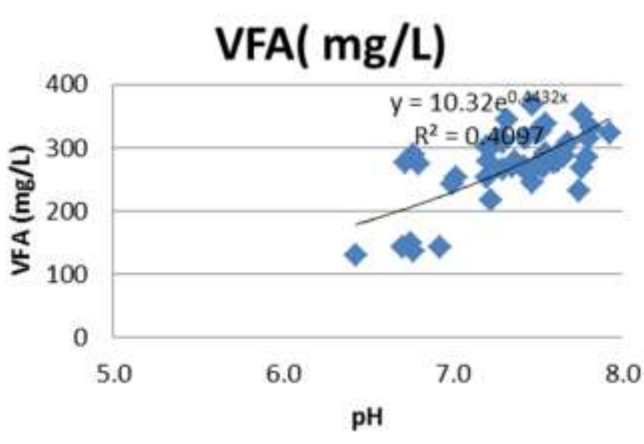

Fig. 6. Graph of VFA and pH Correlation

G. VFA/TA Ratio and pH Correlation

In the ratio between VFA / TA was between 0,04 to 0,06 while the average is 0,07 and it acceptable when the standard is under 0,2 (< 0,2). The VFA / TA ratio is when the higher the VFA the concentration of hydrogen ion evaporative acids will increase while the alkalinity will decrease so the system cannot buffering.

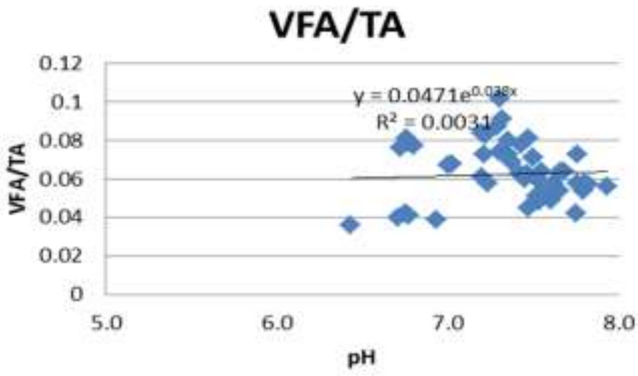

Fig. 7. Graph of VFA/TA Ratio and pH Correlation

The correlation between VFA / TA ratio and pH was presented at (Fig.7) with exponential equation 0,0471e0,038x and R^2 = 0,003.

When the high decarboxylation process produces carbon dioxide reacts with water to produce ionic carbonic acid it produces bicarbonate then the system will buffering for the process of degradation organic matter. So the ratio of VTA / TA shows the process of degradation of organic matter.

IV. CONCLUSIONS

The performance of the palm oil mill effluent treatment ponding systems was well marked by the compliance of operational standards due to the increasing parameters in each pond such as the significant pH, TA and VFA. Anaerobic POME processing process with single feeding system is very helpful in the process of degradation of organic matter, by mixing between old waste and fresh waste, the average pH value is 7,3 VFA value average 274 mg/L and TA 4,355 mg/L. The feeding process was said to be good with marked with a ratio of VFA / TA of 0,07.

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REFERENCES

[1] R. A. Renjani, Priyambada, and E. Suhartanto, "Utilization of Oil Palm Solid Waste into Biomass Pellet Solution for Friendly Waste Management," in *Prosiding Seminar Nasional Perhimpunan Teknik Pertanian Indonesia*, 2016, pp. 447–454.

[2] A. M. Syam, R. A. Renjani, and N. D. Dharmawati, "Analisis Losses pada Nut and Kernel Station Melalui Proses Pendekatan di Setiap Peralatan," in *Prosiding Seminar Nasional PERTETA*, 2011, pp. 134–137.

[3] M. Hafiz, R. A. Renjani, A. Haryanto, N. Araswati, and I. D. M. Subrata, "Design of Temperature and Volume Control System at Crude Palm Oil (CPO) Storage Tank," in *International Conference on the Role of Agricultural Engineering for Sustainable Agriculture Production*, 2016, vol. C, no. December, pp. 95–102.

[4] Hermantoro and R. A. Renjani, "Studi Pemanfaatan Water Rejected Reverse Osmosis untuk Kebutuhan Air Domestik dan Sebagai Boiler Feed Water di Pabrik Kelapa Sawit," in *Prosiding Seminar Nasional Perhimpunan Teknik Pertanian Indonesia*, 2014, no. September, pp. 195–199.

[5] A. N. Ma and A. S. H. Ong, "Treatment of Palm Oil Steriliser Condensate by an Anaerobic Process," vol. 23, pp. 85–97, 1988.

[6] E. I. Ohimain and S. C. Izah, "A review of biogas production from palm oil mill effluents using different configurations of bioreactors," *Renew. Sustain. Energy Rev.*, vol. 70, no. November 2016, pp. 242–253, 2017.

[7] T. Yeong, A. Wahab, J. Jahim, and N. Anuar, "Pollution control technologies for the treatment of palm oil mill ef fl uent (POME) through end-of-pipe processes," *J. Environ. Manage.*, vol. 91, no. 7, pp. 1467–1490, 2010.

[8] W. Loan, M. Azraai, K. Muda, S. Kheang, and A. Chioma, "Conventional methods and emerging wastewater polishing technologies for palm oil mill ef fl uent treatment : A review," *J. Environ. Manage.*, vol. 149, pp. 222–235, 2015.

[9] K. Gobi and V. M. Vadivelu, "By-products of palm oil mill ef fl uent treatment plant – A step towards sustainability," *Renew. Sustain. Energy Rev.*, vol. 28, pp. 788–803, 2013.

[10] N. Wongfaed, P. Kongjan, and S. O-thang, "Effect of Substrate and Intermediate Composition on Foaming in Palm Oil Mill Effluent Anaerobic Digestion System," in *Energy Procedia*, 2015, vol. 79, pp. 930–936.

[11] P. Rupani and R. Singh, "Review of current palm oil mill effluent (POME) treatment methods: Vermicomposting as a sustainable practice," *World Appl. Sci. …*, vol. 11, pp. 70–81, 2010.

[12] M. Khemkhao, S. Techkarnjanaruk, and C. Phalakornkule, "Bioresource Technology Simultaneous treatment of raw palm oil mill effluent and biodegradation of palm fiber in a high-rate CSTR," *Bioresour. Technol.*, vol. 177, pp. 17–27, 2015.

[13] S. Sisbudi, P. Grundmann, and S. Soebronto, "Anaerobic treatment of palm oil mill ef fl uents : potential contribution to net energy yield and reduction of greenhouse gas emissions from biodiesel production," *J. Clean. Prod.*, vol. 64, pp. 619–627, 2014.

[14] J. D. Bala, J. Lalung, and N. Ismail, "Palm Oil Mill Effluent (POME) Treatment '' Microbial Communities in an Anerobic Digester: A Review," *Int. J. Sci. Res. Publ.*, vol. 4, no. 6, 2014.

[15] A. Y. Zahrim, A. Nasimah, and N. Hilal, "Journal of Water Process Engineering Pollutants analysis during conventional palm oil mill effluent (POME) ponding system and decolourisation of anaerobically treated POME via calcium lactate-polyacrylamide," *J. Water Process Eng.*, vol. 4, pp. 159–165, 2014.

[16] I. Ntroduction, "Use of fungi in bioremediation of palm oil mill effluent (POME)," *Int. J. Adv. Res. Technol.*, vol. 3, no. 5, pp. 1–8, 2014.

[17] A. W. Krisdiarto and L. Sutiarso, "Study on Oil Palm Fresh Fruit Bunch Bruise in Harvesting and Transportation to Quality," *Makara J. Technol.*, vol. 20, no. 2, pp. 67–72, 2016.

[18] W. Suksong, P. Kongjan, P. Prasertsan, T. Imai, and S. O-Thong, "Optimization and microbial community analysis for production of biogas from solid waste residues of palm oil mill industry by solid-state anaerobic digestion," *Bioresour. Technol.*, vol. 214, pp. 166–174, 2016.

E.9

INDONESIAN PALM OIL: FROM GLOBAL MARKET TO DOMESTIC MARKET FOR BIOFUEL

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ABSTRACT

Increasing pressure from European Market for sustainable palm oil and uncertainty demand for palm oil in international market have provoked Indonesia to convert market destination to domestic market for biofuel industry. Changing market destination from global to domestic market was considered to save palm oil industry and oil palm growers, particularly smallholders. However, use of palm oil for biofuel need subsidy from government while the effort of EU to increase sustainability in palm oil production is still not clear. The objective of this paper is to assess prospects and challenges of Indonesian palm oil facing pressure from EU and potential domestic market for biofuel industry. Can domestic biofuel industry be an alternative market for Indonesian palm oil? Can sustainability in oil palm production still be achieved? This study was conducted using literature reviews and data from previous literatures and report from various institutions. The result shows that biofuel could be a long-term alternative strategy. The use of biofuel to replace fossil fuel need research to ensure its compatibility with current machinery products. Price fluctuation of fossil fuel affects the competitiveness of biofuel as a substitution.

Keywords : palm oil, biofuel, global market, domestic market

I. INTRODUCTION

Increasing pressure from international market, particularly European Market, for sustainable palm oil and uncertainty demand for palm oil in international market have inspired Indonesia to change market destination from global to domestic market for biofuel industry and downstream industry.

Palm oil plantation and mill have been established in early 20th Century in North Sumatera, Indonesia. However, development of large-scale palm oil industry commercially by Indonesian government estate plantations (Perusahaan Negara Perkebunan/PNP and Perseroan Terbatas Perkebunan/PTP) has been started since 1970s, followed by PIR scheme (1980), PIR Trans (1986) and PIR KKPA (1996) [1,2]. PNP was funded by The World Bank and The Asian Development Bank while PIR Trans was funded by Domestic National Banks. PIR KKPA was funded by Skip Kredit KKPA. There is little information on when independent oil palm smallholders started their plantation, however some literatures mentioned that independent farmers have started their own plantation since 1990s [3,4].

Palm oil industry grows significantly due to increase demand for palm oil and its derivative products. Crude Palm Oil (CPO) and Kernel Palm Oil (PKO) are preferable material for industry and manufactures for food, non-food, and biodiesel [5,6]. Palm oil has several advantages for manufactures and industries: first, oil palm productivity is the highest amongst vegetable oil providing large quantity of supply with relatively low prices [6]; second, oil palm needs less agricultural land compared to other edible oil.

Demand for CPO and Fresh Fruit Bunch (FFB) grew rapidly in 1990s and 2000s. High demand for FFB was responded by growers through land expansion. Increasing productivity in the existing plantations was not chosen due to lack of information and knowledge [3,7]. Oil palm plantation areas increased from 294,560 ha in 1980 to 1,126,677 ha in 1990. Then, land expansion increased by fourfold to 4,158,077 ha in 2000 (Fig. 1) [8]. Currently, oil palm plantation areas have achieved 11.4 million ha which consists of 42% smallholders, 8% government estates, and 50% large-scale private companies. Indonesia and Malaysia accounts for 85% of global palm oil supply. Malaysia was the largest palm oil producers before it was replaced by Indonesia in 2006.

High price of fossil fuel and large amount of fossil fuel subsidies in 1980s and 1990s cause pressure on Indonesian development budget (APBN). Government of Indonesia started to search alternative energies for domestic consumption by issuing Presidential Instruction No. 1/2006 regarding Biofuel Supply and Utilization. Palm oil was the most potential renewable energy to be used as substitution for fossil fuels. Therefore, Minister of Agriculture Regulation (MoAR) No. 33/2006 was established to promote palm oil production as a basic material for biodiesel.

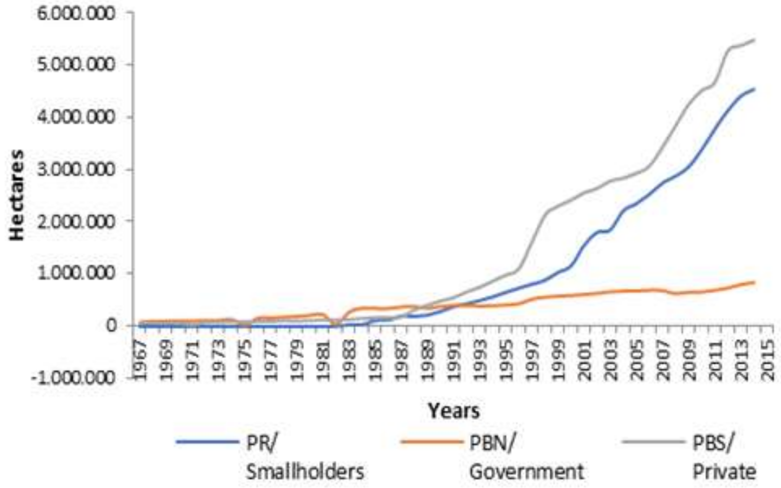

Fig. 1. Oil palm plantations area in Indonesia [8].

However, expansion for new planting created environmental, social, and economic issues. Land expansion for new planting was conducted without adequate legality and created negative impacts on environment and social aspects. Many of plantation have been operated without land ownership certificate (HGU or SHM), business registration or permit (IUP or STD-B) [9], and environmental impact assessment (AMDAL or SPPL) [10]. Large-scale companies (more than 25 ha) must have HGU, IUP and AMDAL while smallholders (less than 25 ha) must have SHM, STD-B and SPPL. This condition was claimed event worse by global consumers, non-governmental organization (NGOs), and private multinational companies as the cause of deforestation [11-14], land degradation [15-17], biodiversity loss [18-21], greenhouse gas (GHG) emissions [22,23], land conversion [24,25], land and forest fires [26-29], food security problem [30-33], land use conflicts [34-37] and other environmental degradation.

Stakeholders, at international, national, and local level, have implemented actions to reduce negative impacts of oil palm expansion [38-41]. A number of private companies, NGOs, and third parties established forum/institution to create sustainable norm for oil palm production such as RSPO, ISPO, and ISCC. However, the progress of certification process was very slow. In the last ten years, companies, mills, and smallholders that have been certified were few while commitments and policies in importer countries towards fully sustainable palm oil will start by 2020 [42].

II. MATERIALS AND METHODS

A. *Objectives*

The objective of this paper is to investigate prospects and challenges of Indonesian palm oil facing pressure from EU and potential domestic market for biofuel industry. Can domestic biofuel industry be an alternative market for Indonesian palm oil? Can sustainability in oil palm production still be achieved? This study can be used for policy evaluation on alternative renewable energy for Government of Indonesia, actors and stakeholders in palm oil supply chains.

B. *Scope of The Study*

This study focuses on alternative CPO market between international market and domestic market. Global market interest are environmental, social and economic aspects. How does certification and sustainable production become a norm in palm oil supply chain. Indonesia interest are finding alternative renewable energy to meet rapid demand for fuel and meet certification standard for oil palm production.

C. *Analyses*

This paper conducted literature reviews and qualitative analysis to trace the development of palm oil sector and government policy to facilitate national growers, companies, millers, and smallholders to be included in the global palm oil supply chains. Analysis was conducted in relation with policy in supply and demand, environmental and social issues, and certification system. A number of in-depth interview were implemented to stakeholders and government officers to reveal current situation of oil palm industry.

III. RESULTS AND DISCUSSION

A. Fossil fuel versus Biofuel

1. Fuel Consumption

Indonesia is one of the largest market for vehicles which grew rapidly between 2003 and 2012 [43]. Demand for fuel for transportation is also high. Use of fuel in Indonesia increases from 47 billion litters in 2005 to 69 billion litters in 2015 [44] with an average annual growth rate 5% per year [45]. Gasoline and diesel fuel consumption grew rapidly before 2013, then use of diesel declining while gasoline continue to grow (Fig. 2).

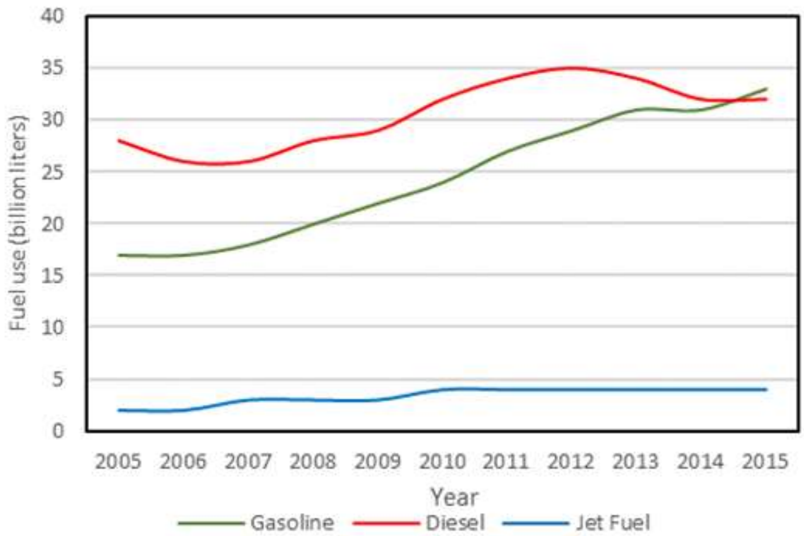

Fig. 2. Use of Fuel in Indonesia 2005-2015 (Billion Litters) [44].

Use of diesel fuel accounts for more then 50% of fuel consumption. The majority of diesel fuel was used for land transportation (76%) and industry (24%). The use of biodiesel for electricity generation and off-road transportation was not significant (Fig. 3).

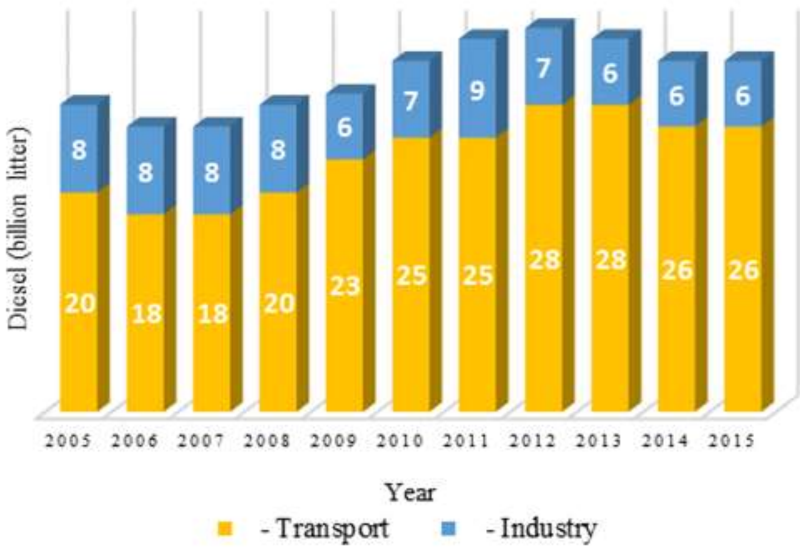

Fig. 3. Use of Diesel in Indonesia 2005-2015 (Billion Litters) [44].

2. Indonesian Fuel Policy

Indonesia was one of fossil fuel producing countries. However, increasing demand for fuels in 1980s and 1990s has incited Indonesia to import fuels. Indonesia imported about 40% of diesel consumption. Increasing demand for imported diesel with growing prices in 1990s has consumed a large portion of government budget for subsidies. This condition become a major driver for Indonesia to search renewable energy. In 2006, Government of Indonesia established Presidential Instruction No. 1/2006 regarding Biofuel Supply and Utilization followed by Presidential Regulation No. 5/2006 regarding National Energy Policy and Presidential Decree No. 20/2006 regarding a National Biofuels Development Team. The objectives of biofuel development includes reduce unemployment, poverty alleviation, reduce domestic fossil fuel consumption, and stimulate economic activities. Production of biofuel blend has been promoted to reduce dependency on imported diesel fuel by providing biofuels subsidies to producers [46]. Government policy on renewable energy and biofuels was strengthen by Law No. 30/2007 regarding Energy. Then, a biofuel blending mandate was established in 2008 through Ministry of Energy and Mineral Resource (MoEMR) Regulation No. 32/2008 followed by other MoEMR regulations which set blending rate from 10% in 2014 to 15% in 2015 and 20% in 2017. In 2015, palm oil-based biodiesel production have been supported by subsidies through export levy on CPO and CPO derivatives managed by Indonesian Oil Palm Estate Fund (BPDP-KS). The BPDP-KS collected US$50 per ton levy on CPO exports for funding biodiesel subsidies. The funds for subsidy are based on Government Regulation No. 24/2015 and 61/2016.

3. Renewable Biofuel

Indonesia's biofuel sector has been developed mainly based on palm oil-derived biodiesel. The Government of Indonesia has decided to enforce biodiesel blending to 20% (B20) and started the B20 policy in 2016 while at the same time powerplant were obliged to use 30% of blended biodiesel. This policy was expected to increase domestic use of biodiesel more then 30% in 2017. Consumption target of biodiesel has increased from 2.9 million kilolitres (90% blended with subsidized diesel fuel and 10% blended with non-subsidized fuel) in 2016 to 4.6 million kilolitres (54% blended with subsidized diesel fuel and 46% blended with non-subsidized fuel) in 2017. The Indonesian Oil Palm Estate Fund (BPDP-KS) support the implementation of the B20 policy by provided IDR 9.6 trillion.

B. Indonesian Palm Oil Industry

1. Palm Oil Supply and Demand

Palm oil is the most competitive edible products amongst vegetable oil. Palm oil is preferable raw materials for various industrial product: food, non-food, and biodiesel [5]. Oil palm is the most productive vegetable [6]. Palm oil production needs less agricultural land compared to other vegetable oil. Indonesia and Malaysia are the main producers in the world, both accounts for 85% of global supply. Indonesia has replaced Malaysia position as the largest palm oil supplier since 2006. Currently, Indonesia oil palm plantations accounts for 11.4 million ha which produce 31 million tons of CPO.

2. Positive Externality of Oil Palm Production

Palm oil becomes a key driver in Indonesian economy. Palm oil sector contributes to economic growth, provides employment, alleviates poverty, increase foreign earnings, enhance rural development, and improve people welfare [1,47].

3. Negative Externality of Oil Palm Production

Increasing demand for crude palm oil (CPO) has provoked demand for fresh fruit bunch (FFB). However, producers and growers responds the market through land expansion. This creates problems when new plantations were developed without adequate legal documents and agricultural practices. Lack of information and technology and low access to agricultural inputs, financial, market were the barriers for growers to implement sustainable oil palm production. Palm oil has been blamed to be the source of environmental issues such as deforestation [14], forest and land fires [29], biodiversity loss [48], and land-use conflicts [49].

C. Key Actors in Palm Oil Supply Chains

1. Palm Oil Growers and Industries

Palm growers are the key actors in the upstream palm oil industries. There are three types of oil palm producers in Indonesia: Government Estate Company, Private Estate Company, and Smallholders. Downstream oil palm players have also developed and product palm oil derivative products such as cooking oil, detergent, etc. Currently, large-scale palm oil producers account for 1607 companies [50] while the number of oil palm smallholders achieve 2,2 million farmers [8].

2. Government of Indonesia

Palm oil sector plays a important role in Indonesia economy. Therefore, government has facilitated palm oil development through various regulations. As the main regulator in domestic market, government created laws, government regulations, presidential regulations, presidential decrees, presidential instruction, and ministerial regulations and decrees. Key government actors include the President of Indonesia and Ministers in national level, governors, bupati and other government officers at provincial and district levels.

3. International Institutions

Palm oil is a globally tradable products. A number of actors and institutions involve in the palm oil supply chains: multinational companies, growers, processors and traders, consumer goods manufacturers, retailers, banks/investors, environmental NGOs, and social NGOs. Sustainable palm oil is a shared responsibility for balancing people, planet, and profit.

D. Palm Oil Certification

Growing awareness of global consumers on negative environmental, social and economic issues has motivated private sectors to establish certification as a filter for sustainable product of palm oil and its derivative products. Certification is a procedure by which a third party gives written assurance that a product, process or service is in conformity with certain standards. Certification is documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines or definitions, to ensure that materials, products, processes and services are fit for their purpose [51]. A number of certification body for oil palm products have been established to ensure oil palm sustainability such as RSPO, ISPO, and ISCC. Certification scenarios consist of 1) leaving it to the market (institutionalization of private governance arrangements, inclusiveness, and increasing relationships between schemes), 2) bringing the state back in (transparency and accountability requirements, creating complementarities between private and state regulations, information dissemination and training), and institutionalizing meta-governance (collaborative public-private efforts to enhance coherence in the world of sustainability standards [52].

1. RSPO

Global forest fires at the end of 1990s has increased public concern on oil palm production process. A number of multinational private companies and NGOs established Roundtable on Sustainable Palm Oil (RSPO) in 2004. The founders of RSPO are WWF, MPOA, Unilever, Migros, and AAK. The vision of RSPO is to transform market to make sustainable palm oil the norm. Sustainable palm oil production comprises of 8 Principles, 42 Criteria, and 78 Indicators. The RSPO Principles are 1) Commitment to transparency, 2) Compliance with applicable laws and regulations, 3) Commitment to long-term economic and financial viability, 4) Use of appropriate best practices by growers and millers, 5) Environmental responsibility and conservation of natural resources and biodiversity, 6) Responsible consideration of employees, and of individuals and communities affected by growers and mills, 7) Responsible development of new plantings, and 8) Commitment to continuous improvement in key area of activity. There is the growing number of the global companies committed to 100% RSPO certified sustainable palm oil. There are more than 40 companies have obtained RSPO certificates and only five independent farmer groups with about 3,500 of 2.2 million farmers of have been certified in Indonesia. The RSPO-certified independent farmer groups comprises of Amanah Association, Gapoktan Tanjung Sehati, Yayasan Sapta Tunggal Mandiri, and Forum Petani Swadaya Merlung Renah.

2. ISPO

Indonesia Sustainable Palm Oil established by the Government of Indonesia on 2011 by Minister of Agricultura Regulations (MoAR) No. 19/2011 and was revised on MoAR No. 11/2015. ISPO has been claimed to adopt all Indonesian rules and regulations related to sustainability. ISPO is a mandatory standard that guarantee that oil palm plantation companies, mills, and growers fulfil the Indonesian regulations and also international sustainable principles. However, ISPO is still voluntary for oil palm smallholders and CPO to use for renewable energy. Prior to ISPO certification, a number of pre-certification requirements are needed: legal permit, plantation management, processing, socio-economy, environment and reporting [53]. Then, oil palm companies (plantations and/or mills) will be classified into five classes. Companies that classified as class 1 to 3 are eligible to apply for ISPO certification. ISPO consists of seven sustainability principles: 1) The legality of plantation business, 2) Plantation management, 3) Protection to the utilization of primary forest and peatlands, 4) Environment management, 5) Responsibilities of workers, 6) The responsibility of the social and economic empowerment, and 7) Continuous business improvement [54]. There are five category of palm oil producers in the standard of ISPO: 1) Plantation companies, 2) Plantation only with no mill, 3) Mill with no plantation, 4) Plasma smallholders, 5) Independent smallholders, and 6) CPO used as renewable energy. These categories determined the principles that must be complied by each category. Large-scale companies and/or mills (Category 1, 2 and 3) must apply 7 principles while plasma smallholders apply 6 principles and independent smallholders apply 4 principles. Category 6 for renewable energy apply 7 principles and must calculate GHG Emission according to EU RED Annex V. In 2014, the number of approved ISPO certificate was 63 companies with total area of 549,468 ha and CPO production 2,821,567 tons. In 2015, additional 33 companies have been approved with total area of 297,278 ha and CPO production of 1,027,484 tons. In 2016, more than 30 companies were in the process of ISPO certification [55]. Currently, the total number of ISPO certified companies are less than 200 of 1601 companies in Indonesia or less than 15% [56]. There is only one independent farmers group obtained ISPO certificate, i.e. the Amanah Oil Palm Independent Smallholders Group at Ukui, Riau Provinces. A number of plasma smallholders have also certified under after the nucleus obtained their ISPO certificate. Sustainability bioenergy criteria adopted by ISPO standards includes economic criteria (maximizing policy efficiency), environmental criteria (protecting the environment), and social criteria (improving social environment). Economic criteria consists of reducing biofuels production costs, increasing biofuels productivity per ha, insuring national food security, and securing farmers' incomes. Environmental criteria comprises of reducing greenhouse gas emissions, reducing bate usage, reducing land use, and protecting forest, peatland, biodiversity and landscapes. Social criteria includes increasing consumer welfare, supporting local communities, improving health and safety issues, and creating new jobs [57].

3. RSPO versus ISPO

RSPO was established by private multi-national companies and International NGOs in 2004 while ISPO was created by Government of Indonesia in 2011. RSPO is a certificate required if palm oil products are exported to EU market while ISPO certificate must be obtained by companies and/or mills that operate in Indonesia. Basically, both certificates have almost the same principles for product certification, i.e., reducing deforestation, mitigation of GHG emission caused by land conversion and compliance to applicable laws and regulation. However, there are still a number of differences including protection areas, the concept of HCV, procedures and legality of land-use for oil palm plantation, implementation of Free Prior Informed Concern (FPIC) in RSPO, and new planting procedures [58].

E. Global versus Domestic Market

The application of certification for globally tradable palm oil products will have significant impacts on accessibility of Indonesian palm oil in international market. There are increasing number of stakeholders in EU market that have commitment to apply sustainable standards. The Amsterdam Declaration shows a commitment of EU Countries to support a fully sustainable palm oil supply chain by 2020. Commitment on sustainable product and certification has been broadened and potentially adopted by other palm oil importer countries like India and China. Access to international market can only be done by having international certificate like RSPO or ISCC. In the next three years effort should be increased to get international certificate and access to global market.

F. Prospect and Challenges for Biofuels

Indonesian palm oil industry is in a critical position between global market and domestic market. As the largest producers Indonesia provides 52% of the global palm oil market. Palm oil has absolute and competitive advantages in physical production. Palm oil sector contribute to economic growth and foreign exchange earnings. This sector provides employment for 5.7 million farmers and plantation workers and more than 16 million household rely their income on palm oil sector indirectly [59].

Competitiveness of Indonesian palm oil could reduce if access to international market drop when growers, millers, and traders could not meet and comply with international standards such as RSPO and ISCC. Even though, Indonesia has established ISPO, this standard is not applicable in the global market.

Claimed that palm oil industry in Indonesia have been sustainable cannot be proved and supported with evidences since the number of companies, mills and smallholders that obtained RSPO, ISPO, and ISCC are less than 15%. Obtaining one or all of these certificates indicates that oil palm industries are sustainable. Therefore, responses from government of Indonesia and other actors in Indonesian palm oil supply chain on EU document (Report on palm oil and deforestation of rainforest)[42] should be supported by showing and presenting number of companies, mills and smallholders that have complied with the certification standards.

This study shows found that legality is the most crucial problem in the process of certification. There are many growers that do not have legal ownership on their plantations. Some of the plantations located in protected areas and some others located in protected peatland [60]. Therefore, it is impossible for the growers to get access to legal land title (HGU or SHM).

Growers will also face problem for business permit (IUP) or registration (STD-B) because growers must have legal land title to apply for this document. The same problem also occurs when growers would like to apply for environmental impact assessment document. Challenges to provide legal documents for applying certification is the main problem almost in all areas in Indonesia.

The study found that the map used by central government is not the same as map used by provincial and district governments. This is the basic source of land use conflict in many plantation sites.

Results from in-depth interview with local government officers shows that many of officers do not understand about certification body, both RSPO and ISPO, even some of them have never know what is certification, RSPO, and ISPO. This condition indicates that laws and regulations have not been informed adequately from central government to local government agencies.

IV. CONCLUSION

Palm oil is one of Indonesian most competitive feedstock for biodiesel. Indonesian biodiesel production capacity for B15 and B20 is projected sufficient for domestic market to replace fossil fuels. However, its competitiveness is debateable related to sustainable issues and product certification. Even though, ISPO has been claimed to be an appropriate standard for sustainable biodiesel, however, the ISPO is not an applicable and acceptable standard in the global supply chains. Currently, the standard applied in international market are RSPO and ISCC.

The majority of Indonesian palm oil are exported to international market where the ISPO is not applicable. Certification issues become a challenge or a barrier for Indonesian palm oil when the Amsterdam Declaration to support a fully sustainable palm oil supply chain by 2020 is adopted by European Parliament. There are a growing number of Non-EU countries that also make commitment to support sustainable palm oil.

Facing the barrier in accessing international market, Indonesia may focus on domestic market to produce biodiesel and expand downstream palm oil industry. However, producing biodiesel needs fund for subsidies while developing downstream industry may have negative impact when excess supply occurs in domestic market.

This study suggests that Indonesia may benefits from biodiesel in the future if the cost of production can be lowered to reduced the price gap between biodiesel and fossil fuel. Palm oil as a potential renewable energy may substitute fossil fuel and reduce dependency of fossil fuel. Downstream industry may be another solution for palm oil products. However, palm oil derivative products can only be sold in domestic market because of traceability requirement in certification system. Therefore, improving palm oil business performance to meet certification standards is still a must and should become a main strategy.

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REFERENCES

[1] A. Manggabarani, Palm Oil: A Golden Gift From Indonesia to the World, Directorate General of Estate Crops in Colaboration with Sinar Mas, Jakarta, 2009.
[2] M. Badrun, Lintasan 30 Tahun Pengembangan Kelapa Sawit, Direktorat Jenderal Perkebunan, Kementerian Pertanian Republik Indonesia dan GAPKI, Jakarta, 2010.
[3] D. Rahadian, Delivering the Independent Palm Oil Smallholder into Sustainable: The First RSPO Certified for Indonesia Independent Palm Oil Smallholders., WWF, Jakarta, 2013.
[4] A. Manggabarani, Memaknai Sebuah Anugrah Sumbangsih Kelapa Sawit Indonesia Bagi Dunia, Ideals Agro Akbar, Jakarta, 2009.
[5] C. May-Tobin, D. Boucher, E. Decker, G. Hurowitz, J. Martin, K. Mulik, S. Roquemore, A. Stark, Recipes for Success., Solutions for Deforestation-Free Vegetable Oils. Union of Concerned Scientists, MA, USA, 2012.
[6] C.H. Teoh, Key Sustainability Issues in the Palm Oil Sector., A Discussion Paper for Multi-Stakeholders Consultations (Commissioned by the World Bank Group). International Finance Corporation, The World Bank., Washington DC, 2012.
[7] D. Rahadian, Petani Sawit Swadaya dan Tantangan Praktik Budidaya Sawit Lestari, 2013.
[8] Directorate General of Estate Crop, Oil Palm, Tree crop estate statistic of Indonesia, 2012-2014. Indonesia Ministry of Agriculture, Jakarta, 2015.
[9] Indonesian Minister of Agriculture, Minister of Agriculture Regulation No. 98 year 2013 regarding Guideline of Licensing of Estate Crops. Ministry of Agriculture and Ministry of Justice and Human Right, Republic of Indonesia, Jakarta, 2013.
[10] Indonesian Minister of Environment, Ministry of Environment Regulation No. 13 year 2010 regarding Environmental Monitoring and Management (UKL-UPL) and Statement of Environmental Monitoring and Management Capability (SPPL). Ministry of Environment Republic of Indonesia, Jakarta, 2010.
[11] A. Casson, The hesitant boom: Indonesia's oil palm sub-sector in an era of economic crisis and political change. CIFOR, Occasional paper, Bogor, Indonesia, 2000.
[12] F. Ansari, A. Bhartata, A. Hudata, P.M. Kurniawan, E. Rianda, Indonesian Tropical Deforestation, APRIL and APP case studies. Erasmus Universiteit Rotterdam, Rotterdam, 2007.
[13] A. Angelsen, Shifting cultivation and "deforestation": A study from Indonesia, World Dev 23 (1995) 1713.
[14] K. Carlson, L. Curran, D. Ratnasari, A. Pittman, B.S. Soares, G.P. Asner, S. Trigg, D. Gaveau, D. Lawrence, H. Rodrigues, Committed carbon emissions, deforestation, and community land conversion from oil palm plantation expansion in West Kalimantan, Indonesia, Proc. Natl. Acad. Sci. U. S. A. 109 (2012) 7559.
[15] T. Fairhurst, D. McLaughlin, Sustainable Oil Palm Development on Degraded Land in Kalimantan. World Wildlife Fund, Washington, DC USA, 2009.
[16] World Resources Institute (WRI), Degraded Land, Sustainable Palm Oil, and Indonesia's Future, 2010.
[17] H.R. von Uexkull, E.W. Mutert, Rehabilitation and Lasting Improvement of Degraded Land in Indonesia, Giessener Beitrge zur Entwicklungsforschung Reihe1 (Symposien) Band 21. Wissenschaftliches Zentrum Tropeninstitute Giessen, 1994, p. 47.
[18] L.P. Koh, J. Ghazoul, Biofuels, biodiversity, and people: understanding the conflicts and finding opportunities, Biol Conserv 141 (2008) 2450.
[19] H. Swarna Nantha, C. Tisdell, The orangutan–oil palm conflict: economic constraints and opportunities for conservation, Biodivers Conserv 18 (2009) 487.
[20] E.B. Fitzherbert, M.J. Struebig, A. Morel, F. Danielsen, C.A. Bruhl, P.F. Donald, B. Phalan, How will oil palm expansion affect biodiversity?, CellPRESS, 2008.
[21] F.A. Edwards, D.P. Edwards, T.H. Larsen, W.W. Hsu, S. Benedick, A. Chung, C.V. Khen, D.S. Wilcove, K.C. Hamer, Does logging and forest conversion to oil palm agriculture alter functional diversity in a biodiversity hotspot?, Anim. Conserv. 17 (2014) 163.

[22] P.D. Smith, D. Martino, Z. Cai, D. Gwary, H. Janzen, P. Kumar, B. McCarl, S. Ogle, F. O'Mara, C. Rice, B. Scholes, O. Sirotenko, B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer, Climate Change 2007: Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, 2007, p. 497.
[23] K.M. Carlson, L.M. Curran, A.M. Pittman, K.M. Marion Adeney, L.M. Carlson, A.M. Curran, L.M. Pittman, G.P. Marion Adeney, S.N. Curran, K.M. Asner, K.M. Trigg, Carbon emissions from forest conversion by Kalimantan oil palm plantations, Nature Climate Change 3 (2013) 283.
[24] A. Susanti, P. Burgers, in: M. Behnassi, O. Pollmann, G. Kissinger (Eds.), Sustainable Food Security in the Era of Local and Global Environmental Change, Dordrecht, Springer, 2013, p. 301.
[25] E. Anggraini, P. Grundmann, Transactions in the Supply Chain of Oil Palm Fruits and Their Relevance for Land Conversion in Smallholdings in Indonesia, The Journal of Environment & Development 22 (2013) 391.
[26] A. Rowell, P.F. Moore, Global review of forest fires. WWF International & The World Concervation Union (IUCN), 2000.
[27] S. Suyanto, Underlying cause of fire: different form of land tenure conflicts in Sumatera, Mitig Adapt Strat GLob Change 12 (2007) 67.
[28] A. Priadjati, Proefschrift Wageningen Met lit. opg. - Met samenvatting in het Engels, Nederlands en Indonesisch, Tropenbos International, Wageningen, 2002.
[29] A. Lima, T.S.F. Silva, L.E.O.e.C.d. Aragão, R.M.d. Feitas, M. Adami, A.R. Formaggio, Y.E. Shimabukuro, Land use and land cover changes determine the spatial relationship between fire and deforestation in the Brazilian Amazon, Applied Geography 34 (2012) 239.
[30] M. Ewing, S. Msangi, Biofuels production in developing countries: assessing tradeoffs in welfare and food security, Environmental Science & Policy 12 (2009) 520.
[31] H. Nesadurai, Food security, the palm oil-land conflict nexus, and sustainability: a governance role for a private multi-stakeholder regime like the RSPO?, Pac. Rev. 26 (2013) 505.
[32] G. Koczberski, G. Curry, J. Anjen, Changing Land Tenure and Informal Land Markets in the Oil Palm Frontier Regions of Papua New Guinea: the challenge for land reform, Aust Geogr 43 (2012) 181.
[33] World Growth, Palm oil and food security: The impediment of land supply. World Growth, 2010.
[34] M. Colchester, Lahan Yang Dijanjikan: Minyak Sawit dan Pembebasan Tanah di Indonesia - Implikasi terhadap Masyarakat Lokal dan Masyarakat Adat. Forest People Programme, Perkumpulan Sawit Watch, Huma and the World Agroforestry Centre, Jakarta, 2006.
[35] M. Kohne, Multi-stakeholder initiative governance as assemblage: Roundtable on Sustainable Palm Oil as a political resource in land conflicts related to oil palm plantations, Agric. Human Values 31 (2014) 469.
[36] V. Tauli-Corpuz, P. Tamang, Oil Palm and Other Commercial Tree Plantations, Mono-cropping: Impacts on Indigenous People's Land Tenure and Resource Management Systems and Livelihoods, UN Permanent Forum on Indigenous Issues Working Paper, E/C.19/2007/CRP.6, para.33 (hereinafter "UNPFII Working Paper"), 2007.
[37] S. Marti, Losing ground: The human rights impacts of oil palm plantation expansion in Indonesia. Friends of the Earth, London, UK; LifeMosaic, Edinburgh, UK; and Sawit Watch, Bogor, Indonesia, 2008.
[38] ProForest, Defining Sustainability in Oil Palm Production: An Analysis of Existing Sustainable Agriculture and Oil Palm Initiatives, The Roundtable on Sustainable Oil Palm. Proforest, 2003, p. 1.
[39] A.L. Maulud, H. Saidi, The Malaysian Fifth Fuel Policy: Re-strategising the Malaysian Renewable Energy Initiatives, Energ Policy 48 (2012) 88.
[40] UNDP, Indonesia Sustainable Palm Oil Initiative. United Nations Development Program, Green Commodities Facility, 2012.
[41] WWF-Malaysia, Forest Conversion Initiative, Foreign Exchange or a Sustainable Future for Malaysian Forests. WWF-Malaysia, 2003.
[42] European Parliament, Report on palm oil and deforestation of rainforests. Committee on the Environtment, Public Health and Food Safety, 2017.
[43] A. Bandivadekar, Top vehicle markets, 2012. The International Council on Clean Transportation, Washington, D.C., 2013.
[44] USDA, Indonesia Biofuel Annual Report 2016, GAIN Report Number: ID1619. Global Agricultural Information Network, 2016.
[45] BPPT, Indonesia Energy Outlook 2015, 2015.
[46] A. Kharina, C. Malins, S. Searle, Biofuels Policy in Indonesia: Overview and Status Report. The International Council on Clean Transportation (ICCT), 2016.
[47] M. Badrun, Tonggak Perubahan: Melalui PIR Kelapa Sawit Membangun Negeri, Direktorat Jenderal Perkebunan, Kementerian Pertanian Republik Indonesia, Jakarta, 2010.
[48] D.P. Edwards, A. Magrach, W.F. Laurance, P. Woodcock, F.A. Edwards, K.C. Hamer, Y. Ji, D.W. Yu, N.T.L. Lim, T.H. Larsen, W.W. Hsu, S. Benedick, C.V. Khen, A.Y.C. Chung, G. Reynolds, B. Fisher, D.S. Wilcove, Selective-logging and oil palm: Multitaxon impacts, biodiversity indicators, and trade-offs for conservation planning, Ecol. Appl. 24 (2014) 2029.
[49] F.M. Kohne, Multi-stakeholder initiative governance as assemblage: Roundtable on sustainable palm oil as a political resource in land conflicts related to oil palm plantations, (2014).
[50] BPS-Statistics Indonesia, Statistik Indonesia (Statistical Year Book of Indonesia) 2016. BPS-Statistics Indonesia, Jakarta, 2016.
[51] I.A. Marzuq, Sertifikasi Sebagai Instrument Untuk Mendorong Keberlanjutan Komoditas, RSPO General Lecture UNRI. RSPO, Pekanbaru, 2017.
[52] B. Arifin, Roles of Commodities in Poverty Alleviation and Strengthening Landscape Management: Towards Sustainability Advantage, Workshop Perencanaan Tataguna Lahan dan Pengelolaan Sumberdaya Alam, Kementerian Koordinator bidang Perekonomian dan CIFOR, Jakarta, 2016.
[53] Indonesian Minister of Agriculture, Minister of Agriculture Regulation No. 02 year 2009 regarding Guidelines for Plantation Business Assessment in M.o. Agriculture (Ed.). Ministry of Agriculture, Republic of Indonesia, Jakarta, 2009.

[54] Indonesian Minister of Agriculture, Minister of Agriculture Regulation No. 11 year 2015 regarding Indonesian Sustainable Palm Oil Certification System (ISPO). Ministry of Agriculture and Ministry of Justice and Human Right, Republic of Indonesia, Jakarta, 2015.

[55] R. Suharto, ISPO Current Progress and Future Challenges: How certification drives sustainability objectives and reduces deforestation and GHG emissions, ISPO Workshop: "Certification and Beyond - Balancing Development". ISPO Secretariat, The Hague, Netherlands, 2015.

[56] ISPO Commission, Indonesian Palm Oil Commission (ISPO). ISPO Commission, Ministry of Agricultural Republic of Indonesia, Jakarta, 2017.

[57] J.R. Ziolkowska, Optimizing biofuels production in an uncertain decision environment: Conventional vs. advanced technologies, Appl Energ 114 (2014) 366.

[58] ISPO & RSPO, Studi Bersama Persamaan dan Perbedaan Sistem Sertifikasi ISPO dan RSPO. Ministry of Agriculture Republic of Indonesia and Roundtable on Sustainable Palm Oil, and United Nations Development Programme, Sustainable Palm Oil Initiative, Jakarta, 2016.

[59] T. Rumondang, Transforming the market to make sustainable palm oil the norm, RSPO General Lecture UNRI. RSPO, Pekanbaru, 2017.

[60] Dinas Lingkungan Hidup dan Kehutanan Provinsi Riau, Implementasi Rencana Perlindungan dan Pengelolaan Ekosistem Gambut: Optimalisasi Peran Stakeholders dalam Membangun Kesatuan Hidrologi Gambut (KHG) Berkelanjutan di Provinsi Riau., Pra Workshop Implementasi Rencana Perlindungan dan Pengelolaan Ekosistem Gambut. LPPM Universitas Riau, Pekanbaru, 2017.

F

FOOD

F.1

STUDY CONTROL OF Salmonella Sp. CONTAMINATION ON WHITE SHRIMP (*Litopenaeus vannamei*) USING NATURAL ANTIMICROBIAL FROM EXTRACT OF CHERRY TOMATOES FRUITS (*Lycopersicum cerasiformae* Mill.)

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ABSTRACT

White shrimp (*Litopenaeus vannamei*) is one of the most widely produced of fishery commodities in Indonesia. The white shrimp's production in Indonesia is increasing every year, but the exports of it face obstacles and rejection, it is caused by the contamination of *Salmonella sp*. One of the alternative ingredients which is safe and natural used to reduce contamination of *Salmonella sp.* on white shrimp besides using antibiotics is extracts of cherry tomatoes fruit and leaves. This study aims (1) to find out the inhibitory power extracts of cherry tomato fruits on the contamination of *Salmonella sp*. on white shrimp (*Litopenaeus vannamei*), (2) to determine the best concentration for the extract of cherry tomatoes fruits in the inhibition of the contamination of *Salmonella sp*. on white shrimp (*Litopenaeus vannamei*).

The research design was RAKL using single factor and six repetitions. The data were analyzed by variance analyzed and the Smallest Differential Test (BNT) at the level α 5%. The results showed that extracts of cherry tomatoes fruits has inhibitory effect against the contamination of *Salmonella sp.* on white shirmp. Tomato fruits extract is able to inhibit the growth of *Salmonella sp*. with the diameter of the inhibitory area 17.29 mm with strong antimicrobial activity. The best extract of cherry tomatoes fruits concentration on decreasing the contamination *Salmonella sp*. on white shrimp is 100% for each. Extracts of cherry tomatoes fruits could reduce the contamination of *Salmonella sp*. on white shrimp, with total decrease by cherry tomatoes extract is 2,66 x 10^7 CFU/ml (97,06%).

Keywords : Antimicrobial, Salmonella sp, Antibiotic, Inhibitory, Extract of Cherry Tomatoes Fruits, White Shrimp, Contamination, Smallest Differential Test.

I. INTRODUCTION

A. Background

White shrimp (*Litopenaeus vannamei*) is one of the most widely produced of fishery commodities Indonesia. According to the Data Center of Statistical and Information (2014), national shrimp production has increased an average of 23% per year. White shrimps or vannamei shrimps have increased by 20% per year. This is because Indonesia has the potential of marine aquaculture of 2 million ha and brackish cultivation (pond) reaches 913,000 ha, one of which is the potential of white shrimp farming (Lasabuda, 2013). According to Slamet Soebjakto, Director General of Aquaculture Ministry of Marine Affairs and Fisheries (KKP), national shrimp production in 2016 amounted to 535,237 tons. This amount includes 392,513 tons of white shrimp, 127,908 tons of windu shrimp and 14,816 tons of other shrimps (Agrina, 2016).

Increased production of shrimp is not offset by an increase in shrimp exports to export destination countries. Export destination countries include the United States, Japan, China and Australia. According to the Data Center of Statistical and Information (2016), demand for shrimp exports in Indonesia to various export destinations has decreased. This is seen in the export demand to China in 2013 of 5,600.1 tons fell to 5,531 tons in 2014. Demand for shrimp exports to Japan in 2013 amounted to 32943.7 tons fell to 27,597.8 tons in 2014. The United States in 2009 Imports of 45,213.6 tons fell to 43,560.9 tons in 2010. Australia did the same, namely demand in 2013 of 895.8 tons fell to 780.7 tons in 2014.

The decline in the number of shrimp exports to various destination countries such as China, Japan, the US and Australia because the shrimp do not meet the quality standards of consumer countries such as the requirement for the negative *Salmonella sp*. terms of quality and safety of fresh shrimp by the Indonesian National Standard (SNI) 01-2728.1-2006 namely Escherichia coli bacterial contamination maximum <2 APM / g, Vibrio cholerae is negative, and *Salmonella* is negative in units APM / 25 gram. The shrimp were exported allegedly still contain pathogens, antibiotics and preservatives. Shrimp should be free of pathogenic bacteria such as *Salmonella sp*. and Vibrio cholera (National Standardization Body, 2006). The decline in shrimp exports has an impact on the country's economy and an obstacle to the marketing of Indonesian shrimp export destination country. Noviani (2013), states that the decline in shrimp exports affect marine and fisheries ministry targets to increase in shrimp production and most will be devoted to export products to various countries.

Shrimp export from Indonesia a lot of rejection because in general is still contaminated with Salmonella sp. In 2012, the United States refused 181 fishery products from Indonesia due to polluted Salmonella sp. (Supriadi, 2012). The Food and Drug Administration (FDA) in July 2013 rejected 5 white shrimp lots from Indonesia because export shrimp was contaminated with *Salmonella sp*. (Maas, 2013). *Salmonella* contamination sp. in *vannamei* shrimp may cause a reduction in the quality of shrimp. *Salmonella* contamination sp. in food can cause Salmonellosis which can cause serious infections in humans and weaken the immune system of children, elderly and pregnant women (Anjung, 2016). According to Sorrels et al. (1970) in Isyana (2012), *Salmonella sp.* is causing disease of digestive organs. People with salmonellosis may show symptoms such as diarrhea, nausea, headache, and fever.

Salmonella sp. contamination in white shrimp can be derived using antibiotics such as chloramphenicol and nitrofuran. The Food Drug and Administration has determined that imported commodities, including shrimp, are prohibited from foreign bodies and the use of prohibited or exceeding maximum limits such as antibiotics. It is also stipulated in SNI 01-2728.1-2006 that chemical contaminants such as chloramphenicol and nitrofuran are the maximum 0 in units of μg / kg. The use of antibiotics can have a serious impact because the problem of residual antibiotic ingredients in shrimp can lead to the emergence of bacterial resistance to antibiotics (Muliani and Atmomarsono, 2010). Residues of antibiotics found in shrimp consumed can adversely affect consumer conditions such as causing allergic reactions or retention, physiological disorders and poisoning (Wibowo et al., 2010).

Natural ingredients are needed to reduce contamination of *Salmonella sp.* as a natural antimicrobial. Natural antimicrobials are thought to be extracted from cherry tomato fruit. According to research Kartikasari (2008) showed that tomatoes contain compounds alkaloids and saponins. National tomato production in 2015 was 915,987 tons, while tomato production in Lampung province was 244,900 tons (Badan Pusat Statistik, 2017). The research of the utilization of cherry tomato fruit and leaves (Lycopersicum cerasiforme Mill.) as an antimicrobial to decrease contamination of Salmonella sp. is not much done yet. This research needs to be done because to know the existence of antimicrobial from tomato on *Salmonella sp.* on white shrimp that can be used instead of antibiotics. This research needs to be done because to get the best concentration that can be used as the natural antimicrobial to decrease contamination of *Salmonella sp.* on white shrimp.

B. Research Purposes

The purposes of this research are:

1. To find out the inhibitory power extracts of cherry tomato fruits on the contamination of Salmonella sp. on white shrimp (Litopenaeus vannamei)
2. To determine the best concentration for the extract of cherry tomatoes fruits in the inhibition of the contamination of Salmonella sp. on white shrimp (Litopenaeus vannamei).

II. MATERIALS AND METHODS

A. Place and time

This research was conducted in Laboratory of Microbiology of Agricultural Products and Agricultural Processing Farming Laboratory, Department of Agricultural Product Technology Faculty of Agriculture, University of Lampung in January - March 2017.

B. Materials and tools

The materials used in this research are cherry tomato fruit from Kemiling, Bandar Lampung, white shrimp obtained from Rawajitu Timur pond, Tulang Bawang, 96% ethanol, filter paper, aquades, aluminum foil, label paper , Paper disc (Whatman no.42), cotton, 70% alcohol, Salmonella sp., NaCl, Peptone Water Buffer (BPW), Sodium Agar (NA), and Xylose Lisine Deoxycholate (XLD) agar.

The tools used include digital scales, blenders, vortex, colony counters, petri dishes, bunsen lamps, Erlenmeyer, Beaker glasses, test tubes, drop pipettes, measuring pipettes, micro pipets, tip pipettes, spatulas, ose needles, incubators, vacuum Rotary evaporator, funnel, blade, scooter and water bath shaker.

C. Method

The study looked for the best concentration of antimicrobial extracts on tomatoes. The experiment used a Completely Randomized Block Design (RAKL) with a single factor and six replications. In the first study using tomato-ethanol extract 96% with five levels of concentration 0%, 25%, 50%, 75% and 100%.

Tomato fruit extract used was 10 ml for 100% extract concentration, 7.5 ml extract plus 2.5 ml of distilled water for 75% concentration treatment. At a concentration of 50%, 5 ml of the extract was added with 5 ml of distilled water, then for 25% concentration was used 2.5 ml of extract plus 7.5 ml of distilled water at the level of 0% using aquades. The data obtained were tested for their similarity by using Bartlet test. Data were analyzed by fingerprint to obtain the error estimator. Data analysis was continued by using the LSD test at α = 5%.

III. RESULTS AND DISCUSSION

A. Results of Antimicrobial Activity Testing by Using ExtractsCherry Tomato Fruit

The result of observation of inhibitory diameter diameter by using cherry tomato extract obtained by average of diameter which were vary from each treatment of extract concentration given. The results of these observations are presented in Table 1.

Table 1. The results of observation of inhibitory power of cherry tomato extract on *Salmonella sp.*

Extract Concentration (%)	Average resistor diameter (mm)
0	0,00
25	3,80
50	11,45
75	14,85
100	17,29
Control (Etanol 96%)	0,8
Control (Cakram Paper)	0

The results of the antimicrobial testing using paper disc with different concentration treatments (Table 1) showed that at 100% concentration formed the largest obstacle zone with the mean diameter of 17.29 mm. The concentration of cherry tomato extract is 75%, 50%, 25% respectively resulted 14.85 mm, 11.45 mm, and 3.80 mm per each. Treatment at 0% concentration (using aquades) which is a negative control does not form a clear zone (0 mm). A drag zone test trial was also conducted to determine the antimicrobial activity in 96% ethanol solvent. Resistor zone that is formed that is equal to 0,8 mm. This suggests that ethanol, presumably still present in the extract, contributes to the formation of a 0.8 mm drag zone, but the activity of the active compound in the extract shows a larger drag zone compared to the ethanol solvent.

In the treatment of cherry tomato extract showed that the more concentrated the extract of cherry tomato fruit then form the diameter of the greater obstacles. This is in accordance with the statement Ajizah (2004) that the concentration of antibacterial compounds greatly affected the ability of these compounds in inhibiting the growth of microorganisms. According to Noer (2011) one of the factors affecting the drag zone diameter is concentration. The higher the antimicrobial concentration used, the more microorganisms can be inhibited. This shows that the antimicrobial active substance in cherry tomatoes will be lower in potency as the concentration of extract

According to Suryawiria (1978) in Saraswati (2015) based on the inhibition zone formed the antimicrobial activity can be classified into several classes, namely antimicrobials are classified as weak (inhibition zone <5 mm), medium (inhibition zone between 5-10 mm), strong (zone Resistor between 10-20 mm), and is very strong (inhibition zone> 20 mm). Cherry tomato extract at 25% concentration is relatively weak, while concentrations of 50%, 75%, and 100% are strong. The results of this study showed that all treatments of cherry tomato extract at concentrations of 25%, 50%, 75%, and 100% had antibacterial activity with resistance diameters ranging from 3.80 mm - 17.29 mm. Negative control test results in the form of sterile distilled water in this study showed that there was no inhibit zone or 0 mm (Table 1). The absence of inhibition zone in negative control was used as an indicator of Salmonella sp. Normally at various treatments. The analysis results of various inhibit zone data are presented in Table 2.

Table 2. Test analysis of antimicrobial assays of cherry tomato extract on *Salmonella sp* bacteria.

Sources of Diversity	db	JK	KT	F hitung		F tabel	
						0.05	0.01
Group	5	7.414	1.483	1.546	tn	2.711	4.103
Treatment	4	1295.236	323.809	337.694	**	2.866	4.431

Statistical results (Table 2) showed that between treatments (concentrations of 100%, 75%, 50%, 25% and 0%) had a very significant difference to inhibit *Salmonella sp.* growth. Seen on Ftest> Ftable (5%) = 337,694> 2,866. Significance for the source of group diversity shows an unreal result, this is because Ftest <Ftabel (5%) =

1.546 <2.711, this means that the group does not affect the research data. A further test using BNT at the α = 5% level is obtained as shown in Table 3.

Table 3. BNT test result α 5% to know the concentration of cherry tomato extract effective in inhibiting bacteria *Salmonella sp.*

Concentrations of Extracts (%)	Middle value
100	17,29[a]
75	14,85[b]
50	11,45[c]
25	3,80[d]
0	0,00[e]

Description: The numbers followed by the same letter show no significant difference at the α 5% level.

The result of BNT test (Table 3) showed that the average of negative control zone control zone diameter (0%) was significantly different with all treatments of 25%, 50%, 75%, and 100% cherry tomato extracts. The concentration of 0% was significantly different with concentrations of 25%, 50%, 75% and 100%. The 25% concentration was significantly different with concentrations of 50%, 75% and 100%. Concentrations of 50% differ significantly with concentrations of 75% and 100%. Concentrations of 75% of differ obviously with 100% concentration. The concentration of cherry tomato extract is effective as an antimicrobial against *Salmonella sp.* is 100%, because it has a drag diameter of 17.29 mm and is significantly different from the drag diameter at lower extract concentrations. The resulting inhibit zone can be seen in Fig. 1.

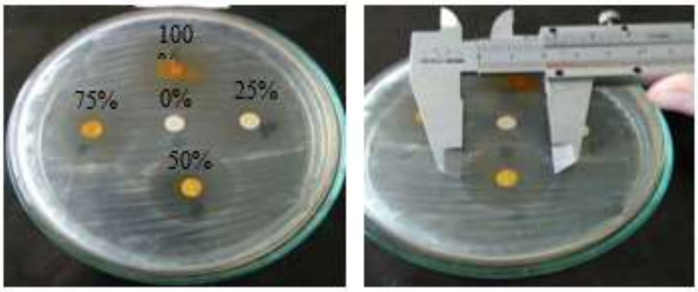

Fig. 1 Clear zone area formed around disc paper by cherry tomato extract on *Salmonella sp.* bacteria.

Treatment with 100% concentration has the most inhibitory or transparent zone in inhibiting the growth of Salmonella sp bacteria. It can be seen in Figure 12 that the area around the disc paper is not overgrown by a test bacterial colony called a radical zone. The radical zone is an area around the disc where there is no bacterial growth (Pelczar and Chan, 1986).

The difference is apparent between the lowest concentration (25%) and the highest concentration (100%). There is a tendency to increase the diameter of the growth inhibition area of test bacteria along with the increase of extract concentration. The difference in the diameter of the inhibitory area of each concentration can be caused by the difference in the amount of active compound contained in the extract. According to Katno *et al*. (2009), the factors that influence the inhibitory test are the concentration of active compounds, the susceptibility of microbial growth test, the thickness and viscosity of the medium and the reaction between the active substance to the medium and the incubation temperature.

Extracts of cherry tomatoes used as antimicrobial compounds can be used to inhibit gram-positive or negative bacteria. According to Al-Oqaili *et. al*., (2014) tomato extract proved effective to inhibit *E. coli* bacteria with 75% concentration and inhibition zone of 35-50 mm. According to Nasser (2012) chloroform extract and tomato ethanol showed antimmicrobial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *E. coli* and *Klebsiella pneumoniae.* This study shows that cherry tomato extract has the same ability to inhibit the growth of Salmonella sp bacteria. This suggests that tomato extract can inhibit the growth of bacteria that have gram negative cell walls other than E. coli, the Salmonella sp bacteria. (Test bacteria). There is a difference in cell wall structure between gram positive and gram negative. Gram positive bacteria wall structures consist of several layers of peptidoglycan forming a thick and rigid structure and contain a cell wall substance called teicoic acid. Gram-negative bacteria have a thinner peptidoglycan layer, only one to two percent of their dry weight. This is because the gram-negative bacteria contains a small layer of peptidoglycan and does not contain the te acidic acid. Gram-negative bacteria have two or three layers of peptidoglycan. While a gram-positive cell, it can contain peptidoglycan 20 times, enough for 40 layers or more (Brock and Madigan, 1991). This is what makes the walls of gram-negative bacteria such as *Salmonella sp.* More susceptible to physical shocks, such as antibiotics or other antibacterial agents (Radji, 2011).

The results showed that cherry tomato extract can be used as an antimicrobial in the control of bacterial contamination of *Salmonella sp.* According to Kartikasari (2008), the content of alkaloids and saponins in tomato extract can be an antimicrobial compound. According to Gunawan in Saputra and Lilis (2012), alkaloid compounds utilize the reactive properties of basic groups (-NH) to react with amino acid groups in bacterial cells. The presence of such a base group, when in contact with the bacteria will react with amino acid compounds and bacterial DNA. This reaction occurs because chemically an alkaline compound will react with the acid compound in this case is an amino acid. This reaction results in changes in the structure and structure of amino acids since most of the amino acids have reacted with the basic groups of the alkaloid compounds. This amino acid sequence change will obviously alter the arrangement of DNA chains in the nucleus of cells that originally have an interlocking array of acids and bases. This will cause a change in the genetic balance of the DNA acid so that the bacterial DNA will be damaged.

Damage to cells that occur in bacteria will make the bacterial cells are not able to perform metabolism so it will become inactive and destroyed. According Fitrianti (2011) states that the working mechanism of the alkaloids is associated with the ability to intercalate (put themselves in between the DNA). The presence of substances that exist between the DNA will inhibit DNA replication itself. Cell death will occur due to DNA replication. Thus the bacteria *Salmonella sp.* will become inactive and destroyed (lysis).

Saponins are compounds that naturally contain glycosides, widely present in plants (Naidu, 2000). Gruiz (1996) stated that 76% of Asian plant species contain Saponins. Saponins are like soap. The presence of saponins can be detected by observing its ability to form foams. Saponins inhibit growth or kill microbes by interacting with sterol membrane. The main effect of saponins on bacteria is the release of proteins and enzymes from within cells (Zablotowicz et al., 1996). Saponins can be antimicrobial by damaging cell membranes. Damage to the membrane causes an important substance out of the cell and also can prevent the entry of important ingredients into the cell. If cell membrane function is destroyed it will lead to cell death (Monalisa et al., 2011)

B. Total Salmonella sp. on White Shrimp

Test of total decrease of *Salmonella sp*. on white shrimp performed to determine the ability of antimicrobial extract of cherry tomato fruit in controlling contamination of *Salmonella sp.* on white shrimp (Litopenaeus vannamei). Decrease in the amount of *Salmonella sp*. produced, indicating that the active compound on fruit extract and cherry tomato leaves can kill *Salmonella sp.* test result of total decrease of *Salmonella sp.* on white shrimps using cherry tomato extract is presented in Table 4.

Table 4. Test results of total decrease of Salmonella sp. On white shrimp using fruit extract and cherry tomato leaves

Treatment	Amount of *Salmonella sp.* (CFU/ml)		Total decrease (CFU / ml) ± Standard Deviation	Total decrease (%)
	Without the extract	With extract		
Cherry Tomato Fruit Extract	2,74 x 10^7	8,07 x 10^5	2,66 x 10^7±2516611,5	97,06

Test results of total decrease of Salmonella sp. (Table 7) shows that the extract of cherry tomato fruit has the potential to decrease contamination of Salmonella sp bacteria on white shrimp. White shrimp used is shrimp that comes from farming pond Rawajitu Timur, Tulang Bawang. The amount of bacteria Salmonella sp. is calculated on shrimp that has not been given treatment on XLD media. The results showed negative or no *Salmonella sp* bacteria. that grows. This is according to Anjung (2016) which states that testing of Salmonella sp. on white shrimp from Rawajitu Timur is negative. Shrimp that have been tested is then given the culture of *Salmonella sp.* which comes from the veterinary hall, Lampung, 1 ml (Mc Farland standard 108 CFU / ml).

Tests showed that total bacteria on shrimp before being given an average extract of 2.74 x 107 CFU / ml. Provision of tomato extract as much as 5 ml into 5 grams of white shrimp showed a decrease in the number of bacteria. The average number of Salmonella sp. after being given cherry tomato extract of 8.07 x 104 CFU / ml. This shows that there is a decrease in the number of *Salmonella sp.* of 2.66 x 107 CFU / ml, which, when suppressed by 97.06%. This proves that the extract of cherry tomato fruit is able to control the contamination of Salmonella sp bacteria which is in white.

The content of compounds present in extracts of cherry tomatoes such as alkaloids and saponins are able to control contamination of Salmonella sp. bacteria on white shrimp. Salmonella bacteria sp. that existed in the shrimp will interact with antimicrobial compounds. The alkaloid compounds present in the tomato extract will react with the amino acid group in the bacterial cell. This will make the structure and structure of amino acids changed and can lead to changes in the genetic makeup of DNA acids that are damaged. Damage that occurs will result in metabolic disturbance in the body of bacteria that will become inactive and destroyed and resulted in dead bacteria (Gunawan, 2004). Saponins present in tomato extracts can cause damage to bacterial cell membranes resulting in cell death (Gruiz, 1996).

Cherry tomato extract showed a more acidic pH (3,4). *Salmonella sp.* can generally live at an optimum pH of 6-8 (Hiramatsu et al., 2005). The degree of acidity or acid pH can generally affect the growth of *Salmonella sp.* Because it can cause membrane damage, interfere with protein or genetic synthesis systems (DNA synthesis / RNA), and microbial deaths due to run out of ATP due to the use of ATP to run proton pumps in order to remove H + from within cells to maintain pH equilibrium in cells (Ray, 2005).

IV. CONCLUSION

A. Conclusion

Based on the results of research that has been done then it can be concluded as follows:

1. Extracts of cherry tomatoes fruits has an inhibitory effect on contamination of *Salmonella sp.* bacteria on white shrimp. Tomato extract is able to inhibit the growth of *Salmonella sp* bacteria with the inhibitory diameter diameter of 17.29 mm with strong antibacterial activity.
2. The best concentration of cherry tomato fruit in the decrease of contamination *Salmonlla sp*. on white shrimp that is each concentration of extract 100%.

B. Suggestion

Further research is needed by using fruit extract and cherry tomato leaves on other microbial species, gram-negative bacteria and gram-positive bacteria.

REFERENCES

Agrina. 2016. Produksi Meningkat Budidaya Makin Cermat. www.scanie.com. agrina-online.com/redesign2php?rid=7&aid=5713. Diakses pada 11 Januari 2017. 15.00 WIB. 1 hlm.

Agromedia, R. 2007. Panduan Lengkap Budidaya Tomat. PT. Agromedia Pustaka. Jakarta. hlm 7-47.

Ajizah, A. 2004. Sensitivitas *Salmonella typhimurium* terhadap Ekstrak Daun. Psidium *Guajava* L. *J. Bioscientiae.* 1(1): 8-31 pp.

Al-Oqaili, R. M., B. Basim., M. Istabreq., M. A. Salman., and D.A. Al-Satar Asaad. 2014. In Vitro Antibacterial Activity Of Solanum Lycopersicum Extract Against Some Pathogenic Bacteria. *J. Food Science and Quality Management*. Al-Mustansiriya University. Baghdad. Iraq. 27(1):12-18 p.

Andryan, R. 2007. Vitamins And Nutrition Is Very Important For Human Body. Http://Www.Geocities.Com/Andryan_Pwt/Foodsecret.Html?20097. Diakses Pada Tanggal 10 Agustus 2016. Hlm 8.

Anjung, M. U. K. 2016. Identifikasi Cemaran Salmonella sp. dan Isolasi Bakteriofage sebagai Biokontrol dalam Penanganan Pasca Panen Udang Vannamei (*Litopennaus vannamei*). (Tesis). Magister teknologi Agroindustri Pertanian. Unila Press. Bandar Lampung. hlm 2-3.

Arisman. 2009. Buku Ajar Ilmu Gizi Keracunan Makanan. Penerbit EGC. Jakarta. hlm 93.

Badan Pusat Statistik. 2017. Basis Data Statisti Pertanian Subsektor Hortikultura Komoditi Tomat. BPS-Statistik. Jakarta. 1 hlm.

Badan Standardisasi Nasional. 2006. Standar Nasional Indonesia 01-2728.3-2006. Udang Segar-Bagian 3: Penanganan dan Pengolahan. Badan Standardisasi Indonesia.3 hlm.

Baker, S. 2007. A Novel Linear Plasmid Mediates Flagellar Plasmid Variation In Salmonella Typhi .Available From http://www.Plos pathogens.Org /Article/Info%3Adoi%2F10.1371%2Fjournal.Ppat.0030059#Abstract1. Diakses Pada 11 Oktober 2016, pukul 09.20 WIB. 5 p.

Brock, J. A., and K. L. Main. 1994. A Guide To The Common Problems and Diseases Of Cultured Penaeus Vannamei. World Aquaculture Society, Baton Rouge, LA, USA. 242 p.

Brock, T. D, and M. T. Madigan. 1991. Biology of Microorganisms. Sixth ed. Prentice- Hall International,Inc.

Brooks, G. F. dan S. Morse. 2004. Mikrobiologi Kedokteran; Jawetz, Melnick and Adleberg's Medical Microbiology. Edisi 23. Salemba Medika. Jakarta. hlm 325.

Buckle, K. A., Edwards., G. H. Fleet dan M. Wooton. 1985. Ilmu Pangan. Diterjemahkan oleh H. Purnomo dan Adiono. UI Press. Jakarta. 365 hal.

Budiyanto, A. K. 2004. Mikrobiologi Terapan. UMM Press. Malang.

Departemen Kesehatan RI. 2000. Parameter Standar Umum Ekstrak Tumbuhan Obat. Direktorat Jendral Pengawasan Obat dan Makanan, Departemen Kesehatan. Jakarta. 163 hlm.

Dinnarwika, S.N. 2012. Uji Potensi Ekstrak Etanol Daun Tomat (*Solanum lycopersicon Linn*) sebagai Insektisida Terhadap Nyamuk Culex Sp. Dengan Metode Elektrik. Fakultas Kedokteran. Unibraw Malang. 7 hlm.

Dzen, S. M. 2003. Bakteriologi Medik, Ed. 1. Bayumedia Publishing. Malang. hlm 187-197.

Effendi, H. 2000. Telaah Kualitas Air: Bagi Pengelolaan Sumberdaya dan Lingkungan Perairan. Kanasius. Yogyakarta. 258 hlm.

Ekabo, O. and N. R. Farnsworth. 1996. Antifungal and Molluscicidal Saponins from *Serjania salzmanniana*. *J Nat Prod.* 59(1): 431-435 p.

Fardiaz, S. 1987. Penuntun Praktikum Mikrobiologi Pangan. Lembaga Sumber Informasi. Institut Pertanian Bogor. Bogor. 142 Hlm.

Fitriani, Y. 2011. Daya Antibakteri Infusa Daun Sirih Merah (Piper crocatum) sebagai Bahan Irigasi Saluran Akar terhadap Bakteri *Streptococcus viridans* (Abstr.). Skripsi. Universitas Airlangga. Surabaya. Hlm 7.

Giguere, S., J. F. Prescott, and P. M. Dowling. 2013. Antimicrobial Therapy in Veterinary Medicine. Edisi ke-5. Wiley Blackwell. USA. 704 pp.

Gruiz, K. 1996. Fungitoxic Activity of Saponins: Practical Use and Fundamental Principiles. Di dalam Naidu, A. S. (ed.). 2000. *J. Natural Food Antimicrobial Systems.* CRC Press. USA. 108 p.

Gunawan D. dan D.S. Mulyani. 2004. Ilmu Obat Alam. Jilid I. Penerbit AgroMedia Pustaka. Jakarta. 144 hlm.

Haliman, R. W., dan D. Adijaya. 2005. Udang Putih (*Litopenaeus vannamei*). Penebar Swadaya. Jakarta. 75 hlm.

Harjadi, S. S. 1989. Dasar Hortikultura. Jurusan Budidaya Pertanian. Institut. Pertanian Bogor. 195 hlm.

Hiramatsu, R., M. Matsumoto, K. Sakae and Y. Miyazaki. 2005. Ability of shiga toxin-producing Escherichia coli and Salmonella spp. to survive in a desiccation model system and in dry foods. *J. Applied and Environmental Microbiology*. 71(11): 6657-6663 p.

Huss, H. H. 1995. Quality and Quality Changes In Fresh Fish. Food and Agriculture Organization of The United Nations. Rome. 348 p.

Isyana F. 2012. Studi Tingkat Higiene Dan Cemaran Bakteri *Salmonella* sp pada Pembuatan Dangke Susu Sapi Di Kecamatan Cendana Kabupaten Enrekang (skripsi). Makasar : Program Studi Teknologi Hasil Ternak Jurusan Produksi Ternak Fakultas Peternakan Universitas Hasanuddin. 27 hlm.

Jacobs R. A. 2001. General problems in infectious diseases: acute infectious diarrhea. In: Tierney LM Jr, McPhee SJ, Papadakis MA, eds. Current Medical Diagnosis and Treatmen. 40th ed. NY: McGraw-Hill. New York, 12(1).6-15.

Kartikasari. 2008. Pengaruh Ekstrak Batang Salvadora Persica terhadap Pertumbuhan Bakteri *Streptococcus A-Haemolyticus* Hasil Isolasi Paska Pencabutan Gigi Molar Ketiga Mandibula (Kajian In Vitro). *J. Fakultas Kedokteran Gigi*. Universitas Gadjah Mada. Djogjakarta. 1(1): hlm 1-6.

Katno, S. Haryanti, dan A. Triyono. 2009. Uji Daya Hambat Ekstrak Etanol Daun Sembung (Blumea balsamifera (L.) DC.) Terhadap Pertumbuhan Mikroba *E.Coli, S. Aurens* dan *C. Albians*. Balai Besar Litbang Tanaman Obat dan Obat Tradisional, Depkes RI. Jakarta. hlm 5.

Lasabuda, R. 2013. Pembangunan Wilayah Pesisir dan Lautan dalam Perspektif Negara Kepulauan Republik Indonesia. *J. Ilmiah Platax.* Vol. 1-2. hlm 94.

Lay, W. B, dan S. Hastowo. 1994. Analisis Mikroba di Laboratorium. PT Raja Grafindo Persada. Jakarta. hlm 61-71.

Liston, J., and J. Barros. 1973. Distribution of *V.Parahaemolyticus* in the natural environment. *J. Milk Food Technology*. 36 : 113-117pp

Maas, R. 2013. Wholey Brand Cooked Shrimp Recall Issued Due To *Salmonella* Risk.Lawsuits.com.http://www.Aboutlawsuites.Com/Shrimp-RecallSalm onella -Risk51148/. Diakses pada11 Oktober 2016, 17:12 WIB.

Madigan. 2012. Brock Biology Of Microorganism 13th Edition. Pearson Education, Inc. San Fransisco. 22 p.

Milton, R. J. S, dan S. K. Kwang. 2001. Structur of Bacteria. www.bact.wisc.edu. Departement of Baceriology University of Wisconsin- Madison. USA. 1 p.

Monalisa, D., T. K. Handayani, dan D. Sukmawati. 2011, Uji Daya Antibakteri Ekstrak Daun Tapak Liman (*Elephantopus scaber* L.) Terhadap *Stpahylococcus aureus* dan *Salmonella typhi*., *J. Biologi BIOMA,* 9 (2), hlm. 13-20.

Muliani, N., dan M. Atmomarsono. 2010. Penggunaan Probiotik pada Pemeliharaan Udang Windu (*Penaeus monodon*) dengan Dosis yang Berbeda. *J. Prosiding Forum Teknologi Akuakultur.* 249-259 hlm.

Murray, R. K., D. K, Granner, dan V. W, Rodwell. 2009. Biokimia Harper (27 Ed.).Buku Kedokteran. Penerbit EGC. Jakarta. 709 hlm.

Naidu, A. S. dan Clemens, R. A. 2000. Natural Food Antimicrobial System: Probiotics. CRC Press. New York. hlm. 431-462.

Noer, S. F. 2011. Pengaruh Kadar Etanol dalam Sediaan Gel Antiseptika terhadap Pertumbuhan Bakteri *Salmonella thyposa. J. Ilmu Teknologi*. 6(12): hlm 889.

Noviani, A. 2013. Produksi di Dunia Turun, Ekspor Udang Indonesia Bisa Naik. Bisnis Indonesia.Com. Rabu, 14 Agustus 2013, 17:58 WIB. http://industri.Bisnis.Com/Read/20130814/99/156625/Produksi-Di-Dunia-Turun-Ekpor-Udang-Indonesia-Bisa-Naik. Diakses pada 9 Oktober 2016 20:02 WIB.

Opena, R. T, and V. D. Vossen. 1994. *Lycopersicon esculentum Miller*. *J. S. Siemonsma and K. Pileuk (Eds*). Plant Resources of South-East Asia. Prosea Foundation, Bogor. 199-201 pp.

Pelczar, M. J., dan E. C. S. Chan. 1988. Dasar-Dasar Mikrobiologi. Universitas Indonesia Press. Jakarta. 443 hlm.

Pui, C. F., W. C, Wong, L. C. Chai, R. Tunung, P. Jayeletchumi, M. S. Noor, A. Ubong, M. G. Farinazleen, Y. K. Cheah, and R. Son. 2011. Review Article Salmonella: A Foodborne Pathogen. *J. International Food Research*. Vol 18. 465-473 Pp.

Purwanti, L. A., Maharani., L. Syarir. 2014. Uji Aktivitas Antibakteri dan Isolasi Alkaloid dalam Daun Tomat (*Lycopersicon esculentum Mill*).*J. Sains and Technology*. RPPM Unisba. 4(1):hlm 37-42..

Pusat Data Satatistik dan Informasi. 2014. Statistik Perikanan Tangkap, Perikanan Budidaya, dan Ekspor Impor Setiap Provinsi Seluruh Indonesia 2003-2013. Pusat Data Sattistik dan Informasi Sekretariat Jendral Kelautandan Perikanan Jakarta.302 hlm.

Pusat Data Statistik dan Informasi. 2016. Ekspor Udang Menurut Negara Tujuan Ekspor, 2000-2014. Pusat Data Statistik dan Informasi Sekretariat Jendral Kelautan dan Perikanan. Jakarta. 302 hlm.

Radji, M. 2011. Mikrobiologi. Buku Kedokteran. EGC. Jakarta. Hlm 22.

Ray, B. 2005. Control by Low pH and Organic Acid. Di dalam: Fudamental Food Microbiology, Boca Raton CRC Press. 3(35): 483-490 p.

Reapina M, E. 2007. Kajian Activitas Antimikroba Ekstak Kulit Kayu Mesoyi (*Cryptocaria massoia*) Terhadap Bakteri Patogen dan Pembusukan Pangan (Skripsi). Fakultas Teknologi Pertanian. Institut Pertanian Bogor. Bogor. hlm 37-38.

Rismunandar. 2001. Tanaman Tomat. Sinar Baru Algensindo. Bandung. hlm 8.

Rubatzky, V. E. dan M. Yamaguchi. 1999. Sayuran Dunia 3. Edisi ke-2. Institut Teknologi Bandung. Bandung. 320 hlm.

Saputra, T. dan S. Lilis. 2012. Aktivitas Antimikroba Infusa Buah Asam Jawa (*Tamarindus indica Linn*) terhadap Berbagai Mikroba Patogen, *J. Science.* Universitas Muhammadiyah Yogyakarta. Fakultas Kedokteran. Yogyakarta. 15 hlm.

Saraswati, F. N. 2015. Uji AKtivitas Antibakteri Ekstrak Etanol 96% Limbah Kulit Pisang Kepok (*Musa balbisiana*) terhadap Bakteri Penyebab Jerawat (*Staphylococcus epidermidis*, *Staphylococcus aureus*, dan *Propionibacterium acne*). (Skripsi) Fakultas Kedokteran dan Ilmu Kesehatan. Jakarta. 15 hlm.

Serdaroglu, M., and E. Felekoglu. 2005. Effects Of Using Rosemary Extract and Onion Juice On Oxidative Stability Of Sardine (*Sardina pilchardus*) Mince. *J. Food Qual*. Vol. 28. 109–120 p.

Silvikasari. 2011. Aktivitas Antibakteri Ekstrak Kasar Flavonoid Daun Gambir (*Uncaria gambir Roxb*). (Skripsi). IPB Press. Bogor. hlm 5.

Singh. 2001. Introduction To Food Engineering. Academic Press. London. 44 p.

Suhartati, R., dan D. Nuryanti. 2015. Potensi Antibakteri Limbah Tomat (*Lycopersicum esculentum Mill*) Terhadap Bakteri Staphylococcus Aureus.*J. Kesehatan Bakti Timnas Husada.* 13(1): hlm 186-190.

Supriadi. 2012. Mengandung Salmonella, Produk RI Sempat Ditolak Amerika Serikat. Surabaya Pos, Rabu, 03/10/2012 12:14 WIB.http://www. Seafoodservicecentre.Com/Salmonela-Produk-Ri-Sempat-Ditolak-As&Cat id=34&Itemid =1. Diakses pada 9 Oktober 2016 20:15 WIB.

Taher, N. 2010. Penilaian Mutu Organolaptik Ikan Mujair (*Tilapia mossambica*) Segar dengan Ukuran Yang Berbeda Selama Penyimpanan Dingin.*J. Perikanandan Kelautan.* 4(1): hlm 8-12.

Terasaki, R., H. Ikeura., S. Motoki., and T.Handa. 2013. Antibacterial Activity Against Escherichia Coli And Component Analysis Of Tomato Leaf And Stem Volatile Extract In Different Parts And Developmental Stages. *J. International Symposium On Agricultural-Foods For Health And Wealth*. 5 p.

Tortora, Kunke, and Case. 2001. Microbiology an introduction. 6th edition. America: Addison Wesley Longman,Inc . p. 593–595, 578–579, 454–455, 339–341, 340.

Triwibowo, R. Rachmawati., dan I. Hermana. 2013. Penggunaan Cetylperidinium Chloride Sebagai Anti Bakteri pada Udang. *J. JPB Perikanan.* 8(2): hlm153.

Tugiyono. 2005. Tanaman Tomat. Agromedia Pustaka. Jakarta. 250 hlm.

Utami, E. R. 2012. Antibiotika, Resistensi, dan Rasionalitas Terapi. *J. Saintic.* 1(1). hlm 124-38.

Wibowo, S., L. Muliana., dan M. H. Prabowo. 2010. Analisis Residu Antibiotik Kloramfenikol dalam Daging Ikan Gurami (*Osphronemus gourami, Lac*) Menggunakan Metode High Performance Liqiud Chromatography. *J. Ilmiah Farmasi*. 1(7):1-10 hlm.

Wiedenfeld, H., A. Pietrosiuk, M. Furmanowa, and E. Roeder. 2003. Pyrrolizidine Alkaloidsfrom Lithospermum canescens Lehm. Z. Naturforsch. 58c. p.173-176.

Wiryanta, W. T. B. 2004. Bertanam Tomat. Agromedia Pustaka. Jakarta. 28 hlm.

Zablotowicz, R. M., R. E. Hoagland, and S. C. Wagner. 1996. Effect of Saponin on The Growth and Activity of Rizophere Bacteria. In Naidu, A. S. (ed). *Natural Food Microbial Systems*. CRC Press. USA. 431-462 pp.

F.2

PROTECTION OF FISHMEAL PROTEIN WITH TAMMARIND SEED TANNIN ON FERMENTABILITY, DRY MATTER AND ORGANIC MATTER DIGESTIBLE, AND UNDEGRADED DIETARY PROTEIN *IN VITRO*

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ABSTRACT

Ruminant's feed must be capable of supplying protein in the intestine and contribute amino acids for livestock. Tannin can be added as protein protection in rumen. The research aims to determine the protectioneffect of fishmeal protein with tannin from tammarind seed on concentration of ammonia (NH_3), VFA total, Dry MatterDigestible(DMD), Organic Matter Digestible (OMD) and Undegraded Dietary Protein (UDP) *in vitro*. This research isusing experimental method and a completely randomized design with four types of treatments, consisted of P_0 = fishmeal without tannins, P_1 = fishmeal+0.4% tannin, P_2 = fishmeal+0.8% tannin, and P_3 = fishmeal+1.2% tannin, and five replications. The data obtained are analyzed using polynomal orthogonal statistical test. Based on the result of the statistical analysis, it can be concluded that the higher given level of tammarind seeds tannin significantly decrease ($P<0,05$)the consentration $NH_3$with the equation $y = 8,17 -6,4x$ ($R^2=1$), significantly increase ($P<0,05$) the concentration of VFA with the equation $y = 62,88 + 86,2x$ ($R^2=1$), decrease ($P<0,05$) DMD with the equation $y = 68,152 – 50,397x$ ($R^2=1$), increase ($P<0,05$)OMD with the eqution $y = 47,279 + 8,52x$ ($R^2=1$), and increase ($P<0,05$)consentration of UDP with the equation $y = 26,01 + 13.968x$ ($R^2=0.999$). The tammarind seeds tannin that can be used to protect all of fishmeal protein is 5,3%.

Keywords : protection of proteins, fishmeal, tammarind seeds tannin, NH_3, VFA, DMD, OMD, UDP.

I. INTRODUCTION

High producing ruminants livestock requires higher quantities of essential amino acids in their ration. Those needs could not be fulfilled by a microbial origin proteins only, but the majority has to be supplied from the feed. Fishmeal is one of the feeds that contains high levels of essential amino acids. In fact, the use of fishmeal in ruminant rations are often not effective. That is because fishmeal is easily degradated by microbes in the rumen, so many essential amino acids being overhauled to ammonia. Ammonia is the N source that is synthesized in the body of rumen microbial to be returned to amino acid (Sutardi, 1997). This process is not considered effective and efficient because it requires longer periods of time compared to directly granting the protein that is already protected, so it can be used directly by the body of ruminants after enzimatic digested into amino acids in the intestine (Uchida *et al*., 2003).

Protection of feed protein aims not to overhauled it in the rumen, but it will be overhauled and the amino acid will be absorbed in the pascarumen digestive track (Suhartati, 2005). One of the feed protection technique is with the release of tannin (Min *et al*., 2002; Smith *et al*., 2005). Tannin is the best protection agent to gain the highest Ruminal Undegradable Dietary Protein (RUDP) (Suhartati, 2005). The existance of tannin have positive impacts if they are added on high-protein feed, both in quality and quantity (Jayanegara & Sofyan, 2008). Tannin is a complex polyphenol compounds (Deaville *et al*., 2010), that allows to form an effective cross-bonding with protein and other molecules (Fahey & Berger, 1988). Tannins are able to bind (Kondo *et al*., 2004) and to protect protein (Oliveira *et al*., 2000), so they are resistant to degradation by rumen microbes.

Tannins are classified in two groups, which are hydrolyzed tannin and condensed tannin (Makkar, 2003). Tannin that come from forage as contained in leguminosa are generally condensed tannin (Fahey & Berger, 1988). Condensed tannin have a stronger complex bind with protein compared to hydrolyzed tannin, so the complex of condensed tannin and protein have a strong effect in lower the degradation ability by rumen microbes (Kumar, 1992).

The complex of tannin-protein occurs due to hydrogen bonds, hydrophobic interactions, and the bond between the covalent compounds. The existence of a number of functional groups on the tannin led to the deposition of protein (Makkar, 2003). Preston and Leng (1987) say that the limit of the condensed tannin tolerance levels in the ration is 20 – 40 gr per kg dry matter. Kumar (1992) suggests that as much as 2 – 3% condensed tannin in ration have a favourable influence. Tannin bind the protein with a hydrogren bind that sensitive to pH change. Condensed tannin will bind stably on pH 4 – 7 in the rumen, but on the extrem pH (less than 4) tannin will be released in the abomasum and the protein could be absorbed by the enzim, so they are available for the livestock (El-Wazry *et al*., 2005). Protein that passes from rumen degradation are ranged form 20 – 80%, depend on the solvency in the rumen fluid, the flow rate of feed, the host animal, and microbial conditions (Sutardi, 1978).

Tannin can be obtained from plant parts. One of the plant parts that contains tannin is tammarind seed (*Tamarindus indica*). Tammarind seed can be used to protect the feed protein source because it contains tannin so the mixture of tannin extract from tammarind seed with feed protein source can form tannin-protein binds. Tammarind seed contains the highets levels of tannin, which is 20,2%, and it is centered on the part of the seed skin. (Gunasena & Hughes, 2000).

Tannin from tammarin seed are extracted and mixed with fishmeal, cause fishmeal protein protected from rumen microbial protease activity. With the protected fishmeal, the number of proteins that are degradated become lower so that will affect the levels of ammonia, VFA, digestability of dry matter and organic matter, and also Undegraded Dietary Protein (UDP) in rumen fluid.

II. MATERIALS AND METHODS

Materials used are: 1) Fishmeal with 38.64% protein (based on the result from Laboratory of Livestock Nutrition of Ruminants and Cattle Food Chemistry, Faculty of Animal Husbandry, Padjadjaran University), 2) Tammarin seed flour, as the disk mill grinding result with screen mash 20, 3) Dairy cow rumen fluid, taken from RPH Banjaran, Bandung, 4) Artifical saliva, based on the formula from McDougall (1949), cited from Tilley and Terry (1963).

The work procedure is: 1) Extract and isolate tannin with the Voight (1994) procedure, which is marinate the tammarind seed flour in 96% alcohol in the ratio of 1 : 3, and let it stand for 12 hours. Then evaporate and dry it so the dry extract of tammarind tannin is obtained. The evaporate stage is performed in the Laboratory of Organic Chemistry, Faculty of Mathematics and Natural Sciences, Padjadjaran University. 2) Fishmeal protein protection by the extract tammarin tannin is performed by mixing tammarind tannin extract that has been dissolved in accordance with the treatment, in 30 ml aquades with 100 gr fishmeal, and dried in 40^0C oven. 3) The retrieval of dairy cow rumen fluid is performed by taking it at different positions of the rumen, then filtered using muslin fabric, put into the thermos until full to guarantee the anaerobic state. 4) The manufacture of artificial saliva is performed by mixing the appropriate measure set of chemicals for 2 litres, which are 19.6 g of $NaHCO_3$, 18.60 g of $Na_2HPO_4.12H_20$, 0.94 g of NaCl, 1.14 g KCl, 0.08 g of $CaCl_2.2H_2O$, and 0.12 g of $MgSO_4.7H_20$.

The research is performed experimentally with Complete Random Design (CRD), with four treatments and five replications:

T_0 = Fishmeal with 0% additional tannin w/w
T_1 = Fishmeal with 0,4% additional tannin w/w
T_2 = Fishmeal with 0,8% additional tannin w/w
T_3 = Fishmeal with 1,2% additional tannin w/w

The parameters observed are the fermentability (levels of ammonia, total VFA), the digestability values (dry matter = DMD and organic matter = OMD), and UDP. The differences between treatment are statistically analyzed using Orthogonal Polynomial test (Gaspersz, 1995).

A. *In Vitro Fermentability Measurement*

One gram of treatment fishmeal is put into fermenters tube, added with 10 ml rumen fluid and 40 ml McDougall fluid, mixed with CO_2 in 30 seconds so the anaerob state can be obtained. Then the tube is closed with ventilated rubber and fermented in waterbath in 39^0C. After three hours, open the fermenters tube and drop saturated $HgCl_2$ to kill microbes. Then sentrifudge the tube with 3000 rpm speed in 20 minutes. The liquid part (supernatan) is used to analyze NH_3 and total VFA.

1. *Rumen Fluid NH_3 Levels*

The measurement of NH_3 levels is performed with Conway microdifuse technique (General Laboratory Procedure, 1966). 1 ml of supernatan is placed on the left side of the Conway cup and 1 ml of saturated Na_2CO_3 is placed on the right side. The middle small cup is filled with 1 ml of boric acid with red methyl and green bromine indicators. Close the Conway cup tightly with vaslin lid and shake so the supernatan is mixed with Na_2CO_3. Let it stand for 24 hours in room temperature. Ammonia binded with boric acid is titrated with H_2SO_4 0,005 N until the color changes to reddish. The NH_3 levels is calculated with this formula:

$$NH_3 = (\text{ml titration x N } H_2SO_4 \text{ x } 1000) \text{ mM} \quad (1)$$

Where :
ml = the volume of sulfuric acid that used in titration
N = sulfuric acid normality

2. Total VFA Levels

The measurement of total VFA levels is performed with steam distillation (General Laboratory Procedure, 1996). 5 ml of supernatan is placed into the distillation tube that has been heated with steam. The tube is closed as soon as possible after 1 ml of 15% H_2SO_4 is added. The hot steam will push the VFA to go through the condensed cooling tubes and will be accomodated by erlenmeyer tube that cointains 5 ml of NaOH 0,5 N until it reaches about 300 ml volume. Then 2 drops of phenolpthalein will be added and titrated by HCl 0,5 N. The titration is done when the color changes from red to transparant. Blanko titration is also performed to 5 ml of NaOH. VFA levels is calculated with this formula:

$$\text{VFA total} = (b - s) \times \text{N HCl} \times 1000/5 \quad (2)$$

Where :
b : volume of blanko titration
s : volume of sample titration
N : normality of HCl fluid

B. In Vitro Dry Matter Digestability and Organic Matter Measurement

This measurement is perfomerd by Tilley and Terry (1969) Method. One gram of treatment fishmeal is put into fermenters tube, added with 10 ml rumen fluid and 40 ml artificial saliva (McDougall) fluid, mixed with CO_2 so the anaerob state with pH 6.5 – 6.9 can be obtained. Then the tube is incubated in 39^{0}C waterbath within 24 hours. After that, open the tube lid and drop 0,2 ml of saturated $HgCl_2$ to kill the microbes. Sentrifudge the tube with 10000 rpm speed within 10 minutes. Dispose supernatan and add 50 ml of 0.2% pepsin in acid condition to the deposition. Incubate the tube again in aerob state within 24 hours. Furthermore, the deposition is filtered by Whatman 41 and analyze the levels of dry matter and organic matter. As the blanko, rumen fluid without treatment is used. The coefficient of dry matter and organic matter digestibility is calculated with this formula:

$$\text{DMD (\%)} = \frac{\text{DM onset - (DM residue - DM blank)}}{\text{DM onset}} \times 100 \quad (3)$$

$$\text{OMD (\%)} = \frac{\text{OM onset - (OM residue - OM blanko)}}{\text{OM onset}} \times 100 \quad (4)$$

Where :
DMD : digestibility of dry matter
OMD : digestibility of organic matter

C. Undegraded Dietary Protein (UDP) Measurement

One gram of treatment fishmeal is put into fermenters tube, added with 10 ml rumen fluid and 40 ml McDougall fluid, mixed with CO_2 in 30 seconds so the anaerob state can be obtained. Then the tube is closed with ventilated rubber and fermented in waterbath in 39^{0}C. After 48 hours, the fermenter fluid is filtered by filter paper. The residue is dried using the oven, then the protein levels is analyzed using Kjedahl method. The protein part in the residue is UDP. The analysis stage is performed in the Laboratory of Animal Nutrition of Ruminants and Feed Chemistry, Faculty of Animal Husbandry, Padjadjaran University.

The measurement of UDP is involving two protein levels measurements. The measurement of protein levels is performed with Kjedahl method. From both protein measurements, UDP is obtained with this formula:

$$UDP\ Levels\ (\%) = \frac{protein\ in\ residue\ (g)}{protein\ in\ ration\ (g)} x\ 100\% \quad (5)$$

III. RESULTS AND DISCUSSION

A. Tannin Protected Fishmeal Fermentability

The fermentability of tannin protected fishmeal is showed by the levels of NH_3 and total VFA in rumen fluid. The high NH_3 levels shows the large amount of tannin protected fishmeal that easily degradated by rumen microbes. On the other hand, the high levels of total VFA shows the large amount of tannin protected fishmeal organic matter that easily degradated by rumen microbes. The average of NH_3 and VFA levels on each treatment are showed in Table 1.

Based on Table 1, the addition of tannin on the fishmeal gives response to lower the ammonia (NH_3) levels. This shows that tammarind seed tannin can protect fishmeal protein from rumen microbes degradation. The protein will become bypass protein when enter the rumen. The higher the tannin addition levels, the lower the ammonia (NH_3) levels, or the lesser the fishmeal protein that can be degradated. This result is in accordance with Hume (1982), who said that the higher the degradated protein by rumen microbes then the higher the NH_3 levels that can be generated. The highest NH_3 levels is 5.45 mM, generated by T_0 (fishmeal protein without tannin protection), and the lowest is 3.50 mM, generated by T_3 (fishmeal protein with 1.2% tannin protection).

The statistical analysis shows that tannin is significant ($P<0.05$) to NH_3 levels. The connection between NH_3 and the tannin levels in protecting the fishmeal protein is following the $y = 8.17-6.4x$ ($R^2 = 1$) equation. The curve of the connection between NH_3 and the tannin levels that added in fishmeal is showed on Fig. 1.

Table 1. The Effect of Treatments to Ammonia (NH_3) Levels and total VFA

Variables	Treatments			
	T_0	T_1	T_2	T_3
NH_3, mM	5.45 ± 0.19^{a}	4.45 ± 0.19^{b}	3.92 ± 0.11^{c}	3.50 ± 0.21^{d}
VFA total, mM	112.0 ± 4.4^{b}	95.2 ± 3.5^{c}	118.2 ± 4.2^{b}	133.1 ± 10.2^{a}
UDP, %	30.50 ± 1.13^{b}	35.76 ± 2.26^{a}	36.24 ± 1.82^{a}	$34.96 \pm 3.08 \pm$

Description : different superscript in a row shows the significance effect ($P<0.05$)
T_0 = Fishmeal protein without tannin protection
T_1 = Fishmeal protein with 0.4% tannin protection w/w
T_2 = Fishmeal protein with 0.8% tannin protection w/w
T_3 = Fishmeal protein with 1.2% tannin protection w/w

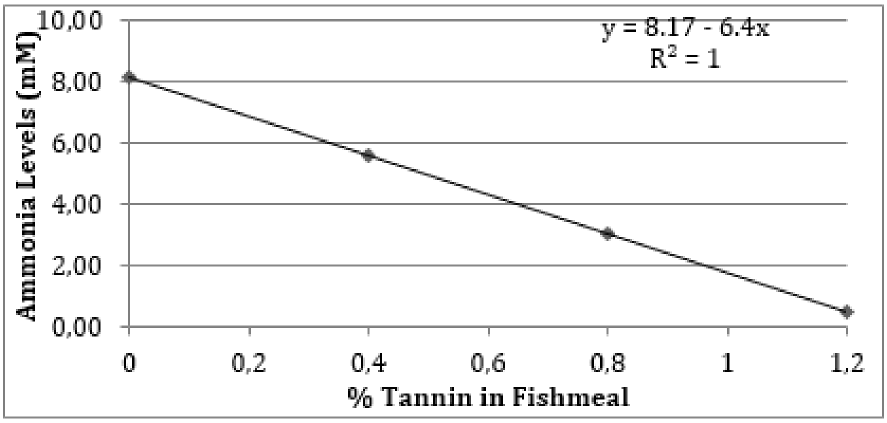

Fig. 1. Linear Connection Between Ammonia Levels and Tannin

Based on Illustration 1, NH_3 levels is decreasing as the tammarin seed tannin is increasing in protecting fishmeal protein. The reduction is started on the additional of 0.4% tannin and reach the lowest point on the additional of 1.2% tannin. The role of tannin as the protection agent can be seen on each treatment. T_0 is when fishemal is not added by tannin and resulting the higher NH_3 levels compared to other treatments with tannin. This is because the protein on T_0 is unprotected, so the rumen microbes are able to degrade more fishmeal protein than the tannin protected fishmeal. Satter and Slyter (1974) state that feed with high levels of protein pass the degradation, so the rumen NH_3 levels is low (lower than 3.57 mM).

Tannins can form complex compound with protein. The tannin-protein bind causes feed protein undegradable by rumen microbes (Sugoro *et al.*, 2004). The higher the tannin levels used in protecting fishmeal protein, the lower the NH_3 levels in rumen. The tannin ability in reducing rumen fluid NH_3 levels is through the tannin interaction mechanism to the feed protein. The NH_3 levels will decreasing when there are more tannin that protecting the protein (Tanner *et al.*, 1994).

The relation of tannin addition with the rumen fluid NH_3 levels is following the $y = 8.17-6.4x$ ($R^2 = 1$) equation, which means that every additional of 1% tammarind seed tannin is reducing the NH_3 levels as much as 6.4 mM. The reduction of the NH_3 levels is caused by the tannin good function as the protecting fishmeal protein agent. The higher the tannin levels, the lower the NH_3 levels that is generated. The complex of condensed tannin-protein has a strong effect in reducing degradation ability by rumen microbes (Kumar, 1992).

VFA is a result of the hydrolysis of polysaccharide carbohydrates by rumen microbes. Polysaccharide is transformed into monosaccharide, especially glucose, and then reorganized to acetic, propionic, butyrate and isobutyrate, valerate, isovalerate, methan, and CO_2 (Sutardi, 1977). A high total VFA production shows that the organic matter in feed is easily degadrated by rumen microbes.

The tannin addition into fishmeal has a significant effect ($P<0.05$) to the total VFA levels. The protected fishmeal by 0.4% tammarind tannin (T_1) is resulting the lower VFA levels ($P<0.05$) than unprotected fishmeal (T_0). But when the tannin levels is increased to 1.2%, there is an increasing in total VFA levels. This result is not in accordance with the NH_3 levels. This indicates that the role of tannin in protecting fishmeal protein is not followed by protecting organic matter beside protein such as carbohydrate and fat. The tammarind tannin is more dominant in forming complex compound with protein than polysaccharide.

The relation between tannin and total VFA levels is following the y = 62.88 + 86.2x (R^2 = 1) equation. The equation shows that every 1% tammarind tannin addition in fishmeal is increasing the total VFA levels by 86.2% mM. There is an indication that tannin has less well function as the agent in protecting fishmeal polysaccharide.

The average of UDP levels is protein that is undegradable by rumen microbes. The result shows that the UDP levels is increasing as the tannin is added more in the fishmeal. The relation between tannin and UDP is following the y = 26.01 + 13.968x (R^2 = 0.999) equation. The curve of the relation between the treatments and the UDP levels that added in fishmeal is showed on Fig. 2.

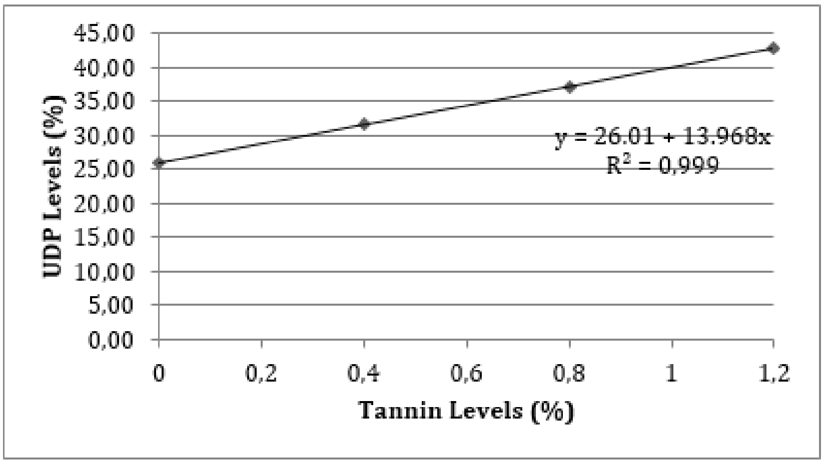

Fig. 2. Linear Connection Between Treatments and UDP Levels

Based on Fig. 2, the UDP levels is increasing as the tammarind seed tannin added in fishmeal is increasing. The higher the tammarind seed tannin added, the higher the UDP that is generated. This is because the tannin is bind with protein so it forms the compound bond that unable to be dissolved in neutral pH in rumen. Makkar (2005) stated that the interaction between tannin and protein has three binding forms, which are hydrogen, ionic, and covalent.

The hydrogen bond is formed because of the bond between the tannin hydroxyl cluster and the protein reactive cluster. The hydrogen bond is the most bond bwtween protein and tannin. The ionic bond is formed because of tannin as the anion and protein as the cation. The covalent bond is formed as the interaction quinon cluster form tannin, which oxidized with protein reactive cluster. This bond causes the protein pass from rumen degradation. This is in accordance with Jayanegara and Sofyan (2008), who state that protein that binds with tannin is undegradable by rumen microbes, but available in pascarumen because the tannin-protein bond can be released in low pH in abomasum.

Based on the y = 26.01 + 13.968x (R^2 = 0,999) equation, we can estimate that in every 1% addition of tammarind seed tannin can increase UDP by 13.97%. So, to protect all of fishmeal protein, 5.3% of tammarind tannin is needed. In other words, to protect the feed, which is the fishmeal with 38.64% protein levels, we need 5.3% tammarind seed tannin.

B. Digestability of Tannin Protected Fishmeal

The ration digestability in pascarumen is showed with the digestability of dry matter (DMD) and organic matter (OMD). The value of DMD and OMD can be used as an indicator of convertibility feed degadrated by rumen microbes and digested by digestion enzyme in pascarumen. The digestability value of DMD and OMD in feed usually used as one of the determinants in knowing about the amount of feed nutrients that can be absorbed by the body. The higher the DMD and the OMD in feed, the larger the amount of food substances that can be used to fulfill the needs of livestock nutrition (Arora, 1989). The average of DMD and OMD in ration is showed in Table 2.

Based on Table 2, the digestability of tannin protected fishmeal DMD (T_1, T_2 dan T_3) is lower ($P<0.05$) than unprotected fishmeal DMD (T_0). The value of fishmeal KcBK is decreasing as the tannin is added more in the fishmeal. The relation between tannin and the protected fishmeal DMD digestability is following the y = 68.152 – 50.397x (R^2=1) equation. The digestability value of the treatment fishmeal KcBK is contradictive with the digestability value of OMD, which is increasing as the tannin levels added into the fishmeal is increasing. The relation between the digestability of tannin protected fishmeal OMD is following the y = 47.279 + 8.520x (R^2 = 1) equation.

This means that the digestability of tannin protected fishmeal organic matter is increasing as the tannin added more into the fishmeal. The highest digestability of tannin protected fishmeal organic matter is 55.0 ± 1.4 %, obtained in the treatment of 1.2% w/w tannin added.

Table 2. The Effect of Treatments to Digestability of Dry Matter and Organic Matter

Variables	Treatments			
	T_0	T_1	T_2	T_3
	---------------------------- % -------------------------------			
DM Digestability	51.4 ± 0.8^{a}	32.6 ± 0.5^{c}	33.4 ± 0.3^{bc}	34.3 ± 0.3^{b}
OM Digestability	53.0 ± 0.8^{b}	49.6 ± 1.0^{c}	52.0 ± 1.8^{b}	55.0 ± 1.4^{a}

Description : different superscript in one row shows significant effect (P<0.05)
T_0 = Fishmeal protein without tannin protection
T_1 = Fishmeal protein with 0.4% tannin protection w/w
T_2 = Fishmeal protein with 0.8% tannin protection w/w
T_3 = Fishmeal protein with 1.2% tannin protection w/w

The value of the tannin unprotected fishmeal DMD and OMD (T_0) is 51.4 ± 0.8% and 53.0 ± 0.8%. The value of fishmeal DMD is decreasing after the tannin protection, on the other hand the OMD is increasing. The difference between dry matter and organic matter is caused by the digestability of the very low protected fishmeal ash component. The dry matter that is digested consists of ash nutrients, protein, fat, and carbohydrate. On the other hand, the organic matter that is digested consists of nutrients, protein, fat, and carbohydrate.

The protected fishmeal by 1.2% tannin (T_3) caused the value of DMD is decreasing to 34.3 ± 0.3%. This indicates that some of the bond of tannin with fishmeal nutrients is still binded with acid pH (the condition in abomasum). This result is contradictive with Nolan (1993), who states that tannin that form the complex bond with protein in the rumen becomes less digestable, because the complex tannin-protein becomes stable above pH 3.5. But, under pH 3.5, which is the condition in pascarumen, the complex tannin-protein is separated so it is possible to digest.

The reduction of digestability of protected fishmeal dry matter is closely related to the existence of the tannin-protein complex. This is in accordance with Butler and Roger (1992), that the negative effect of the tannin existence in feed can reduce the consumption and the ration digestability.

Tannin has more ability to form complex with protein rather than with carbohydrate or any other polymer. The complex tannin and the protein formed by covalent bond is the most stable bond compared to hydrogen bond, ionic bond, or hydrophobic bond (Hagerman, 1989).

IV. CONCLUSION

Tannin that is extracted from the tammarind seed can protect fishmeal to be bypass protein source of the feed for ruminant ration, viewed from the fermentability, digestability, and UDP in the rumen. The additional 1,2% of tannin in the fishmeal resulting the highest UDP. To obtain 100% UDP fishmeal protein, tannin that is extracted from tammarind seed needs to be added by 5.3% w/w.

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REFERENCES

Arora, S.P. 1989. *Pencernaan Mikroba pada Ruminansia.* Transletted by *Srigondo, B (ed)*. Gadjah Mada University Press, Yogyakarta.

Butler LG and J.C.Rogher. 1992*. Biochemical mechanism of the antinutritional effects of tannins*. In : Chi-Thang H, Chang YL, and Mou-Tuan H. editor. Phenollic compound in food and their effects on health. Washington DC: American Chemical Society. 298-304.

Deaville, E.R., D.I. Givens, and I. Mueler-Harvey. 2010. Chesnut and Mimosa Tanin Silages: *Effect in Sheep Differ for Apparent Digestibility, Nitrogen Utilitation and Loses. Anim. Feed Sci. Technol.* 157: 129-138.

El-Wazry, A.M., MEA. Nasser, and S.M.A. Salam. 2005. *Processing Methods of Soybean Meal : 1- Effect of Roasting and Tannic Acids Treated-Soybean Meal on Gas Production and Rumen Fermentation in vitro. J of Appl Sci Res*. 1 (3) : 313-320.

Fahey, G.C., and L.L. Berger. 1988. *Carbohydrate Nutririon of Ruminants. In :* D.C . Church (Ed.). *Digestive Physiology and Nutrition of Ruminants.* Prentice Hall, Englewood Cliffs, New Jersey.

Gunasena, H.D.M, and A. Hughes. 2000. *Tamarind : Tamarindus indica*. International Centre for Underutilised Crops, Southampton.

Hagerman, A. E. 1989. *Chemistry of Tannin – Protein Complexation Chemistry and Significance of Condensed Tannins*. Plenum Press. New York.

Jayanegara, A. and A. Sofyan. 2008. *Penentuan Aktivitas Biologis Tanin Beberapa Hijauan Secara in vitro Menggunakan Hohenheim Gas Test dengan Polietilen Glikol Sebagai Determinan*. *Med. Pet.* 31: 44-52.

Kondo, M., K. Kita, and H. Yokota. 2004. *Feeding Value to Goats of Whole Crop Oat Ensiled with Green Tea Waste. Anim. Feed. Sci. Technol.* 113:71-81.

Kumar, R. 1992. *Anti Nutritional Factors, The Potential Risks of Toxicity and Methods to Alleviate Them.* In : Legume Trees and Other Fodder Trees as Protein Sources for Livestock. Speedy, A. And P.L. Pugliese, Editor. Food and Agriculture Organization of the United Nation, Rome.

Makkar, H. P. S. 2005. *Quantification of Tannins in Tree and Shrub Foliage*. A Laboratory Manual. Kluwer Academic Publisher, Dordrecht.

McDonald, P., R.A. Edwards, J.F.D. Greenhalg and C.A. Morgan. 2002. *Animal Nutrition*. 6th Ed. Ashford Color Pr., Gosport.

Min, B.R., G.T. Atwood, K.Reilly, W.Sun, J.S. Peters, T.N. Barry, dan W.C. McNabb. 2002. *Lotus Corniculatus Condensed Tannins Decrease in vivo Populations of Proteolytic Bacteria and Effect Nitrogen Metabolism In Rumen of Sheep. Can. J. Microbiol*. 48:911-921.

Nolan, J.V. 1993. *Nitrogen Kinetics.* In : Ouantitative Aspects of Ruminant Digestionand Metabolism. Forbes, J.M and J. France, Editor. CAB International, Wallingford.

Oliveira, R.L., Santos, G.T., H.V.Petit, U. Cecato, L. M. Zeoula, L.P. Rigolon, .C. Damasceno, A.F. Branco, and V. Bett. 2000. *Effect of Tannins Acid on Composition and Ruminal Degradability of Bermudagrass And Alfalfa Silages. J. Dairy Sci.*83:2016-2020.

Preston, T.R and R.A Leng. 1987. *Matching Ruminant Production System with Available Resource in the Tropics and Sub Tropics.* Penambul Books Armidale, New South Wales. 21 – 128

Satter, L.D. and L.L. Slyter. 1974. *Effect of Ammonia Concentration on Rumen Microbial Production in Vitro. Brit. J. Nutr.* 32 : 199-208.

Smith, A.H., E. Zoetendal, and R.I Mackie. 2005. *Bacterial Mechanisme to Overcome Inhibitory Effect of Dietary Tannins.* Microb. Ecol. 50: 197-205.

Sugoro, I.I., Gobel, N., Lelananingtyas, and W. T. Sasongko. 2004. *Pengaruh Variasi Konsentrasi Tanin terhadap Produksi Gas secara in Vitro*. Prosiding Presentasi Ilmiah Keselamatan dan Radiasi Lingkungan X. Puslitbang Teknologi Isotop dan Radiasi. Batan.

Suhartati, F. M. 2005. *Proteksi Protein Daun Lamtoro (Leucaena leucocephala) Menggunakan Tanin, Saponin, Minyak Dan Pengaruhnya Terhadap Ruminal Undegraded Dietary Protein (RUDP) Dan Sintesis Protein Mikroba Rumen. Jurnal Animal Production*. **7** (1): 52-58.

Sutardi, T. 1978. *Ketahanan Protein Bahan Makanan Terhadap Degradasi Oleh Mikroba Dan Manfaatnya Bagi Peningkatan Produktivitas Ternak*. Fakultas Peternakan, IPB. Buletin Makanan Ternak 5 (1): 1.

Sutardi, T. 1997. *Peluang Dan Tantangan Pengembangan Ilmu-ilmu Nutrisi Ternak*. Orasi Ilmiah. Fakultas Peternakan, Institut Pertanian Bogor.

Tanner, G.J.. Moore A.E., and Larkin, P.J. 1994. *Proanthocyanidins Inhibit Hydrolysis of Leaf Proteins by Rumen Microflora in vitro*. *J. Nutr*. 74 : 947-958.

Tilley, J.M.A. and R.A.Terry. 1963. *A Two Stage Technique for the in vitro Digestion of Forage Crop. Journal of British Grassland*. 18: 104-111.

Uchida, K., P. Mandebvu, C.S. Ballard, C.J. Sniffen, and M.P. Carter. 2003. *Effect of Feeding Methionine Supplements with Different Rumen Escape Values on Performance of High Producing Dairy Cows in Early Lactation. Anim. Feed Sci. Tech.* 107:1-14.

Voight, R. 1994. *Buku Pelajaran Teknologi Farmasi*. Diterjemahkan oleh S. Noerono, Gadjah Mada University Press, Yogyakarta.

F.3

THE EFFECTIVENESS OF VEGETABLE OILS AS COATING MATERIALS TO REDUCE DETERIORATION OF TOMATO FRUIT DURING STORAGE

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ABSTRACT

This study aims to find the effective vegetable oil used as a tomato coating material to decelerate the quality deterioration during storage at ambient temperature. Four emulsions (o/w) of vegetable oils, namely coconut oil, sunflower seed oil, sesame seed oil and canola oil, with the same concentration of 0.5% were tested for their ability in reducing the intensity of spoilage of the fruit. The most effective vegetable oil was then combined with lemon grass oil with the same concentration of 0.5% (o/w), and the emulsion was then used for coating in different stages of maturity of tomato fruits. The weight loss, intensity of spoilage, hardness, color change, total soluble solid and pH were measured during storage at room temperature (28$\pm$2).. The results showed that different vegetable oil emulsions as a coating material had a significant effect on the intensity of spoilage of tomato fruit during storage. Sesame oil emulsion was found as the most effective emulsion compared to others vegetable oils and control in reducing the spoilage intensity of the tomato fruits. Further research showed that the combined sesame and lemongrass oil with the same concentration of 0.5% (o/w) for coating effectively reduced the intensity of spoilage or decay, weight loss, firmness, color changes and pH of tomato fruit compared to uncoated fruits during storage at room temperature. The coated tomato fruits of the breaker stage with the combined emulsion were found more responsive in reducing the spoilage, firmness, color change compared to other maturity stages.

Keywords: vegetable oil, fruit coating, fruit shelf life, tomato, sesame oil, lemongrass oil.

I. INTRODUCTION

Horticultural products have a high potential to be developed in Indonesia to meet the needs of domestic or export demand. The potency is supported by the climate of which is varied in topographic elevation from low land to high land. The topographic variation generates different temperatures to support the growth of various species and varieties of crops. Tomato is one of the products demanded by consumers since it is a source of vitamin C and minerals, and is a multi purpose as vegetables, table fruit, juices or drinks. Tomatoes is a commodity that is classified as very susceptible to damage (very perishable) where a damage of postharvest tomato fruit is mostly due to improper handling, and it can reach up to 32% (Utama and Kitinoja, 2015). The postharvest damages include physical, physiological, mechanical and microbiological damages. One of the indications of the high deterioration rate of harvested tomato fruits during storage is the softening and shriveling of the fruits of which decreases the price during marketing. Therefore, necessary efforts to maintain fruit quality and extend the shelf life of fresh tomatoes are important.

Coating of fruits or vegetables is a method of applying a thin layer film on the surface of the fruit to mainly control the exchange of respiratory gases (O_2 and CO_2), inhibit the water vapor transpiration so that the physiological changes and shriveling of the products can be slowed. A coating material can be incorporated with active antimicrobial agents to inhibit the growth of decay microorganisms (Rojas-Grau et al., 2009). The materials used as coatings should be selected to be able to form a thin layer of barrier on the surface of the fruits. The material does not harmful for human consumption and plant products (phytotoxic), colorless, tasteless extend the shelf life of the fruit or vegetable, and economically visible (Dahll, 2013). The extension of the shelf life occurs because of the slowing respiration rate of the fruit through the reduction of the concentration of internal O_2 and the increase of CO_2 without causing an anaerobic condition. The freshness of the coated products which can be maintained for a longer period compared than un-coating products is due to the reduction of water vapor transmission from the inner product to the surrounding atmosphere.

One type of edible coating materials that can be promisingly used on fruit and vegetable products are vegetable oils as edible coating materials. Vegetable oil is known as triglyceride (three molecules of fatty acids) which is derived from vegetable or plant materials, mostly from the seeds (Thomas, 2002; Barnwal and Sharma, 2005; Vargas et al., 2008). Most of the commercial lipids as edible coatings are derived from animals and insects and only a few from plants, such as carnauba and candelilla exudates. This article, therefore, reports the result of a screening of different vegetable oils as coating materials on tomato fruits based on their effectiveness in reducing the intensity of the spoilage of the fruits. The best vegetable oil was then tested its ability to maintain the quality and extend the storage life of different stages of maturities of tomato fruits.

II. MATERIALS AND METHODS

A. *Materials*

This study used tomato fruits (*Solanum lycopersicum* var Marta) (East-West Seed Cap Pana Merah) with the weight range of 100-120 grams and diameter of 4-6 cm per fruit. The fruits were directly harvested from the garden of a farmer in the village of Bedugul Candikuning, Baturiti, Tabanan, Bali. Before used for the experiment, the fruits were washed with 125 ppm chlorine. Vegetable oils used as coating materials were coconut, sunflower seed, sesame seed and canola oils which were purchased from the Super Market of Tiara Dewata, Denpasar - Bali. Polystearat or Tween 80 and oleic acid are used as emulsifier and ethanol were added to disperse the particle of oils in the water.

B. *Experimental Design*

The experiment consisted of two stages. The first stage was to screen the effectiveness of the emulsion of the vegetable oils on their effectiveness in reducing the intensity of spoilage of the tomato fruits of which was measured every three days during storage at room temperature (28±2°C). The vegetable oils involved were coconut oil (Co), sunflower seed oil (Sf), sesame seed oil (Ss) and canola oil (Cn) with the same concentration of 0.5% (O/W), Control fruits (Ctrl) without coating were prepared for comparison. The breaker stadium of maturity of tomato fruits was used in this stage. The best vegetable oil from the screening was then mixed with lemongrass oil with the same concentration of 0.5% in the emulsion (O/W) and used for the experiment in the second stage. The mixed oil emulsion was further used for coating the tomato fruits with different stadia of maturities, namely breaker (S2), turning stage (S3), pink stage (S4) and red (S5) stadia. Uncoated fruits with different stadia of maturities were also prepared as comparisons. The coated (Tf) and uncoated or control (Cf) fruits for each stadia were stored at room temperature (28±2°C) for 25 days. The weight loss, texture, intensity of spoilage, total soluble solid, pH, and color of the fruits were measured at the interval of five-day storage. The experiment was performed in three replications with a completely randomized design. The unit of experiments consisted of 15 fruits and lied on the room temperature. The variances of the data taken from the first experimental stage (single factor) and the second experimental stage (two factors) were analyzed. If there is a significant difference of the variances, multiple comparisons of the means of the treatments were conducted using Duncan's Multiple Range Test (Steel and Torrie, 1980).

C. *Vegetable oil emulsion*

The concentration of 0.5% emulsion of each vegetable oil was made up by involving 3 % of ethanol as a dispersing agent, and 0.5% of tween 80 and 0.5% oleic acid as emulsifiers. The oil and ethanol were immersed in the water and blended using a warring blender (ABM 7011HS) at the speed of 14,000 rpm for one minute. The dispersed oil particles in the water were then heated in the hot plates and stirred with a glass rod until boiling. During the stirring, tween 80 and oleic acid were added. The hot boiled emulsion was poured in the warring blender and was further blended at the highest speed for two minutes. The stable emulsion was found if there was no separation of water and oil after one hour left in the room temperature. The emulsion was then used for coating by dipping the fruits in the emulsion. The excessive water was evaporated under forced air of a fan. The coated fruits were then stored at room temperature (28±2°C), and the quality parameters were measured every five days of storage.

D. *The Parameters Observed*

1. *Intensity of Spoilage/Decay*

The formula below was used to measure the intensity of spoilage of each experimental unit of the fruits. Before the calculation, the spoilage of individual fruits in the experimental units was given ratings as shown in the Table below. The formula is the adaptation of the formula given by Townsend and Heuberger (Kremer and Untertenshofer, 1967) to estimate the rate of percentage of disease incidence. Where 0 means no infection, and 6 means the maximum rating which indicates more than 50% of individual fruits are infected by spoilage microorganisms.

$$\text{Decay intensity of the experimental unit (\%)} = \frac{\sum (n \times v)}{N \times V} \times 100\% \quad (1)$$

where :
n = the number of chili fruits in each rating
v = the ratings of spoilage
N = the number of fruit per unit of experiment
V = the maximum rating (6)

Table 1. The infection of individual fruit and its rating

Infection on individual fruit (%)	Rating
0	0
1-10	1
11-20	2
21-30	3
31-40	4
41-50	5
>50%	6

2. *Firmness*

The firmness of the tomato fruits was measured using texture analyzer (T.A XT plus, USA) that was connected to the computer and open application of "Texture Exponent 32". The texture analyzer with 0.6 cylinder probe was settled up; 5 sec speed and depth of 10 mm and the level of firmness was in the unit of kg force.

3. *Weight loss*

The weight loss of the tomato fruits was measured during storage. The weight loss in percent of the fruits was measured using the formula below. Where; W_{t0} is the weight at day-0 and W_{tn} is the weight on the day of measurement

$$\text{\% of weight loss} = [(W_{tn} - W_{t0})/W_{t0}] \times 100 \quad (2)$$

4. *Color*

The color of the skin of tomato fruits was measured at three different parts; at the basal, middle and tip (near the attached stem, using colorimeter (AccuProbe HH 06, New York, USA). The *L*, a*,* and *b** color system were involved in this measurement. The letter *L* indicates the whiteness of the color which ranges from 0 to 100; the increase of value, the increase of whiteness. The letter *a** indicates red-green color which ranges from -90 to +90; positive means the color more red and negative means the color more green. While the letter *b** indicates yellow-blue color which ranges from -90 to +90; positive means more yellow and negative means the color more blue. The color differences between the coated tomato fruits with different stages of maturities and the control or uncoated fruits in the same maturity. The formula used to measure the differences as follows (Rhim et al. 1999).

$$\Delta E* = \sqrt{\Delta a*^2 + \Delta b*^2 + \Delta L*^2} \quad (3)$$

Where :
ΔE* = the total difference of the color
ΔL* Δa* Δb* = the color difference of the L*, a* and b* value, respectively.

5. *Total Soluble Solid*

The measurement of the total soluble solid of the flesh of the tomato fruit was conducted using a digital refractometer (Misco V 1.04 Palm Abbe II, USA). Before using, the refractometer was calibrated by placing distilled water on the prism and then set as ”zero”. The distilled water was cleaned using a tissue then the juice of the tomato fruit was dripped on to the prism. TSS was then identified as ^{o}Brix.

6. *Ph*

Measurement of pH was conducted using digital pHmeter (Shindengen Isfet KS 701, Japan). The pHmeter was calibrated by dipping the sensor of the tool in the buffer solution (pH 6.9). The flesh of the tomato fruits was squeezed and filtered by using filter paper. The clear solution was then dropped on the probe of the pHmeter, and the value of the pH was obtained. The pH of each fruit was measured three times to get a consistent measurement.

III. RESULTS AND DISCUSSION

A. Vegetable Oils Screening

The vegetable oils selected for the experiment were screened based on their emulsion ability (0.5% O/W) to reduce the intensity of spoilage of the coated tomato fruits during storage. Observation conducted at day 12, 15, 18 and 21 of storage indicated that different vegetable oil emulsions as edible coatings and controls fruits (Ctrl) were significantly affected the intensity of spoilage of the tomato fruits during storage. Comparing all the vegetable oils and controls, coating with sesame oil emulsion (Ss) caused the greater reduction in the intensity of spoilage of tomato fruits followed by coconut oil and canola oil. The sunflower seed oil emulsion was found comparable to the control which was not effective in reducing the spoilage (Fig. 1).

Sesame oil is known to be rich in an antioxidant of Vitamin E (Mohebbi et al., 2015) and the effectiveness of the oil could be related to the control of the exchange of oxygen as a respiratory gas. As an essential oil, the sesame oil contains tocopherols with a predominance of γ-tocopherol (90.5%), the phytosterol marker β-sitosterol, protein and high amount of lipid (Gharby et al., 2017). Magnesium, copper, calcium, iron, zinc and vitamin B6 were also reportedly found in the sesame oil (Gokbulut, 2010). Therefore, sesame oil is nutritious for human consumption and approves that it is safely used as an excellent edible coating for fruits and vegetables. The sesame oil which had the greatest effect on spoilage reduction of tomato fruits was further used in the second stage of the experiment.

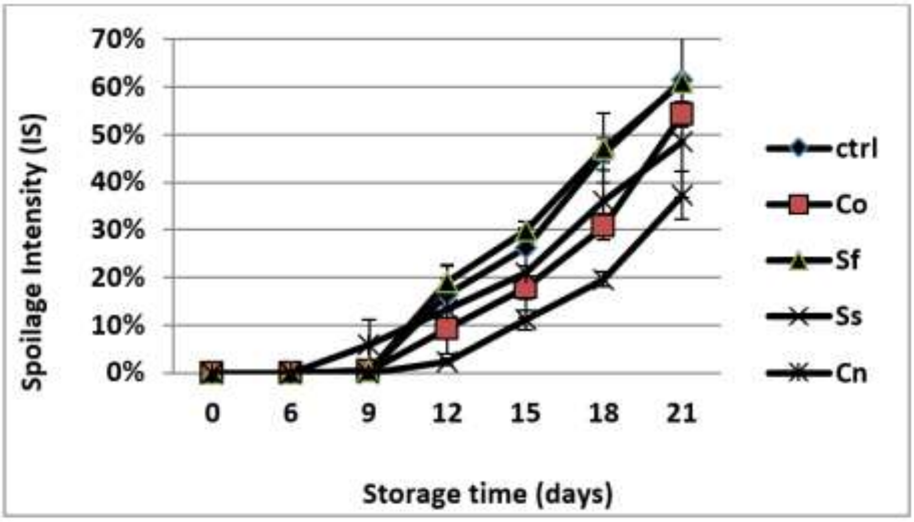

Fig. 1. The effect of vegetable oils as edible coating materials on the spoilage intensity of tomato fruits measured at the different times of storage.

B. Efficacy of Sesame Oil as Edible Coating

The combined Sesame and lemongrass oil emulsion with the same concentration of 0.5% O/W was tested in the second stage of the experiment. The emulsion was used for coating different stadia of maturity of tomato fruits to investigate the response of the emulsion on the quality (chemicals and physical) parameters of the fruits during storage. The results were compared with the uncoated fruits (control) which were discussed below.

C. Spoilage Intensity

The coated tomato fruits were significantly different than the uncoated fruits in reducing the spoilage during storage (Fig. 2). In general, there was a significant reduction of spoilage of coated tomato with various stadia of maturity compared to the control or uncoated fruits. The difference was seen when the measurement performed at day 10, 15, 20 and 25-day storages. The This indicated that the combined oil emulsion was effective to reduce the spoilage of different stadia of maturity of tomato during storage. Is there any synergism effect of the sesame oil and lemongrass oil? Since lemongrass oil was known that contains antimicrobial compound (Singh et al., 2015), and sesame oil was found as an antimicrobial for the gram negative and gram positive microorganisms (Saleem, 2011), the combined of both essential oil emulsion seems that has a synergistic effect on the reduction of spoilage of tomato fruits during storage.

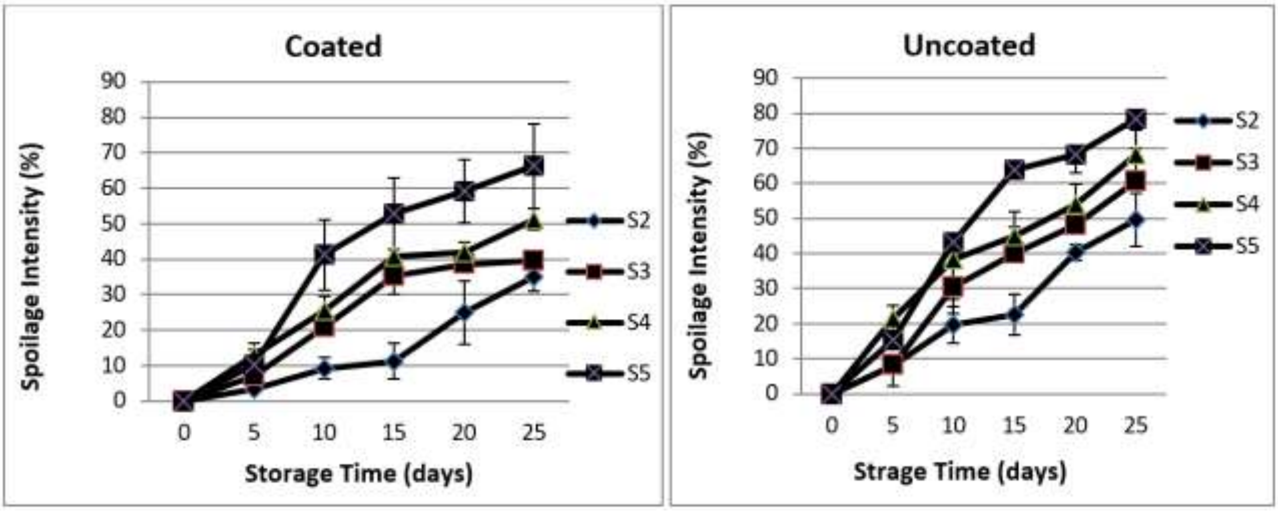

Fig. 2 The effect sesame oil and lemongrass oil as a combined emulsion on the spoilage intensity of tomato fruits measured at the different times of storage.

D. Firmness

The unpredicted result was found that there is no significant difference in the firmness of coated and uncoated tomato fruits during storage (Fig. 3). The only different of hardness was found that is due to differentiation of fruit maturity especially in the early period of storage or by up to 5-day observation. However, for the coated fruits of the second stadium of maturity, the firmnesss was significantly higher by up to 15-day observation.

The nonsignificant difference in the firmness of the coated and uncoated fruits could occur because of the dryness and shrivel of the skin of the uncoated fruits needs more pressure to puncture, even though the flesh is juicier than the coated fruits. The shriveling of the fruit skin of the uncoated fruits was due to the transpiration of the moisture in the skin tissues which was higher than the coated fruits. Lerdthanangkul and krochta (1996) were similarly found that the reduction of water loss of green bell peppers was significantly hastened with the mineral based oil coating material. While Hasan et al. (2013) reported that the commercial coating of Bio-Fresh™ retarded the shriveling of pear during storage.

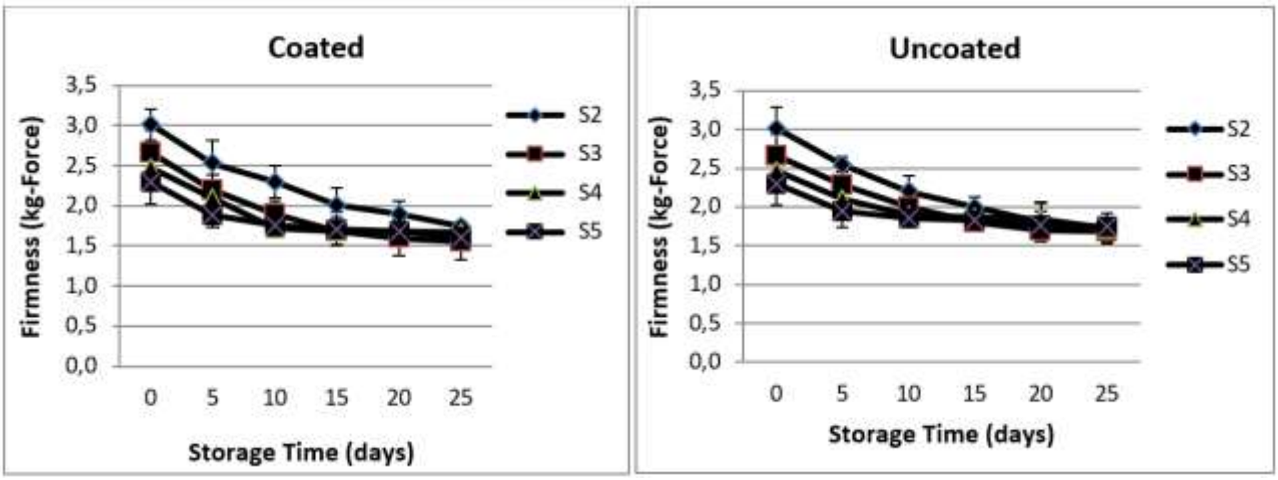

Fig. 3. The effect sesame oil and lemongrass oil as a combined emulsion on the hardness of tomato fruits measured at the different times of storage.

E. Weight Loss

The weight loss of fresh produce naturally occurs during storage. Coating of fruits is partly intended to reduce the weight loss. The rate of the weight loss of the coated tomato fruits was significantly lower than the uncoated fruits as shown in the measurements every five days of storage (Fig. 4). However, comparing among the stadia of maturities, the coated fruits with different maturities gave a significant difference on the weight loss. The breaker stage (S2) had the lowest weight loss compared to other stadia measured at 20 and 25 days of storage. Meanwhile, different stadia of the uncoated fruits could not give significant differences on the weight loss. It can be summarized that coating the fruits with mixed 0.5% sesame and 0.5% lemongrass oil emulsion is significantly reduced the weight loss compared to the uncoated fruits. The response of the fruit maturities when they coated with the mixed sesame and lemongrass oil emulsion was significant.

Adetunji et al. (2015) reported that the mixed essential sesame oil and aloe vera gel for coating carrot was effectively reduced weight loss and extending the shelf life compared to the single treatment of sesame oil or aloe vera. The addition of lemongrass oil in the emulsion of sesame oil could be beneficial as the lemongrass oil has a broad spectrum inhibition effect on the growth of various clinical, environmental and food origin microorganisms (Singh et al., 2011).

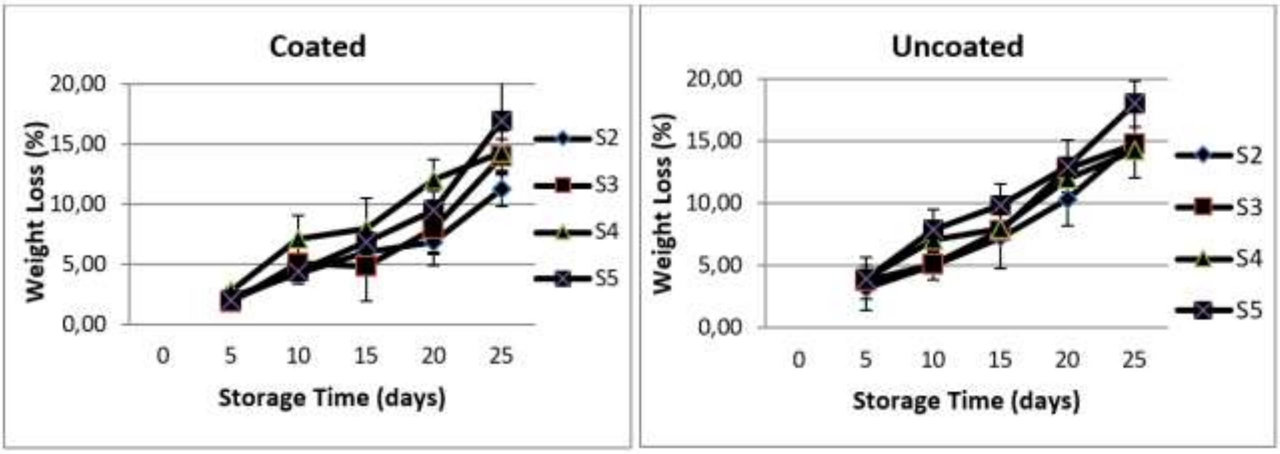

Fig. 4. The effect sesame oil and lemongrass oil as a combined emulsion on the weight loss of tomato fruits measured at the different times of storage

F. Color Difference (ΔE)*

The color difference (ΔE*) between the coated and uncoated (control) fruits was highly significant among fruit maturities. The differences were seen when the measurement began at 5-day storage. The following measurements with the interval five days of storage found the similar results (Figure 5). The highest and relatively constant change of the fruit color was shown by the breaker stage (S2) at different days of measurements. The color differences of turning stage fruits (S3) tended to decrease with the increase of storage times, while the color difference of the pink stage fruits (S4) tended to decline during the storage of 5 to 10 days, then steady by up to 25-day storage. The color difference of the red stage fruits (S5) was the lowest and relatively stable during storage. The higher the differences, the more effective of the mixed sesame and lemongrass oil emulsion in reducing the color change of the tomato fruits. Therefore, the mixed oil emulsion was more useful in reducing the color change of the S2 and S3 fruits compared to the S4 and S5 fruits.

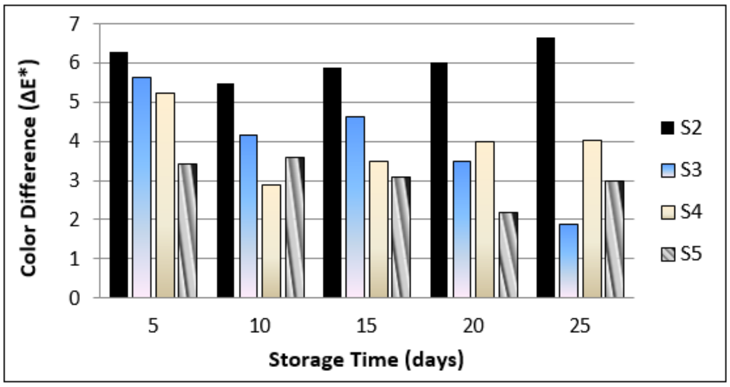

Fig. 5. The effect sesame oil and lemongrass oil as a combined emulsion on the color difference (ΔE*) of coated and uncoated tomato fruits measured at the different times of storage.

G. Total Soluble Solid (TSS) and pH

There was the only variation of data of the TSS of the fruit juice affected significantly by the interacted of coating material and the stages of maturity of the fruit when measured at day-10 and day-15 of storage (Tabel 2). The insignificant difference TSS data were found at day-5, day-20 and day-25 due to coating and stages of maturity. The lowest TSS was 3.5 ^{o}Brix of coated S4 fruits and slightly less than the highest TSS which was 4.13 ^{o}Brix of the and uncoated S2 fruits at day-10. While at day-15, the finding was not consistent. The lowest TSS was 3.8^{o}Brix of the coated 4S fruits, and the highest was 4.37^{o}Brix for the coated S5 fruits. The significant variation of the TSS data was possibly due to other sources of variance and was not because of the coating and the stages of maturity.

The pH of the juice was significantly affected by the coating and stages maturity of the fruits at day-5 up to a day-20 (Table 3). However, the actual difference of the value of pH between the lowest and the highest was small. For example at day-20, the lowest pH was 4.87 of uncoated S2 fruits, the highest was 5.02 of coated S5 fruits. The fact that the difference is relatively small (0.25). The same finding reported by Dávila-Aviña et al. (2011) that the pH of the tomato fruits during storage was not affected by the coating made from mineral or carnauba wax.

Tabel 2. The effect of mixed sesame and lemongrass oil emulsion as a coating material on the TSS of different stages of maturity of tomato fruits during storage.

	Stage of Maturity	TSS (°B					
		Day-0	Day-5	Day-10	Day-15	Day-20	Day-25
Coated	S2	3,67	5,50	**3,90 ab**	**3,93 ab**	3,97	3,73
	S3	3,47	5,90	**3,67 bc**	**3,63 b**	4,97	3,90
	S4	3,40	4,80	**3,50 c**	**3,80 b**	3,63	3,73
	S5	4,00	5,40	**3,73 bc**	**4,37 a**	3,60	4,33
Uncoated	S2	3,67	5,13	**4,13 a**	**4,10 a**	3,63	3,43
	S3	3,47	4,77	**3,67 bc**	**4,30 a**	3,70	3,90
	S4	3,40	5,13	**3,93 a**	**3,97 ab**	3,87	3,90
	S5	4,00	5,47	**3,77 bc**	**3,90 ab**	3,57	3,83

Note: data followed by the same lowercase letter in the same column indicates no significant difference with DMRT 5%.

Tabel 3. The effect of mixed sesame and lemongrass oil emulsion as a coating material on the pH of different stages of maturity of tomato fruits during storage.

	Stage of Maturity	pH					
		Day-0	Day-5	Day-10	Day-15	Day-20	Day-25
Coated	S2	4,86	**4,86 ab**	**4,77 d**	**4,90 cd**	**4,89 bc**	4,76
	S3	4,93	**4,85 ab**	**4,82 c**	**4,98 ab**	**4,99 a**	4,94
	S4	4,95	**4,92 a**	**4,95 a**	**5,02 a**	**4,97 abc**	4,29
	S5	4,75	**4,93 a**	**4,95 a**	**5,00 a**	**5,02 a**	4,98
Uncoated	S2	4,86	**4,71 c**	**4,80 d**	**4,89 cd**	**4,87 c**	4,89
	S3	4,93	**4,72 c**	**4,92 ab**	**4,86 d**	**4,93 abc**	4,92
	S4	4,95	**4,75 c**	**4,94 ab**	**4,89 cd**	**4,95 abc**	4,92
	S5	4,75	**4,75 c**	**4,93 ab**	**4,93 bc**	**4,98 ab**	4,96

Note: data followed by the same lowercase letter in the same column indicates no significant difference with DMRT 5%.

IV. CONCLUSION

Sesame oil emulsion of 0.5% (O/W) was the most effective emulsion in retaining the quality of tomato fruit during storage at room temperature of (28+2°C) compared to coconut oil, sunflower seed oil, and canola oil with the same concentration of 0.5% (O/W).

The combined of sesame and lemongrass oil emulsion with the same concentration of 0.5% (O/W) effectively reduced the intensity of spoilage or decay, the weight loss and the color changes of tomato fruit during storage at room temperature (28+2°C).

The coated tomato fruits of the breaker stage with the combined emulsion of sesame and lemongrass oils were found more responsive in reducing the spoilage, firmness, color change compared to other maturity stages.

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REFERENCES

Adetunji, C.O.; Arowora, K.A; Ogundele, B.A. 2015. Improving Carrot (Daucus carota L.) Fruit Storability by Edible Coating Containing Aloe Vera Gel and Essential Oil from Sesame Seed. Management of land use systems for enhanced food security: conflicts, controversies and resolutions. Tropentag, September 16-18, 2015, Berlin, Germany.

B. K. Barnwal and M. P. Sharma, "Prospects of Biodiesel Production from Vegetable Oils in India," Renew. Sust. Ener. Reviews., 9 (4), 363-378.

Dávila-Aviña, J.E. de J., Villa-Rodríguez, J., Cruz-Valenzuela, R., Rodríguez-Armenta, M., Espino-Díaz, M., Ayala-Zavala, J.F., Olivas-Orozco, G.I., Heredia, B. and González-Aguilar, G. 2011. Effect of Edible Coatings, Storage Time and Maturity Stage on Overall Quality of Tomato Fruits. Am. J. Agric. Biol. Sci. 6 (1), 162-171.

Dhall, R.K. 2013. Advances in edible coatings for fresh fruits and vegetables: a review. Crit. Rev. Food Sci. Nutr. 53(5), 435-50.

Gharby, s.; Harhar, H.; Bousoubaa, Z.; Asdadi,A.; El Yadini A; Charrouf, Z. 2017. Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco. J. Saudi Soc. Agric. Sci. , 16 (2), 105-11.

Gokbulut, C. 201.0. Sesame oil: potential interaction with P450 isozymes. J. Pharmacol. Toxicol., 5 (8), 469-472.

Hasan, S.M.K., Sarker, M.S.H. and Nicolai, B. 2013. The effect of Bio-FreshTM edible coatings on shelf life and quality of pears. Int. J. Agri. Sci. Res., 2(3), 074-082.

Kremer, Fr. & Unterstenhofer, G. (1967): De l' emploi de la metode de Townsend et Heuberger dans l'interpretation de results d'essais phytosanitares. Pflanzenschutz Nachrichten, Bayer 4: 625–628.

Lerdthanangkul, S. and Krochta, J.M. 1996. Edible Coating Effects on Postharvest Quality of Green Bell Peppers. J. Food. Sci., 61 (1), 176-179.

Mohebbi, S,; Harhar,H.; Bousoubaa, Z.; Asdadi, A.; El Yadini A. 2015. Effects of Aloe vera and sesame oil coating on physicochemical properties of bell pepper during storage. Int. J. Food Sci.Technol., 47, 299–305

Rhim, J.,Wu, Y.,Weller, C., and Schnepf, M. (1999). Physical characteristics of a composite film of soy protein isolate and propyleneglycol alginate. J.Food Sci., 64(1), 149–152.

Rojas-Crau, M.A., Soliva-Fortuny, R. and Martln-Belloso, O. 2009. Edible coatings to incorporate active ingredients to fresh-cut fruits: a review. Trends Food Sci. Tech., 20, 438-447.

Saleem, T.S.M. 2015. Antimicrobial activities of sesame oil. Int. J. Phytochem. Pharmacol, 1(1), 21-23.

Singh, B.J.; Singh, V.; Singh, R,K,; Ebibeni, N. 2015. Antimicrobial activity of lemongrass (*Cymbopogon citratus*) oil against microbes of environmental, clinical and food origin. Int. Res. Pharmacy Pharmacolo.,. 1(9), 228-236.

Steel, R.G.D., and Torrie, J.H. 1980. Principles and Procedures of Statistics: A Biometrical Approach (2nd Ed). McGrow-Hill Inc., New York.

Thomas, A. 2002. Fats and Fatty Oils. Ullmann's Encyclopedia of Industrial Chemistry . John Wiley and Sons.

Utama, I M.S., and Kitinoja, L. 2015. Post-harvest Vegetable Losses in Small-scale Agribusiness Chains of Bali, Indonesia. CAPSA Palawija Newsletter, 32 (2), 6-8.

Vargas, R.J., Souza, S. M., Kessler, A. M. and Baggio, S. 2008. Replacement of fish oil with vegetable oils in diets for jundia (Rhamdia quelen Quoy and Gaimard 1824): effects on performance and whole body fatty acid composition. Aquacul. Res. 39(2), 657-665.

F.4

EFFECT OF SOYBEAN DIET TO IMPROVE FAT ACCUMULATION: A REVIEW

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ABSTRACT

Abnormal body weight (obesity and overweight) due to fat accumulation is becoming a serious health problem. Two cardiovascular diseases that mostly cause deaths, namely stroke (21.1%) and systemic heart disease (12.9%) are closely related to fat accumulation (hypercholesterolemia and obesity). Soybean is an important food crop in Indonesia, particularly as a protein source. It contains the highest amino acid score among legumes and approaching the standard criteria set by FAO as well as 80% of poly-unsaturated fatty acids that are good for heart health. A number of studies conducted in many countries revealed that soybean can effectively reduce fat accumulation in human body. PubMed and other scientific journals from 2010 to 2017 were studied to identify animal pre-clinical and human clinical trials on the effects of soybean diet on fat accumulation. These were a meta-synthesis review against parameters of body weight, body fat percentage, lipid profile, lipolysis, lipogenesis and adipogenesis. Thirteen studies consisting of 544 animals and 34 human experiments were given oral diet of soybean food products or extract of soybean compound within 14 – 270 days of treatment. The results showed that soybean diet caused a significant difference in lipid profile and was involved in lipid metabolism. It can improve the blood lipid profile and decrease body fat composition. Soy isoflavones significantly reduce body weight, Lipid accumulation in liver (hepatic steatosis) through suppressing lipogenesis and adipogenesis gene expression and increase lipolysis. Black soybean peptide extracts effectively decrease BMI, body fat percentage and triglycerides. Soy protein can improve adipocyte tissue dysfunction in mice resistant to dyslipidemia-insulin and can maintain the function of adipose-liver tissue. This suggests that soybean diet can be an alternative therapy to maintain body fat accumulation.

Keywords: Soybean, diet, obesity, fat accumulation

I. INTRODUCTION

A survey conducted in 2014 reported that, among ten main factors that cause death in Indonesia, there were two main factors are stroke (21,1%) and systemic heart disease (12,9%). Heart and artery disease have been significantly increasing because on 1990 those were not the top ten factors but start from year of 2000 those were becoming the top five factors. Heart and artery diseases are significantly becoming the top five factors since the last 20 years [1]–[3]. Both cardiovascular diseases are highly related to hypercholesterolemia and obesity. Overweight and obesity are defined as abnormal or excessive fat accumulation that can be determined by Body Mass Index (BMI). BMI is obtained by simply dividing a person's weight with the square height (kg/m^2). A person is assumed to be overweight and obesity the BMI is equal or greater than 25 and 30, respectively [4]. Fat accumulation that exceeds BMI has been reported to be a risk health factor that may cause hypertension, hypercholesterolemia, increased blood triglycerides and insulin resistance with multiple complication such as stroke, coronary heart disease, diabetes mellitus type 2, even several types of cancer [5-6]. Since diet, especially dietary fat, has been recognized as contributing to the development and prevention of obesity, the influence of the quantity and quality of dietary fat on the pathogenesis of obesity-induced diseases has been studied [7].

Soybean (*Glycine max* L.) is an essential food crop in Indonesia, particularly as a protein source and mostly consumed as tempe and tofu. Other soybean products are soy sauce, *tauco*, soy milk, etc. Reference [8] reported that soybean is a legume that has the highest amino acid score that meet the standard criteria by Food and Agriculture Organization (FAO). Soybean contains 38 g of protein, 18 g of lipid and 6,3 g of carbohydrate. Soybean also contains a heart-healthy balance of fatty acids that is high in mono and polyunsaturated fatty acids (80%) and low in saturated fatty acids (20%). The unsaturated fatty acids are primarily in the form of linoleic acid. The nutritional contents of soybean seeds vary, depend on the variety and growing condition.

Currently, soybean is included in the six important food commodities that is prioritized by the Government to increase the production in order to achieve the self-sufficiency in food. About 65% of soybean yet needs to be imported. Therefore, introduction of high yielding improved varieties and appropriate cultivation technologies as well as extending the planting area are intensively performed in terms of achieving that target [9-10]. This suggests the importance role of soybean in the Indonesian diet and the relevance health consequences. A number of studies conducted in many countries revealed that soybean can effectively reduce fat accumulation in human body [11-12]. In this paper, we discuss the role of soybean components in lipid metabolism, particularly its effect on fat accumulation.

II. MATERIALS AND METHODS

This study is used a meta-synthesis review through narrative and qualitative analysis [13]. Information was collected through computerized publication database, originally in Medline via PubMed (https://www.ncbi.nlm.nih. gov/pubmed). According to reference [14], we combined the search strategy between the text words and MeSH-Terms (Medical Subject Heading). The text words that was used are soybean and lipolysis. Search was limited to original articles published in English between January 2010 and June 2017.

The results searching from the PubMed database (Search date: 17 June 2017) after combining text word and MeSH-Terms, displaying 45 articles. The study was confined to oral delivery or diet-induced soybean of soybean or soybean compound extract for animal (pre-clinical trial) and human (clinical trial). Articles related to soybean fermented products or other microbial food process or in the form of drug or having a combination diet factor were excluded. After applied the search strategy and articles sortation from exclusion criteria, we summarized 12 articles in this study consisting of 1 clinical trials and 11 pre-clinical trials. The validity of this review was determined by the Systematic Review Appraisal Worksheet developed by Centre for Evidence-Based Medicine [15].

III. RESULTS AND DISCUSSION

In our initial screening, we identified 45 studies on soybean and lipolysis. This review only revealed for the pre-clinical and clinical trials, so there were excluded articles of 12 in-vitro studies and 2 literature review. This sorting yielded 1 clinical trials and 30 preclinical trials. The sorting continued by the exclusion criteria. In principle, articles were excluded if (1) in-vitro studies or literature review, (2) fermented soybean products or other forms, and (3) there were a factor from the diet combination ingredients. There were 2 articles of soybean fermented/ microbial processed products, 7 soybeans in the form of drugs and 9 studies that have a combination diet factor. In the final, after checking all abstract identified, discarding duplicate articles and reading the full text versions, 12 articles were considered for inclusion consisting of 1 clinical studies and 11 pre-clinical studies. The search process is showed in Fig. 1.

The presentation of the findings is organized into four core domains: (1) soybean protein, (2) soybean oil, and (3) soy phytochemical compound, include isoflavones, saponin and anthocyanin (black soybean) and (4) soy effect on inflammation and allergy. The summary of pre-clinical clinical studies provided by Table 1. The summary encompasses information regarding sample size, the material, dose, duration, results against parameters of: body mass index or body weight or body weight gain, body fat percentage, lipid profile (HDL, LDL, triglycerides), lipolysis, lipogenesis and adipogenesis.

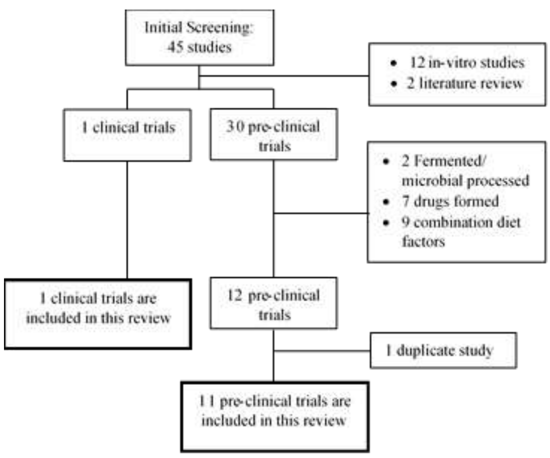

Fig. 1 Summary of search process

A. Soybean Protein

As in all legumes, the most protein content of soybean is globulin. The principal protein content of soybean are β-conglycinin and glycinin, 40% and 30% of total protein, respectively [8], [29]. The effect of body weight reduce by soybean protein is presented on reference [18], [21], [27]. While in reference [16] no significant effect on body weight gain of soybean protein diet with dose of 100 and 200 g kg^{-1} soy protein isolate (SPI). This may be due to the dosage of soybean protein. Studies showed the reduced of body weight gain presented in a dose of 180 g kg-1 of SPI with longer diet duration [27].

Soybean protein is effect the lipid metabolism and prevented hepatic steatosis [16], [21], [27] and reduce the level of triacylglycerol (TAG) concentration [18], [21]. Rats recovered with soybean diet showed low body weight and normalization of serum TAG. Reference [16] showed that SPI lowered hepatic de novo lipogenesis through modulation of hepatic free fatty acids (FFA) and also through altered bile acid signaling, suggesting an overall healthier cardiometabolic profile. It is identified that consumption of soybean β-conglycinin after 4 weeks has the effect of hypolipidemia by increasing the consumption of carbohydrate and increasing adiponectin, resulting the improvement of lipid profile. β-conglycinin accelerates carbohydrate consumption and then induces the suppression of fatty acid synthesis in the liver. This could be a major cause of serum TAG reduction. This indicating that the intake of β-conglycinin can fix obesity induced by metabolic dysfunction, possibly through attenuate the de novo fatty acids synthesis [18], [38]. β-conglycinin has more peptide series than that in glycinin subunit that inhibit fat accumulation and induce adiponectin in 3T3-L1 adipose. So it can be concluded that β-conglycinin is an important component in a diet that control fat accumulation in lipid tissues [31]-[32].

B. Soybean Oil

Soybean oil could exhibit lipolysis but dependent on a duration of diet intervention. A study in 2011 was observed the inducing conjugated-linoleic acid (CLA) to soybean oil (SO) compared coconut oil (CO) induced showed that CLA induces lipolysis in CO but not in SO-fed mice. This differential effect of CLA likely contributes to the overall enhanced body fat loss [26]. But, the next study in 2013 declared that CLA also induced lipolysis in SO-fed mice, which correspond with body fat index reduction. The effect of CLA in response to different lipid source appears to be time-dependent. SO contains large amounts of linoleic acid, well excess of dietary requirement, that could interfere with CLA actions and could be the reason for delayed response of CLA-induced lipolysis [22].

C. Soybean Isoflavones

Soybean is also a source of isoflavones, the legume bioactive compound. Soy isoflavones could be an effective way in lipid metabolism regulation via complicated mechanism. Soy isoflavones could reduce the lipid accumulation that induced by oleic acid in HepG2 cell and 3T3-L1 after differentiation to adipocytes [17], [28]. Consumption of soy isoflavones could suppress mTORC1 via the AKT pathway, resulting in a decreased lipogenesis and adipogenesis and an enhanced lipolysis and β-oxidation in DIO male rats. AKT/mTORC1 plays a role in lipid metabolism, which regulates lipogenesis, lipolysis, transport of adipogenesis and lipid [33].

The effect of soy isoflavones is different among tissues and organs. Moreover, isoflavones influence the lipogenic and lipolytic gene expression, along with its role as PPARα and PPARγ activators. Soy isoflavones suppress the expression of SREBP1 and its downstream genes of ACC, ACL, FASN (lipogenic gen), increase PPARα (lipolytic gene) expression in liver and decrease PPARγ (lipogenic gene) expression in white adipose tissue (WAT), accompanied with enhanced lipolysis and β in DIO rats [17]. Soy isoflavones modulate lipid metabolism in white adipose tissue through regulating ERs expression in a site-specific manner [19]. Study of *Bama Xiang* mini-pigs showed that in DSA, soy isoflavones suppressed lipogenic genes expression (PPARγ, FAS, ACC) but increased lipolytic genes expression (PPARα, HSL, ATGL). Though in ASA and PRA, it increased lipogenic genes expression and inhibited lipolytic gene expression [19]. Reference [24] reported that soy isoflavones diet increase the expression of PPARα and PPARγ in most tissues in *Huanjiang* mini-pigs. Soy isoflavones regulated downstream target genes (FAS, ACC, HSL and ATGL) of PPARs involved in both lipid anabolism and catabolism in various tissue. The effect of soy isoflavones diet in *Huanjiang* mini-pigs may modulate different expression of myokines and adipokines in DSA (dorsal subcutaneous adipose), ASA and PRA of myokines and adipokines to regulate lipid metabolism. This may be due to the difference abilities of DSA, ASA and PRA in adipokines expression or because their different sensing abilities for soy isoflavones because ERα and ERβ expression was different in adipocytes from different tissue depots [34].

Obesity is always accompanied with high levels of triglycerides (TG) and low-density lipoprotein (LDL) in plasma. Reference [17] showed that the moderate (500 mg kg^{-1}) and high dose (1250 mg kg^{-1}) reduced TG and LDL concentrations, resulting soy isoflavones could mitigate obesity in male rats. In another study investigated that genistein and daidzein, the major component of soy isoflavones, have an anti-adipogenic effect. Intervention of genistein within 12 weeks effectively improves lipid serum and metabolism in liver and reduce hepatic steatosis through AMPK activation, resulting fatty acid oxidation and lipid synthesis inhibition in liver [35]. But daidzein inhibits the adipogenesis through lipolysis stimulation, proved by the increased of glycerol that was released by AD-MSCs [36].

D. Black Soybean

A number of studies have been showed that black soybean is also potential to improve fat accumulation. The testa of black soybean is rich with anthocyanin. It was reported that testa extract of black soybean significantly decreased food intake and fat accumulation in mice, along with several indication of altered expression of genes and protein involved in lipogenesis and lipolysis, without hepatic toxicity incidence [20], [25]. The effect appears on 1 g kg^{-1} of black soybean testa extract on white adipose tissue weight, synthesis and degradation of fat and inflammatory cytokines related gene and protein. [20]. The inhibitory effect of fat probably through up-regulating the UCPs (uncoupling proteins) expression and suppressed the obesity-caused inflammatory state through down-regulation of the inflammatory-related cytokines (TNFα and MCP-1). The study of black soybean peptide is also showed lowered of food intake and body weight gain when replacing the casein [27]. Soya protein could maintain the functionality of the adipose tissue-liver axis by improving lipotoxicity. Soya protein intake may limit adiposity at least in part decreasing food intake as well as reducing the number of dysfunctional adipocytes (low lipogenesis and lipolysis) [27].

E. The Side Effect

Soybeans known as one of the "big 8'" allergen source from food. The IgE antibodies of soybean-allergic patients has sensitivity to α'-, α- and β-subunits of β-conglycinin that is present in soybean, resulting potential food allergen of soybean [36]. Reference [21] also showed that soybean diet resulted in TNFα-mediated inflammation. But, a number of studies that showed that soybean consumption is healthy and has no effect of toxicity. The diet intervention with soybean has no effect on hepatic toxicity in DIO mice [20]. It is also known that soybean protein could maintain the number of functional adipocytes could also prevent the excessive transfer of fatty acids to other tissues decreasing its lipotoxicity [27]. Moreover, the black soybean testa extract (BE) in a dose of 2% could down-regulation the level of TNFα and MCP-1, the inflammatory-related cytokines [20]-[25].

IV. CONCLUSION

Soybean can be an alternative therapy to improve fat accumulation. Soybean regulate the lipid metabolism in a complex mechanism. The component that related to lipid metabolism is soybean protein, oil, isoflavones and black soybean testa extract that contains anthocyanin.

NOMENCLATURE

a	specific concentration	g kg^{-1}

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Table 1. Pre-clinical (n = 12) and clinical (n = 1) studies with soybean diet relating to fat accumulation

Reference	Method	Subjects	Treatments	Material & Dose	Result	Discussion	Adverse Effect
Panaseviz et. al. (2017); USA [16]	Pre-clinical, ANOVA, post hoc Pearson's correlation. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	OLETF rats (♂) Age: 4 w N = 9-10/group (4 groups)	Duration: 112 days • MPI : milk protein isolate (control) • SPI : soy protein isolate • MS : MPI:SPI = 50:50	Milk protein isolate (MPI) & soy isolate protein (SPI) MPI = 217.5/0 SPI = 0/200 MS = 108.8/100 (MPI/SPI in g kg^{-1})	Body weight: no difference after all treatment. Fat: supressed total fat mass & percent body fat ($P \leq 0.5$), no significant difference within groups, lowered lipogenic gene, decreased hepatic steatosis. Cholesterol: lowered total cholesterol and LDL-C, reduced indices of oxidative stress.	SPI lowered hepatic *de novo* lipogenesis or hepatic lipid accumulation through modulation of hepatic FFA species and also through altered bile acid signalling, suggesting an overall healthier cardiometabolic profile.	N/A
Huang et. al. (2016); China [17]	Pre-clinical, ANOVA, post hoc test. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	DIO *Sprague* rats (♂) Age = 5 w n/N = 15/80	Duration : 56 days • Ctr, n=10 : basal diets • OB, n=15 : basal diets • LSI, MSI, HSI, n=9 : basal diets + soy isoflavones	Soy Isoflavones (91,64%) Ctr = 0 OB = 0 LSI= 50 mg kg^{-1} MSI = 150 mg kg^{-1} HIS = 400 mg kg^{-1}	Soy isoflavones reduce body weight (MSI & HSI, food intake reduce), plasma LDL & triacylglycerol levels. Soy isoflavones groups have less lipid accumulation & steatosis in livers.	Soy isoflavones supress mTORC1 activity via AKT pathway, resulting decreased lipogenesis and adipogenesis and enhance lipolysis and β-oxidation.	N/A
Inoue et. al. (2015); Japan [18]	Pre-clinical, ANOVA, Student's *t*-test. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	*Wistar* rats (♂) Age = 19 w n/N = 6/12	Duration: 28 days • Exp.1, n=6 : 20% casein + β-CG • Exp.2, n=6 : 20% casein + β-CG	Soy β-Conglycinin (0.4% isoflavones & 0.2% saponin) Exp.1 = 219 g $100g^{-1}$ Exp.2 = 231 g $100g^{-1}$	Final body weight, body weight gain, liver weight are lowered. β-Conglycinin contains isoflavones and saponin do not influence TAG metabolism.	β-Conglycinin accelerates carbohydrate consumption and then induces suppression of fatty acid synthesis in the liver. This could be a major cause of serum TAG concentration reduction.	N/A

Table 1. Continued

Reference	Method	Subjects	Treatments	Material & Dose	Result	Discussion	Adverse Effect
Jiang et. al. (2015); China [19]	Pre-clinical, ANOVA, post hoc New Duncan comparison test. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	*Bama Xiang* mini-pigs (♀) Age = 5 w n/N = 6/24	Duration : 120 days • Control: basal diet • LSI: basal diet + low dose isoflavones • MSI: basal diet + moderate dose isoflavones • HSI: basal diet + high dose isoflavones	Soy isoflavones Control = 0 LSI = 250 mg kg^{-1} MSI = 500 mg kg^{-1} HSI = 1250 mg kg^{-1}	No effect on body weight and body fat mass. Soy isoflavones affect lipid metabolism in white adipose tissue in a site-specific manner and most likely modulate fat synthesis by regulating the expression of ERs in different white adipose tissue.	In DSA: Soy isoflavones supressed lipogenic genes expression (PPARγ, FAS and ACC) and increased lipolytic genes expression (PPARα, HSL and ATGL). In ASA and PRA: Soy isoflavones increased lipogenic genes expression and inhibited lipolytic genes expression.	N/A
Kim et. al. (2015); Republic of Korea [20]	Pre-clinical, ANOVA, post hoc Pearson's correlation. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	DIO C57BL/6N Mice (♂) Age = 4 w n/N = 10/41	Duration : 84 days • CON, n=10: control AIN-76A diet • HF, n=10: high-fat diet • BBC, n=9: high-fat diet + BBC • O, n=12: high-fat diet + orlistat (obesity drug)	Black soybean Cheongja #3 testa extract (BBC) CON = 0 HF = 0 BBC = 1 g kg^{-1} bw O = 0	Body weight & body weight gain not decreased. Decrease weight of mesenteric fat & epididymal adipose tissue. Reduced plasma TC & hepatic TG levels and reduced lipid peroxidation. Increase lipolysis-related gene and proteins (LPL, HSL, p=AMPKα). Strongly reduced lipogenesis gene expression (ACC and C/EBPα)	The effect of BBC on lipogenesis and lipolysis were higher than those exerted by orlistat. BBC was involved in various causal effects of anti-inflammation on lipolysis and adipogenesis. But, the mechanisms and related pathways remain unclear, so the results of the current animal study cannot yet be replicated in humans.	N/A

Table 1. Continued

Reference	Method	Subjects	Treatments	Material & Dose	Result	Discussion	Adverse Effect
Reis et. al. (2015); Brazil [21]	Pre-clinical, ANOVA, post hoc LSD test. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	*Wistar* rats (♂) Age = 4 w N = 56	Duration : 90 days • CC, n=10: mother's fed 17% casein + 17% casein • CS, n= 10 : mother's fed 17% casein + soy protein • LL, n=12: mother's fed 6% casein + 6% casein • LC, n=12: mother's fed 6% casein + 17% casein • LS, n=12: mother's fed 6% casein + soy protein	Soybean flour (17% soy protein) CC = 0 CS = 17% LL = 0 LC = 0 LS =17%	Reduce final body weight (LS & CS) and hepatic fat content. Increase serum insulin concentration. Lower fatty acid synthesis rates.	Rats recovered with soybean diet showed low body weight and normalization of serum triacylglycerol concentrations. Soybean diet prevented steatosis at least in part through reduced lipogenesis but resulted in TNFα-mediated inflammation.	TNFα-mediated inflammation.
Ippagunta et. al. (2013); USA [22]	Pre-clinical, ANOVA, least square means, SEM. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	ICR Mice (♂) Age = 3 w n/N = 20/80	Duration = 14 days • SO: soybean oil • SO + CLA: soybean oil + conjugated linoleic acid • CO: coconut oil • CO + CLA: coconut oil + conjugated linoleic acid	Soybean oil SO = 70 g kg^{-1} SO + CLA = 61.7 g kg^{-1} CO = 0 CO + CLA = 0	The enhanced body fat loss appeared to involve CLA inducing lipolysis earlier in CO-fed mice compared to SO-fed mice. CLA also induced lipolysis (increase NEFA release) in SO-fed mice, which corresponded with body fat index reduction.	The effect of CLA in response to different lipid sources appears to be time-dependent. SO contains large amounts of linoleic acid, well in excess of dietary requirement, that could interfere with CLA actions and could be the reason for delayed response of CLA-induced lipolysis.	N/A
Kim et. al. (2013); Republic of Korea [23]	Clinical, ANOVA. Randomization, blinding.	Humans, overweight/obese Age = 19-65 years n = 34	Duration : 84 days	Black soybean peptide extract (BSP)	BSP intervention lowered BMI, body fat percentage and triglyceride. No effect pf total cholesterol concentration but increase HDL-cholesterol level.	Effect of body weight loss by black soybean is related to the favourable changes in blood metabolite levels.	N/A

Table 1. Continued

Ippagunta et. al. (2011); USA [26]	Pre-clinical, ANOVA, SAS procedure. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	ICR Mice (♂) Age = 3 w N = 80	Durations = 54 days · SO: soybean oil · SO + CLA: soybean oil + CLA · CO: coconut oil · CO + CLA: coconut oil + CLA · FF : fat-free · FF + CLA: fat free + CLA	Soybean oil SO = 70 SO + CLA = 61.7 CO = 0 CO + CLA = 0 FF = 0 FF + CLA = 0	CLA induces lipolysis in coconut oil but not in soybean oil-fed mice.	Coconut oil enhances the anti-obesity effects of CLA due to enhanced lipolysis and may be time-dependent but not in soybean oil. This differential effect of CLA likely contributes to the overall enhanced body fat loss.	N/A
Olivia et. al. (2010); [27]	Pre-cinical, ANOVA, post hoc Newman-Keuls test. Randomized, approved animal protocol, acclimation period, guaranteed isonitrogenous and isocaloric on the basis.	*Wistar* rats (♂) Age = n/N = 24/48	Duration : 240-270 days · Control: purified diet (replace with maize starch) · SRD: purified diet · SRD-S: purified diet + soy protein	Soy protein isolate (SPI) Control = 0 SRD = 0 SRD-S = 18 g 100 g-1	The amount of food intake as well as body weight gain are lower when soya replaces casein.	Soya protein could maintain the functionality of the adipose tissue-liver axis by improving and/or reversing lipotoxicity. Soya protein intake may limit adiposity at least in part decreasing food intake as well as reducing the number of dysfunctional adipocytes (low lipogenesis and lipolysis)	N/A

REFERENCES

[1] K. Azwar. (2015) Sepuluh Penyakit Penyebab Kematian Tertinggi on EPaper Republika. [Onlne]. Available: http://www.republika.co.id/be rita/koran/medika/15/05/25/nowbk617-sepuluh-penyakit-penyebab-k ematian-tertinggi (accessed on 22 June 2017).

[2] D. Sari. (2015) Waspada, Inilah Penyakit Paling Mematikan di Indonesia on Tempo.Co. [Online]. Available: https://m.tempo.co /read/news/2015/05/18/060666962/waspada-inilah-penyakit-paling-mematikan-di-indonesia (accesed on 22 June 2017).

[3] U. Widowati. (2015) 10 Penyakit Paling Mematikan di Indonesia on CNN Indonesia. [Online]. Available: https://www.cnnindonesia.com/ gaya-hidup/20150513163407-255-53129/10-penyakit-paling-memati kan -di-indonesia/ (accessed on 22 June 2017).

[4] "Fact Sheet No. 311," World Health Organization (WHO), Geneva.

[5] P. Kopelman, "Health risk associated with overweight and obesity," Obesity Reviews, vol. 8, pp. 13–17, 2007.

[6] T. Byers and R. L. Sedjo, "Body fatness as a cause of cancer: epidemiologic clues to biologic mechanism," Endocrine-Related Cancer, vol. 22, pp. R125–R134, 2015.

[7] K. Nagao and T. Yanagita, "Bioactive lipids in metabolic syndrome," *Progress in Lipid Research*, vol. 47, pp. 127 – 146, 2008.

[8] S. Burssens, I. Pertry, D. D. Ngudi, Y. Kuo, M. V. Montagu and F. Lambein, *Soybean and Nutrition*, ser. 8: Soya, Human Nutrition and Health, H. A. El-Shemy, Ed. Rijeka, Croatia: InTech, 157 – 180, 2011.

[9] "Peraturan Menteri Pertanian Republik Indonesia Nomor 19/Permentan/HK.140/4/2015 tentang Rencana Strategis Kemntrian Pertanian Tahun 2015 – 2019," Kementerian Pertanian Republik Indonesia, Jakarta, Indonesia.

[10] Pusat Data dan Sistem Informasi Pertanian, Outlook Komoditas Pertanian Subsektor Tanaman Pangan: Kedelai, L. Nuryati, B. Waryanto, Noviati and R. Widaningsih, Ed. Jakarta, Indonesia: Kementerian Pertanian Republik Indonesia, 2015.

[11] J. W. Anderson, B. M. Johnstone and M. E. Cook-Newell, "Meta-analysis of soy protein intake on serum lipids," *The New England Journal of Medicine*, vol. 33, pp. 276 – 282, Aug. 1995.

[12] J. I. Harland and T. A Haffner, "Systematic review, meta-analysis and regression of randomized controlled trials reporting an association between an intake of circa 25 g soya protein per day and blood cholesterol," *Atherosclerosis*, vol. 200, pp. 13 – 27, 2008.

[13] Siswanto, "Systematic Review sebagai metode penelitian untuk mensintesis hasil-hasil penelitian: sebuah pengantar," *Buletin Penelitian Sistem Kesehatan*, vol. 13, pp. 326 – 333, 2010.

[14] L. D. Gillespie and W. J. Gillespie, "Finding current evidence: search strategies and common databases," *Clinical Orthopaedics and Related Research*, vol. 413, pp. 133 – 145, 2003.

[15] M. Thompson, A. Tiwari, R. Fu, E. Moe and D. I. Buckley, Oregon *Evidence-based Practice Center, A Framework to Facilitate the Use of Systematic Reviews and Meta-analyses in The Design of Primary Research Studies*. Rockville, MD: Agency for Healthcare Research and Quality, 2012.

[16] M. R. Panasevich, C. M. Schuster, K. E. Phillips, G. M. Meers, S. V. Chintapalli, U. D. Wankhade, K. Shankar, D. N. Butteiger, E. S. Krul, J. P. Thyfault and R. S. Rector, "Soy compared with milk protein in a Western diet changes fecal microbiota and decreases hepatic steatosis in obese OLETF rats," *J. of Nutritional Biochem.*, vol. 46, pp. 125 – 136, 2017.

[17] C. Huang, D. Pang, Q. Luo, X. Chen, Q. Gao, L. Shi, W. Liu, Y. Zou, L. Li and Z. Chen, "soy isoflavones regulate lipid metabolism through an AKT/mTORC1 pathways in diet-induced obesity (DIO) male rats," *Molecules*, vol. 21, pp. 585 – 586, 2016.

[18] N. Inoue, Y. Fujiwara, M. Kato, A. Funayama, N. Ogawa, N. Tachibana, M. Kohno and I. Ikeda, "Soybean β-conglycinin improves carbohydrate and lipid metabolism in Wistar rats," *Bioscience, Biotechnology., and Biochemistry.*, pp. 1 – 7, 2015.

[19] G. Jiang, L. Li, J. Fan, B. Zhang, A. O. Oso, C, Xiao and Y. Yin, "Dietary soy isoflavones differentially regulate expression of the lipid-metabolic genes in different white adipose tissues of the female Bama mini-pigs," *Biochemical and Biophysical Research Communications*, vol. 461, pp. 159 – 164, 2015.

[20] S. Y. Kim, H. Wi, S. Choi, T. J. Ha, B. W. Lee and M. Lee, "Inhibitory effect of anthocyanin-rich black soybean testa (*Glycine max* (L.) Merr.) on the inflammation-induced adipogenesis in a DIO mouse model," *J. of Functional Foods*, vol. 14, pp. 623 – 633, 2015.

[21] S. R. L. Reis, N. H. Feres, L. M. Ignacio-Souza, R. V. Veloso, V. C. Arantes, N. H. Kawashita, E. M. Coloded, B. L. Botosso, M. A. B. Reis and M. Q. Latorraca; "Nutritional recovery with a soybean diet after weaning reduces lipogenesis but induces inflammation in the liver in adult rats exposed to protein restriction during intrauterine life and lactation," *Mediators Inflammation*, pp. 1 – 12, 2015.

[22] S. Ippagunta, Z. Angius, M. Sanada and K. M. Barnes, "Dietary CLA-induced lipolysis is delayed in soy oil-fed mice compared to coconut oil-fed mice," *Lipids*, vol. 48, pp. 1145 – 1155, 2013.

[23] M. J. Kim, H. J. Yang, J. H. Kim, C. Ahn, J. H. Lee, K. S. Kim and D. Y. Kwon, "Obesity-related metabolomic analysis of human subjects in black soybean peptide intervention study by ultraperformance liquid chromatography and quadrupole-time-of-flight mass spectrometry," *J. of Obesity*, pp. 1 – 11, 2013.

[24] H. Yang, F. Li, X. Xiong, X. Kong, B. Zhang, X. Yuan, J. Fan, Y. Duan, M. Geng, L. Li and Y. Yin, "Soy isoflavones modulate adipokines and myokines to regulate lipid metabolism in adipose tissue, skeletal muscle and liver of male Huanjiang mini-pigs," *Molecular and Cellular Endocrinology*, vol. 365, pp. 44 – 51, 2013.

[25] Y. Kanamoto, Y. Yamashita, F. Nanba, T. Yoshida, T. Tsuda, I. Fukuda, S. Nakamura-Tsuruta and H. Ashida, "A black soybean seed coat extract prevent obesity and glucose intolerance by up-regulating uncoupling proteins and down-regulating inflammatory cytokines in high-fat diet-fed mice," *J. of Agricultural and Food Chemistry*, vol. 59, pp. 8985 – 8993, 2011.

[26] S. Ippagunta, T. J. Hadenfeldt, J. L. Miner and K. M. Hargrave-Barnes, "Dietary conjugated linoleic acid induces lipolysis in adipose tissue of coconut oil-fed mice but not soy oil-fed mice," *Lipids*, vol. 46, pp. 821 – 830, 2011.

[27] M. E. Oliva, D. Selensci, M. E. D'Alessandro, A. Chicco and Y. B. Lombardo, "Soya protein ameliorates the metabolic abnormalities of dysfunctional adipose tissue of dyslipidaemic rats fed a sucrose-rich diet," *British J. of Nutrition*, vol. 105, pp. 1188 – 1198, 2011.

[28] S. Murosaki, T. R. Lee, K. Muroyama, E. S. Shin, S. Y. Cho, Y. Yamamoto and S. J. Lee, "A combination of caffeine, arginine, soy isoflavones, and L-carnitine enhances both lipolysis and fatty acid oxidation in 3T3-L1 and HepG2 cells in vitro and in KK mice in vivo," *The J. of Nutrition*, vol. 137, pp. 2252 – 2257, 2007.

[29] H. B. Krishnan and R. L. Nelson, "Proteomic analysis of high protein soybean (*Glycine max*) accessions demonstrates the contributin of novel glycinin subunits," *J. of Agricultural and Food Chemistry*, vol. 59, pp. 2432 – 2439, 2011.

[30] C. Martinez-Villaluenga, N. A. Bringe, M. A. Berhow and E. G. de Meija, "β-conglycinin embeds active peptides that inhibit lipid accumulation in 3T3-L1 adipocytes in vitro," *J. of Agricultural and Food Chemistry*, vol. 56, pp. 10533 – 10543, 2008.

[31] C. Martinez-Villaluenga, V. P. Dia, M. Berhow, N. A. Bringe and E. G. de Meija, "Protein hydrolysates from β-conglycinin enriched soybean genotypes inhibit lipid accumulation and inflammation in vitro," *Mol. Nutr. Food*, vol. 53, pp. 1007 – 1018, 2009.

[32] C. Martinez-Villaluenga, S. G. Rupasinghe, M. A. Schuler and E. G. de Meija, "Peptides from purified soybean β-conglycinin inhibit fatty acids synthase by interaction with the thioesterase catalytic domain," *FEBS Journal*, vol. 277, pp. 1481 – 1493, 2010.

[33] D. W. Lamming and D. M. A. Sabatini, "A central role for mTOR in lipid homeostasis," *Cell Metab.*, vol. 18, pp. 465 – 469, 2013.

[34] M. N. Diodonne, M. C. Leneveu, Y. Giudicelli and R. Pecquery, "Evidence for functional estrogen receptors α and β in human adipose cell: regional specificities and regulation by estrogens," *Am. J. Physiol. Cell Physiol.*, vol. 286, pp. C655 – C661, 2004.

[35] H. Liu, H. Zhong, Y. Yin and Z. Jiang, "Genistein has beneficial effects on hepatic steatosis in high fat-high sucrose diet-treated rats," *Biomedicine and Pharmacotherapy*, vol. 91, pp. 964 – 969, 2017.

[36] M. H. Kim, J. S. Park, M. S. Seo, J. W. Jung, Y. S. Lee and K. S. Kang, "Genistein and daidzein repress adipogenic differentiation of human adipse tissue-derived mesenchymal stem cells via Wnt/β-catenin signaling or lipolysis," *Cell Prolif.*, vol. 43, pp. 594 – 605, 2010.

[37] H. B. Krishnan, W. Kim, S. Jang and M. S. Kerley, "All three subunit of soybean β-conglycinin are potential food allergens," *J. of Agricultural and Food Chemistry*, vol. 57, pp. 938 – 943, 2009.

[38] S. Wanezaki, N. Tachibana, M. Nagata, S. Saito, K. Nagao, T. Yanagita and M. Kohno, "Soy β-conglycinin improves obesity-induced metabolic abnormalities in a rat model of nonalcoholic fatty liver disease," *Obesity Research & Clinical Practice*, vol. 374, pp. 1 – 7, 2014.

F.5

THE PROFILE OF RED DRAGON FRUIT PEEL EXTRACT AS A NATURAL ANTIMICROBIALS IN REDUCING *E. coli*

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ABSTRACT

Red dragon fruit is a kind of fruits that is widely consumed by the people in Indonesia because the content is very beneficial for health. Utilization of fruit is still the most part of the fruit, but red dragon fruit peel is still much discarded and untapped. The purpose of this research is to know the profile of red dragon fruit peel extract and its inhibitory activity in decreasing contamination of *E. coli*. This research is divided into two stages, the phase of fruit peel extraction and the phase of inhibitory testing against contamination of *E. coli* bacteria. Red dragon fruit peel extract produced was a light brown, odorless, less viscous, and has a pH of 5.2. The test results produced inhibition against *E. coli* contamination at concentrations of red dragon fruit peel extract are 10%, 25%, 50%, 75%, 100%, respectively 3.58 mm, 3.97 mm, 4.95 Mm, 6.95 mm, and 9.30 mm. With these data, the inhibitory power of the red dragon fruit peel is still classified into the medium antimicrobial category.

Keywords: Antimicrobial, Inhibitation, *Escherichia coli*, Red dragon fruit peel.

I. INTRODUCTION

Indonesia has many potential fruits i.e. red dragon fruit. Red dragon fruit is a fruit of the *Cactaceae* tribe, which has began to be widely consumed in Indonesia. Dragon fruit is a very potential commodity so that dragon fruit cultivation in Lampung Province increasingly in demand by farmers because of economic value, useful value and high market demand from dragon fruit. So the extent of the red dragon fruit plant in Lampung Province is wider. South Lampung is a center of red dragon fruit cultivation in Lampung Province. South Lampung is the district with the largest amount of red dragon fruit plantation area, recorded 52 hectares of the total area in Lampung Province (Nugraha, 2015).

The red dragon fruit has several ingredients that can be antimicrobial agent. The red dragon fruit has a phenolic-containing betalains and non-phenolic structure responsible for the ultimate purple Hylocereus antioxidant capacity, while non-betallic fenolics contribute only to a small extent of 7.21 ± 0.02 mg CE / 100 gram. Betalains are associated with anthocyanins (flavonoid derivatives), reddish pigments found in most plants. However, betalains are structurally and chemically like anthocyanins because they contain nitrogen while anthocyanins are not (Nurliyana et al., 2010). This is reinforced by Nurliyana et al. (2010) which states that red dragon fruit contains phenol and flavonoids. Flavonoids contained in red red dragon fruit include quercetin, kaempferol, and isorhamnetin (Panjuantiningrum, 2009). With some content in the red red dragon fruit, it is predicted that red dragon fruit peel also contains the active compounds betalains, phenols, and flavonoids although with a different percentage of the content. Utilization of this fruit peel content as antimicrobial subsequently expected to reduce contamination of E. coli up to a certain amount.

II. MATERIALS AND METHODS

A. Materials and tools

The materials used in this research were red dragon fruit peel obtained from Cendrawaih Metro Market, 96% ethanol, Mac Conkey Agar (MCA) media, Nutrient Agar, Nutrient Broth, Buffton Peptone Water, Aquades, Alcohol 70%, aluminum foil, Cotton and paper discs.

The tools used in this research were knife, basin, blender, filter paper, maserator, beaker glass, Erlenmeyer, petry cup, waterbath shaker, vacuum rotary evaporator, measuring cylinder, stirrer, incubator, dropper dropper, screw length, autoclave and equipment Other laboratories.

B. Research methods

The study was conducted in two stages separately. The first study aimed to obtain red dragon fruit peel extract. The second stage is testing the inhibitory power of red dragon peel in reducing contamination E.coli. Red dragon fruit peel extraction was done by using maceration method and 96% ethanol solvent. The red dragon fruit peel extract is then tested into Petri dish containing medium of Nutrient Agar and E. coli bacteria with paper disc method. Incubation is carried out for 24 hours at 37 ° C. The inhibitory zone diameter around the disc paper showing the antimicrobial activity of the extract is then measured using a sliding range.

III. RESULTS AND DISCUSSION

Red dragon peel extract is obtained from the process of extraction of simplicia that had previously experienced the drying process. According to Tilaar (2009), the drying process aims to get the simplicia that is not easily damaged, so it can be stored in a longer time. In addition, drying also aims to stop the enzyme activity that can further describe the content of active substances in the sample and to facilitate the management in the next process (Nuria, 2010). Dry dried simplicia is made in powder form in order to increase the surface area of the raw material, this is because the more surface area the raw material will dry faster and can enlarge the contact with the solvent so that the desired active compound is more easily sintered (Gunawan et al. 2004). Dry simplicia of red dragon fruit peel as shown in Fig. 1.

Fig. 1 Dry simplicia of red dragon fruit peel.

Total of red dragon fruit peel extract obtained as much as 100 ml. The results of red dragon fruit peel extract produced light brown, odorless, less viscous, and had a pH of 5.2. The color of brown is produced from the content of betalains, phenols, and phenolics contained in the peel of red dragon fruit. This brown color is not too brown when compared with some fruit peel extracts such as orange peel extract and pineapple peel extract is extracted into the same method and treatment. The faded brown color is predicted to be caused by damage to leather dragon fruit betalains content in the drying process. Betalains are natural pigments in dragon fruits that are affected by pH, light, air and water activity, with better pigment stability at low temperatures with a pH of 5.6 (Cai et al 1998). So if too long exposed to high temperatures will cause damage. Results of fruit peel extract can be seen in Fig. 2.

Fig. 2 Extract of red dragon fruit peel

Inhibition zone tests were performed on E. coli bacteria obtained from rejuvenated isolates. The bacteria were grown on Nutrient Agar medium with the spread method for further application of disc paper with a diameter of 5.5 mm which has been soaked in fruit peel extract to determine the resulting inhibit zone. Observation of the inhibit zone was performed after 24 hours incubation. The inhibit zone is the clear region surrounding the disc paper as shown in Fig. 3.

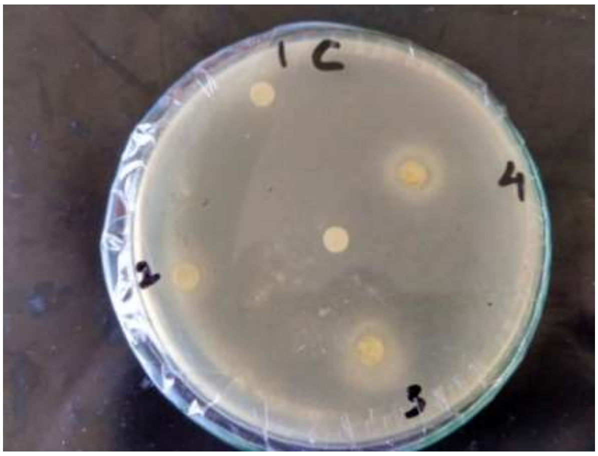

Fig. 3 Inhibition zone of red dragon fruit peel extract.

This zone is then measured in diameter by using a vertical or horizontal sliding threshold. Furthermore, each diameter is reduced by the diameter of the paper disc and calculated on the average of each diameter of the clear zone. The average value is then the data zone of each inhibition treatment. The test results of inhibition zone of red dragon fruit peel extract against E. coli bacteria can be seen in Table 1.

Table 1. The test results of dragon zone extract of red dragon fruit peel against E. coli bacteria.

consentrations (%)	Inhibition Zone (mm)
10	3,58
25	3,97
50	4,95
75	6,95
100	9,30

The results of inhibitory activity test showed that red dragon fruit peel extract had antimicrobial activity against *Echerichia coli* bacteria. This is evidenced by the formation of bacteria-free areas (clear zone) around the paper discs. Based on Table 1. it can be seen that the smallest inhibitory zone obtained is the treatment of dragon peel extract with a concentration of 10% with a diameter of resistance of 3.58 mm. While the highest inhibitory zone is produced by 100% red dragon fruit extract that is with the inhibitory zone diameter of 9.30 mm. Based on the data table can also be known that while in the higher concentration of extract used in the test, so the zone of inhibition produced can be greater. This is because the higher concentration of the extract, the content of active substances that work as a natural antimicrobial is higher too.

The red dragon fruit has betalains containing phenolic and non-phenolic structures. Betalains associated with anthocyanins are flavonoid derivatives (Nurliyana et al., 2010). Flavonoids contained in red dragon fruit include quercetin, kaempferol, and isorhamnetin (Panjuantiningrum, 2009). The mechanism of action of phenol compounds in killing bacterial cells is 3 ways, namely denaturing the bacterial cell protein, inhibiting cell wall synthesis, and destroying bacterial cell membranes. The phenol compound denatures the bacterial cell protein by forming a hydrogen bond with a bacterial protein. This results in the structure of bacterial proteins becoming damaged and enzymes become inactive. Due to the denaturation of bacterial cell proteins, all of the bacterial cell metabolism activity stops, because all bacterial cell metabolism activities are catalyzed by enzymes that are proteins (Lawrence and Block, 1968). The mechanism of phenol in inhibiting bacterial cell wall synthesis by poisoning the protoplasm and breaking the peptidoglycan bond (Naidu, 2000).

According to Volk and Wheeler (1993) the mechanism of phenol in damaging bacterial cell membranes, by way of H + ions from phenol compounds will attack the polar group (phosphate group) bacteria so that the phospholipid molecules decompose into phosphoric acid, glycerol and carboxylic acids. This condition causes the bacterial cell membrane to leak. Similarly with flavonoid compounds, flavonoid compounds have 2 ways to kill bacteria that is by destroying the bacterial cell membrane and denaturing the bacterial cell protein. The mechanism of action of flavonoid compounds in destroying bacterial cell membranes is to form complex compounds with extracellular proteins so that the bacterial cell membranes are damaged and followed by the entry of uncontrolled water into the bacterial cells, causing swelling and eventually the bacterial cell membranes rupture (Black and Jacobs, 1993). This is reinforced by Harborne (1987) which states that flavonoid compounds have the ability to denatured protein cell bacteria by forming a complex hydrogen bond with bacterial cell protein. Thus, cell wall structures and bacterial cytoplasmic membranes that contain proteins, become unstable and lose their biological activity, consequently the function of bacterial cell permeability is disrupted and bacterial cells undergo lysis resulting in bacterial cell death.

This is in agreement with Volk and Wheeler (1991) that the occurrence of microbial inhibition of bacterial colony growth is also caused by damage that occurs in the structural components of bacterial cell membranes. Cell membranes composed of proteins and lipids are particularly susceptible to chemicals that can reduce surface tension. Cell membrane damage causes a disruption of nutrient transport (compounds and ions) so that bacterial cells experience nutritional deficiencies necessary for their growth.

According to Davis and Stout (1971) in Saraswati (2015) which states that if the inhibit zone formed on the diffusion test is less than 5 mm in size, the inhibitory activity is categorized as weak. When the 5-10 mm inhibit zone is categorized as being, 10-19 mm is categorized strong and 20 mm or more is categorized as very strong. Based on the observation and measurement of the diameter of the dragon green peel extract drainage area at concentrations of 10%, 25%, and 50%, the inhibitory power of the extract is still categorized into a weak inhibitory power. Meanwhile, at concentrations of 75% and 100%, the inhibitory power of red dragon fruit peel can be categorized into moderate inhibitory power.

IV. CONCLUSION

Based on the results of research that have been done then obtained the following conclusions:

1. Extract of red dragon fruit peel produced has a light brown color, odorless, less viscous, and pH of 5.2.
2. The test results of inhibitory power of red dragon fruit extract produced on contamination of E. coli at 100% concentration is equal to 9,30 mm. Thus, the inhibitory power of red dragon fruit peel is still classified in the medium antimicrobial category.

REFERENCES

Black, J. M. and E. M. Jacobs. 1993.Medical Surgical Nursing. 4th edition. Philadelphia: W. B. Saunders Company.

Cai, Y., M. Sun., H. Wu, R. Huang and H. Corke. 1998. Characterization and quantification of betacyanin pigments from diverse Amaranthus species. J. Agric. Food Chem. 46(6):2063-2069.

Gunawan., Didik dan Sri, M. (2010). Ilmu Obat Alam (Farmakognosi) jilid 1, Jakarta: Penebar Swadaya. Halaman 106, 107, 120.

Harbone, J. B. 1987. Metode Fitokimian Penuntun Cara Modern Menganalisis Tumbuhan. ITB. Bandung.

Lawrence, C. A. and S. S. Block. 1968.Disinfection, Sterilization and Preservation. Philadelphia: Lea and Febiger.

Naidu, A. S. dan R. A. Clemens. 2000. Natural Food Antimicrobial Systems. LCC: CRC Press.

Nuria, M.C., A. Faizatun., dan Sumantri.2009. Uji Antibakteri Ekstrak Etanol Daun Jarak Pagar (*Jatropha cuircas* L) terhadap Bakteri *Staphylococcus aureus* ATCC 25923, *Escherichia coli* ATCC 25922, dan *Salmonella typhi* ATCC 1408. *Jurnal Ilmu – ilmu Pertanian*. 5: 26 –37.

Nurliyana, R., dkk. 2010. Antioxidant Study of Pulps and Peels of Dragon Fruits: A Comparative Study. International Food Research Journal. 17: 367-375.

Panjuantiningrum, Feranose. 2009. Pengaruh Pemberian Buah Naga Merah (Hylocereus Polyrhizuz) Terhadap Kadar Glukosa Darah Tikus Putih Yang Diinduksi Aloksan. Skripsi. Universitas Sebelas Maret. Solo.

Reveny, Julia. 2011. Daya Antimikroba Ekstrak dan Fraksi Daun Sirih Merah (*Piper betle* Linn.). Skripsi. Fakultas Farmasi Universitas Sumatra Utara. Medan.

Saraswati, F.N., 2015. Uji AKtivitas Antibakteri Ekstrak Etanol 96% Limbah Kulit Pisang Kepok (Musa Balbisiana) terhadap Bakteri Penyebab Jerawat (*Staphylococcus epidermidis*, *Staphylococcus aureus*, dan *Propionibacterium acne*). (Skripsi). UIN Syarif Hidayatullah. Jakarta. 67 hlm.

Tilaar, M., 2009, *Healthy Lifestyle with Jamu*, Dian Rakyat, Jakarta, p. 67.

Volk, W. A dan M. F Wheler. 1991. Mikrobiologi Dasar Jilid *2.* Erlangga. Jakarta.

F.6

RESPONSE OF COCOA (*Theobroma cacao* L.) SEEDLING TOWARDS WATERING INTERVAL AND SHELTER DENSITY

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ABSTRACT

Cocoa is a plantation crop which originally comes from tropical rainforests and is a foreign exchange income source of Indonesia. Procurement of good seeds is one of essential factors in cocoa cultivation. Growth and improvement of cocoa seed are influenced by luminous intensity and water condition. This research aimed to identify the effect of interaction between luminous intensity and watering interval towards cocoa seed growth. Research was conducted at Ciparanje Experimental Field of Agriculture Faculty of Padjadjaran University in February until May 2017. Plant material used a month old cocoa seed of cultivar Sulawesi I. This research used experiment method of Split Plot Design with two factors—main factor was shelter density (25%, 50%, and 75%), and subplot was watering interval (every day, every three days, and every five days). Research result indicated that there was not any interaction between shelter density and watering interval on variable of plant height, while interaction in number of leaf was only found on observation 2 weeks after planted. This result explained that cocoa seed can grow properly although the watering interval is long (infrequent) with various luminous intensities.

Keywords: Cultivar Sulawesi I, luminous intensity, watering condition

I. INTRODUCTION

Cocoa (*Theobroma cacao* L.) is a plant that originally comes from tropical rainforests and a foreign exchange income source of Indonesia. Cocoa production of Indonesia is ranked on number 3 in the world, which reaches 728,400 ton/year, after Ivory Coast and Ghana [2]. The planting area is also regarded large, which reaches 8,487 ha in West Java. Cocoa takes the third place after oil palms and rubber as subsector of plantations [7]. This becomes a base for the importance of improving cocoa quality and productivity in Indonesia. Essential step on cocoa cultivation is seedling. Good handling on seedling process becomes one succession factor of planting in field.

Good seed is started by selecting good genetic source. Cultivar Sulawesi 1 is a selected cultivar that is resistant from pest and disease, with high productivity [4], so that this cultivar is highly recommended in planting cocoa. Next factor on seedling is nursery, such as water supply with watering and luminous intensity with shelter.

Cocoa is originally grows in tropical rainforests where high humidity and low luminous intensity. Thus, it needs environmental modification when is planted in tropic region like Indonesia. Some modifications those can be conducted are sheltering since seedling phase and optimal watering interval, so that cocoa can grow properly.

Shelter management is important to support optimal seed growth. One of research was stated that *sambiloto* (green chiretta) plant with shelter has more number of leaf and better height than without shelter[10]. This is also supported by other research who stated that sheltered *meranti* (shorea) plant has wider leaf than the unsheltered one[5]. Shelter affects both luminous intensity and microclimate—such as temperature and humidity. Humidity relates to transpiration rate (water loss) on plants. This will relate to water supply through watering.

Water functions on plant are as solvent and transportation media for plant nutrient. Water lack will hamper plant growth that plant becomes dwarf [11]. Based on another researcher said plant response on water lack can be affected by plant type, so it needs information of proper watering interval for each plant to identify water optimization [9]. Thus, each plant has different water need. Oil palms seed that is watered everyday has bigger stem diameter than the ones that are watered every two or three days [3]. Previous research about cocoa watering showed that the best interval is every three days [8]. Interaction between watering interval and shelter density will affect transpiration rate and water absorption on plant. This is supported by research of one literature, that the lower luminous intensity will lower water need of a plant [1].

Based on those explanations, research on cocoa seed with treatments of watering interval and shelter density was conducted to reach information about interaction between the two factors on cocoa seed growth.

II. MATERIALS AND METHODS

Research was conducted at Ciparanje Experimental Field, Agriculture Faculty of Padjadjaran University. The field is located on around 750 AMSL and precipitation of type C according to Smith and Fergusson. This research was conducted on February until May 2017. Materials and tools were 1 month old cocoa seed of cultivar Sulawesi 1 from Research Center for Coffee and Cocoa of Jember, shading net in various densities, poly bag (20 x 30) cm, and measuring tools for observation. Design method used Split Plot Design that consisted of two factors. Main factor was shelter density (n) with 3 levels:

n1 = shelter 25%
n2 = shelter 50%
n3 = shelter 75%

while subplot factor was watering interval (p) which also consisted of 3 levels:

p1 : everyday
p2 : every two days
p3 : every five days

Treatments were repeated four times and each treatment used three samples, that there were 108 plants totally. Data that showed significance result was given advance examination through Duncan's Multiple Range Test at significance level of 5%.

Research used 1 month old seed that was selected by its uniformity on number of leaf (around 2—5 leaves) and free from pest and disease. The seed was put under shelter using shading net, based on each treatment. Shelter was propped by pillars with 2 meter height from ground. Water volume was 253 m^3 as a result of field capacity test based on media size in poly bag. Observation parameter was number of leaf and plant height those were checked every 2 weeks after treatment in 2 months.

III. RESULTS AND DISCUSSION

Result of plant height variant analysis only had significant effect at 4 weeks after treatment (WAT) on shelter density factor, while there was not significant effect on another observation (Table 1). This result indicated that there was not interaction between the two factors. This was also supported by a research in 2016 which used treatment of shelter density and watering frequency on *sunan* candlenut, and the result did not indicate any interaction between the two factors yet there was a possibility of any independent effect [6].

This research used cocoa seed, a plant that needs high humidity for its growth. Young cocoa plant can grow properly if it is given shelter with high density level, and then will be gradually reduced since the plant gets older [4]. Therefore, at 4 WAT with shelter 75% it showed best result comparing to other treatment on cocoa plant height. Parameter of leaf amount also indicated insignificant effect; this can be seen on Table 2, except on observation 2 WAT. Leaf amount at 2 WAT indicated an interaction between shelter density and watering frequency (Table 3).

Interaction on the young plant could be caused by metabolism of cocoa seed that still needed microclimate as well as its original place. Shelter affected microclimate in surrounding area, such as luminous, temperature, and humidity. High shelter density will cause low luminous absorption that transpiration rate will be low. This causes the lower amount of water that root absorbs that it needs [1]. Based on research of rosella plant, shelter and water volume will interact on component of cell number and fiber. Best interaction on the research is shelter 55% with water level at half of field capacity. This happens because of high luminous intensity on some plants will destroy auxins hormone which is important in process of cell division [12]. Table 3 shows best interaction on character of leaf number with shelter 50% and watering every five days. This showed that young cocoa seed is able to live with irregular watering (not every day) if any treatment of sheltering.

Table 1. Effect of Shelter Density and Watering Frequency on Cocoa Seed Height

Treatment	2 WAT	4 WAT	6WAT	8 WAT
Shelter Density				
25%	17.94	18.75 a	19.80	21.93
50%	17.75	18.80 a	19.22	20.64
75%	18.69	19.75 b	19.83	21.58
Watering Frequency				
Everyday	18.14	19.14	19.83	21.45
Every three days	18.16	19.22	19.64	21.14
Every five days	18.08	18.94	19.38	21.02

note: Number without letter indicates insignificant according to Fisher's Significance Test at 5%. Different letter indicates different significant result according to Duncan Test at 5%

Table 2. Effect of Shelter Density and Watering Frequency on Leaf Amount of Cocoa Seed

Treatment	4 WAT	6WAT	8 WAT
Shelter Density			
25%	5.00	7.33	9.67
50%	4.67	7.00	9.00
75%	5.33	7.67	9.00
Watering Frequency			
Everyday	5.33	8.00	10.00
Every three days	4.67	7.00	8.67
Every five days	5.00	7.00	9.00

Note: Number without letter indicates insignificant according to Fisher Test at 5%

Table 3. Effect of Interaction between Shelter and Watering on Leaf Amount of 2 WAT

Shelter	Watering		
	Every day	Every three days	Every five days
25%	3.83 (a)	3.92 (b)	3.58 (a)
	A	A	A
50%	3.83 (a)	3.42 (a)	4.08 (b)
	A	A	B
75%	3.67 (a)	4.00 (b)	3.83 (a)
	A	A	A

Note: Numbers followed by small letter in same column and numbers followed by capital letter in same line indicate insignificant at 5% of Duncan's Significance Test.

IV. CONCLUSION

There was not any interaction between shelter density and watering interval on variable of plant height. There was an interaction between shelter density and watering interval on character of leaf number 2 WAT, with best interaction on seed that was given shelter 50% and watered every 5 days. This indicated that cocoa seed can grow properly although watering interval is rare but is covered by shelter.

REFERENCES

[1] E. Wardiana and M. Herman. 2009. Effect of Shelter and Growing Media on *Sunan* Candlenut Growth. Bulletin RISTRI Vol. 1: 197-205.

[2] FAOSTAT. 2013. World Food and Agriculture. <www.fao.org> [June 8, 2017]

[3] Hermanto, F. E. Sitepu, and J. Ginting. 2014. Growth of Oil Palm (*Elaeis guineensis* Jacq) Seed Using Rice Husk Media and Watering Frequency in Main Nursery. Online Journal of Agro-technology Vol. 2 No. 3: 1211-1218.

[4] Indonesia Research Center for Coffee and Cocoa. 2010. Cultivation and Postharvest of Cocoa. Jakarta: Agromedia Pustaka.

[5] Marjenah. 2001. Effect from Different Shelter in Nursery on Growth and Morphology of Two Types Shorea Seed. Rimba Kalimantan Vol. 6. No.2.

[6] N. M. Audina, Y. Maxiselly, and S.Rosniawaty. 2016. Effect of Shelter Density and Watering Frequency on Seed Growth of *Sunan* Candlenut (*Reutealis trisperma* (Blanco) airy shaw). Kultivasi Vol.15 (2).

[7] Plantations Office of West Java Province. 2015. Plantations Area and Production in West Java.

[8] R. Hendra and Sutardi. 2009. Response of Cocoa Seed on Basis, Middle, and Sprout towards Compound Fertilizing. Agrovigor 2: 103-109.

[9] R.P. Mumpuni. 2012. Effect of Frequency and Watering Volume on Lettuce Seed Growth. Bulletin AGH 542 (2012). IPB.

[10] S. Suryawati, D. Achmad, and T. Ana. 2007. Response of Green Chiretta Plant by Shelter and Watering Interval. Bulletin EMBRYO Vol. 4: 2.

[11] Saefudin and D. Pranowo. 2007. Effect of Watering Interval and Mulching on Physic Nut's Growth and Flowering. Workshop Proceeding II Technology Status of Physic Nut Plant. Spice and Industrial Plants Research Institute.

[12] T. Astuti and S. Darmanti. 2010. Stem Fiber Growth of Rosella (*Hibiscus sabdariffa* var. Sabdariffa) with Different Treatments of Shelter and Watering Volume. Bulletin of Anatomy and Physiology Vol. XVIII No. 2.

F.7

SHELF LIFE STUDY OF WHEY PROTEIN CONCENTRATE (WPC) AT VARIOUS PACKAGING MATERIALS WITH ACCELERATED SHELF LIFE TESTING (ASLT) APPROACH

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ABSTRACT

Whey protein concentrate (WPC) is a milk component separated from non-whey components so the whey protein concentration is more than 25%. The using of WPC in foodstuffs is intended to increase the nutritional value of products and the utilization of functional properties especially in the formation of product textures. Based on the production process WPC can be divided into native and denatured WPC. Preparation in native WPC tends to produce a hard product texture, while denatured WPC does not affect the texture of product. WPC in processed food products is available in both liquid and powder forms. WPC in powder preparations has a small particle size that its diameter is of 391.16, it also has a large cohesion value and hygroscopic that is affected by lactose levels. Many properties allow for damage such as agglomeration, enzymatic and non-enzymatic that will change of colour, and the composition of volatile components during storage. Those damage affects consumer acceptance of the product and the decrease of functional properties of WPC in food products. An attempt to avoid damage is using of film packaging materials, which the protective power of the packaging material is affected by its permeability. Therefore, in this research, the shelf life of native and denatured WPC is estimated on various packagings so the most appropriate type of packing and storage conditions can be determined, so it will extend the WPC's shelf life. This research is done by descriptive explanatory research method. The estimation of shelf life was done by Accelerated shelf life testing (ASLT) method with critical moisture approach, Labuza (1982) and will be verified using Arrhenius method. In this study also conducted observations on the functional properties of native and denatured WPC on prime conditions and when damaged.

Keywords : ASLT, packaging, Shelf life, functional properties, WPC.

I. INTRODUCTION

One of dairy products is whey protein concentrate (WPC). Which is milk component that has been separated from non-protein components by physical separation such as filtration and has been separated from casein by acidification or by heat to contain more than 25% protein [1].

According to [2] WPC has functional benefits in good gel-forming materials, foam-formers and emulsifiers as well as nutrient-enhancing proteins. WPC presented in two preparations such as liquid and powder.

According to [3] powder WPC is formed by evaporating the water in an evaporator or using a spray dryer which is processed to reduce the size of the powder form (Smith, 2008). WPC powder has a small particle size, therefore the smallest size of a particle has a great the greater the cohesion value. In addition, the presence of amorphous lactose in powdered dairy products is related to the glass transition temperature. Under suitable conditions of temperature and humidity of the air of storage, the powder can mobilize so the viscosity is high which can lead to sticky and crusty material, then the crust combines into form clumps [4].

The damage of food powder is usually due to the changes in physical characteristics and chemical reactions that are affected by the availability of water in the food and the influence of water (aw) and storage temperature that can cause damage such as crystal formation, aggregate, enzymatic and non-enzymatic browning and oxidation So it is necessary to control the storage conditions and packing materials of powdered food [5].

II. MATERIALS AND METHODS

A. Production Process of WPC

First, fresh milk is conditioned at 35°C and then 0.2g/L rennet enzyme was added. Whey produced separated fat by using a cream separator. The next step is whey denaturation with steam jacket for 60 minutes at 90°C. Whey aggregation are separated from other substrates using centrifugation at 4000 rpm speed for 20 minutes. Then the aggregation dried in a vacuum oven for 3 hours at 50°C and minimized the size using a grinder.

B. Shelf Life Testing of WPC using Critical Moisture Content Approach

The shelf life of WPC is determined by the equation below

$$t = \frac{\ln\frac{(\mathrm{Me-Mi})}{(\mathrm{Me-Mc})}}{\frac{\mathrm{k}}{\mathrm{x}}\left(\frac{\mathrm{A}}{\mathrm{Ws}}\right)\frac{\mathrm{Po}}{\mathrm{b}}} \quad (1)$$

1. Initial Moisture Content (Mi)

The initial moisture content of the product is calculated using an oven or gravimetric method based on AOAC 2000.

2. Critical Moisture Content (Mc)

The critical water content was determined by storing the sample at 96% RH at 45°C until the panelists rejected the sample quality. The critical water content was tested with AOAC 2000.

3. Equilibrium Moisture Content (Me) and Isotherm sorption curves

Isotherm sorption curves are done by storing samples at various RH and weighing the sample every 12 hours until the sample weight reaches constant. The conditioning of various RH is carried out using saturated salt solution such as the table below.

Table 1. Preparation of Saturated Solution For The Determination of Isothermal Sorption Curves

Salt	RH (%)
NaOH	10 %
$MgCl_2$	35 %
K_2CO_3	47%
KI	79 %
NA_2SO4	87 %

4. Determination of Isothermal Sorption Model

The equation model used is determined based on previous research and is intended to obtain the suitability of the curve. The model choosed in this study is the Brauner model known as the GAB equation (Guggenheim, Anderson, and de Boer), Caurie, Hasley, Oswin, and Chen Clayton.

The model accuracy test is performed using Mean Relative Determination (MRD) calculation. The MRD equation is as follows:

$$MRD = \frac{100}{n}\sum_{i=1}^{n} |Mi - \frac{Mpi}{Mi}| \quad (2)$$

where :

Mi = Water content of the experiment

Mpi = Calculated water content

N = amount of data

If MRD <5 then the isotherm sorption model can describe the actual state very precisely. If 5 <MRD <10 then the model somewhat appropriately describes the true state, and if MRD> 10 then the model is not appropriate to describe the actual condition.

5. Determination of Supporting Parameters

Packaging permeability (k / x) is determined by the method of gravimetric by storing the packaging at RH 96% and weighing every 24 hours for 5 days. The packagings of permeability tested are metalized, PP, multilayer packaging (3 layers of craft paper + 1 layer PP).The saturated pressure (Po) is determined at a temperature of 27 °C based on the Labuza table (1992). The packaging area (A) is determined based on the packaging dimension of 7 × 9 cm. The total packing solids (Ws) is determined by the initial moisture content of the sample.

C. Shelf Life Testing of WPC using Arrhenius Approach

Shelf life testing of the product is done by storing samples at three different temperatures at 35°C, 40°C, and 45°C. Then the colour, water content, and water activity was observed every 12 hours for 5 days. Water activity was tested by using aqualab and colour meters tested using a C65 chromameter. From the results of these observations determined the order of quality decline reaction, the rate of decline in quality, and the shelf life of the product. The store age of the product is determined by the equation

The 0 order reaction : ts = (Q0-Qs) / kT (3)

The 1 order reaction : ts = [ln (Q0 / Qs)] / kT (4)

D. Functional Property of WPC

The functional property was observed in two conditions, namely in prime condition and in critical condition. The functional property that was observed are gel texture, stired gel viscosity, whey drainage, and solubility.

III. RESULTS AND DISCUSION

A. Shelf Life Testing of WPC using Critical Moisture Content Approach

1. Initial Moisture Content

The initial moisture content of the commercial WPC product is 0.0505% db and the denatured WPC is 0.058% db

2. Critical Moisture Content.

The critical moisture content of commercial WPC products is 0.134% db and denatured WPC is 0.142% db.

3. Equilibrium Moisture Content and Isothermal Sorption Curve

In the denatured WPC samples, the water content of the sample equilibrium decreased from RH 35% to RH 70% and the lowest was at RH 47% namely 1.9%. It also occurs in commercial WPC samples where the equilibrium moisture content decreases at 35% to 47% and the lowest equilibrium moisture content is at RH 35% ie 0.3%. The results can be saw in the picture below.

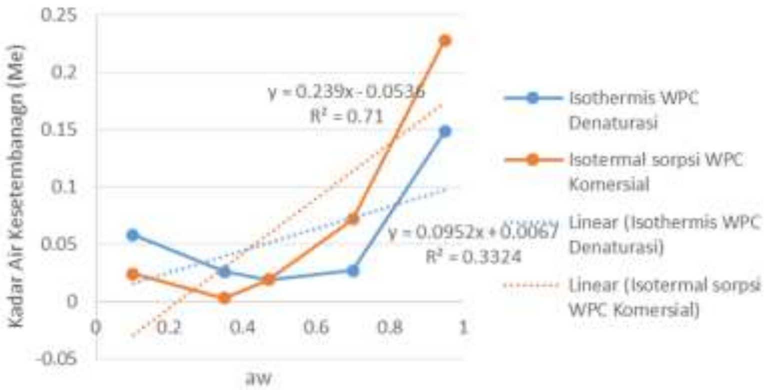


Fig. 1. Isothermal Sorption Curve

Decreasing of moisture content in certain RH indicates the presence of a phenomenon of absorbed water loss. It is also found in a study conducted by [6] in which skim milk samples lost water contents at RH 50-60% that is higher RH than in this study. [7], also found in powdered milk samples stored at RH 53.8% -76.4% for 9 days the water content decreased until the moisture content was constant at days 4 and 5. The loss of this absorbed water revealed the presence of lactose crystallization. At the the RH used in the study. Vuataz in [7] found that lactose began crystallizing in milk powder at RH 39% at 35°C

The crystallization of lactose depends on the rate of crystallization of the amorphous solid. The loss of water content absorbed on milk powder depends on the absorption of water by crystalline and amorphous lactose which depends on the form and condition of crystallization. Most crystals forms anhydrous, but at highest RH the number of α-lactose monohydrate crystals formed increased [8].

[7] Found that lactose crystallization resulted in the loss of absorbed water in skim milk during the storage at certain RH. Where the most crystallized lactose is the α- and β-lactose anhydrous. A-lactose monohydrate crystallized at RH 77% in 21°C and an β-lactose anhydrous crystallized at RH 57% in 25°C.

4. Determination of Isothermal Sorption Model

The mathematical models used to determine the isotherm sorption model are the Henderson, Caurie, Hasley, Oswin, Chen Clayton and GAB models. Modelling is done by modifying equations into linear equations with logarithmic (log) and / or normal logarithmic logs (ln). The value of the equilibrium moisture content was mathematically tested for its accuracy with the equilibrium moisture content obtained during the experiment by the method of MRD (Mean Relative Determination). In this study the value of MRD obtained > 10 so the six equations used cannot describe the actual condition of the sample being studied.

5. Determination of Supporting Parameters

The shelf life of WPC is assumed to be at 27°C at RH 76% on three types of packaging i.e. metalized 0.08 mm, PP 0.08 mm, multilayer packaging (3 layers of 0.1 mm craft paper + 1 layer PP 0.04 mm). The permeability of the packagings are respectively 0.0031 g /m^2 mmHg day, 0.0066 g / m^2 mmHg day, and 0.0941 g/m^2 mmHg day. The surface area of packaging is 0.0126 m^2. The total soluble solids of the sample were 2.83 g in the denatured WPC sample and 2.85 g in the commercial WPC sample. The partial pressure is based on the Labuza table where at 27°C the partial pressure is 26.739 Pa. The slope value (b) is determined from the isotherm sorption graph of 0.239 in the commercial WPC, and 0.0952 on the denatured WPC.

6. Shelf Life of WPC

The equilibrium moisture content (me) of the sample was obtained from the experimental results by observing of weight the sample stored in based on American Dairy Council 2014 that is 76% every 12 hours until the sample reaches equilibrium. The value of Me is not based on the calculation of the water content of mathematical equilibrium because in this study the six models used are not accurate that indicate the state of the sample used. The Me score for the commercial WPC sample is 15.71% db and denatured WPC sample is 15.78% db.

All parameters that have been observed that used to calculate the shelf life of the WPC sample. the shelf life of sample shown in the table below.

Table 3. Shelf Life of WPC in Various Packaging

Sample	Multilayer	PP	Metalized
Denatured WPC	0.5 month	0.6 year	1.3 year
Commercial WPC	1.1 month	1.3 year	2.8 year

The highest shelf life was demonstrated by the use of metalized packaging ie 1 year and 4 months in denatured WPC samples and 2 years 9 months in commercial WPC samples. Therefore, the packaging is used in the estimation of WPC shelf life with Arrhenius approach.

B. Shelf Life Study of WPC using Arrhenius Approach

1. Determination of Reaction

Determination of the order of the reaction is done by plotting the percentage value of the quality of each parameter (y) to the storage period (x) on the 0 order graph and Ln decreasing the quality parameter (y) to the storage period (x) on the 1 order graph. Then from the graph is determined the linear equation and compared the value of R2 on each parameter at each storage temperature during the study. The value of each R2 can be seen in the table below

Table 4. Regression Value of WPC's Order Reaction

Parameter	Temperature	Denatured		commercial	
		order 0	order 1	order 0	order 1
Colour Value	35°C	0.161	0.202	0.385	0.413
	40 °C	0.535	0.001	0.761	0.828
	45 °C	0.655	0.010	0.870	0.768
Moisture Content	35 °C	0.996	0.998	0.996996	0.999
	40 °C	0.969	0.977	0.994395	0.996
	45 °C	0.997	0.998	0.998167	0.998
Water activity	35 °C	0.884	0.842	0.940309	0.939
	40 °C	0.971	0.970	0.941987	0.924
	45°C	0.943	0.923	0.95688	0.965

Based on the above table it can be seen that the colour change parameter in the denatured and commercial WPC samples is the 0 order, the water content parameter is the 1 order on the denatured and commercial WPC, while the water activity is the 0 order on the denatured WPC and the 1 order in the commercial WPC sample.

2. Determination of K Value and Activation energy

The value of the reaction rate constant (K) of each parameter is determined from the slope value of the linear equation in the reaction order of each observation parameter, can be seen in the table below.

Table 5. Value of Reaction Rate Constant of WPC

Parameter	Temperature	Denatured WPC		Commercial WPC	
		order 0	order 1	order 0	order 1
Colour Value	35°C	-0.0103	-0.0001	-0.0055	-0.00007
	40 °C	-0.0199	-0.0003	-0.0103	-0.0001
	45 °C	-0.0258	-0.0003	-0.0169	-0.0002
Moisture Content	35 °C	0.0001	0.0019	0.0002	0.0032
	40 °C	0.0001	0.0021	0.0002	0.0034
	45 °C	0.0001	0.002	0.0002	0.0032
Water activity	35 °C	0.0005	0.0007	0.0007	0.0015
	40 °C	0.0004	0.0006	0.0008	0.0017
	45°C	0.0004	0.0009	0.0008	0.0017

The value of the constant rate of the reaction will be used in the determination of the Arrhenius equation by plotting the Ln of the reaction rate constant (y) to 1 / T (x) where the temperature is converted to the kelvin (K) unit. So obtained the relationship between Ln K with 1 / T as the graph below.

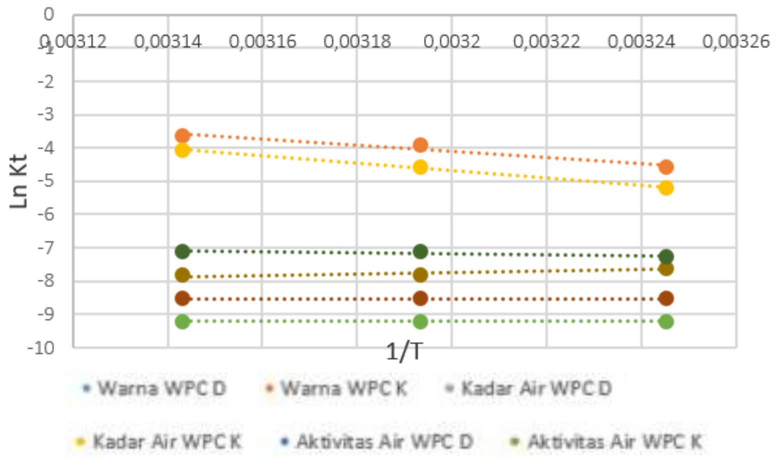


Fig. 2. Graph of Arrhenius quality parameters at Order 0

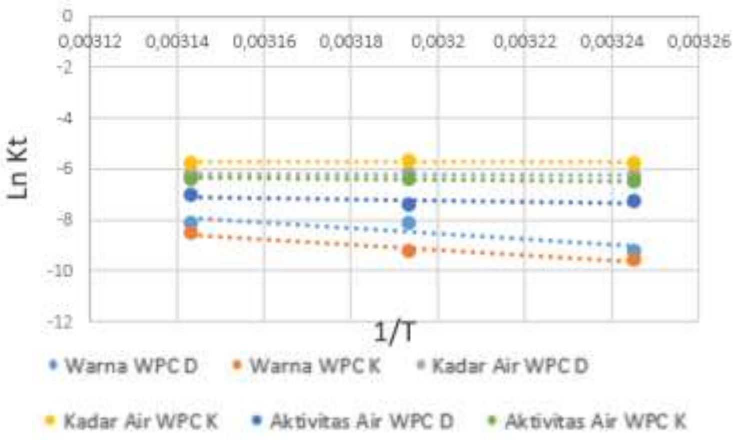


Fig. 3. Graph of Arrhenius quality parameters at Order 1

From the Arrhenius graph obtained equation which followed the equation

$$LnK = Ea / RT + Ko \tag{5}$$

From that equation can be determined the value of activation energy changes each parameter by multiplying slope with R. Where R value equal to gas constant that is 8,314 J/mol. K.

Example calculation:

The Arrhenius Equation of the denatured WPC color parameter is

y = -51884x + 159.74
Ea / R = 51884
Ea = 51884 × 8.314 J/mol.K
Ea = 431363.6
As for each equation and activation energy can be seen in table below

Table. 6 Energy Activation of Each Pharameter

Parameter	Equation		Ea	
	order 0	order 1	order 0	order 1
Colour WPC K	y = -11011x + 30.55	y = -10274x + 23.715	91545.45	85418.04
Colour WPC D	y = -9022.2x + 24.766	y = -10827x + 26.102	75010.57	90015.68
Moisture Content WPC K	y = - 9.2103	y = -6.326x - 5.7042	0	52.59436
Moisture Content WPC D	y = - 8.5172	y = -510.59x - 4.5847	0	4245.045
aw WPC K	y = -1316x - 2.9723	y = -1233.5x - 2.4792	10941.22	10255.32
aw WPC D	y = 2199.1x - 14.773	y = -2434.4x + 0.5433	18283.32	20239.6

It is basically known that the rate of reaction is strongly influenced by temperature. In the Arrhenius model temperature is a influential factor on the decline in the quality of food products. The highest temperature, will enhance the rate of reaction, in other words the highest of T as much as the value of k. This relationship is based on the activation theory, that a reaction of change will begin to take place when giving a minimum amount of energy called activation energy (Ea). Therefore the smallest value of activation energy means the less energy the parameters need to make changes. These results indicate that the smallest activation energy is the moisture content. Therefore, in this study the parameters used as critical parameters to determine the shelf life of the product is the change in moisture content during storage.

3. *Shelf Life of WPC*

The calculation of WPC shelf life is based on the determination of shelf life with the reaction order of change of quality parameter ie order 0 for color change, order 1 for moisture content, order 1 for aw commercial WPC and order 0 for aw WPC denatured. The equation of calculation shelf life for each order is :

Order 0: ts = (Qo-Qs) / K

Order 1: ts = Ln (Qo / Qs) / K

Where Q0 shows the product initial parameters and Qs shows the critical parameters of product. So based on these parameters can be determined the shelf life of the sample as in the table below.

Table 7. The calculation of WPC shelf life

Parameter	K		Q0		Qs		Shelf Life	
	order 0	order 1	order 0	order 1	order 0	order 1	order 0	order 1
Colour WPC K	0.002166	2.71E-05	78.334	78.334	76.674	76.674	2.1 year	2.2 year
Colour WPC D	0.005027	4.68E-05	79.609	79.609	76.587	76.587	1.6 year	2.3 year
Moisture Content WPC K	0.0001	0.003262	0.0505	0.0505	0.1345	0.1345	2.3 year	0.8 year
Moisture Content WPC D	0.0002	0.001863	0.058	0.058	0.1422	0.1422	1.2 year	1.3 year
aw WPC K	0.000638	0.001376	0.426	0.426	0.808	0.808	1.7 year	1.3 year
aw WPC D	0.000584	0.000517	0.608	0.608	0.7975	0.7975	0.9 year	1.4 year

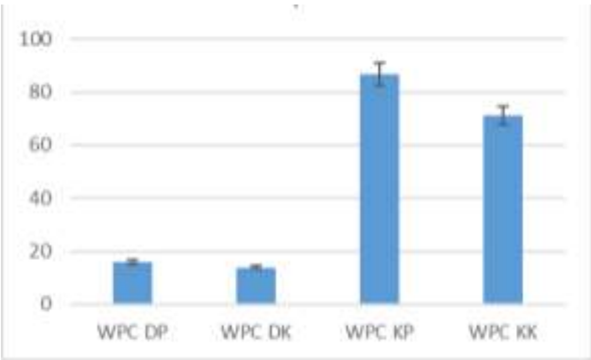
Based on the Table 7, the highest sample shelf life was determined by the color quality parameter of 2.1 years in the commercial WPC sample and 1.6 years in the denatured WPC samples. The shelf life based on the water content parameter of the shelf life of sample was 1.3 years in the denatured WPC sample, and 0.8 years in the commercial WPC. While the water activity parameter is 0.9 years in denatured WPC and 1.2 years in commercial WPC. However, shelf life should be determined based on the lowest activation energy ie moisture content.

C. *Functional Property of WPC*

1. *Solubility*

The functional properties observed were solubility of samples tested by dissolving samples of 3 grams in 25ml of distilled water, then weighing the dissolved sample solids and calculating the percentages.

The figure below shows that the solubility of the commercial WPC sample is higher than the denatured WPC sample. This occurs in both conditions ie in prime samples and critical samples. This is because in the manufacture of denatured WPC heating is carried out at 90°C which causes the protein to undergo a conformity transition which exposes the SH group so that the hydrophobic group is temporarily exposed to the surface native conditions of the hydrophilic group very much [9].



Note:
DP= Prime Denatured WPC
DK= Critic Denatured WPC
KP= Prime Commercial WPC
KK= Critic Commercial WPC

Fig. 4. Solubility Value of WPC

The sample at prime condition has higher solubility than the sample at critical condition. This is indicated by the percentage value of denatured WPC solubility in prime condition having solubility value of 15.78% while the solubility percentage of WPC denatured in critical condition of 13.95%. The prime commercial WPC sample has a solubility percentage of 86.66% while the critical commercial WPC sample has a solubility percentage of 71.25%.

The decrease of WPC solutibility sample was also demonstrated by the results of [10] on changes in the functional properties of WPC powder during storage where the solubility decreased in storage for 3 months at various temperatures. This is thought to be due to changes in protein structure followed by aggregation, in addition to that Maillard reaction can also be one of the contributing factors.

The solubility difference was also influenced by the aw sample rate, where samples with highest aw had a lowest solubility [10]. This also occurs in commercial WPC samples with lower aw of denatured WPC having higher solubility. The assumption is true of samples that have the same WPC type was different solubility values, ie in critical conditions with higher aw than prime conditions, the sample has lower solubility.

2. *Whey Drainage*

The observation of whey drainage was done by conditioning the gel at room temperature of the petridish containing Whatman filter paper for 20 minutes, then weighing the gel released liquid and calculated the percentage to the gel weight of the beginning.

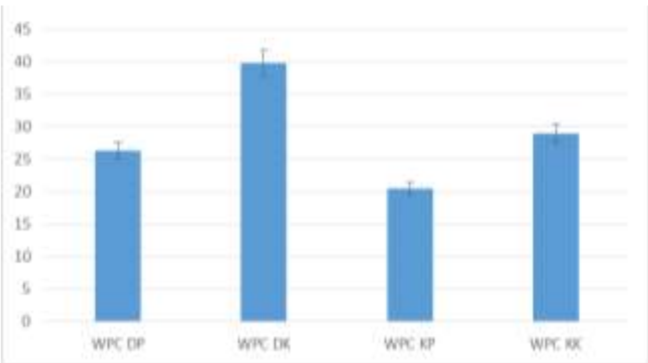


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Fig. 5. Whey Drainage Value of WPC

The results showed that there was an increase in the value of whey drainage in gel samples formed from WPC that was already in critical condition or rejected by consumers. In the case of the denatured WPC gel in the prime condition the value of whey drainage was found of 26.27%, which is smaller than the value of whey drainage from the critical denatured WPC gel sample of 39.82%. The same is true of commercial WPC gel samples in which the value of whey drainage gel commercial WPC prime with a value of 20.50% lower than whey drainage gel WPC critical ie 29%

The value of whey drainage is inversely related to the value of water holding capacity. Water holding capacity (WHC) can be defined as the ability of a foodstuff system to retain water under certain conditions such as force, pressure, centrifugation and heating. In protein is defined as the ability of the food system to retain water so as not to be separated from the three-dimensional structure of the protein [11].

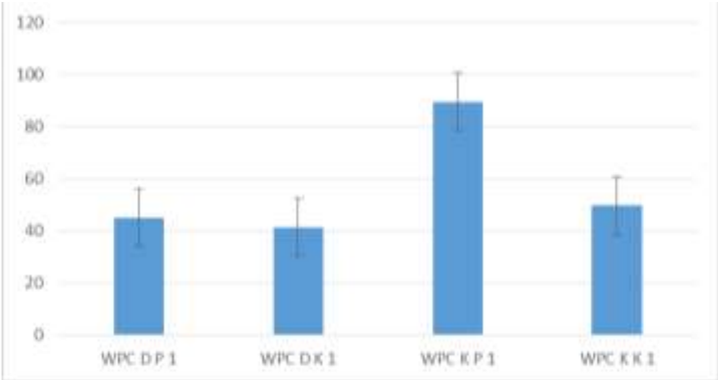
The results of this observation indicates that gel samples with WPC in prime condition is higher water holding capacity than in critical condition. The phenomenon shows that WPC in critical condition decreased its functional properties.

The gel sample with commercial WPC has a lower drainage value than the gel sample with denatured WPC. It occurs in both conditions ie in critical samples and prime samples. The amount of water attached increases with increasing protein concentration. The amount of water holding by the protein depends on the amino acid composition, especially by the number of exposed polar groups [11]. Based on the literature, commercial WPC will retain more water than denatured WPC due to a high of protein concentrations.

According to [11], protein hydration and water retention capacity are also influenced by changes in protein conformation during processing, especially in the presence of heating which results in denatured proteins. Such denaturation may lead to a reduction in the availability of amino acid groups to bind water. This is why commercial WPCs have higher whey drainage values than commercial WPCs.

3. Gel Texture

The gel strength was measured using a texture analyzer using a muffin project where the probe used would be pressed on a sample with a penetration depth of 0.5cm and a holding time of 30s. So from the test obtained a gel texture value that is marked by firmness and springiness value. The test results of gel samples can be seen in the picture below.



Note:
DP= Prime Denatured WPC
DK= Critic Denatured WPC
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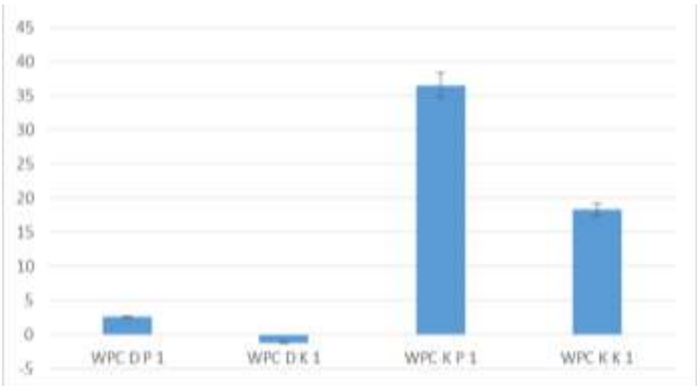
Fig. 6. Firmness Value of WPC

The above test results show that the firmness value of the commercial WPC gel sample was greater than the denatured WPC gel, it also occured in both conditions. The gel density (fimness) is defined as the force given by the gel when given compression at a certain distance. The gel density will increase with increasing protein concentrations, the WPC solubility also affected so that the denatured protein will have a lower solubility resulting in decreasing gel density. This is because intermolecular hydrophobic interactions dominate in the gel matrix [12]. In addition to protein concentrations, firmness values are also affected by the rate of denaturation determined by the amount of disulfide bonds that stabilize the gel microste- lens [13].



Note:
DP= Prime Denatured WPC
DK= Critic Denatured WPC
KP= Prime Commercial WPC
KK= Critic Commercial WPC

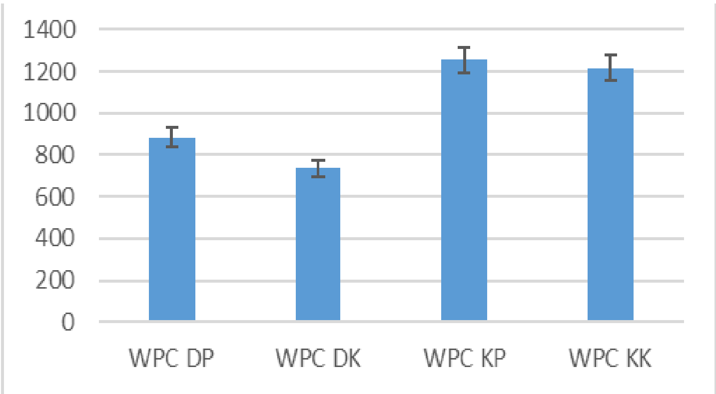
Fig. 7. Springiness Value of WPC

Springiness showed the value of gel elasticity that has a value inversely proportional to the degree of crosslinking in the gel structure [14]. The results of the tests show that the value of commercial WPC springiness gel is higher than the deformated WPC gel, it occured in both sample conditions ie prime and critical. Similar results were also found by [15], whereby on gel texture testing with denatured WPC 80°C had a springiness value of 2.382 and found that the value was smaller than the gel formed by WPC without denaturation. This is because in the denaturation process formed intra-aggregate bonds and formation of aggregates in the next stage. The heating exposes hydrophobic sections, sulfhydryl groups and disulfide bonds, and promotes the formation of disulfide bonds and hydrophobic interactions.

The value of springiness of gel samples with prime WPC was greater than that of the critical WPC gel. This is indicated by the value of the WPC gel denaturation is 2.54 in the prime condition and -1.22 in the critical condition. The same is true of commercial WPC gel, which is 36.51 under prime conditions and 18.36 in critical conditions. This value indicates the elasticity of the prime sample is reduced after reaching its critical point.

4. Viscosity of Stirred Gel

The sample viscosity was tested by gel first homogenized with magnetic stirrer for about 2 minutes, then calculated its viscosity with rotational viscometer using V4 probe with speed of 100rpm, to obtain the sample viscosity as shown below.



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KK= Critic Commercial WPC

Fig. 8. Viscosity of Stirred Gel

The gel viscosity value derived from commercial WPC is higher than gel viscosity derived from denatured WPC. The protein viscosity has an exponential relationship with protein concentration. High concentrations of proteins have considerable protein interactions resulting in viscoelastic properties of [16]. Where the commercial WPC sample is used WPC 80 where the protein concentration is higher than the denatured WPC belonging to WPC 50.

The viscosity is also influenced by the solubility of the sample where the commercial WPC has high solubility so that the amount of water attached by the protein is higher, whereas the WPC denatures its solubility low and forms aggregate so that less gel gelation is significantly affected the decrease of gel viscosity [17].

While in both types of gel samples, the sample viscosity value derived from prime WPC has a higher value than the sample viscosity value sourced from critical WPC. This is because during WPC erosion decreased solubility during storage and the change of nature of hydration and poor reconciliation resulting in changes in its functional properties such as viscosity reduction, gel formation, foam formation, and emulsifying properties [18].

IV. CONCLUSION

The shelf life of samples with the critical moisture approach it was found that the highest shelf life was indicated by the metalized packaging followed by the PP packaging and the shortest shelf life was on multilayer packaging. In the estimation of shelf life by Arrhenius approach the commercial WPC and denatured WPC have shorter shelf life the critical moisture approach. Samples at critical condition decreased functional properties when compared with prime condition samples. This is indicated by the decrease in the value of viscosity, solubility, firmness, springiness, and increased value of whey drainage.

REFERENCES

[1] Croissant, A. E., Kang, E. J., Campbell, R. E., Bastian, E., & Drake, M. A. The effect of bleaching agent on the flavor of liquid whey and whey protein concentrate. Journal of Dairy Science,2009, 92(12), 5917–5927

[2] Miloradovic, Z. N., Macej, O. D., Kljajevic, N. V., Jovanovic, S. T., Vucic, T. R., & Zdravkovic, I. R. The effect of heat treatment of caprine milk on the composition of cheese whey. International Dairy Journal,2016, 58, 39–42.

[3] Smith, K. Dried Dairy Ingredients. Winconsin Center for Dairy Research. 2008. Dairy Management, Inc.

[4] Fitzpatrick, J. J., Hodnett, M., Twomey, M., Cerqueira, P. S. M., O'Flynn, J., & Roos, Y. H. Glass transition and the flowability and caking of powders containing amorphous lactose. Powder Technology, 2007,178(2), 119–128

[5] Hedegaard, R. V., & Skibsted, L. H. 16 - Shelf-life of food powders. In Handbook of Food Powders (pp. 409–434). 2013.Woodhead Publishing.

[6] Amagliani, L., O'Regan, J., Kelly, A. L., & O'Mahony, J. A. Physical and flow properties of rice protein powders. Journal of Food Engineering, 2016,190, 1–9.

[7] Jouppila, K., & Roos, Y. H. Glass transitions and crystallization in milk powders. Journal of Dairy Science, 77(10), 1994,2907–2915.

[8] Roos, Y. H. Importance of glass transition and water activity to spray drying and stability of dairy powders. Le Lait, 82(4),2002, 475–484

[9] Morr, C. V., & Ha, E. Y. W. Whey protein concentrates and isolates: Processing and functional properties. Critical Reviews in Food Science and Nutrition, 33(6), 1993, 431–476.

[10] Hsu, K.-H., & Fennema, O. Changes in the functionality of dry whey protein concentrate during storage. Journal of Dairy Science, 72(4), 1989, 829–837.

[11] Zayas, J. F. Water holding capacity of proteins. In Functionality of proteins in food (pp. 76–133). Springer, 1997.

[12] Shimada, K., & Cheftel, J. C. Texture characteristics, protein solubility, and sulfhydryl group/disulfide bond contents of heat-induced gels of whey protein isolate. Journal of Agricultural and Food Chemistry, 36(5), 1988,1018–1025.

[13] Fertsch, B., Müller, M., & Hinrichs, J. Firmness of pressure-induced casein and whey protein gels modulated by holding time and rate of pressure release. Innovative Food Science & Emerging Technologies, 4(2), 2003,143–150.

[14] Schmidt, R. H., Illingworth, B. L., Deng, J. C., & Cornell, J. A.Multiple regression and response surface analysis of the effects of calcium chloride and cysteine on heat-induced whey protein gelation. Journal of Agricultural and Food Chemistry, 27(3), 1979, 529–532.

[15] Ju, Z. Y., & Kilara, A. Textural Properties of Cold-set Gels Induced from Heat-denatured Whey Protein Isolates. Journal of Food Science, 63(2), 2008, 288–292

[16] Damodaran, S., Parkin, K. L., & Fennema, O. R. Fennema's food chemistry. CRC press.2007.

[17] Abd El-Salam, M. H., El-Shibiny, S., & Salem, A. Factors Affecting the Functional Properties of Whey Protein Products: A Review. Food Reviews International, 25(3), 2009, 251–270.

[18] Kher, A., Udabage, P., McKinnon, I., McNaughton, D., & Augustin, M. A. FTIR investigation of spray-dried milk protein concentrate powders. Vibrational Spectroscopy, 44(2),2007, 375–381.

F.8

STABILITY AND ADAPTABILITY ANALYSIS ON YIELD AND YIELD COMPONENTS OF SEVEN RED PEPPER (*Capsicum* sp.) GENOTYPES

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ABSTRACT

Experiments were conducted to determine stable or adaptable red pepper variety for yield and yield component traits in West Java, Indonesia. Seven red pepper varieties were evaluated using Randomized Complete Block Design in three replications at three locations (Ciamis district, Garut District, and Tasikmalaya district) from July 2016 until May 2017. The seven varieties were UNPAD CK 6, UNPAD CK 7, LARIS, and Lembang-1 for *Capsicum annum* and UNPAD CR 8, Rabani, and Prima varieties for *C. frutescens*. The altitude of location are 800 m above the sea level for Ciamis, 1 200 above the sea level for Garut, and 1 100 above the sea level for Tasikmalaya. AMMI Model was used for estimating stability and adaptability. According to AMMI Model, the genotipes that stable in three locations are Prima and Rabani for yield and UNPAD CK 6 for fruit diameter. The genotype that adaptive in Garut was UNPAD CK 6 for fruit weight per plant and fruit diameter, UNPAD CK 7 for fruit weight per plant and Laris for fruit diameter. The adaptive genotypes in Ciamis was UNPAD CR 8 for fruit diameter. UNPAD CR 8 is the best yield than the others.

Keywords: red pepper, adaptability, stability, yield, yield component

I. INTRODUCTION

Red pepper (*Capsicum annum* L.) is an important vegetable in Indonesia. Indonesian people consume red pepper 1.550 kg per capita per year and chili pepper 1.329 kg [1]. The productivity in 2014 were 24.36 t.Ha^{-1}. Production in 2014 was 1,0754,611 t and 1,045,200 t for 2015. Twenty three percent production from West Java planting area [2]. In Indonesia, there are two kind of red pepper, i.e. red pepper and curl red pepper or “cabai merah besar” and “cabai merah keriting”. Chili pepper or “cabai rawit” is popular too in Indonesia. The spesies of “cabai rawit” could be *C. annuum* or *C. frutescens*.

One hundred and twenty red pepper variety are release or registered since 1994 until 2016 and 116 variety for curl red pepper [3]. Agriculture Faculty of Universitas Padjadjaran had breed three new genotypes UNPAD CK6, UNPAD CK 7 (*C. annuum*) and UNPAD CR 8 (*C. frutescens*). The other four genotypes that used in this research are releasing variety named Laris, Lembang 1 (*C. annuum*) and Rabani, Prima (*C. frutescens*).

Looking for the stable variety in some red pepper central productions is an important thing for registering the variety. Registering is the step that might be done for seed distribution and commercialization of the new variety. More registered new variety, more choice for farmer to plant the right variety of red pepper.

Therefore, multi-location test is the important step to get stable variety. Environmental conditions such as soil type, soil fertility, moisture level, temperature, and the cultivation of different habits have different effects for plants. According to [4], all influential factors in crop production as a whole can be described as the environment.

Additive main effect and multiplicative interactions (AMMI) is a statistical model that used to analize genotype × environment interaction [5] and [6]. visualized AMMI component as biplot.

Seven genotypes were evaluated in three locations to get stable or adaptive genotypes using AMMI (Additive Main Effects and Multiplicative Interaction) Models for stability and adaptability. Misra *et al.* were used AMMI Models analysis to get adaptive genotypes of finger millet [7].

II. MATERIALS AND METHODS

The experiments were carried out in September 2016 until May 2017 in three locations. The locations were Garut, Tasikmalaya, and Ciamis, West Java, Indonesia. The altitude of location are 800 m above the sea level for Ciamis, 1 200 above the sea level for Garut, and 1 100 above the sea level for Tasikmalaya. These locations are the red pepper central production in West Java, Indonesia.

Randomized Complete Block Design was used in each locations with seven red pepper genotypes as a treatment in three replications. The seven genotypes consist of UNPAD CK6, UNPAD CK 7, Laris, Lembang-1, UNPAD CR 8, Rabani, and Prima) and three of these genotypes belongs to Plant Breeding Laboratory of Agricultural Faculty, Universitas Padjadjaran (UNPAD CK6, UNPAD CK 7, and UNPAD CR 8).

UNPAD CK6, and UNPAD CK 7 were selected progeny from F_8 of crossing UNPAD CK 5 x Lembang, while UNPAD CR 8 was the selected progeny from F_8 of crossing *C. frutescens* Collection of UNPAD, i.e. Unpad CRG1 x Unpad CRL1. AMMI Model was used for stability and adaptability analysis.

III. RESULTS AND DISCUSSION

Analysis variance of AMMI model (Table 1) indicate that AMMI component 2 could be used in analysing yield , fruit weight per plant, fruit number per plant, fruit length, fruit diameter, and weight of one fruit. The result of AMMI biplot of yield and yield component of the seven genotypes in three location was showed that two genotypes (Prima and Rabani) stable for yield and one genotype stable (UNPAD CK 6) in fruit diameter. Based on AMMI bi-plot in Fig. 1 untul Fig. 6, there were four genotypes adaptive for one or two traits in Garut and Ciamis (Table 2).

AMMI model is an effective statistical for interpretation of multi environmental data [6]. Sweet corn multi-locations test of [8] research showed that The AMMI bi-plot determined Padjadjaran G 10 sweetcorn hybrid as a stable hybrid across locations and seasons in West Java, while Padjadjaran G5 and G11 as the specific environment hybrid.

Many researchers using AMMI model for getting the stable genotypes. The GGE results also confirmed two crosses number was stable, and recommended the genotypes for drought and salinity environment. Besides, one genotype was identified as the best line due to its stability and high yield [9]. But [10] had three genotypes stable by AMMI bi-plot, whereas two genotypes had hight yield and one genotype was low yield.

The other methods for estimating stability in low variance of environment using Si^2 and CV [11]. Dynamic stability use Coefficient regression (b_i), stability variance (σ_i^2), and *eco-valence* to estimate the stability [12 and 13] One peanut genotype was stable for seed yield but below average yields using regression coefficients of Eberhart-Russell [14].

This AMMI model could give a stable genotype but the yield might be considered to get high yield. The average yield and yield component could be seen in Table 3. The stable genotypes Prima and Rabani were medium yield. The highest yield was UNPAD CR 8, but not stable in three locations (Garut, Tasikmalaya and Ciamis).

Table 1. Analysis of variance for the AMMI model

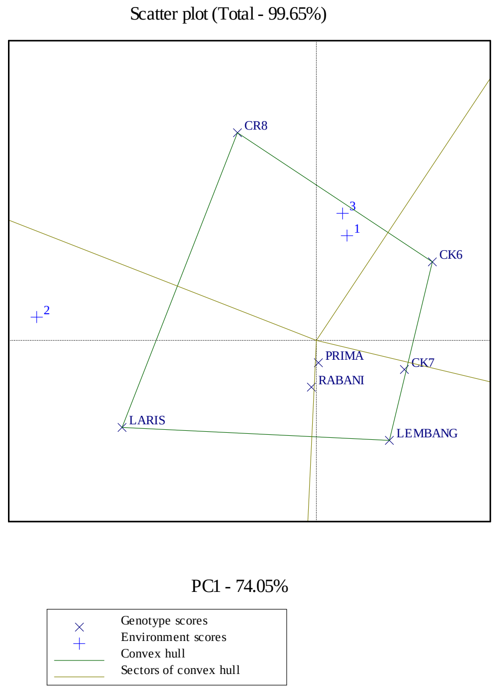
No	Traits	Mean Square		
		G x L	AMMI 1	AMMI 2
1	Yield (t ha^{-1})	4.90	8.31	0.11*
2	Fruit weight per plant (g)	38860.90	63031.10	5022.61*
3	Fruit number per plant	5221.63	8759.97	267.96*
4	Fruit length (cm)	1.14	1.32	0.88*
5	Fruit diameter (cm)	0.37	0.48	0.20*
6	Weight of one fruit (g)	0.46	0.57	0.31*

Table 2. Stable and adaptive genotypes using the AMMI model

No	Traits	Genotype			
		stable	adaptive		
			Garut	Tasik	Ciamis
1	Yield (t ha^{-1})	Prima Rabani			
2	Fruit weight per plant (g)		UNPAD CK 6 UNPAD CK 7		
3	Fruit number per plant				
4	Fruit length (cm)				
5	Weight of one fruit (g)		UNPAD CK 6 Laris		
6	Fruit diameter (cm)	UNPAD CK 6			UNPAD CR 8

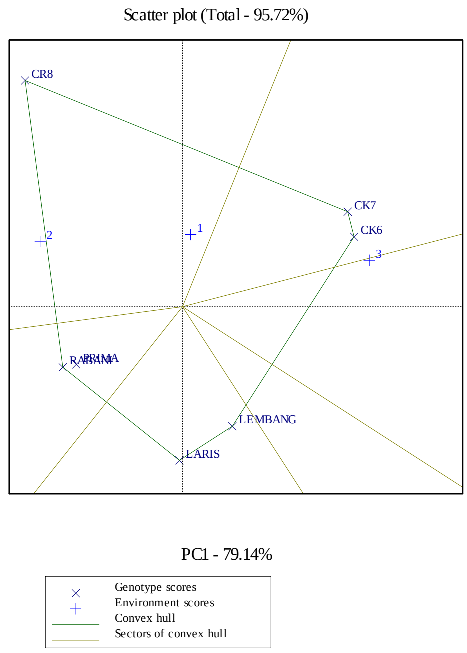
Table 3. Yield of seven genotypes

No	Genotypes	Yield (t ha^{-1})			
		Garut	Tasik	Ciamis	Average
1	UNPAD CK6	8.65	7.38	4.68	6.90 bc
2	UNPAD CK7	7.54	5.51	5.24	6.10 bc
3	LARIS	5.64	4.24	13.74	7.87 ab
4	LEMBANG	6.34	4.85	5.52	5.57 c
5	UNPAD CR8	10.23	7.80	10.95	9.66 a
6	PRIMA	7.20	5.51	7.89	6.87 bc
7	RABANI	6.71	5.37	8.05	6.71 bc



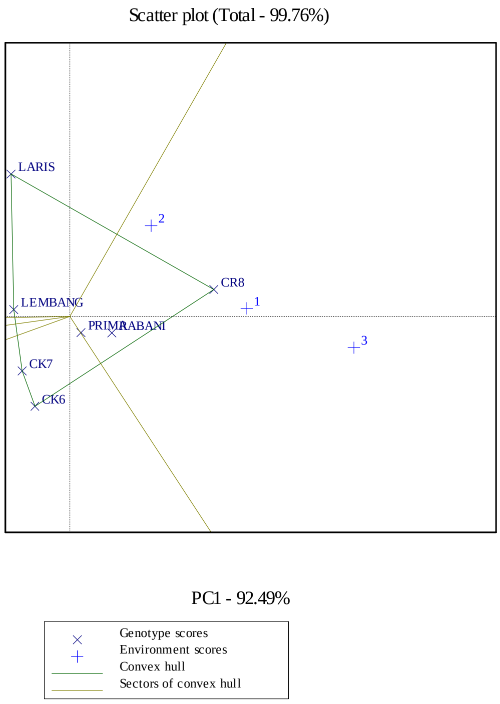
Note : 1= Ciamis, 2 = Garut, and 3 = Garut

Fig. 1. AMMI biplot for Yield (t ha^{-1})



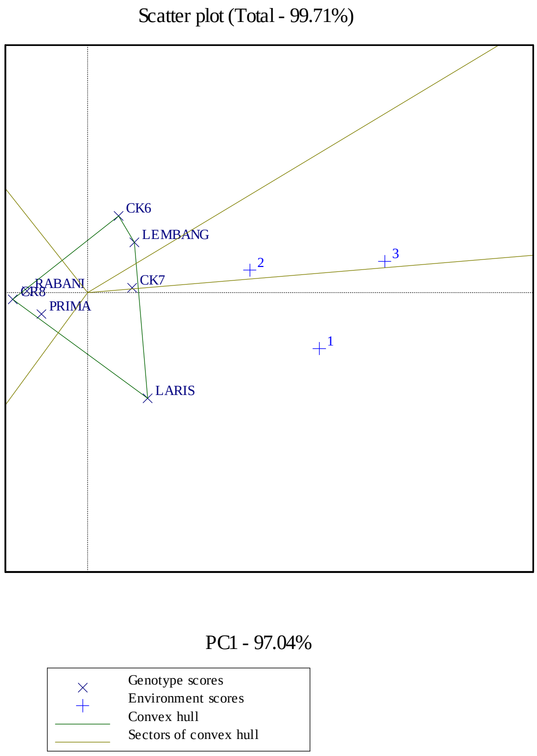
Note : 1= Ciamis, 2 = Garut, and 3 = Garut

Fig. 2. AMMI biplot for fruit weight per plant (g)



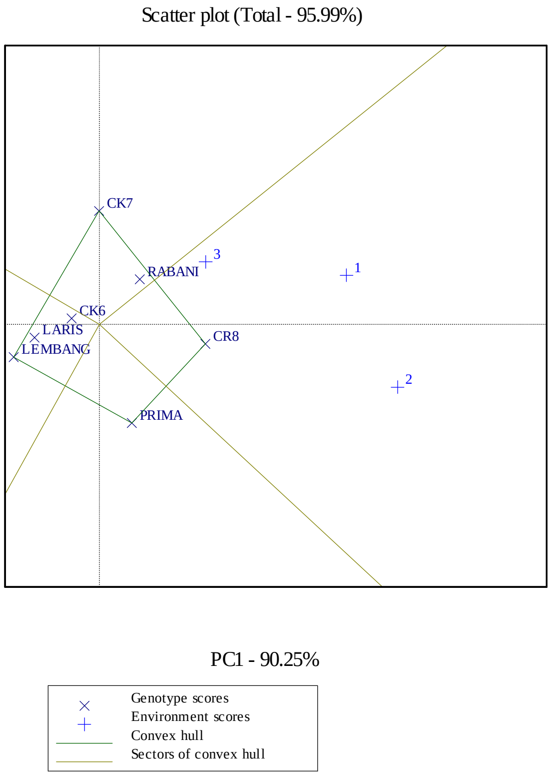
Note : 1= Ciamis, 2 = Garut, and 3 = Garut

Fig. 3 AMMI biplot for fruit number per plant



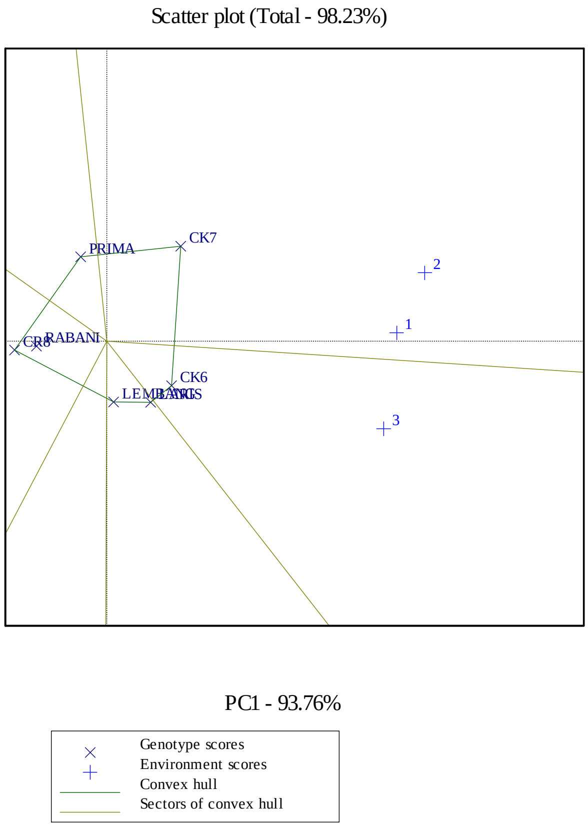
Note : 1= Ciamis, 2 = Garut, and 3 = Garut

Fig. 4. AMMI biplot for fruit length (cm)



Note : 1= Ciamis, 2 = Garut, and 3 = Garut

Fig. 5. AMMI biplot for fruit diameter (cm)



Note : 1= Ciamis, 2 = Garut, and 3 = Garut

Fig. 6. AMMI biplot for weight of one fruit (g)

IV. CONCLUSION

The genotipes that stable in three locations are Prima and Rabani for yield and UNPAD CK 6 for fruit diameter. The genotype that adaptive in Garut was UNPAD CK 6 for fruit weight per plant and fruit diameter, UNPAD CK 7 for fruit weight per plant and Laris for fruit diameter. The adaptive genotypes in Ciamis was UNPAD CR 8 for fruit diameter. UNPAD CR 8 is the best yield than the others.

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REFERENCES

[1] National Development Planning Agency. Preliminary Study of the National Medium Term Development Plan (RPJMN) Field of Food and Agriculture 2015-2019. Directorate of Food and Agriculture. Bappenas. Jakarta . 2014.
[2] Central Bureau of Statistics.. Red pepper production, Chilli pepper, and Shallot in 2014. https://www.bps.go.id. 2016.
[3] Database of registered varieties of horticulture. Horticulture Vareiety. https://www.db.varietas hortikultura. 2017.
[4] Fehr, W.R. Principles of Cultivar Development. Vol. 1: Theory and Technique. MacMillan Publishing Co. New York. 1987.
[5] Gauch, H.G., and R.W. Zobel. AMMI analysis of yield trials. In Kang, M.S., and Gauch, H.G. (Eds.). Genotypes by Environmental Interaction. CRC Press Inc., Boca Raton, FL. Pp. 85-122. 1996.
[6] Yan, W., L.A. Hunt, Q. Sheng, and Z. Szlavnics. Cultivar evaluation and mega-environtment investigation based on the GGE biplot. Crop Sci. 40(3), pp. 597-605. 2000.
[7] Misra, R.C., S. Das, and M.C. Patnaik. AMMI model analysis of stabilyti and adaptability of late duration finger millet (*Eleusine coracana*) genotypes. Wowld Applied Sciences Journal 6(12): 1650-1654. 2009.
[8] Ruswandi, D., J. Supriatna, N. Rostini, and E. Suryadi. Assessment of sweetcorn hybrids under sweetcorn/chilli pepper intercropping in West Java, Indonesia. J.Agron., 15(3, pp.:94-103. 2016.
[9] Rad, M.R.N., M. Abdul Kadir, M.Y. Rafii, Hawa Z.E. Jaafar, M.R.Naghavi5\ and Farzaneh Ahmadi. Genotype × environment interaction by AMMI and GGE biplot analysis in three consecutive generations of wheat (*Triticum aestivum*) under normal and drought stress conditions. Australian J. of Crop Sci. Vol. 7(7), pp. 956-961. 2013.
[10] Zali, H. O. Sofalian., T. Hasanloo, and A. Asghari. AMMI and GGE biplot of yield stability and drought tolerance in Brassica napus L. Agricultural communications 4(1), pp. 1-8. 2016.
[11] Francis, T.R. and L.W. Kannenberg. Yield Stability Studies in Short-Season Maize. I. A Descriptive Method for Grouping Genotypes. Can. J. Plant Sci. 58: 1029-1034. 1978.
[12] Finlay, K.W. and G.N. Wilkinson. The Analysis of Adaptation in a Plant Breeding Programme. Aust. J. Agric. Res. 14: 742-754. 1963.
[13] Shukla, G.K. Some Statistical Aspects of Partitioning Genotype-Environmental Components of Variability. Heredity. 29(2): 237-245. 1972.
[14] Mekontchou, T., M. Ngueguim, and M. Fobasso. Stability analysis for yield and yield component of selected peanut breeding lines (*Arachy shipogaea* L.) in the North Province of Cameron. Tropicultura 24(2): 90-94. 2006.

F.9

STUDY OF CONSUMER BEHAVIOR : TREND PURCHASE OF COFFEE AND THEIR OPINION TO VARIETY OF PRODUCTS AND POTENTIAL OF THE COFFEE SHOP

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ABSTRACT

The high consumption level of coffee in Indonesia create opportunities for many coffee shop business operators to expand their business. The objectives of this paper is to see how behavior and subjective norm of consumer against coffee purchases they do. The study took place at Armor Coffee Garden, Bandung. Data analysis method used is theory of reasoned action from Fishbein which is comprised of consumer attitudes and subjective norms with a sample of 95 consumer. Attributes are used in this research is the taste, menu variety, product design, complementary services, pricing, and promotion. Subjective norm variables used is family, friends, the media, and the seller. The results showed that the average consumers who come is collage student. The most dominant reason they come to the coffee shop is for a cozy atmosphere (44%), then the desire to simply try (22%), because of it's unique (10%) and a variety of other reasons (22%). Overall, consumer attitudes toward purchase coffee products showed good results. Behavior attributes that is considered as the most good attribute is product design and the most unfavorable attributes is promotion. Based on analysis of the average score, subjective norm consumers of Armor Coffee Garden shows that the most dominant role in making consumer decisions are friends and the media, while the lowest score is score of family. The potential possessed among others is diverse products, complete facilities, as well as a reliable barista. Obstacles that have in running a business is Armor Coffee Tahura which led to the visitors divided.

Keywords : Coffee shop, consumer behavior, subjective norms, product purchases.

I. INTRODUCTION

Along with its development, Indonesian people drink coffee with certain purposes, such as keeping their body fit while driving at night or having a night watch. Drinking coffee is usually only for groups of adults and dominated by men. The increase in the consumption of coffee every year has made a new trend for the people. As seen in the data above, there is an increase in the level of community consumption of coffee every year. Most people have considered that coffee is not only a complementary drink but also as a staple daily beverage especially for people who are addicted to this type of drink.

Consumption of coffee in Indonesia has increased quite rapidly from previous years. This is predicted to increase as the middle class income and lifestyle changes increase. Data on the consumption of arabica, robusta, and others in Indonesia on population growth and Indonesian coffee demand as follow on Fig. 1.

Nowadays, coffee shop business is a promising business. The type of the cafes is various, from an exclusive coffee shop to a standard coffee shop. The stores have various specifications in selling their products. Recently, coffee shop business appears to be a business that has its own concept of place, selling (marketing), packaging, menu, and service. The atmosphere in each coffeehouse with its distinctive characteristic becomes one of the attractions for consumers. The development of coffee shop business in Indonesia has been continously growing since the entry of the coffee shops from Seattle, United States, Starbucks. The emergence of successful and marketable cafe in Indonesia made a lot of new business actors inspired and began to pursue cafe business or coffee shop. Many small and medium enterprises concept stores, coffee shops, cafes and large class businesses such as Starbucks have been growing in various major cities in Indonesia. The data of the growth of coffee shop in Indonesia is as follow on Fig. 2.

Fig. 2. The Indonesian people consumption of coffee
Source : Asosiasi Eksportir Kopi Indonesia (AEKI) from 2014-2016

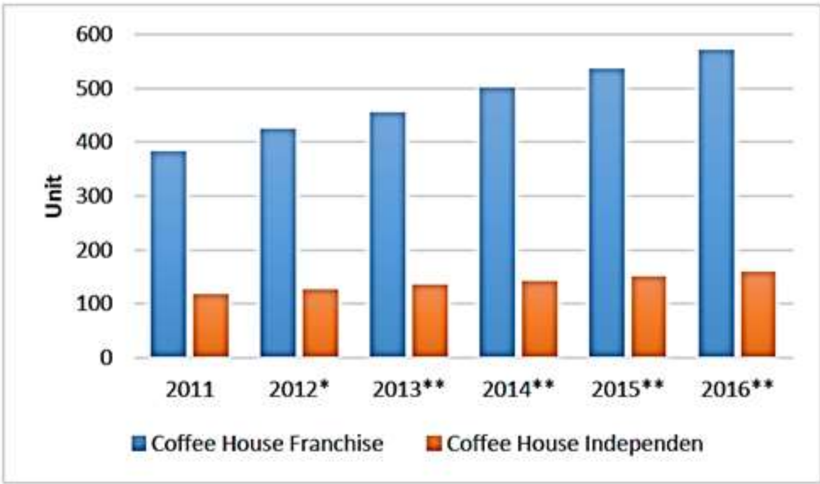

Fig. 3 The Growth of *coffee shop* in Indonesia
Source : Euromonitor (2012), *Angka sementara **Proyeksi

Based on Fig. 2, the growth of independent/local coffee shop is as competitive as coffee shop franchise such as Starbucks, coffee bean, coffee doloe, coffee toffee, and bengawan solo. The growth trend of coffee shop in Indonesia shows an increase every year. The number of coffee shops in Indonesia is projected to increase from 2011 to 2016 by 189 units for coffee shop franchise and 40 units for independent/ local coffee shop.

One of the coffee shop in Bandung City is Armor Kopi. It is one of the coffee shops located in Bandung City. The proliferation of coffee shops located in Bandung creates competition to the coffee shop industry in Bandung. The emergence of new competitors led to the rise and fall of the sales in the Armor Kopi itself.

The high level of coffee consumption in Indonesia creates opportunity for many business entrepreneurs to expand their business. One of the cities inhabited by coffee shops is Bandung City. The emergence of competitors who increasingly harmonize the desires of consumers with the products they sell cause more and more variations of products presented in their own way. Therefore, consumers are selective as they have many options to purchase coffee. Based on the description above, the research objectives are: 1) identify the consumer characteristics of Coffee Armor; 2) analyze the attitudes and subjective norms of the consumers in buying coffee products in Armor Kopi; and 3) identify the potential and constraints that Armor Kopi has in running its business.

II. MATERIALS AND METHODS

E. Research Objects and Place

The object of the research is attitudes and subjective norms of consumers towards the purchase of products in Armor Kopi. Consumers in this study were consumers who buy coffee products in Armor Kopi. The place of research is located at Jl. Legok Randu, Dago, Bandung. The reason for choosing the place is because Armor Kopi is located in the cafe area in Bandung. Another reason is Armor Kopi specializes in manual brewing and has a variety of coffee types. The location is also a tourism area that has a quite interesting atmosphere to visit.

F. Definition of the research variable

The research variables consist of :

1. Consumer Demographics, consisting of: Age, Sex, Education, Income and Domicile
2. Attitude is a good or bad judgment, emotional feelings and a tendency to do something, that endure for a certain time against an object. Based on the theory of Ajzen & Fishbein on attitude towards object the concept of consumer attitudes is measured through Product Attributes consisting of several sub dimensions: Taste, menu variation, Style and product design, Complementary Services, Price and Promotion
3. Subjective norm is defined as acceptance of social pressure to display a specific behavior (Kreitner & Kinicki, 2001). This concept is measured through a group of preferences by whom and to what extent they obey others, including: Family, Friends, Media and Sellers

G. Research Sample

The population of this study was Armor Kopi visitors in a week amounting to an average of 1750 people. The respondents or samples selected were consumers who visited and bought coffee at Armor Kopi. Sample selection method used in this research was probability sampling with systematic sampling technique which obtained the number of respondents as much as 95 people.

Data collection was conducted within a week and was proportional. Selection of respondents was conducted mostly on Saturday and Sunday because at that time there were more visitors than other days. Selection of respondents followed the number of multiples of 10 on Monday to Friday and multiples of 5 on Saturdays and Sundays. So the selection of respondents on Monday and Friday were visitors number- 1, 11, 21, 31, ..., 91 to number 10 people per day. Selection of respondents on Saturdays and Sundays were visitor number - 1, 6, 11, 16, 21, 26, ..., 106 to 22 people per day. All selection of the initial number of visitors was conducted randomly.

H. Data Analysis

1. Descriptive Analysis

Descriptive analysis in this research is used to describe the profile of respondents who visited Armor Kopi by performing tabulation data of respondents in general. Respondent profile data was described and calculated manually with the help of calculator / computer so that it could be easily understood. Descriptive analysis was also used to describe the potential and obstacles possessed by Armor Kopi.

2. Theory of Reasoned Action

This measurement step was carried out in measuring consumer attitudes. Action theories based on the integration of comprehensive components of attitudes into structures intended to produce better explanations as well as better forecasts of behavior (Schiffman and Kanuk, 2000). The model of reasoned action theory is illustrated by the formula $B \sim BI = W1 (Ab) + W2 (SN)$ (Kristianto, 2011).

To see the consumer attitudes and subjective consumer norms towards Coffee Armor products, descriptive statistical methods based on the Fishbein multiattribute model were used. The data obtained and collected were then analyzed based on the applied model in order to find out the attitudes and subjective norms of the consumers on Coffee Armor products.

In this research, the calculation scale used was Likert Scale. Likert scale was used to measure attitudes, opinions and perceptions of a person or group of people about social phenomena. In a research, this social phenomenon has been determined specifically by the researchers, hereinafter are referred to as research variables (Sugiyono, 2011).

By using the Likert Scale, the variables to be measured were translated into sub variables and then translated into measurable indicators. Finally, these measurable indicators were used as starting points to create an instrument item in the form of questions or statements that respondents need to answer (Riduwan and Kuncoro, 2008).

The answers to each questionnaire/instrument item using the Likert Scale have a gradation from extremely positive to extremely negative which can be the words of a statement or question. In this study the measurements were classified into four categories:

Table 1. Scoring Varibles with Likert Scale

Score	Qualitative Response	Indicator
1	Very Disagree	Extremely Negative
2	Disagree	Negative
3	Agree	Positive
4	Very Agree	Extremely Positive

Product attributes and preference groups were analyzed and measured using a four-digit likert scale. Product attributes were then analyzed according to the level of trust and evaluation, in order to find out the attribute trends that cause purchasing behavior according to respondents. Preference groups were also analyzed according to their normative beliefs and motivations, in order to find out the tendency of preference groups as the role models for respondents in buying products. Consumer attitudes toward purchases in Armor Kopi were obtained based on the result of the percentage of attitudes toward attributes based on the priority given by the respondents. While the subjective norm values obtained based on the percentage of who and how far the respondents buy products in Armor Kopi. The next step, the results of the attitude scores on behavior and subjective consumer norms were interpreted based on the range of scores. The formula used was as follows:

$$Skala\ Interval = \frac{(n-m)}{b} \quad (1)$$

Where :
m : highest data that may be occured
n : lowest data that may be occured
b : total of score scale

The result of total score of attitude and subjective norm were calculated based on the attitude and subjective norm formula as above. Furthermore, the average of total attitudes and subjective norms were calculated. Calculation was done partially (each) between Ab attitude and subjective norm SN, then the results of calculation were explained descriptively.

III. RESULTS AND DISCUSSION

A. Consumers Characteristics

There were more male consumers than women. This is in accordance with the research conducted by Riswan A (2013) which found that drinking coffee was usually dominated by men. Then, consumers visiting Armor Kopi Garden was dominated by consumers aged between 20-30 years. According to the MOH RI (2009), age 17-25 years is classified as late adolescence and age 26-35 years is classified as early adulthood. According to Adi (2014), the trend of gathering in a coffee shops, especially among Asian youth, are undoubtedly and prevalent throughout the region. Consumers from Kedai Armor Kopi Garden with the age of 20-30 years can still be classified as young people who follow the trend to gather in the coffee shop.

Table 2. Characteristic of Coffe consuments in Armor Kopi Garden

Characteristic	Variabel Response		F	%
Sex	Male		54	57
	Female		41	43
		Total	95	100
Age	< 20 years old		12	13
	20 - 30 years old		82	86
	> 30 years old		1	1
		Total	95	100
Job	Students/college students		64	67
	Government Employees		1	1
	Private Employees		11	12
	Enterpreneurs		8	8
	Unemployed		11	12
		Total	95	100
Education	High School		56	59
	Academy		4	4
	Bachelor		34	36
	Post Graduate		1	1
		Total	95	100
Pmonthly Revenue	< Rp 1.000.000		21	22
	between Rp 1.000.001 to Rp 3.000.000		60	63
	> Rp 3.000.001		14	15
		Total	95	100
Domicile	Dalam Kota (Bandung)		55	58
	Luar Kota		40	42
		Total	95	100

Consumers visiting were mostly high school/college students. This is because the location of Armor Kopi Garden's shop is close to the location of the restaurant, tour, and not too far from the university environment such as Padjadjaran University at Dipatiukur and Institut Teknologi Bandung, which location can be reached in about 10 minutes. Therefore, the majority of consumers are high school/college students.

The majority of respondents in this study were consumers with middle class level and upper class level with income ranging from Rp 1,000,000 - Rp 2,000,000 and income more than Rp 2,000,000 (Saraswati, 2009). The revenue of most respondents above is because the status of the majority of the respondents are high school/college students who usually earn about Rp 1,000,000, - up to Rp 3,000,000.

Furthermore, the domicile of consumers visiting to Armor Kopi Garden were mostly from within the city. This shows that Armor Kopi Garden was visited by many consumers in Bandung itself. Consumers from outside the city visiting also indicates Armor Kopi Garden is able to attract consumers from within and outside Bandung City. Consumers in the city (Bandung) is more familiar with the location of Armor Kopi Garden itself compared with respondents from out of town because the location is slightly remote and not visible from the main road.

B. Consumers Attitude Toward Purchases in Armor Kopi Garden

Based on Table 3, consumer attitudes toward their purchases at Armor Kopi Garden as a whole were not good. Although the average level of consumer confidence in the attributes of well-sold coffee products and the evaluation of attributes after they make a purchase was satisfying, the attitude toward their buying behavior was not good.

The smallest attitude scores was attitudes toward their buying behavior based on promotional attributes that showed bad results. This shows that purchases made by consumers are less influenced by promotions made by Armor Kopi Garden. In the assessment of beliefs made by consumers to the promotion showed that the results were also not good. According to them, purchases made were not based on the promotions made. Based on the score figures, they were unsure and believe the promotion made by Armor Kopi Garden was interesting.

Table 3. The level of the consumers's trust toward the Armor Kopi Garden Coffee product

No.	Atribute	Score
1	Taste	Good
2	Menu Variation	Good
3	Product design and style	Good
4	*Consulting*	Good
5	Price	Good
6	Promotion	Not Good
	Average	**Good**

The highest attitude scores was in the style and design of the product indicating that the purchases made have the best attitude towards the style and design of the coffee products served by Armor Kopi Garden. This shows that the best reason of consumers to buy products in Armor Kopi Garden was because of the style and design of the coffee products. How to manufacture and serve coffee in Armor Kopi Garden is what consumers find interesting so they want to buy coffee there. The following is a cross tabulation between consumer characteristics and consumer attitudes in Armor Kopi Garden.

The majority of consumers reasoned that convenient location was the reason they visit. Armor Kopi Garden does have a comfortable atmosphere because the place is often used as a place to gather or hang out by the customers. The location is far from the city crowd, cool and also have additional facilities such as wifi and other making Amor Coffee Garden to be convenient to visit.

Fig. 4. The visit reason to Armor Kopi Garden
Source : Data Primer, diolah (2017)

C. Potency and Cons straint in Armor Kopi Garden

Kedai Armor Kopi Garden is one of the manual coffee brewing concept in Bandung. The provided facilities and convenient location make this shop to be crowded by visitors. The name "Armor" is taken from the abbreviation of "Arabica Multi Origin", this is one of the hallmarks of Armor Kopi shops that sell various types of coffee from all over the archipelago.

There are at least 140 types of coffee beans sold there, so consumers can experience a variety of different types of coffee beans. All types of coffee beans sold are all processed from Armor Kopi itself from green beans to roast or roast beans made by the Armor Kopi, namely Mr. Willy as kitchen manager and also beans coffee there.

In addition to the various types of coffee, the diversity of the tools owned by Armor Kopi itself is also a hallmark of this coffee shop. The existing manual brewing tools create the uniqueness of each flavor of the coffee served. Consumers can choose what tool to be used by the barista to make their coffee. Consumers can also buy direct roasted beans or green beans that are there, either in the form of beans or grinded beans or coffee that has been shaped into powder.

Consumers are not only spoiled by serving coffee alone there but the existing atmosphere such as wifi, tv, music, and natural atmosphere support the consumers to do gathering activities, meetings and others comfortably. Armor Garden coffee shop located in Legok Randu has a more private ambience and not too crowded with the hustle and bustle of other visitors as it only stands alone without any shops or other shops around it. Kedai Armor Kopi Garden is also often used as a gathering place by some coffee community in Bandung for sharing about coffee.

Human resources or workers employed in Armor Kopi Garden amounted to 8 people, including 4 baristas, 2 waiters, and 2 dishers who sometimes double as cashier. All employees who become baristas first plays as a past service and pasther trained to become a barista. The division of labor time is divided into two, namely morning shift until afternoon and afternoon shift until night.

Competitor owned by Armor Kopi Garden is only another Armor Kopi stall located in Tahura. The location is fairly new and fairly close to make consumers divided and more familiar with Armor Kopi. In summary the potential and constraints of Armor Kopi Garden are shown in the table below.

IV. CONCLUSION

The characteristics of consumers visiting Armor Kopi Garden are mostly male from female, aged between 21 and 30 years old, having high school/college students status, earning between Rp1,000,000.00 to Rp 3,000,000, -, and coming from Bandung City.

Consumer attitudes at Armor Kopi Garden as a whole showed no good results. Attributes score shows that promotions and complementary services have poor score, but consumer attitudes toward taste, menu variations, product styles and designs, and prices show good results scores.

Consumer subjective norms in Armor Kopi Garden as a whole show no good results. Consumer subjective norms scores per group of preferences show families, media, and sellers with poor results. But in the group of friends preferences, it shows good results so that families, media, and sellers do not affect the consumer's purchase in Armor Kopi Garden but the friend of the consumer has more influence to the purchase at Armor Kopi Garden.

The potentials of Armor Kopi Garden consist of complete and comfortable facilities, convenient and more private locations, complete and diverse set of tools, trained human resources, and diverse products which support them in running the business. But there are obstacles from competitors ,Armor Kopi Tahura, which although still in one ownership but it makes consumers visiting divided and prefer Armor Kopi Tahura than Armor Kopi Garden as both location are near one and each others.

REFERENCES

[1] Asosiasi Eksportir Kopi Indonesia. 2010. Sejarah Kopi di Indonesia. Diakses dari www.aeki-aice.org. (diakses pada Maret 2016)

[2] Atamawinata. 2007. Asosiasi Eksportir Kopi Indonesia. Jakarta. Diakses pada www.aeki-aice.org. (diakses pada Febuari 2016)

[3] Damanik, Anita Magdalena. 2008. Analisis Sikap dan Preferensi Konsumen terhadap Coffee Shop De Koffie – Pot Bogor. Skirpsi. Jurusan Ilmu-ilmu Sosial Ekonomi Pertanian. Fakultas Pertanian. Institut Pertanian Bogor. Bogor

[4] Depkes RI. 2009. Sistem Kesehatan Nasional. Jakarta

[5] Dinas Informasi Kepariwisataan dan Kebudayaan Kota Bogor. 2005. Buku Data Pariwisata Kota Bogor. Bogor : Dinas Informasi Kepariwisataan dan Kebudayaan Kota Bogor.

[6] Direktorat Jendral Perkebunan. 2013. Pedoman Teknis Pengembangan Tanaman Kopi. Kementrian Pertanian RI.

[7] Eagly, A. H. & Chaiken, S. 1993. The Psychology of Attitudes. Fort Worth, TX: Harcourt Brace Jovanovitch.

[8] Engel, J.F., R.D. Blackwell dan P.W. Miniard. 1995. Perilaku Konsumen. Edisi Keenam. Jilid 1 & 2. Binarupa Aksara. Jakarta.

[9] Euromonitor. 2015. Cafe and Bars in Indonesia. Diakses dari www.euromonitor.com. (diakses pada April 2016)

[10] Fishbein dan Ajzen, 1975. Belief, Attitude, Intentions and Behavior: an introduction to theory and research. California: Addison-Wesley Publishing Company, Inc.

[11] Husein Umar, 2005. Metode Penelitian. Jakarta : Salemba Empat

[12] Indriani. 2006. Buku Favorit ala Cafe. Jakarta. Gramedia Pustaka Utama.

[13] Kotler, Philip dan Gary Armstrong. 2008. Prinsip-prinsip Pemasaran (Jilid 1, Edisi 12). Jakarta: Erlangga
[14] Malholtra. 2005. Riset Penelitian. Jakarta: Gramedia Pustaka Utama
[15] Mariana. A. 2004. Analisis Proses Keputusan Pembelian Konsumen ke Kafe Victoria, Cilandak Town Square. Skripsi. Jurusan Ilmu-ilmu Sosial Ekonomi Pertanian. Fakultas Pertanian. Institut Pertanian Bogor. Bogor.
[16] Pradipta, Sony. 2014. Ulasan Bisnis Cafe di Indonesia. Diakses dari www.bincangkopi.com. (diakses pada Maret 2016)
[17] Prof. Dr. Suigiyono. 2011. (Metode Penelitian Kuantitatif, Kualitatif, dan R&D): Alfabeta. Bandung
[18] Riduwan dan Kuncoro, 2008. Cara Menggunakan dan Memakai Analisa Jalur. Alfabeta. Bandung.
[19] Riswan, Oris. 2013. 2.373 kafe dan restoran di Bandung 'bodong'. Diakses dari daerah.sindonews.com. (diakses pada Maret 2016)
[20] Santoso, Singgih dan Fandy Tjiptono, 2002, Riset Pemasaran: Konsep dan Aplikasi dengan SPSS, Penerbit PT Gramedia, Jakarta.
[21] Saraswati, 2009, Pemberdayaan Kesehatan Anak dan Keluarga, Citra Aditya Bakti, Bandung, h.44
[22] Satria. Adi, 2014, Warung Kopi : Gaya Hidup atau?, Diakses dari www.kompasiana.com (diakses pada Agustus 2016)
[23] Schiffman, Leon G., & Leslie Lazar Kanuk. 2000.Consumer Behaviour 7th Edition., Prentice Hall: International
[24] Soetarno, R. 1994. Psikologi Sosial.Yogyakarta : Kanisius
[25] Sutisna. 2001. Perilaku Konsumen & Komunikasi Pemasaran. PT Remaja Rosdakarya. Bandung.
[26] Ukers. William H. 2012. All About Coffee. USA. Adams Media.
[27] Umar, Husein. 2005. Riset Pemasaran & Perilaku Konsumen. Jakarta : PT SUN
[28] Widodo, Adhityo Jatisukmono. 2014. Analisis Preferensi Pengunjung Kedai Kopi Terhadap Menu Kedai Kopi di Kota Semarang. Skripsi. Semarang. Universitas Diponegoro.
[29] Wijaya, A. 2007. Analisis Preferensi Konsumen Terhadap Pengembangan Produk Abon Ikan Kelompok Usaha Bersama (KUB) Hurip Mandiri (Kasus Konsumen Abon Ikan di Kabupaten Sukabumi). Skripsi. Program Sarjana Ekstensi Manajemen Agribisnis. Fakultas Pertanian. Institut Pertanian Bogor. Bogor. Sumarwan, Ujang. 2003. Perilaku Konsumen, Teori dan Penerapannya Dalam Pemasaran. Ghalia Indonesia, Jakarta.

F.10

EFFECT OF PARITY ON MILK YIELD AND LACTATION LENGTH OF ANGLO NUBIAN GOATS

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ABSTRACT

Anglo Nubian was imported in order to increase goat milk production through crossbreeding to local goats. The objective of this preliminary study was to investigate the effect of parity on milk yield and lactation length of Anglo Nubian goats. The study was conducted in Dairy Goat Unit, Indonesian Research Institute for Animal Production. The data thirty parities of Anglo Nubian goats were used. The result revealed that average total lactation milk yield was 244,95 liter/doe. The overall mean of lactation length was 210,03 days. Parity number influenced milk yield and lactation length significantly (P<0,001). Lactation length and milk production increased gradually after first parity (P<0,05). Lactation milk yield is lowest in the first parity and highest in the fourth parity. The first parity has the lowest lactation length, and the third and fourth parity was the highest.

Keywords: parity, lactation length, milk yield, Anglo Nubian.

I. INTRODUCTION

In the world, the major source of milk is mainly cattle; however other source of milk are buffaloes and goats [1]. Goats production yield were 60% as milk, 35% as meat and 5% as skin [2]. Goats is much more efficient milk producer than other species of animals, because they have higher feed conversion efficiency [3].

Goat milk has been acceptable and favorable for consumption like cow milk [4], including for infant [5]. Goat milk has little fat globules that makes easier digestion and absorption [6]. It has been well-known that goat milk has several medicinal values as therapeutic virtues for dietetic and ulcers problems or people allergic to cow milk and inflammatory diseases [7]. Therefore, most people are willing to pay higher price for goat milk in many country [8;9].

Milk production of dairy goats are affected by breed, parity order, age of doe, lactation length, stage of lactation, litter size, season-year of birth, feeding and management system [10]. Therefore, those effects considered as sources of variation especially in analyzing genetic evaluation [11].

In Indonesian, goat milk yield is still low due to traditional management and no breeding program established, with production range of 0,5-1,25 liter/doe/day [9]. Etawah Grade (PE) is one of a local goat breed mostly used to produce milk functioned as dairy animal. Improving genetic of PE goats is through crossbreeding to exotic dairy goats, such as Saanen, Alpine, Anglo Nubian, and Toggenburg. Research Institute for Animal Production (BALITNAK) has started introducing Anglo Nubian goats to creating a composite breed by crossing to PE. The Anglo Nubian has well-known due to their tropical adaptability, high fat content and growth rate, although their daily milk yield 4-5 kg/day or 1040 -1250 kg/lactation [12], were lower than Saanen.

There has been a few information of production and biological characteristics of Anglo Nubian in Indonesia. Therefore, a study has been conducted to investigate effects of parity on milk yield and lactation length of Anglo Nubian goats. This information is very useful for developing Anglo Nubian as dairy goat breed in Indonesia.

II. MATERIALS AND METHODS

This study were conducted in Research Institute for Animal Production (BALITNAK), Ciawi-Bogor. There were 26 Anglo Nubian does used in this study. They were in different parity order consist of 10 does for first parity, 7 does for second parity, 5 does for third parity and 4 for fourth parity.

All animals were housed in individual pen with same management system. They were fed 4-5 kg/day/head of king grass and 1 kg of legumes. Drinking water was available *ad libitum*. Concentrate containing crude protein (CP) 16% and total digestibility nutrient TDN 70% was given about 0,7 kg/day/head.

Does were bred naturally after three months of lactation or showed second estrous in cycle. Does were milked once a day in the morning and the data of milk production were recorded. Dry period started after does produced 100 ml of milk or 4 month of pregnancy. Lactation milk yield was defined as the total milk production per lactation. Milk yield was daily milk production per doe. Lactation length was counted from the first day of doe milked until the last day milked or before does were dried (stopped milking).

Data were analyzed using linear model [13]. P-Diff was used to investigate significances of milk yield and lactation length among parities. Therefore, parity order was the source of variation for milk yield, lactation milk yield and lactation length.

III. RESULTS AND DISCUSSION

The analysis of variance of the lactation milk yield and lactation length of Anglo Nubian does showed in Table 1. The significant effect of the parity order on lactation milk yield (P<0,001). These results agree with those of other researchers who stated that the parity order affected lactation milk yield and lactation length in dairy goats raised in some different countries [14;15]. Other study [16] found that significant effect of parity order on milk yield of Anglo Nubian in Equador. In Indonesia, Peranakan Etawah (Etawah Grade) showed that parity order had weak significant effect on milk yield [17].

The mean of lactation milk yield obtained in this study (244,95 liter) is lower than that obtained by [14] in Nubian Sudan (340,78 kg); (383.05 kg) in Saanen Turkey. On the other hand it is higher than the estimate of [16]. The differences were caused by different breed, country and year of studies.

Table 1. Analysis of variance of the lactation milk yield and lactation length

	Lactation milk yield			Lactation length		
	DF	F	significance	DF	F	significance
Parity	3	25,56	***	3	41,97	***
Error	22			22		

***statistically highly significant (P<0,001)

The least square means for the lactation milk yield and lactation length were demonstrated in Table 2. The overall mean of lactation milk yield was 244,95 liter. Lactation yield is lowest (P<0,05)in the first parity (160,60 liter), and highest (P<0,05) in the fourth parity (396,03 liter). While second and third parity were also different (P<0,05). Milk production is lower for primiparous than for multiparous dairy goats; highest production is for parity 3 or 4 (Ishag et al., 2012) in Sudan Saanen. Similarly, it had been found increasing partial daily milk yield as parity increased from 1 to 3 for Chechnya indigenous goats [15].

Table 2. Least square means and standard error for lactation milk yield and lactation length

	n	Lactation milk yield (litre)	n	Lactation length (days)
Parity	26	244,95 ± 18,54	26	210,03 ± 5,40
First	10	160,60^{a} ± 10,12	10	184,50^{a} ± 5,99
Second	7	234,78^{b} ± 18,59	7	209,85^{b} ± 4,16
Third	5	306,84^{c} ± 25,71	5	231,60^{c} ± 5,19
Fourth	4	396,03^{d} ± 21,68	4	247,25^{c} ± 8,04

^{abcd}within the same column, values with different letters are significantly different at P<0,05)

The effect of parity order on the milk yield is demonstrated in Fig. 1. The figure shows that effect of parity order on milk yield is an almost steady growing trend from first to fourth parity. The lowest milk yield was obtained during the first parity, with 0,87 liter/doe/day and the highest was in the fourth parity of 1,61 liter/doe/day. There was a similar behavior in the Anglo-Nubian breeds raised in Mexico [19], with lower productions during the first parity, although the result of this study was lower. Study by [20] showed there were mean productions of 0.71, 0.76 and 0.92 kg/animal/d for the first, second and third lactations, respectively, of Anglo-Nubian goats in Argentina. Moreover, it had been showed milk yield of 0,65, 0,80, 0,86 kg/doe/day for the first, second and third parity, respectively of Anglo-Nubian does in Equador raised in grazing system [16]. This result was higher due to different management system.

Almost all researchers stated that the first parity reached a productive average significantly lower than the following parities [16]. The multiparous does had higher milk production than the primiparous ones [11] due to the use of the body reserves in completing the morphological development and pregnancy of primiparous does. The highest milk production was reached during the third lactation, which remained constant until the fifth [19].

First parity goats had the lowest milk yield, while third parity goats had the highest milk yield reviewed by [21] The authors also reported that milk yield was gradually increasing until the fourth, and sometimes until the sixth lactation, after which it declines. This implies that milk yield will increase as parity order due to the increase in body weight as age increased and to the full development of the sensory tissue of the udder. He stated that the greatest milk yield occurred with goats after second parity, because of the present greater udder volume in older goats. The mammary alveoli which are developed in previous parity and is added to those developed in following parity, by increasing secretory parenchyma. The study of [14] found the increasing trend of milk production with increasing parity order may be result of better udder development and growth in size of the animal. Review of [14] also stated the models found the parity was a source of variation of milk yield, while the significantly lowest milk production per day was in first parity compared to subsequent parity.

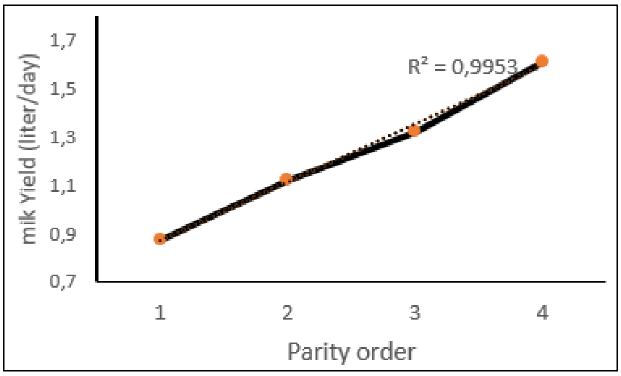

Fig. 1 Effect of parity order on the milk yield

Daily milk yield in the present study was 1,19 liter/doe/day (Figure 1). Milk yield increased gradually with the progress of parity order in the present study. Milk yields were higher than that of [22] for the first (305.2 gram),second (395,99 gram),and third lactations (480,0 gram) in Anglo Nubian; (1.37 kg) estimated of Saanen goats in South Africa similar to this study (1.45 ±0.27 kg) and [14] (1,5 kg/day) due to different breed and management system.

Analysis of variance (Table 1) results revealed that parity order had significant influence on lactation length ($P<0.05$). These results agree with those of other researchers who stated that the parity order affected lactation milk yield and lactation length in dairy goats raised in some different countries [14;15;23].

The results presented in Table 2 show that the average lactation length was 210,03 days. The first parity (184,5 days) was the lowest lactation length ($P<0,05$), however lactation length of third (231,25 days) and fourth parity (247,25 days) were not different ($P>0,05$). While the second parity (209,86 days) was between first and third parity. The average lactation length in this study is less than the review of [10] stated that lactation length ranged 8-10 months of PE goats. [14] estimated that the average lactation length of Anglo Nubian raised in Sudan was 181 days. It is also less than the estimate of [18] (273.12 days), but closed to [14] found 203 days of lactation length.

IV. CONCLUSION

It can be concluded that parity number influenced milk yield and lactation length. Lactation length and milk production increased gradually after first parity. These findings might be important as an information and recommendation for developing Anglo Nubian to improve goat milk production.

REFERENCES

[1] Park, Y. W and George F.W. Haenlein. 2017. Overview of Goat milk. Handbook of Milk of Non-Bovine Mammals. 2nd Ed.

[2] Jackson, M., S W Chenyambuga, E E Ndemanisho and D M Komwihangilo. 2014. Production performance of Toggenburg dairy goats in semiarid and subhumid areas of Tanzania. Liv. Res. Rural Development 26 (2): 1-8

[3] Chenya, S W., M Jackson, E E Ndemanisho and D M Komwihangilo. 2014. Profitability and contribution of small-scale dairy goatproduction to income of smallholder farmers in Babati and Kongwa districts, Tanzania. Livest. Resear. Rural Development 26 (2)

[4] Wanjekeche, E., Z. Macosore, A. Kiptanui1 and T. Lobeta. 2016. Quality And Consumer Acceptability Of Goat Milk With Respect To Goat Breed And Lactation Stage. African Crop Science Journal, Vol. 24, Issue Supplement s1, pp. 95 – 99.

[5] Zenebe, T., N. Ahmed, T. Kabeta and G. Kebede. 2014. Review on Medicinal and Nutritional Values of Goat Milk. Academic Journal of Nutrition 3 (3): 30-39

[6] Hassan, F.A.M., H. M. Abbas, Mona A.M. Abd El-Gawad and Ali K. Enab. 2014. Goats Dairy Products as a Potentially Functional Food [Review Article]. Life Science Journal 2014;11

[7] [7] Asresie, A. and M. Adugna. 2014. Bioactive Properties of Goat Milk: It's Hypoallergenic, Nutritional and Therapeutic Significance: A Review. Global Journal of Animal Scientific Research. 2(4):315-320

[8] Kosgey, I. S., G. Owuor and P. K. Chelanga. 2013. Consumer willingness to pay for dairy goat milk in Siaya County,Kenya. Rebecca Jerop,. Livestock Research for Rural Development 25 (7): 1-10

[9] Sutama, I.K. 2014. Dairy Goat Production on Smallholder Agriculture in Indonesia. Proceeding the 2nd Asian-Australian Dairy Goat Conference. IPB ICC, Bogor. Page: 8-20.

[10] Getaneh G, Mebrat A, Wubie A and Kendie H. 2016. Review on Goat Milk Composition and its Nutritive Value. Journal of Nutrition and Health Science Vol 3 Issue 4: 1-10
[11] Selvaggi, M., and C. Dario. 2015. Genetic analysis of milk production traits in Jonica goats. Small Ruminant Research 126 (2015) 9–12
[12] García-Peniche , T. B., H. H. Montaldo, M. Valencia-Posadas , G. R. Wiggans . 2012. Breed differences over time and heritability estimates for production and reproduction traits of dairy goats in the United States. J. Dairy Sci. 95 :2707–2717
[13] SAS Institute Inc. 2003. SAS/STAT User's Guide: Version 6. SAS Institute Inc. Cary, NC
[14] Ishag, I. A, S.A. Abdalla And M-K.A. Ahmed. 2012. Factors Affecting Milk Production Traits Of Saanen Goat Raised Under Sudan - Semi Arid Conditions. Online J. Anim. Feed Res., 2(5): 435-438
[15] Kraličkova,S., J.Kuchtik, R.Filipčik, T.Lužova, K.Šustova. 2013. EFFECT OF CHOSEN Factors On Milk Yield, Basic Composition And Somatic Cell Count Of Organic Milk Of Brown Short-Haired Goats. Acta Universitatis Agriculturae. Vol. 61: 99-106.
[16] Pesántez, MT., and Arelis Hernández. 2014. Milk production of Criollas and Anglo-Nubian does in Loja, Ecuador. Cuban Journal of Agricultural Science, Volume 48, Number 2:105-108
[17] Nur, D.M., E. Setyowati, and S. Wahyuningsih. 2016. Milk Production Performanceof Etawah Cross Breed Goat Based On Parity, Age, Body Weight, And Pregnancy Status In "Madukara *Farm*", Batu City. Proceedings of National Seminar. Brawijaya University.
[18] Bolacali M and Küçük M (2012). Fertility and milk production characteristics of Saanen goats raised in Muş region, Kafkas Univ. Vet Fak Derg, 18(3): 351-358.
[19] Lôbo, A.M.B.O., R.N.B. Lôbo, O. Facó, V. Souza, A.A.C. Alves, A.C. Costac. 2017. Characterization of milk production and composition of four exotic goat breeds in Brazil. Small Ruminant Research 153: 9–16
[20] Sanogo, S., M. M. Shaker, H. Nantoumé, A. Z. M. Salem. 2012. Milk yield and composition of crossbred Sahelian × Anglo-Nubian goats in the semi-intensive system in Mali during the preweaning period. Trop. Anim. Health and Prod. Vol 45 (issue 1) : 305-310
[21] Assan, N. 2015. Significance of parity, year-season and prolificacy in influencing goat milk production traits. Agricultural Advances 4(1) 1-6
[22] Mia, M.M., M. A. Khandoker, S. S. Husain, Md. O. Faruque, D. R. Notter. 2014. Estimation Of Genetic And Phenotypic Parameters For Daily Milk Yield Of Black Bengal Does. Turk J Vet Anim Sci (2014) 38: 469-473.
[23] Klir, Z., K. Potočnik, Z. Antunović, J. Novoselec, Z. Barać, D. Mulc3 And D. Kompan Milk Production Traits From Alpine Breed Of Goats In Croatia And Slovenia. 2015. Bulgarian Journal Of Agricultural Science, 21 (No 5) 2015, 1064-1068 Agricultural Academy
[24] El-Hassan El-Abid, K. and Abu Nikhaila, A.M.A., 2010. A Study on some son-genetic factors and their impact on milk yield and lactation length of Sudanese Nubian Goats.Australian Journal of Basic and Applied Sciences, 4, 735–739.

F.11

ANALYSIS OF MINIMIZING THE SOYBEAN IMPORT IN INDONESIA: FORECAST OF ITS PRODUCTION AND CONSUMPTION

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ABSTRACT

Since 1975, Indonesia has been importing soybean. In 2014, Indonesia imported almost 2 million tons. It implies that the production of soybean has not been fulfilling its consumption. Indonesia would like to minimize it. This paper attempts to analyze the possibility for decreasing the soybean import. Data used are the FAO's data in the period 1961-2014. Data are analyzed by econometric models and time series analysis. The result revealed that Indonesia still needs the soybean import.

Keywords : Soybean, Production, Consumption, Import

I. INTRODUCTION

Indonesia has been a soybean importer since 1975 (the FAO's data). In addition, the growth of its import increases. This is shown that the production of soybean has not been enough for its need. Since soybean is one of the important foods, it has priority to increase its production. In this case, even the government has a target that Indonesia can be self-sufficiency in soybean.

Hermanto at al. analyzed the soybean outlook in the period 2015-2019 by analyzing three scenarios. This study is shown that Indonesia cannot be self-sufficiency. However, Indonesia can decrease the amount of soybean import [1]. By using time series analysis, Hadi forecasted the production and the consumption of soybean in Indonesia [2]. The result of this study is similar with the previous study done by Hermanto et al. In short run, Indonesia can decrease the soybean import by increasing its productivity and harvested area. In the long run, these two attempts could make Indonesia self-sufficient in soybean.

The other study is done by Adillah. It used the simultaneous forecast [3]. One of the results of this study is Indonesia can decrease the soybean import because the production growth is higher than the consumption growth.

Although those three previous studies already tried to predict the production and the consumption of soybean in Indonesia, we still need to know the possibility that Indonesia can decrease its import due to the slow growing of its production and the fast grow of population. Therefore, we need to forecast the production and the consumption of soybean and then compare them.

II. MATERIALS AND METHODS

The production of soybean is affected by the production factors used. We consider the acreage of land and the amount of seed used for growing soybean are the production factors that affect its production. Other production factors, such as fertilizer and labor, are not included in the model analysis. These data are not available. Because most of the time the use of fertilizer, labor and other production factors is proportional with the acreage of land for growing soybean, we can assume that they are complement with the land.

The farmers have preference whether to plant soybean or other crops in their land. They always compare the profits of many crops depending on the price and the productivity of each crop. Since 1994, the mass adoption or the diffusion of the hybrid corn has been making the farmers prefer corn to soybean. Therefore, we included this factor in the model analysis for the soybean production. The empirical model for the soybean production can be seen in Equation (1).

$$Prod_t = b_o + b_1 AH_t + b_2 Seed_t + b_3 D_t + e_{1t} \quad (1)$$

where :

t : 1961. 1962, ..., 2014
$Prod$: Soybean production (million tons)
AH : Area Harvested for soybean (million hectares)
$Seed$: Seed planted for soybean (million tons)
D : Dummy variable for the diffusion of the hybrid corn
D = 0 for t: 1961, 1962, ... , 1993
D = 1 for t: 1994, 1995, ... , 2015
b : Parameter estimates
e : Error term

For forecasting the independent variables, AH and $Seed$, we use time series analysis, ARIMA. A general empirical model for ARIMA can be seen in Equation (2).

$$X_t = \beta_1 X_{t-1} + \ldots + \beta_p X_{t-p} - e_t - \alpha_1 e_{t-1} - \ldots - \alpha_q e_{t-q} \quad (2)$$

where :

t : 1961. 1962, ..., 2014
X : Variable being forecasted
β, α : Parameter estimates
e : Error term
AH : Area Harvested for soybean (million hectares)
$Seed$: Seed planted for soybean (million tons)

The domestic supply of soybean is its production minus the use for seed and its losses. The amount of seed used and the losses are forecasted by ARIMA.

Soybean can be directly consumed as a food. We call it Food. It can be processed to tempeh, tofu, vegetable oil etc. We call it Processing. Therefore, the consumption of soybean can be as the Food or the Processing. The summation of the food and the processing is the consumption of soybean. We use ARIMA for forecast the Food and the Processing.

If the domestic supply is smaller than the consumption of soybean, we need to import it, vice versa.

The main source of the data is the FAO's website the other source of data is Central Agency on Statistics Indonesia.

III. RESULTS AND DISCUSSION

A. Production and Domestic Supply

The data used for estimating the empirical model of the soybean production is from 1961 until 2015. In this period, the minimum production was 0.35 million tons in 1963 and the maximum one was 1.87 million tons in 1992. During this period, the soybean production growth had been 1.79 percent/year. The production and the area harvested for soybean can be seen in Fig. 1.

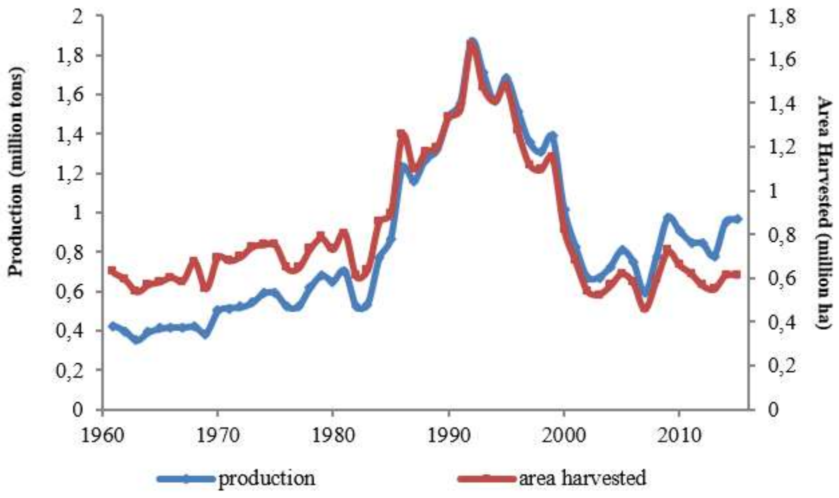

Fig. 1. The production and the area harvested for soybean in Indonesia, 1961-2015

Fig. 1 shows that after the maximum production reached in 1993, it had been declining. After 2000, the production had been below one million tons.

Fig. 1 also shows that the production had been fluctuating with the harvested area. The ration between the production and the harvested area is the productivity of the land. The maximum productivity was 1.57 tons/ha in 2015 and the minimum one was 0.62 tons/ha in 1968.Since the production had been going together with the harvested area, the growth of the productivity is low, i.e. only 1.64 percent/year. This growth also can be seen in Fig. 2.

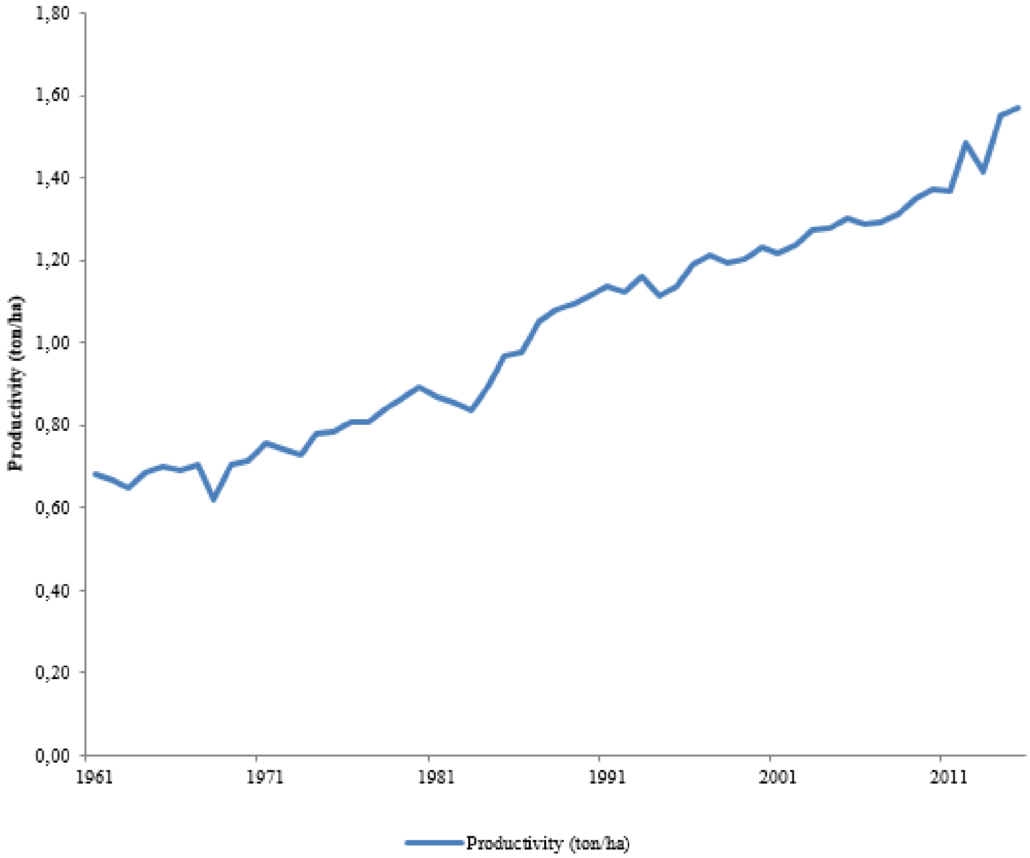

Fig. 2. The productivity of soybean in Indonesia, 1961-2015

By using the OLS method, the estimation of the empirical model for the soybean production can be seen in Table 1.

Table 1. The Estimated Forecast Model for Soybean Production

Independent variables	Coefficient	t-value
Intercept	-0.231*	-6.162
Area harvested	0.999*	25.639
Seed	9.158*	8.234
Dummy	-0.178*	-8.212
F-value	979.7930*	
R Square	0.9830	
Standard error	0.0546	
Observations	55	
DW	1.488	

*: Statistically significant at the 1% level
Note:
Dependent variable: Rice Production (million tonnes)
Independent variables: Area Harvested (million hectars); Seed (million tonnes); and Year (1961=1, 1962=2, ..., 2015=55)

Table 1 shows that all the independent variables are significant. In addition, their signs follow the theory. For example, on the average, holding the other variables constant, if the area harvested increases one hectare, the production will increase 1 ton. The sign of dummy variable also makes sense since the hybrid corn is a substitution crop for soybean.

The R Square is quite high. The Durbin Watson (DW) value shows that the model does not have the autocorrelation problem. Therefore, the forecast model shown in Table 1 can be used for predicting the soybean production.

Firstly, we forecast the area harvested and the seed by using ARIMA. Secondly, we substituted these values to the soybean forecast model. The result of this calculation can be seen in Table 2.

Table 2. The Forecast of Soybean Production

Year	Confidence Interval (95%)		
	Average	Lower limit	Upper limit
2017	0.92	0.58	1.25
2018	0.95	0.61	1.29
2019	0.98	0.64	1.32
2020	1.01	0.67	1.34
2021	1.04	0.70	1.38
2022	1.07	0.73	1.40
2023	1.10	0.76	1.44
2024	1.13	0.79	1.46
2025	1.16	0.82	1.50
2026	1.19	0.85	1.52
2027	1.22	0.88	1.55
2028	1.25	0.91	1.58

The domestic supply is the production minus the use for seed and the losses. We forecast these using ARIMA. We calculate the forecast of soybean domestic supply (Table 3).

Table 3. The Forecast of Soybean Domestic Supply (million tons)

Year	Confidence Interval (95%)		
	Average	Lower limit	Upper limit
2017	0.73	0.40	1.07
2018	0.76	0.43	1.10
2019	0.79	0.45	1.13
2020	0.82	0.48	1.15
2021	0.85	0.51	1.18
2022	0.87	0.54	1.21
2023	0.90	0.57	1.24
2024	0.93	0.59	1.26
2025	0.96	0.62	1.29
2026	0.98	0.65	1.32
2027	1.01	0.68	1.35
2028	1.04	0.70	1.38

B. Consumption

We consume soybean as the seed called Food or the processed food called Processing, i.e. tempeh, tofu etc. Therefore, we forecast the amount of soybean for Food and for Processing. ARIMA is used for forecasting them. The summation of Food and Processing is the soybean consumption. Its forecast can be seen in Table 4.

Table 4. The Forecast of Soybean Consumption

Year	Confidence Interval (95%)		
	Average	Lower limit	Upper limit
2017	2.60	1.68	3.51
2018	2.64	1.61	3.67
2019	2.67	1.54	3.81
2020	2.71	1.47	3.95
2021	2.75	1.40	4.09
2022	2.78	1.34	4.23
2023	2.82	1.28	4.36
2024	2.86	1.21	4.50
2025	2.89	1.15	4.64
2026	2.93	1.09	4.77
2027	2.97	1.03	4.91
2028	3.00	0.97	5.04

C. Import

The difference between the consumption and the domestic supply is the import of soybean. The result of the forecast for the soybean import can be seen in Table 5. We use the average of consumption for calculating the confidence interval.

Table 5 shows that Indonesia still needs to import soybean to fulfil its consumption. In 2017, on the average, the soybean import will be 1.87 million tons. It increases slowly, i.e. 0.47 percent/year. In 2028, the average of soybean import will be 1.96 million tons.

The amount of import can be decreasing if the production is relatively high, i.e. in the upper limit of the production confidence interval. Therefore, the efforts of increasing the soybean production is still important in order to minimize its import.

Table 5. The Forecast of Soybean Import

Year	Confidence Interval (95%)		
	Average	Lower limit	Upper limit
2017	2.60	1.68	3.51
2018	2.64	1.61	3.67
2019	2.67	1.54	3.81
2020	2.71	1.47	3.95
2021	2.75	1.40	4.09
2022	2.78	1.34	4.23
2023	2.82	1.28	4.36
2024	2.86	1.21	4.50
2025	2.89	1.15	4.64
2026	2.93	1.09	4.77
2027	2.97	1.03	4.91
2028	3.00	0.97	5.04

IV. CONCLUSION

Since the soybean production is far less then its consumption, Indonesia still needs to import soybean. In 2017, on the average, the soybean import will be 1.87 million tons. It increases slowly, i.e. 0.47 percent/year. In 2028, the average of soybean import will be 1.96 million tons.

The amount of import can be decreasing if the production is relatively high, i.e. in the upper limit of the production confidence interval. Therefore, the effort for increasing the soybean production is still important in order to minimize its import.

REFERENCES

[1] Hermanto, Delima, Hasri Azahari, Muchjidin Rachmat, Nyak Ilham, I Ketut Kariyasa, Supriyati, Adi Setiyanto, Rangga Ditya Yofa, and Edy Supriyadi Yusuf. 2015. "*OUTLOOK KOMODITAS PANGAN STRATEGIS TAHUN 2015-2019",* Laporan Analisis Kebijakan Tahun 2015. Pusat Sosial Ekonomi dan Kebijakan Pertanian, Badan Penelitian dan Pengembangan Pertanian.

[2] Abida Hadi. 2013. Analisis Produksi dan Konsumsi Kedelai Domestik dalam Rangka Mencapai Swasembada Kedelai di Indonesia. *Tesis*. Departmen Ekonomi Sumberdaya dan Lingkungan. Institut Pertanian Bogor.

[3] Rizma Aldillah. 2015. Proyeksi Produksi dan Konsumsi Kedelai Indonesia. *Jurnal Ekonomi Kuantitatif Terapan*. Vol. 8 (1)

G

NATURAL RESOURCES

G.1

THE APPLICATION OF TERRACE AND GABION ON SLOPE STABILIZATION

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ABSTRACT

Lately, landslides have become more frequent and cause considerable losses. This study aims to examine the application of terrace and gabion on slope stabilization. The study took the case on one of a landslide-prone slope in Puraseda village, Leuwiliang District, Bogor Regency. The results of the study showed that the terrace application with vertical intervals of 1/2, 1/3 and 1/4 of the height of the slope (H) increased the slope safety factor to 1.548, 1.559 and 1.504 from the original safety factor of 1.366. While the gabion application as high as 1/3 high slope increase the safety factor to 2.71.

Keywords: gabion, landslide, stabilization, terrace

I. INTRODUCTION

The soil on a steep slope tends to be drawn by the gravitational force which can lead to avalanches, ie massive land mass movements down the slope slowly or rapidly (Dibyosaputro 1999 in Priyono et al 2006). Additional loading due to human activities such as buildings or embankments above the slopes is one factor that increases the risk of landslides.

Landslide is a natural disaster that many cause losses such as casualties, destruction of settlements, roads, bridges, farmland, irrigation, drainage, and other infrastructure. According to BNPB (2013), Bogor Regency is one of the regions with high disaster risk index class, and is the 53rd district of Indonesia landslide risk index. Based on data released by Bogor Regency Government, Leuwiliang District is one of the sub-districts belonging to the landslide-prone zone with high disaster risk. Landslides that have occurred in this area generally occur around the settlement so that many citizens residents who buried due to landslide.

Putra et. al (2010) to mitigate landslide disaster in disaster prone areas by strengthening the slopes, one of them by constructing anchoring construction. Terrace is a soil and water conservation building that serves to reduce the length of the slope and retain water so as to reduce the speed and amount of surface flow and allow the absorption of water by the soil, thus reducing erosion (Arsyad 1989). The terrace can also improve the stability of the slope as it modified slope geometry. Hardiyatmo (2006) stated that the gabion built on sloping filler ground aims to hold on the foot of the slope, so as not to cause collapse and increase stability.

This study was conducted with the aim to evaluate the application of terraces and gabion in improving the stability of the slope.

II. MATERIALS AND METHODS

This study was conducted in one of the landslide-prone areas in Puraseda Village, Leuwiliang District, Bogor, at coordinates 06°39.29'S and 106°36.99'E, from May to August 2016. The equipment used in this study were theodolite, GPS, measuring tape, ring sample (8 cm diameter), picnometer, direct shear apparatus, oven and scales. Softwares used were GeoStudio SLOPE/W 2007 (student edition), Surfer 8.0 and Microsoft Office 2010. The study was conducted with the following stages: preparation, data collection and sampling, laboratory test, data processing, and analysis of slope stabilization as shown in Fig. 1.

Topographic data were collected through direct measurement using controlling point method. Soil testing were performed using direct shear test method with three different normal stress: 0.5 kg/cm^2, 1.0 kg/cm^2, 1.5 kg/cm^2. The test sample is classified into: the top layer, the middle layer, and the bottom layer of the slope. Slope stability analysis was performed using GeoStudio 2007 software, with one specific feature for slope stability calculation, ie SLOPE/W. Analysis were conducted using grid and radius method. (Fig. 2).

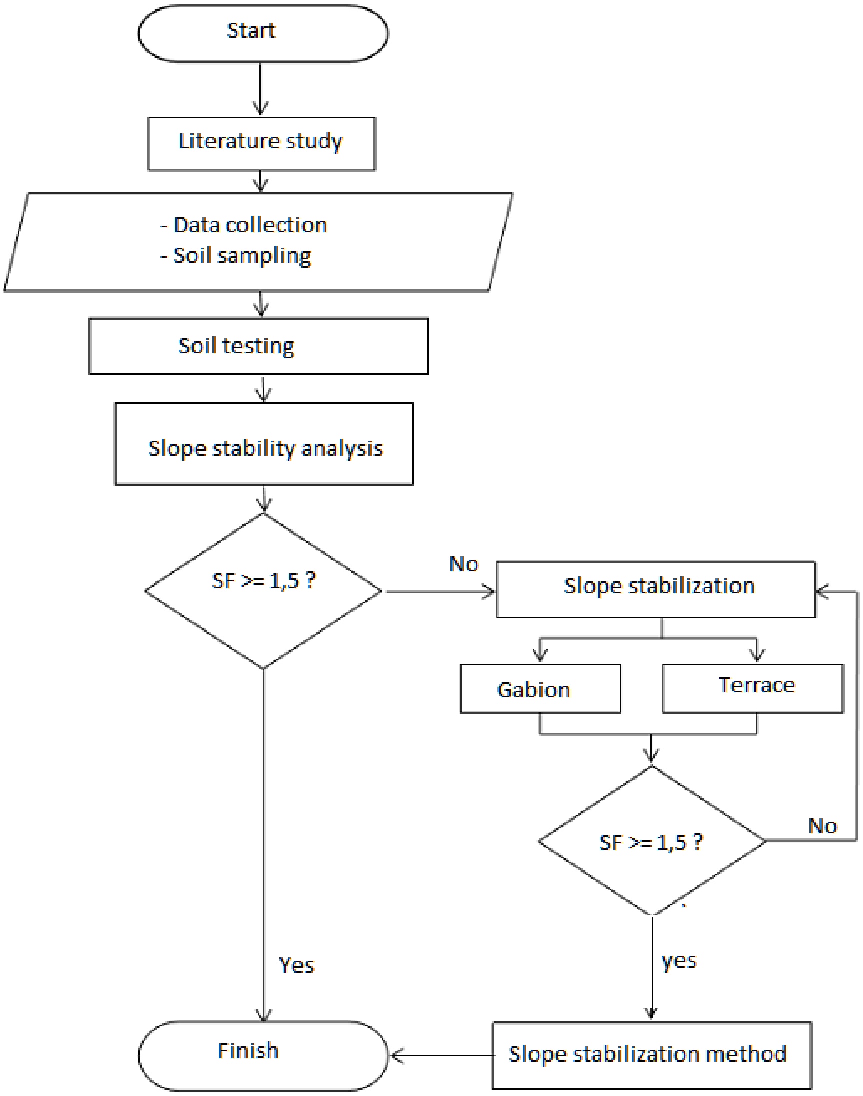


Fig. 1 The stages of study

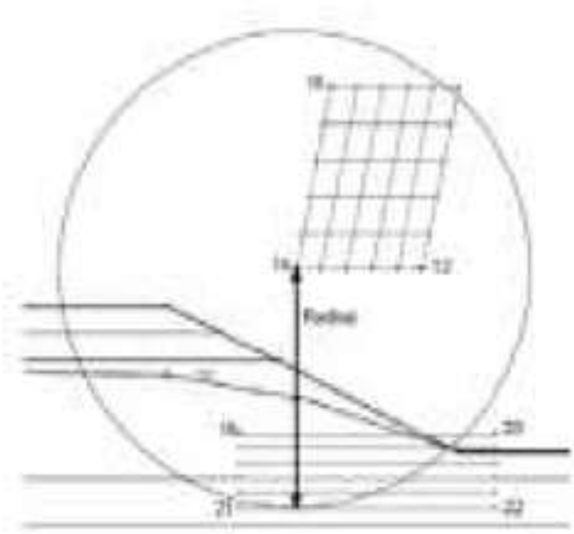


Fig. 2. Schema of grid and radius

Slope stabilization by terrace was determined by the vertical interval (VI) specified by Pramudo (1016), ie with vertical intervals of 1/ H, 1/3H and 1/4H. Gabion (Fig. 3) design was based on GEO (2004) in Akmal (2016), where the height and width of the gabion as presented in Table 1.

Table 1. Height (H) and width (B) of the gabion

H (m)	B (m)	H (m)	B (m)
1	2	6	4
2	2	7	5
3	3	8	5
4	3	9	6
5	4	10	6

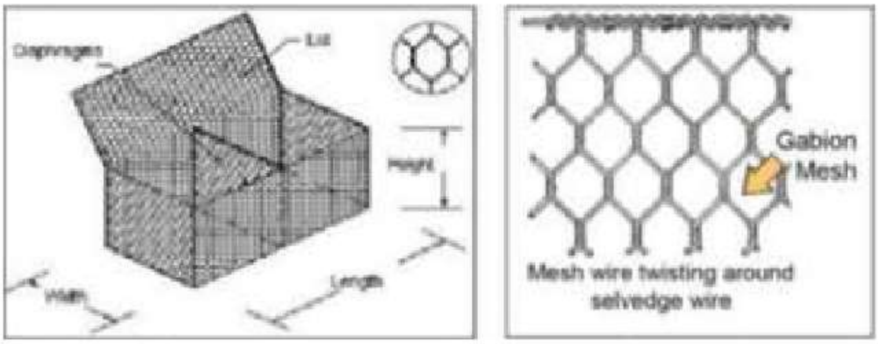


Fig. 3. Gabion

III. RESULTS AND DISCUSSION

A. Site Characteristics

Fig. 4 shows the topography of the case study slope. The slope has an almost uniform slope, the height of the slope reaches 15 m, the length of the slope reaches 16 m and the slope angle of 43°. The characteristic of soil are shown on Table 2.

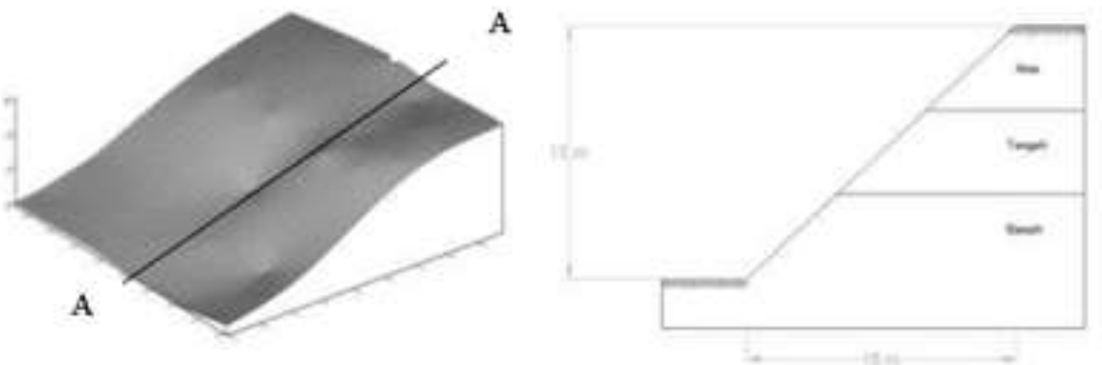


Fig. 4. The slope

Table 2. Soil Characteristics

Layer	Cohesion (KN/m^2)	Internal friction (°)	Specific weight (KN/m^2)
Top	24.16	17.99	14.82
Middle	18.46	20.40	14.45
Bottom	25.86	17.74	16.37

B. Slope Stability

The stability of the study slope at original condition (before stabilization) was obtained by a safety factor of 1.36 (Fig. 5). The value of this safety factor indicates that the slope is unstable and prone to landslides, because the value of its safety factor is less than 1.5 (DPU, 1987), and necessary to be stabilized.

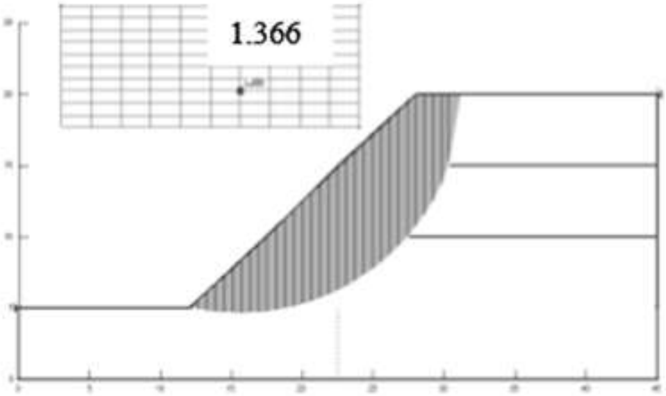
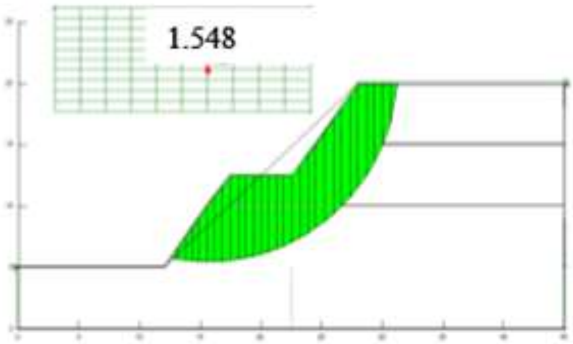


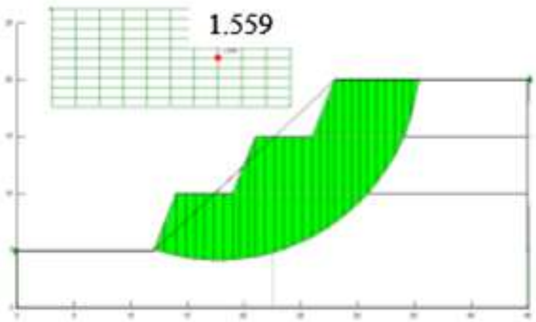
Fig. 5. Safety Factor of the original slope

C. Slope Stabilization with Terrace

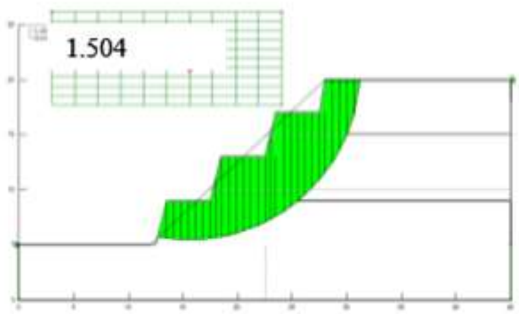
The value of slope safety factor after stabilization with terraces (1/2H, 1/3H and 1 4H) were 1.548, 1.599 and 1.504, respectively. Fig. 6 shows the results of the stabilization analysis using a terrace.



VI 1/2H



VI 1/3H



VI 1/4H

Fig. 6. Safety factor after terracing

Terracing (1/2H, 1/3H and 1/4H) the slope can increase the safety factor to more than 1.5, which indicates that the slope with terrace condition is stable.

D. Slope Stabilization with Gabion

Gabion for stabilization is designed to have a height of 5 m and a base width of 4 m with specifications as shown in Table 3. The result of gabion safety factor analysis on rolling resistance and shear resistance were 4.2 and 1.6. This result indicate that the application of gabion can stabilized the slope. While, safety factor of slope stability which calculated manually using the simplified Bishop method obtained a safety factor of 2.71. This safety factor indicated that the slope became stable by the application of gabion.

Table 3. Gabion analysis

Item		Value
Soil coefficient	*Ka*	0.54
Active soil stress	*Pa*	111.08 kN/m
Horizontal active soil stress	*Ph*	111.08 kN/m
Vertical distance of Ph	*da*	1.6 m
Rotation moment	*Mo*	177.72 kN
Gabion weight/m	*Wg*	322 kN/m
Horizontal distance of Wg	*dg*	2.35 m
Resistance moment	*Mr*	759 kN
Rotation safety factor	*SFo*	4.2
Shear safety factor	*SFs*	1.6

E. Budgeting

The construction budget for slopes stabilization was calculated based on the unit price of work at the Bogor district in 2016. The construction budget required to stabilize the slope are range from 13.9 million rupiah (terrace 1/4H) to 178.8 million (gabion) as shown in Table 4.

Table 4. Construction budget

Stabilization method	Budget (million rupiah)
Terrace 1/2 H	16.476
Terrace 1/3 H	17.873
Terrace 1/4 H	13.917
Gabion 1/3 H	178.763

IV. CONCLUSION

The terrace application with vertical intervals of 1/2, 1/3 and 1/4 of the height of the slope (H) increased the slope safety factor to 1.548, 1.559 and 1.504 respectively from the original safety factor of 1.366. While the gabion application as high as 1/3 high of slope (5 m) increase the safety factor to 2.71.

REFERENCES

[1] Akmal, FZ., Slope stability analysis using Fellenius method by Geostudio SLOPE/W software in Sukamakmur, Bogor [scripts], Bogor: Institut Pertanian Bogor, 2016

[2] Bishop A.W., The Use of Slip Surface in The Stability of Analysis Slopes, London : *Geotechnique*, Vol 5, 1955

[3] National Board for Disaster Management, *Indonesia's Disaster Risk Index: Landslide Disaster*, Jakarta: BNPB, 2013

[4] National Standardization Body, *Specification of Gabion Wire*, SNI 030090-1999, Jakarta : BSN, 1999

[5] Ministry of Public Works, *Planning Guidance for Landslide Prevention,* SKBI - 2.3.06, Jakarta: Foundation of Public Works Agency. DPU, 1987

[6] Hardiyatmo H.C., *Soil Mechanics I*, 4 edition. Yogyakarta: Gadjah Mada University Press, 2006

[7] Murri MM, Niken SS, Sholihin A., Slope Stability Analysis with Gabion, *Civil Engineering Matrix journal*. 2(1) : 162 – 169, 2014

[8] Pramudo LTH., Slope Stability Analysis with Terrace in Sendangmulyo, Tirtomoyo, Wonogiri [scripts]. Solo: Universitas Sebelas Maret. Solo. 2016

[9] Priyono KD, Yuli P, Priyono, Analysis of Landslide Hazards in Banjarmangu region, Banjarnegara District. *Journal of Geographical Forum*. 20(2) : 175 – 189, 2006

[10] Center for Soil Research and Development and Agrolimat, Soil Conservation Technology on Slope Land. Kurnia U, Rahman A, Dariah A, eds. Bogor : Puslitbangtanak, Agency for Agricultural Research and Development, Ministry of Agriculture, 2004

[11] Purnamasari DA., Terraces Design on the Slopes of the Gajah Putih River Surakarta [scripts], Solo : Universitas Sebelas Maret, 2014

[12] Putra TGS, Made DWA, Made A., Slope Stability Analysis of Road and Design of Retaining Wall, *Scientific Journal of Civil Engineering*, 14(1) : 36 – 42, 2010

[13] Rosihun M, Endaryanta, Analysis of Gabion side slope, Yogyakarta. *Inersia Journal*, 7(2), 2011
[14] Subiyanti H, Ahmad R, Rachmad J., Analysis of Landslide Effected by Pore Water Pressure on Prime Channel Kalibawang Kulonprogo. *Journal of Ilmiah Semesta Teknika*. 14(1) : 15 – 25, 2011
[15] Hasanudin Sumiyanto, Adhe NPSH, The Effect of Terracing on Slope Against Landslide Potential. *Journal of Engineering Dynamic*. 6(2) : 50 – 55, 2010.
[16] Utomo BSS., Identification of Landslide Prone Areas in Bogor Regency, West Java [scripts]. Bogor : Institut Pertanian Bogor, 2008

G.2

CLIMATE CHANGE ON MAXIMUM RAINFALL DAN FLOOD AT BANDAR LAMPUNG

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ABSTRACT

Population growth rapidly will never cease as a source of problems that occur in almost all major cities in Indonesia. Local governments that handling and anticipating the population growth tend less prepared andthe city become chaotic day after day. Reduced of open land into building areas will affect the hydrological conditions especially floods in the area. These conditions plus changes in trends and variability of climate variables such as temperature and rainfall causeincreasing temperature and changes of rainfall, especially the frequency of extreme rainfall that occurred in the City of Bandar Lampung.In this preliminary study, identification of the maximum flood areas due to maximum rainfall with return periods of 2, 5, 10, 20, and 30 years. Assess the maximum capacity capacity of river/drainage channels against maximum flooding. Assess the volume and duration of the overflow occurring. Maximum rainfall calculation method with frequency analysis, maximum flood with rational modification method. Calculation method of river capacity / channel with slope area methode and manning formula. Calculation of volume and duration of flood using flood hydrograph analysis. The results of the drainage channel capacity of 38% were only able to drain the flood with a 2 year return period. The expectation of upcoming flood will increase by approximately 10% in 2030. The largest maximum capacity in Way Kuala, the largest flood volume of floods occurs and the longest overflow occurs in Way Kuripan.

Keywords: maximum flood, maximum capacity, rational modification, manning formula.

I. INTRODUCTION

Bandar Lampung city is the capital of Lampung Province with a land area of 19,722 ha, consists of 13 districts and 98 urban villages. The city is traversed by two big rivers namely Way Kuala and Way Kuripan and 23 small rivers. All of these rivers mostly lead to Lampung Bay. Based on the data of 2014, the population of Bandar Lampung approximately 1,167,101 people with population density of 8,316 people/km^2 and population growth estimation reached 2.4 million ppeople in 2030.

Rapid population growth will never cease as sources of problems that occur in almost of all major cities in Indonesia. Local government in handling and anticipating the growth population tend to be less prepared, causing the city to become increasingly chaotic. Reduced and lost of parks and green open area into building area will effect to the hydrological conditions, especially floods event in these area. The great flood disaster in January 2013 that killed 3 people, floods in more than 20 areas with a height of 0.5 m until more than 2 m, flood disaster in every rainy season/year and last flood disaster in 2017 make big financial losses. (nasional.republika.co.id). This condition become worse with the changes of trends and variability of climate variables such as temperature and rainfall, the temperature become warmer and changes of rainfall, especially the frequency of extreme rainfall that occurred in the Bandar Lampung City.

Changes of type or type of land use in urban areas are very influential to hydrological processes in the city, especially the change of forest land use into building areas. This condition will disrupt the natural water balance (Saghafian et.al., 2008; Ali et al., 2011; and Suriya et al., 2012). Changes from forest vegetation types to settlements or industries are examples of land changes. Similarly, land use change for settlements and industries occurs in urban areas.

Change of upstream watershed area function of 15% disturbed river balance. This disorder contributes to the increase in the quality and quantity of flow discharge and sedimentation in rivers (Birkel et al., 2012). It can also be interpreted that an natural watershed areas with dense vegetation can be changed of 15% without change the natural condition. If the change more than 15% then should be found the alternative or need compensation to maintain the river sustainability, for example namely making absorption wells.

Hydrological analysis of flood problem in Bandar Lampung City area is very important to do. Estimate how much a maximum flood can occur, the maximum capacity of the river/canal to accommodate the flood, and how long a flood will occur.

II. MATERIALS AND METHODS

The study was conducted in Bandar Lampung City, using inlet method or the method to divide the research area into smaller drainage areas that called inlet. At the outlet of the inlet area will relate becomes an outlet that called the drainage area (Bambang, 2010). Observations were did in each inlet and outlet of the drainage areas. Research is emphasized on natural drainage or river as city drainage channel as the river network map (presented in Fig. 1). The maximum flood that occurs in urban areas calculated with Rational method (Soemarto, 1986).

$$Q = 0.278\ C.I.A\ (m^3/s) \text{ in a certain reset period} \tag{1}$$

Where :

C = flow coefficient (crop coefficient)
I = Rain intensity for rain duration that equal with concentration time (tc, min) in return period T year (mm/h)
A = Area of river basin (km^2)

Flow coefficient (C) calculated based on the ratio between the thickness of the flow and the thickness of the rain for a long period of time. Factors that affecting the flow coefficient of local conditions and physical characteristics of the flow areas, which are usually interpreted with set of land use (Kundu and Olang, 2011)

As the basis for calculating the flow coefficient for the research area is obtained from the value of the flow coefficient multiplied with the set of land use. The equation for calculate the region's flow coefficient value is :

$$(C) = \frac{(C_1.A_1) + (C_2.A_2) + \ldots(C_n.A_n)}{(A_1 + A_2 + \ldots A_n)} \tag{2}$$

Where :

$C_1, C_2, \ldots C_n$ = The flow coefficient value in each of land use.
$A_1, A_2, \ldots A_n$ = Each of land use area

Rain intensity is a function of the amount of rain and long rain. The relationship of both is expressed in the curve of the intensity of rainfall from various repetitions in the duration of rain (Suyono and Takeda, 1987). The amount of rainfall from various repetition periods is obtained from Gumbel Type 1 frequency analysis method (Soemarto, 1986). In accordance with rainfall data that obtained is the maximum daily rainfall, then the calculation of rain intensity using Mononobe method.

$$I = \frac{R_{24}}{24} + \left(\frac{24}{t}\right)^{2/3} \tag{3}$$

I = Rain Intensity (mm/h)
R_{24} = Maximum rainfall in a particular return period (mm)
T =Duration of rain (hours), if in the calculation then using time concentration (Tc)

The maximum channel/river capacity calculation is determined based on the slope of the method area, which is calculated indirectly by the manning formula.

$$Q = V.A \tag{4}$$

where :

Q = Maximum channel/river capacity (m^3/sec)
A = Area of cross section (m^2)
V = Average of flow velocity, using the manning formula (m/sec)

The hydrograph calculation of flood is assumed with triangular shape (presented in Fig. 2), with peak discharge hydrograph is Qp and rain duration equal with concentration time, while base time (Tb) of 2.17 Tc (Kimaro et al., 2005)

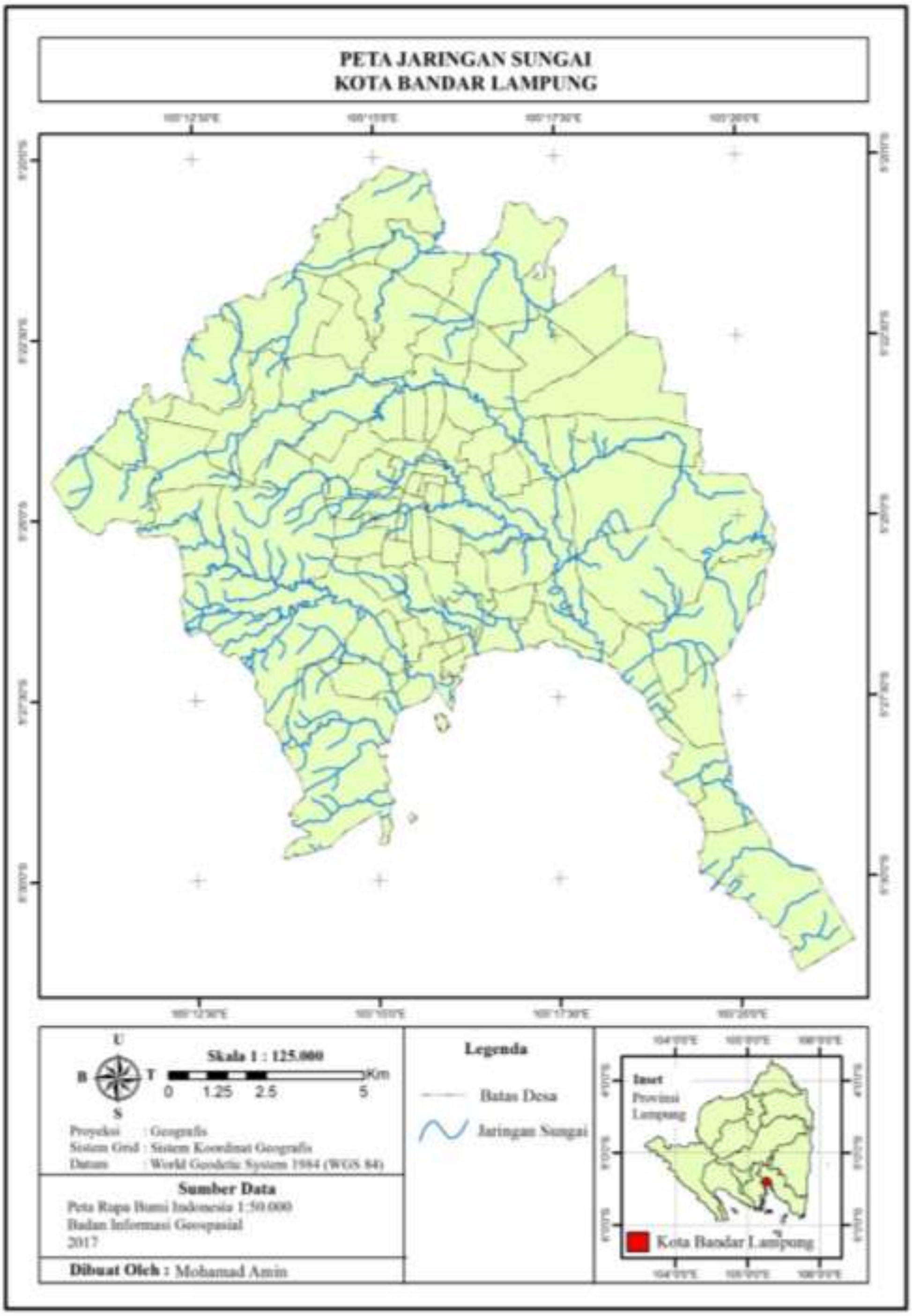

Fig. 1. Map of River Networks in Bandar Lampung City

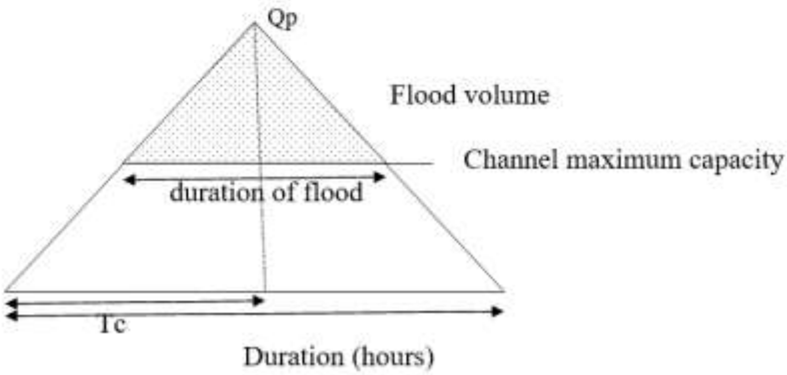

Fig. 2. The hydrograph calculation of flood

III. RESULTS AND DISCUSSION

The calculation of frequency analysis for maximum daily precipitation in the study area from 1998 to 2016 used Gumbel distribution, resulted the average of sample or μ = 115.55, standard deviation or σ = 32.15, reduced mean or yn = 0.5220, and reduced standard deviation or sn = 1.0565. Maximum rain in repeat period (2, 5, 10, 20, 30 years) is presented in Table 1, whereas rain intensity in repeat periods (2, 5,10, 20, 30 years) is presented in Table 2.

Table 1. Maximum rain in repeat periods (2, 5, 10, 20, 30 years)

Average =	115.55	Reduced mean =	0.5220
Deviation =	32.15	Reduced standard =	1.0565
Repeat period	Reduced variate	Frequency factor	Maximum rain
2	0.3668	0.1469	106.8750
5	1.5004	0.9261	141.4178
10	2.2510	1.6365	164.2882
20	2.9709	2.3179	186.2260
25	3.1993	2.5341	193.1850

Table 2. Rain intensity in repeat periods (2, 5, 10, 20, 30 years)

Duration (minutes)	Rain intensity in repeat periods (mm)					
	2 years	5 years	10 years	15 years	20 years	25 years
10	191.50	253.34	294.29	317.39	333.57	346.03
20	120.63	159.60	185.39	199.95	210.14	217.99
30	92.06	121.79	141.48	152.59	160.36	166.35
40	76.00	100.54	116.79	125.96	132.38	137.32
50	65.49	86.64	100.65	108.55	114.08	118.34
60	58.00	76.73	89.13	96.12	101.02	104.80
90	44.26	58.55	68.02	73.36	77.09	79.97
120	36.53	48.33	56.15	60.55	63.64	66.02
150	31.48	41.65	48.39	52.18	54.84	56.89
180	27.88	36.89	42.85	46.21	48.57	50.38

The calculation of rain intensity with rainfall duration using Mononobe formula is presented in intensity duration curve or graph of rainfall intensity curve (Fig. 3).

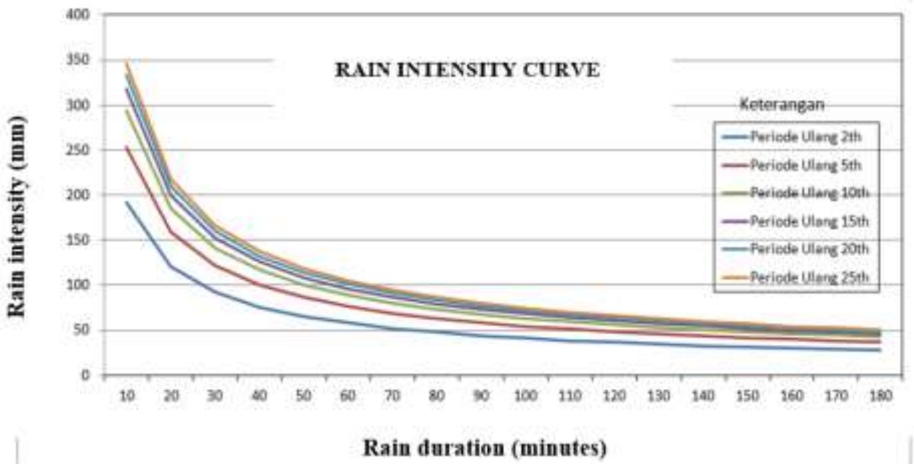

Fig. 3. Rainfall Intensity Curve

Some of river and main drainages in Bandar Lampung will evaluate the capacity for saving water from flood in this area. Big River, Way Kuala divided into sub-watershed namely Way Kedamaian, Way Awy, Way Penengahan, Way Simpur and Way Kuala. The smaller river like as Way Kunyit , Way Kupang, dan Way Kripan. Every sub-watershed divided into some of monitoring outlet point for get the information of flood, river capability and drainage capability in repeat period (2, 5, 10, 20, 25, 30 years in were presented in Table 3 and Table 4).

Table 3. Floods in Repeat Period (2, 5, 10, 20, 25, 30 years)

outlet	Watershed Area	Flow coefficient	Floods in Repeat Period					
			2 y	5 y	10 y	2 y	2 y	3 y
Way Kedamaian								
1	0.50	0.7440	11.4678	15.2989	18.6906	21.8870	22.9786	23.8228
2	0.58	0.6480	7.8084	10.4169	12.7263	14.9028	15.6460	16.2208
3	0.32	0.5906	3.8940	5.1949	6.3466	7.4319	7.8026	8.0892
Way Awi								
4	2.86	0.7198	38.9227	51.9255	63.4373	74.2863	77.9912	80.8565
5	0.27	0.7615	3.0788	4.1074	5.0180	5.8761	6.1692	6.3958
6	1.32	0.9606	27.3617	36.5023	44.5948	52.2214	54.8258	56.8400
7	0.25	0.9490	3.6637	4.8876	5.9712	6.9924	7.3411	7.6108
8	0.47	0.8431	6.4425	8.5947	10.5002	12.2959	12.9091	13.3834
12	0.33	0.7500	6.7062	8.9465	10.9299	12.7991	13.4375	13.9312
13	0.31	0.8045	3.9670	5.2922	6.4655	7.5712	7.9488	8.2409
14	1.03	0.7065	7.5227	10.0358	12.2607	14.3575	15.0736	15.6274
15	1.50	0.5810	10.9004	14.5418	17.7657	20.8040	21.8416	22.6440
16	0.61	0.6156	5.6703	7.5646	9.2416	10.8221	11.3619	11.7793
17	0.20	0.7398	2.3623	3.1515	3.8501	4.5086	4.7334	4.9073
Way Simpur								
18	0.36	0.8000	5.6817	7.5797	9.2601	10.8438	11.3846	11.8028
19	0.51	0.7568	7.1108	9.4864	11.5895	13.5715	14.2483	14.7718
20	0.27	0.7000	5.7955	7.7317	9.4457	11.0611	11.6128	12.0394
21	0.40	0.6463	4.0607	5.4172	6.6182	7.7500	8.1365	8.4354
22	1.17	0.5840	7.7441	10.3312	12.6216	14.7802	15.5173	16.0874
Way Kuala								
23	1.04	0.4500	7.6167	10.1611	12.4138	14.5368	15.2618	15.8225
24	33.40	0.5432	79.7563	106.4004	129.9891	152.2197	159.8114	165.6826
25	1.17	0.4796	8.2870	11.0554	13.5064	15.8163	16.6051	17.2151
26	0.35	0.5500	3.8106	5.0837	6.2107	7.2728	7.6356	7.9161
27	0.36	0.6167	6.1387	8.1895	10.0050	11.7161	12.3004	12.7523
28	0.41	0.7998	5.6894	7.5901	9.2728	10.8586	11.4001	11.8190
29	0.26	0.7808	4.9266	6.5724	8.0295	9.4027	9.8717	10.2343
30	0.06	0.4250	0.2300	0.3069	0.3749	0.4390	0.4609	0.4779
31	0.98	0.7008	6.6567	8.8805	10.8493	12.7047	13.3383	13.8284
Way Kunyit								
1	0.375	0.5613	4.1459	5.5309	6.7571	7.9127	8.3073	8.6125
2	0.530	0.7500	7.2932	9.7296	11.8867	13.9195	14.6137	15.1506
3	1.100	0.5816	20.2753	27.0486	33.0452	38.6966	40.6265	42.1191
4	0.248	0.6895	2.3318	3.1107	3.8004	4.4503	4.6723	4.8439
5	1.020	0.5440	7.3880	9.8562	12.0413	14.1005	14.8038	15.3476
6	0.420	0.7690	6.8768	9.1741	11.2080	13.1248	13.7794	14.2856
7	0.648	0.8698	8.2665	11.0281	13.4730	15.7771	16.5640	17.1725
8	0.570	0.5702	8.6536	11.5446	14.1040	16.5160	17.3397	17.9767
9	0.360	0.6167	2.2090	2.9469	3.6002	4.2159	4.4262	4.5888
10	0.260	0.5596	2.2931	3.0592	3.7374	4.3766	4.5949	4.7637

Continued

Way Kuripan								
1	0.435	0.5500	5.9896	7.9906	9.7621	11.4316	12.0017	12.4426
2	1.430	0.5500	17.7022	23.6159	28.8515	33.7857	35.4707	36.7738
3	0.165	0.5500	1.6404	2.1884	2.6736	3.1308	3.2869	3.4077
4	0.583	0.5530	3.6796	4.9089	5.9972	7.0228	7.3731	7.6439
5	0.220	0.7500	2.4978	3.3322	4.0709	4.7671	5.0049	5.1888
6	0.100	0.7500	1.4823	1.9775	2.4159	2.8290	2.9701	3.0793
7	0.030	0.8000	0.6257	0.8347	1.0198	1.1942	1.2537	1.2998
8	0.260	0.8645	4.4989	6.0019	7.3325	8.5865	9.0147	9.3459
9	0.100	0.7500	1.4138	1.8861	2.3043	2.6983	2.8329	2.9370
10	0.050	0.7500	1.3166	1.7564	2.1458	2.5128	2.6381	2.7350
Way Kupang								
1	0.404	0.6448	6.5258	8.7059	10.6360	12.4550	13.0761	13.5565
2	0.160	0.7563	3.8173	5.0926	6.2216	7.2856	7.6490	7.9300
3	0.210	0.7500	6.7338	8.9834	10.9750	12.8519	13.4929	13.9886
4	0.120	0.7500	4.3183	5.7609	7.0381	8.2418	8.6528	8.9707
5	0.160	0.8594	1.8476	2.4649	3.0113	3.5263	3.7022	3.8382
6	0.040	0.9250	1.0038	1.3392	1.6361	1.9159	2.0114	2.0853
7	0.046	0.7563	0.3750	0.5002	0.6111	0.7156	0.7513	0.7789
8	0.100	0.8000	0.8315	1.1093	1.3552	1.5870	1.6661	1.7273
9	0.020	0.9958	0.3400	0.4536	0.5542	0.6489	0.6813	0.7063
10	0.180	0.7668	5.1355	6.8511	8.3700	9.8014	10.2902	10.6683
Way Penengahan								
9	1.86	0.6639	34.3257	45.7928	55.9450	65.5126	68.7800	71.3068
10	0.72	0.7998	7.7886	10.3905	12.6941	14.8650	15.6063	16.1797
11	0.38	0.7545	4.8202	6.4304	7.8560	9.1996	9.6584	10.0132

Table 4. Maximum capacity of outlets (m^3/sec) and outlets capability (years)

outlets	Cross section of river area (m^2)	roughness Manning	Radius of Hydraulic	slope (S)	Velocity of flow (m/sec)	Kapasitas Max. Capacity of river (m^3/sec)	River capability (years)
Way Kedamaian							
1	1.4000	0.0350	0.4268	0.0300	2.8053	3.9274	0.28
2	4.5900	0.0500	0.7809	0.0087	1.5819	7.2610	0.56
3	1.0800	0.0160	0.3366	0.0164	3.8730	4.1828	6.80
Way Awi							
4	5.3215	0.3500	0.7083	0.0335	0.4155	2.2112	7.90
5	4.4000	0.4500	0.6894	0.0070	0.1451	0.6384	1.10
6	2.7250	0.0550	0.5134	0.0225	1.7486	4.7650	0.28
7	11.8500	0.0500	1.3167	0.0075	2.0807	24.6568	2.30
8	3.1050	0.0200	0.5258	0.0165	4.1840	12.9913	91.50
12	2.0000	0.0400	0.5183	0.0172	2.1156	4.2311	2.50
13	12.6000	0.0450	1.5501	0.0172	3.9035	49.1846	0.45
14	19.2100	0.0300	0.8353	0.0012	1.0242	19.6740	0.60
15	5.2000	0.0350	1.1766	0.0097	3.1362	16.3082	16.50
16	7.6000	0.0350	0.7251	0.0036	1.3836	10.5155	12.00

Continued

Way Penengahan							
9	3.7200	0.0350	0.7880	0.0067	1.9952	7.4222	0.16
10	8.4500	0.0350	1.2210	0.0032	1.8464	15.6018	1.00
11	9.0000	0.0400	1.1002	0.0104	2.7171	24.4538	5.40
Way Simpur							
17	3.3000	0.1600	0.3353	0.0100	0.3016	0.9954	100.00
18	0.7250	0.1600	0.7461	0.0149	0.6276	0.4550	0.25
19	4.5000	0.0200	0.6329	0.0229	5.5776	25.0990	84.00
20	2.9000	0.0287	1.3491	0.0188	5.8330	16.9157	1.00
21	9.6500	0.0345	1.9012	0.0105	4.5582	43.9867	65.00
22	29.6000	0.0402	1.7608	0.0112	3.8387	113.6270	11.80
Way Kuala							
23	39.0000	0.0517	2.1446	0.0256	5.1467	200.7204	30.00
24	36.4000	0.0517	0.4823	0.0161	1.5094	54.9417	85.00
25	164.9000	0.0460	0.2280	0.0132	0.9321	153.7115	100.00
26	3.1250	0.0400	0.3368	0.0268	1.9812	6.1912	95.25
27	0.4800	0.0350	0.3931	0.0250	2.4242	1.1636	0.08
28	0.8800	0.0170	0.4709	0.0191	4.9206	4.3301	2.25
29	1.1200	0.0170	0.3931	0.0268	5.1676	5.7877	3.50
30	1.7000	0.0160	0.4709	0.0010	1.1963	2.0337	0.35
31	65.6000	0.0460	0.4769	0.0853	3.8756	254.2370	25.00
Way Kunyit							
1	0.5800	0.0170	0.2682	0.0354	4.6028	2.6696	2.00
2	2.4788	0.0450	0.6339	0.0333	2.9924	7.4176	6.50
3	3.0400	0.0350	0.6598	0.0222	3.2264	9.8082	0.75
4	3.6100	0.0517	0.6792	0.0050	1.0568	3.8150	0.64
5	0.7000	0.0130	0.2652	0.0089	2.9955	2.0968	0.30
6	0.5000	0.0120	0.2049	0.0089	2.7324	1.3662	0.15
7	0.9350	0.0160	0.3202	0.0181	3.9355	3.6797	0.01
8	3.4000	0.0450	0.5667	0.0624	3.8014	12.9249	1.25
9	0.6400	0.0160	0.2667	0.0006	0.6343	0.4060	0.01
10	8.7700	0.0500	1.1383	0.0056	1.6317	14.3096	0.65
Way Kuripan							
1	1.4000	0.0240	0.2138	0.0433	3.1001	4.3401	2.80
2	0.6800	0.0120	0.2720	0.0643	8.8710	6.0322	34.50
3	1.3230	0.0350	0.3656	0.0486	3.2205	4.2607	1.28
4	1.5000	0.0170	0.4345	0.0163	4.3083	6.4624	38.50
5	0.3200	0.0200	0.2000	0.0170	2.2295	0.7135	0.75
6	0.7225	0.0200	0.4117	0.0042	1.7933	1.2956	11.00
7	1.0000	0.0230	0.4184	0.0015	0.9420	0.9420	4.50
8	1.6500	0.0230	0.4459	0.0025	1.2688	2.0936	0.80
9	2.3400	0.0230	0.5318	0.0030	1.5631	3.6578	0.20
10	2.6000	0.0250	0.5652	0.0100	2.7344	7.1094	0.95

Continued

Way Kupang							
1	0.7000	0.0170	0.3655	0.0577	7.2232	5.0563	38.50
2	0.9750	0.0402	0.2840	0.0268	1.7595	1.7155	0.25
3	0.5615	0.0200	0.3974	0.0125	3.0216	1.6967	5.25
4	4.8325	0.0460	0.9226	0.0186	2.8098	13.5783	7.50
5	5.2240	0.0350	0.6757	0.0170	2.8685	14.9852	7.30
6	1.0000	0.0172	1.0000	0.3522	34.5037	34.5037	86.50
7	0.8000	0.0170	0.3077	0.0025	1.3405	1.0724	0.50
8	0.5600	0.0170	0.2531	0.0083	2.1443	1.2008	0.50
9	1.0800	0.0200	0.4837	0.0209	4.4541	4.8104	99.00
10	7.8500	0.0450	1.0072	0.0135	2.5944	20.3658	8.00

The main disposal channel of the Tanjungkarang area is Way Kuala with a good capability over 100 years except the main outlet (only 25 year old capability). Reduced ability is due to the sedimentation that occurs. Furthermore, the average drainage ability of Way Kedamaian, Way Awy, Way Penengahan, Way Simpur 6.8 years, 12 years, 5.4 years, and 11.8 years respectively.

Outlet with the lowest ability is the outlet of Kuala 27, because it is not in the residential area, so the effect is not too felt. While the outlets 5, 6, 9, 10 floods that occur are felt because of the densely populated area and the center of activity. It happens because of narrowing the cross section of the river by the buildings on the channel cliffs. Length of puddle occurred 9, 18, 13, 7 minute and volume of puddle 880, 4,635, 4,600, and 700 m^3 for 2 year of flood return period.

The main drainage channels in the bay area are Way Kunyit, Way Kuripan, and Way Kupang. Way Kunyit has a capacity of 0.95 years. The puddle length for Way Kunyit is 18 minutes and the flood volume is 1,500 m^3 for 2 year floods return period.

The Kuripan Way has a channel capability of 0.65 years, length of inundation of 6 minutes and 1,100 m^3 flood volume for 2 years flood return period. At outlets 5, 8, 9, 10 are located in densely populated areas and the activity centers have low channel capability of 0.3 years, 1.25 years, 0.8 years, and 0.65 years respectively.

The puddle period for Way Kupang only occurred in 10 years repeat period of 60 minutes and flood volume of 216 m^3. At 8 Way Kupang outlet become problems because in industrial area and dense activity of channel ability 0.5 year, puddle period of 20 minutes and volume 936 m^3, to 2 year flood return period.

IV. CONCLUSION

The main drainage channel of the Tanjung Karang area namely Way Kuala, is basically well-skilled, but the average collector channel is poorly skilled for less than 10 years.

The main drainage channel of Teluk Betung area, Way Kunyit, Way Kupang, and Way Kuripan are generally poorly skilled, the average of capability is less than 10 years.

REFERENCES

Ali M., S. J. Khan, I. Aslam, Z. Khan. 2011. Simulation of the impacts of land-use change on surface runoff of Lai Nullah Basin in Islamabad, Pakistan. LandscapeandUrbanPlanning102. p. 271–279

Fuad Halim. 2014. Pengaruh hubungan tata guna lahan dengan debit banjir pada daerah aliran sungai malalayang. Jurnal Ilmiah Media Engineering Vol.4 No.1, (45-54) ISSN: 2087-933445.

Hidayata A. dan A.Hendrawan. 2017.Model Dan Simulasi Peringatan Dini Bencana Banjir Menggunakan Metode Rasional .JUTEKIN Vol 5 No. 1 (2017) – ISSN : 2338-1477 – EISSN : 2541-6375

Indarto. 2010. Hidrologi Dasar Teori dan Contoh Aplikasi Model Hidrologi. Jakarta : Bumi Aksara.

Kimaro, T.A., Tachikawa, Y., and Takara, K. 2005. Distributed Hydrologic Simulation to Analyze The Impacts of Land Use Change on Flood Characteristic in The Yasu River Basin in Japan. *Journal of Natural Disaster Science : Vol 27, No.2 : pp. 85-94.*

Kimaro, T.A., Tachikawa, Y., and Takara, K. 2005. Distributed Hydrologic Simulation to Analyze The Impacts of Land Use Change on Flood Characteristic in The Yasu River Basin in Japan. Journal of Natural Disaster Science : Vol 27, No.2 : pp. 85-94.

Kodoatie, R.J., 2001. Beberapa Penyebab dan Metode Pengendalian Banjir dalam Prespektif Lingkungan, Pustaka Pelajar, Celeban Timur, Yogyakarta.

Kundu, P. M. And Olang, L. O. 2011. The Impact of Land Use Change On Runoff and Peak Flood Discharges for The Nyando River in Lake Victoria Drainage Basin, Kenya. *WIT Transaction on Ecology and The Environment : Vol. 153 (ISSN 1743-3541).*

Kundu, P. M. And Olang, L. O. 2011. The Impact of Land Use Change On Runoff and Peak Flood Discharges for The Nyando River in Lake Victoria Drainage Basin, Kenya. WIT Transaction on Ecology and The Environment : Vol. 153 (ISSN 1743-3541).

G.3

GROWTH PATTERNS AND CONDITION FACTORS OF SNAKEHEAD FISH (*Channa sriata* (Bloch, 1793)) IN THE FLOOD PLAIN AREA OF SEBANGAU PALANGKA RAYA

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ABSTRACT

Snakehead fish (Channa striata) is one type of fish that lives in the flooding swamp area. Flood waters are shallow waters located in swampy forest area, whose water temperature around 28-32^{o}C, pH 3-4, and low oxygen content of about 2-4 mg/L. This study aimed to examine the pattern of reproduction of snakehead (Channa striata) in the area of flood swampy water. This study was conducted in 6 months from August 2016 to January 2017. Sampling of fish taken from upstream, middle and downstream of Sebangau river. Measurement of total length and body weight was carried out using 545 samples of fish. The results of the research showed that the growth pattern of snakehead generally is allometric positive meaning that the length growth of the fish is not as fast as weight gain, with the equation $W = 0.0196x^{3.1223}$ ($R^2 = 0.9634$). The male snakehead fish has the equation $W = 0.0215x^{3.094}$ ($R^2 = 0.9674$) while the female snakehead fish has the equation $W = 0.0165x^{3.1771}$ ($R^2 = 0.955$) and both are allometric positive. At the station 2 the snakehead fish (male and female) have the equation $W = 0.0258x^{3.0437}$ ($R^2 = 0.9713$) whereas at the station 3 the snakehead fish (male and female) have the equation $W = 0.0168x^{3.1666}$ ($R^2 = 0.9379$), and both stations are allometric positive. The condition of male and female fishes varies based on time place.

Keywords : Channa striata, condition factor, growth

I. INTRODUCTION

Snakehead fish (*Channa striata*) is one type of fish member of the family Channidae. In addition there are several other types that similar to the fish type, they are; fish jalai (*Channa maruliodes*), shed (*Channa pleurophthalma*), persuasion (*Channa lucius*), toman (*Channa micropeltes*), and runtuk (*Channa bankanensis*). According to Paray (2013) the geography distribution area of snakehead fish covers a wide area starts from China, India, Sri Lanka, Philippines, Nepal, Burma, Pakistan, Bangladesh, Singapore, Malaysia, and Indonesia (Sumatra, Kalimantan and Java). This fish generally lives in habitats like lakes, swamps, irrigation canals and rice farmland that are waterlogged.

Snakehead fish (*Channa striata*) is a type of fish that lives in public water with economic price and abundant to catch. This fish contains higher protein than other types of fish (Muhammad *et al*. 2013). According Makmur (2003) this fish mostly used for processed food products of South Sumatra (ex;crackers and pempek). Widodo (2017) states that the production of NCS (Natural Collagen Spray) from fish scales can help to repair damaged skin tissue with anti-aging effect. As the population increases, the demand of snakehead fish is almost entirely derived from the catch in nature. Until now the need for cork fish is almost entirely derived from the catch in nature. The exploitation of these fish is getting higher and not only catch large ones, but the seeds are collected to be used as food for ornamental fish such as flowerhorn fish and arwana fish. The Dense of Snakehead fishing activities with increasing production volume annually can lead to overfishing. The condition affect of growth overfishing occurs because many fishing activities catch too young fish, so there is no chance to reach adult size and this will certainly threaten its sustainability.

This study is aimed to examine the growth patterns and condition factors of snakehead fish (*Channa striata*), in the swampy waters of the Sebangau River, Palangkaraya, Central Borneo.

II. MATERIALS AND METHODS

A. Location and time of study

The research was conducted in the Sebangau River which is part of the Kahayan watershed which is located in the Palangka Raya municipality. The field research was conducted from August 2016 to January 2017.

B. Fish sampling and laboratory activities

Sampling to get a picture that can represent the biology condition of fish in swampy flood of Sebangau River Palangka Raya is implemented by using field survey method. Fish sampling is implemented by Simple Random Sampling (PCAS) technique in one month retrieval time.

The location of the snakehead fishing is in the swampy River flood of the Sebangau which is located in Palangka Raya, Municipality of Central Borneo, namely: station 1 is located in the upstream, of this location called Sungai Koran (forest area), Palangkaraya municipality; station 2 is located in Kereng Bangkirai urban village, Sabangau sub-district, Palangka Raya municipality; and station 3 is located in the downstream, of this location called Bakung (forest area), Palangka Raya Municipality (Fig. 1).

Fig. 1. Location map of snakehead fish research area (*Channa striata*)

This study was conducted in 6 months with fish sampling within interval once a month. Fishes were collected alive from the catch of fishermen. Fishing tools used were fishing rods, traps, and nets. The sampled fishes obtained were classified by location and time place. The measurement of length and weighing of fish samples using scales with 0.1 g accuracy was conducted on field.

C. Data analysis

1. Growth Patterns

Relationship between length and weight of the fish has a practical value that allows changing the value of length into the weight of the fish value or vice versa. Snakehead fish (*Channa striata*) can be considered as a function of its length, and this length and weight relationship almost leads to the cubic law follows the cubic law performed by the model used in hypothesized the length and weight relationship (Effendie, 1979), which is the following exponential relationship:

$$W = a\,L^{b} \tag{1}$$

Where :

W = weight (gram)

L = long (cm)

a and b = Constants

The t test is used to test the value of b is equal to 3 or not. If the value of b greater than 3 means the length of the fish is not as fast as the weight gain or also called the *positive allometric* growth pattern, whereas if the value of b is smaller than 3, it means the growth rate of the length of the fish is greater than the weight of the fish and is also called the *negative allometric* growth pattern. If the value of b is equal to 3, this means that the length increases is proportional to the weight gain and so called the *isometric* growth pattern.

$$t_{hitung} = \left|\frac{b_1 - b_0}{Sb_1}\right| \quad (2)$$

Then conclude a hypothesis:
H0: b = 3, the long relationship with weight is isometric
H1: b ≠ 3, long relationship with weight is allometric
B1 = value b (from relationship of weight length), b0 = 3, Sb1 = coefficient deviation b.

2. Condition Factors

Condition factors analysis was based on size and sex of fish and time place. According to Effendie (2002), to calculate the fish condition factor the following formula was used:

$$Kn = \frac{W}{aL^b} \quad (3)$$

Information:
Kn = condition factors
W = weight of fish (gram)
L = total length of fish (cm)

III. RESULTS

A. Environmental Condition of Waters In The Flood Plain Area of Sebangau

The results of measuring the environmental conditions of the flood waters of the Sebangau River in Palangka Raya are presented in Table 1.

Table 1. Water Physical-chemical parameters of the Sebangau River Palangka Raya

Parameter	Unit	Measurement results		
		Station 1	Station 2	Station 3
Temperature	°C	28.0 – 34.4	28.0 – 35.0	28.0 – 36.7
Depth	cm	50 – 79	63 - 112	50 - 106
Brightness	cm	45 - 66	38 – 76	39 - 75
pH	-	3 - 4	3 - 4	3 - 4
Dissolved oxygen	ppm	2 – 3	2 – 3	1 - 4

Water temperature in the swampy waters flooded the Sebangau River Palangka Raya ranged from 28.0 to 36.70°C. Water depth ranges from 50-112 cm, water brightness ranges from 38 to 76 cm, the pH ranges from 3-4, and dissolved oxygen ranges from 1 - 4 ppm. The parameters natural condition measured in this study is not much different from one location to another. Although there is a tendency that increasingly the downstream, temperature and water depth the trend is widening.

B. Growth Patterns

The long-term relationship of the weight of fish has a very close correlation. Based on the value of correlation coefficient (r) approaching one, the magnitude of the correlation shows that the length of the fish followed by the increase in body weight. From the results of this study the distribution of length of fish (*Channa striata*) is TL: 16.0 - 36.9 cm. The overall growth pattern of fish (*Channa striata*) from 545 samples from the Sebangau River flood plain of Palangka Raya, Central Borneo is *allometric positive,* that the length of fish increase is not as fast as the weight gain by following the length equation of total fish weight $W = 0.0196x^{3.1223}$ ($R^2 = 0.9634$). The male fish is equation $W = 0.0215x^{3.094}$ ($R^2 = 0.9674$) while female fish with equation $W = 0.0165x^{3.1771}$ ($R^2 = 0.955$) is *allometric positive*. At the station 2 male and female fish with equation $W = 0.0258x^{3.0437}$ ($R^2 = 0.9713$) while station 3 male and female fish with equation $W = 0.0168x^{3.1666}$ ($R^2 = 0.9379$) *allometric positive*. Therefore, male and female snakehead fish have long growth is *allometric positive* presented in Fig. 2, 3, and 4.

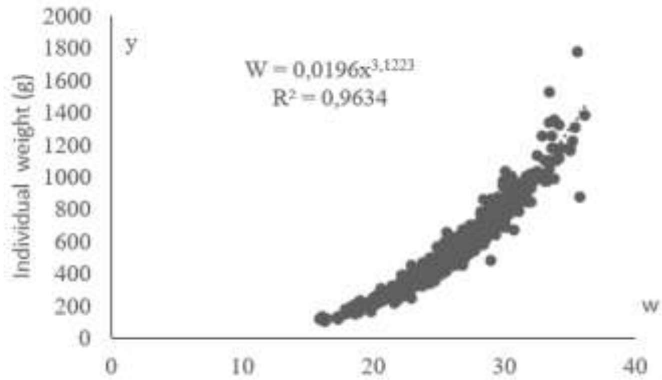
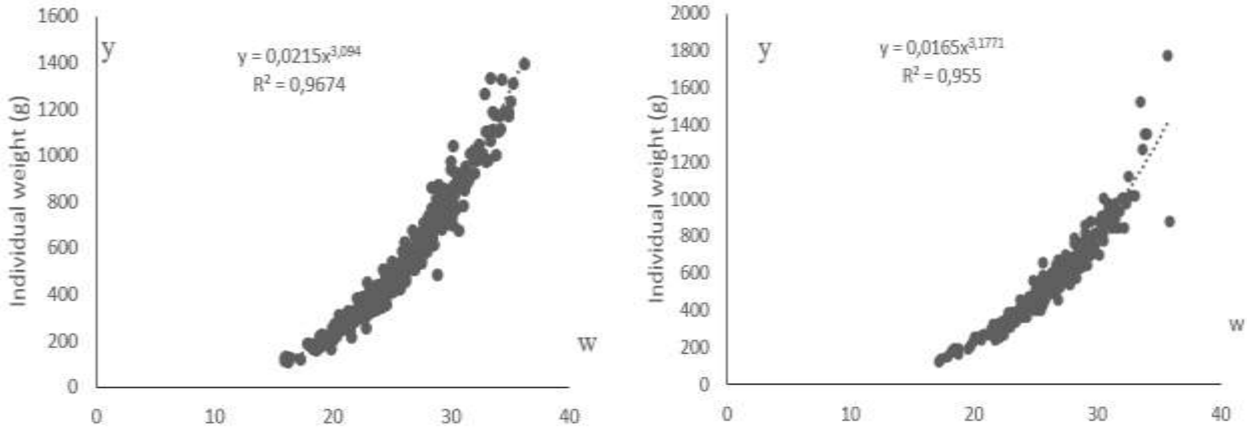
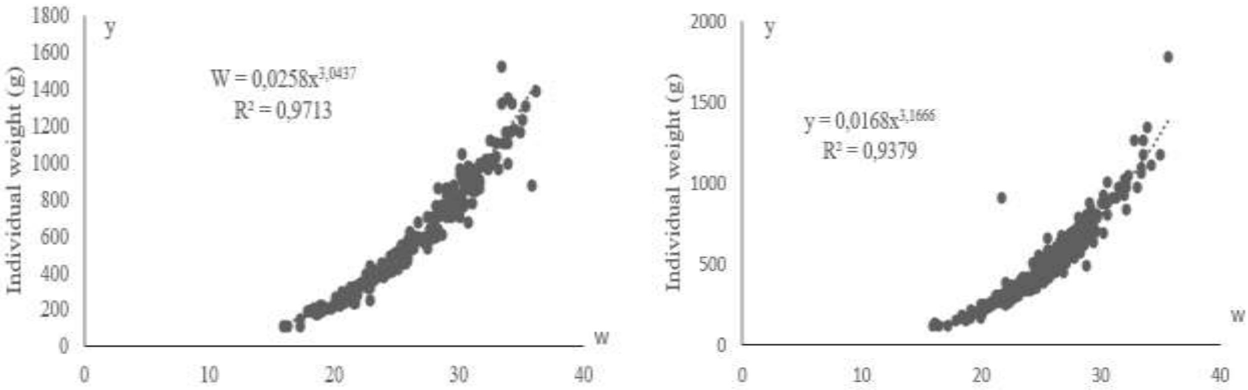


Fig. 2. Length-weight relationship snakehead fish generally



(a) (b)

Fig. 3. Length-weight relationship of snakehead fish (a) male and (b) female

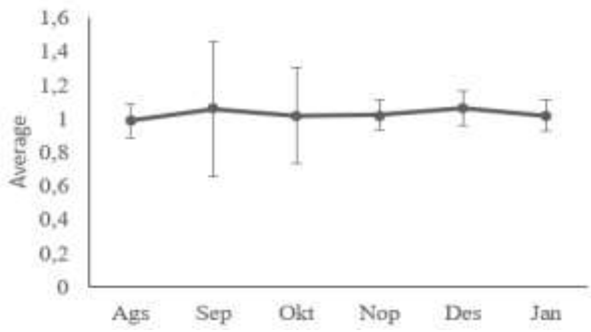


(a) (b)

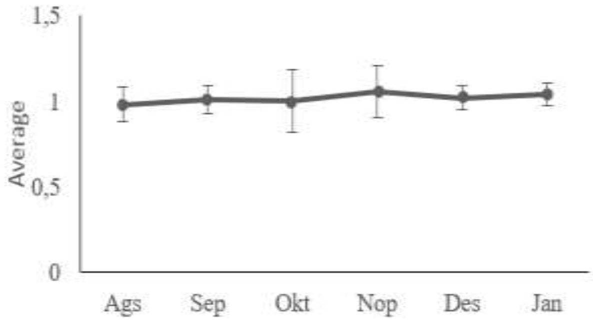
Fig. 4. Length-weight relationship snakehead fish (a) at station 2 and (b) at station 3

C. Condition Factors

Data on the condition factors of male and female snakehead fish in each month of observation are presented in Fig. 5. While the condition of male and female snakehead fish as a whole is presented in Fig. 6, from the overall Snakehead fish condition factor data based on the observation station is presented in Fig. 7. The lowest condition factor values for each males were the smallest value of the average condition factor present in August (0.98 ± 0.09) and largest in December (1.05 ± 0.10). While for the each females is the smallest condition factor found in August (0.97 ± 0.9) and largest in November (1.05 ± 0.15). Overall, the value of the male and female conditions were not different (Fig. 6), the value of the snakehead fish condition factor did not show any difference between station 2 and 3 either by sex or overall.



(a)



(b)

Fig. 5. Condition factors of male snakehead fish during the study (a) male and (b) female

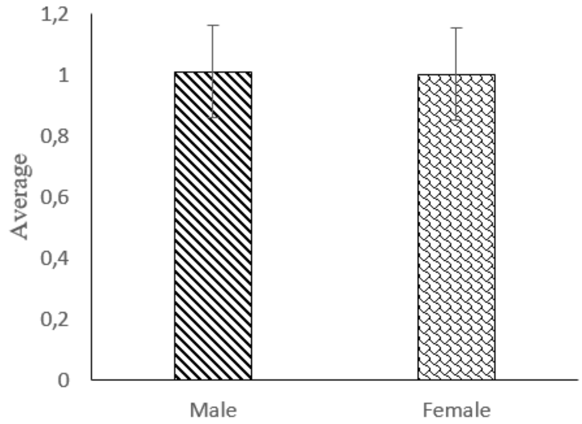


Fig. 6. Condition factors snakehead fish of male and female during the study

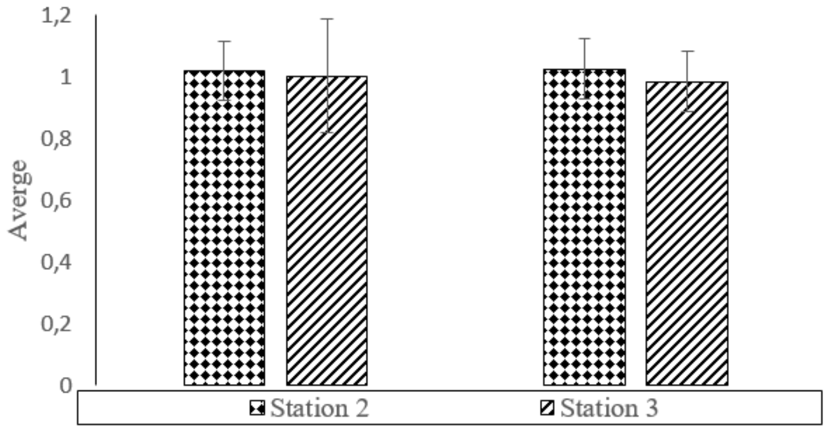


Fig. 7. Condition factors snakehead fish of male and female based on location

IV. DISCUSSION

Saputra *et al*. (2015) recoded that temperature for snakehead fish spawning is 28-32ºC. This temperature was the optimal for spawning snakehead fish. Snakehead fish has the advantage of being able to tolerate unfavorable conditions such as low oxygen levels and low pH (4.5-6.5) (Kusumaningrum, 2014). The result of Ramli's research (2010) showed that in the general waters of South Borneo the degree of acidity (pH) in small river was 5.74-6.15 and swamp was 5.30-6.40, and dissolved oxygen content was 3.9-6.0 ppm. Another study conducted by Nurdawati *et al*. (2007) on the snakehead fish in the peat swamp found in South Barito regency of South Borneo, the pH was 4.0-5.0.

A. Growth Patterns

Makmur *et al*. (2003) stated that the growth pattern of snakehead fish from July to August is *isometric*, while in September to December 2002 the growth pattern of snakehead fish is *allometric negative*. In another study of snakehead fish in the swamp of Musi Sumatera Selatan watershed conducted by Karmon (2011), the relationship of length and weight of all male and female fish has the same determinant (R^2) value of 0.97 with b value of male 3.10 and female 3.15. The growth pattern of snakehead fish is *allometric* (counted > table) which means weight growth during observation was faster than the length growth of snakehead fish. Muthmainnah (2013) states that the length-weight relationship of the snakehead fish does not show any significant difference with the value of b below the value 3 which means the growth of the fish is *allometric negative*. Based on the literature data, it can be concluded that the pattern of snakehead fish growth in this study is consistent with the results of another studies that is *allometric positive*.

B. Condition Factors

Another study of snakehead fish in the swamp of Musi Sumatera Selatan watershed conducted by Karmon (2011) obtained the value of the conditions in February the average male fish 1.04 ± 0.10, and female 1.02 ± 0.14. Next on month March, there was an increase in the condition factor for males 1.09 ± 0.19, mean while in females decreased in the condition factors to 0.98 ± 0.09. In April there was a decrease in male value condition factors (1.02 ± 0.13), and female (0.96 ± 0.09). In May the male fish condition factors is 1.00 ± 0.10, female 0.97 ± 0.08. While in June the value of male fish condition factors 0.98 ± 0.13, and in female 0.97 ± 0.26. Makmur (2004) stated that the value of snakehead fish condition factors is influenced by differences in age, environmental conditions, and availability of food in the waters. The results of this study indicate that the snakehead fish (*Channa striata*) is still at the threshold of normal conditions because it is still in the range of values (k), that is between 1-3.

V. CONCLUSION

The growth pattern of snakehead fish in the swampy water of the Sebangau River flood, Palangka Raya is *allometric positive*, based on both gender and sampling location. The snakehead fish condition factor varied based on the time place but did not show any difference between the sexes.

The overall growth pattern of the snakehead fish *Channa striata* (TL: 16.0 - 36.9 cm) taken from of 545 samples of the swampy River flood Sebangau, Palangka Raya, Central Borneo was *allometric positive*. The lowest snakehead fish value condition factors on (0.98 ± 0.09) and the highest in December (1.05 ± 0.10) while the female snakehead fish in August was the lowest (0.97 ± 0.09) and the highest in November (1.05 ± 0.15).

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REFERENCES

Effendie MI. 1979. *Method of Fisheries Biology. Bogor*: Yayasan Dewi Sri.112 pages.

---------------. 2002. *Fisheries biology. Yogyakarta*: Yayasan Pustaka Nusatama.

Kusumaningrum GA, Alamsjah MA, Masithah ED. 2014. Albumin level Test and Snakehead Fish (*Channa striata*) Growth with Different Commercial Feed Protein Level. *Journal Fisheries and Marine*. 6(1): 25-29.

Makmur S, M.R Rahardjo MF, Sukimin S. 2003. Reproductive Biology of Snakehead Fish, *Channa striata* Bloch in Flood Plain Area of Musi River,
South Sumatera. *Journal Iktiologi Indonesia*. 3(2): 57-62.

------------. 2004. Growth of snakehead fish (*Channa striata* Bloch) in flood plain area of Talang Fatima Musi river, South Sumatra. *JPPI Resources and arrests*. 10(6): 1-6.

Muhammad, Alfarisy U, Abdulgani N, Ulfin I. 2013. Effect of Body Length and Gender on Albumin Contents of Snakehead Fish (*Channa striata*). *Journal Sains and Seni Pomits*. 2(1): 2337-3520.

Muthmainnah D. 2013. The length-weight relationship and condition factor of striped snakehead (Channa striata Bloch, 1793) grow out in swamp pond, South Sumatra Province. *Journal Depik*. 2(3): 184-190.

Nurdawati S, Husnah, Asyari, Prianto E. 2007. Fish fauna in peat swamp lake in
South Barito, Central Kalimantan. *Journal Iktiologi Indonesia*. 7(2): 89-97.

Paray, Haniffa M.A, Manikandaraja D, James Milton M. 2013. Journal Breeding Behavior and Parental Care of the Induced Bred Striped Murrel *Channa striatus* Under Captive Conditions. Turkish. *Journal of Fisheries and Aquatic Sciences*. 13(4): 707-711.

Putra, KK. 2011. Growth and Reproduction of Chevron Snakehead (*Channa striata*); Their relationship with Habitat Conditions of Musi Flood plain, South Sumatera. [Tesis]. Bogor (ID): Bogor Agricultural University.

Ramli HR, Rifa'i MA. 2010. Study on food Habits, Parasites and habitat Bio-Limnology of Snakehead Fish (*Channa striata*) in Common Aquatic of South Kalimantan. *Journal Ecosystem*. 10(2): 76-84.

Saputra A, Muslim, Fitriani M. 2015. The Spawning of Snakehead (*Channa striata*) Stimulated Synthetic Gonadotrophine Hormone with Different Doses. *Journal Aquaculture Swamp Indonesia*. 3(1) :1-9.

Steel RG, Torrie JH. 1993. *Principles and Procedures of Statistics. Sumantri B. Translator Jakarta*. Gramedia Main library. Translation of: Principles and Procedures of Statistics.

Widodo. 2017. Production of Natural Collagen Spray (NCS) Based on Samples of Fish Procesing. UB [Internet]. [Downloaded] on April 5, 2017. Available at https://prasetya.ub.ac.id/berita/Dosen-Biologi Create-Collagen-of-Scales-Snakehead-fish-19531-id.html

G.4

APPLICATION METHOD OF BIOCHAR ON THE SOIL AMELIORATION TO INCREASE PRODUCTION OF RICE (*Oryza sativa* L.)

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ABSTRACT

Soil amelioration used either organic materials or mineral materials accelerate the availability of nutrients and correlated to the increase in rice production. It's depends on the precision of the type, dose and application methods ameliorant. The study aimed to determine the best combination of ameliorant and biochar application techniques on growth and yield of rice were conducted from April until August 2016 at the greenhouse STIPER Dharma Wacana Metro. The research was design prepared in factorial by completely randomized block design with three (3) replicates. The first factor is the composition of ameliorant (A), consists of three levels, namely: manure 20 tons/ha + zeolite 2 tons/ha + dolomite 2 tons/ha (a_1), rice straw compost 50 tons/ha + zeolite 2 tons/ha + dolomite 2 tons/ha (a_2), and rice straw compost 75 tons/ha + zeolite 3 tons/ha + dolomite 3 tons/ha (a3). The second factor is biochar application techniques (B), consists of three levels, namely: as amelioration (b_1), as a coating urea (b_2), and a filter (b_3). The results showed that fine biochar application both as ameliorant or as a coating of urea in combination with rice straw compost 75 tons/ha + zeolite 3 tons/ha + dolomite 3 tons/ha is more effective in the increasing nutrient availability which is indicated by the growth and yield of rice is better than the other treatments.

Key words: Ameliorant organic, mineral ameliorant, biochar, rice production.

I. INTRODUCTION

Efforts to improve soil quality have a positive correlation to increased growth and production of rice. The application of various ameliorants in paddy soil both in the form of organic materials and mineral materials can improve the physical, chemical and biological properties of the soil. Straw is a source of organic ameliorant that needs to be considered to maintain soil quality because of its profusion after the rice harvest. The aplication 5 tons of straw contributed 38 kg N, 3 kg P, 113 kg K and 209.5 kg Si. [1] reported that rice straw that has been fermented with EM4 recommended for replacement of manure in increasing growth and yield of rice, but requires In large quantities around 50 tons/ha.

In addition to fermentation techniques, ameliorants can also be produced by carbonation organic wastes techniques become the biochar. Biochar was a process of pyrolysis of carbon at temperature 600-900^oC from agricultural waste material such as rice husk, rice straw, corn cob, corn stalk, coconut fiber, corncob waste, empty bunches, palm shell, cacao [2]. The fundamental difference between activated charcoal and biochar is its larger and branched pore shape and zigzag in the biochar. Some research results on the use of biochar in agricultural cultivation both in vitro culture medium [3] and ex vitro in reducing pesticide residues in soil, water and agricultural products such as Cd and Pb [4]. Biochar of corn cob waste in cabbage garden can decrease chlorpyrophic residual insecticide in water up to 50%. Biochar from rice husk can reduce the content of pesticide residue in the soil up to 70%. Biochar pore as the ideal home for Pseudomonas sp bacteria that serves as carbofuran degradation up to more than 50%. In addition, the use of biochar in agricultural land can increase the number of bacteria pemfiksasi Nitrogen (Azotobacter) in the soil, especially around the roots of food crops. Thus the study of application methods of biochar on soil paddy has been given ameliorant important to get healthy food free from heavy metal Pb and Cd and can reduce emission CO_2, CH_4 and N_2O produced in paddy field.

The purpose of this research is to obtain the best technology package to increase the production of healthy rice in a sustainable manner with amelioration biochar.

II. MATERIALS AND METHODS

The experiment was conducted in the green house STIPER Dharma Wacana, Kota Metro, Lampung, Indonesia, starting from April until July 2015. The tools used were: tubs, buckets, hoes, sickles, machetes, plastic bags of various sizes, glasses measurement, analytical scale, stationery and documentation. The materials used were: rice seed of ciherang variety, manure, fresh straw, compost straw, zeolite, dolomite, insecticide with chlorantraniliprol active ingredient.

The research was design in factorial by completely randomized block design with three replicates. The first factor is the composition of ameliorant (A), consists of three levels, namely: manure 20 tons/ha + zeolite 2 tons/ha + dolomite 2 tons/ha (a_1), rice straw compost 50 tons/ha + zeolite 2 tons/ha + dolomite 2 tons/ha (a_2), and rice straw compost 75 tons/ha + zeolite 3 tons/ha + dolomite 3 tons/ha (a3). The second factor is biochar application techniques (B), consists of three levels, namely: as amelioration (b_1), as a coating urea (b_2), and a filter (b_3). So, there are nine treatment combinations.

The observation data were tested homogeneity with Barlett test, the non-additives with Tuckey test, analysis of variance was done by comparing F value than F table, and follow with the lest small difference test (LSD). All tests are performed at a 5% level.

Implementation of the experiment

The experiment was carried out in greenhouses, beginning with prepared planting media in a tub which have 45 cm diameter. The paddy soil in the basin was water then crushed to mud, left for a week, freshly fed and biochar application techniques in accordance with the treatment a_1b_1, a_2b_1, a_3b_1, a_1b_2, a_2b_2, a_3b_2, a_1b_3, a_2b_3, and a_3b_3. Seeds of cultivated varieties of ciherang seedlings were planted in tubs of 3 pieces per planting hole. Fertilizer was given 3 times, namely: 150 kg.ha^{-1} Ponska when age plant 14 days, 150 kg.ha^{-1} Ponska + 50 kg.ha^{-1} Urea at 21 days and 50 kg.ha^{-1} Urea at 35 days. Maintenance includes flooding 5 cm above ground level, spraying of insecticides using active chlorantraniliprol 50 g.l^{-1} done during disease attack and weeding weed manually.

III. RESULTS AND DISCUSSION

The analysis of variance showed that the differences amelioran type and application method of biochar had no significant effect on some observed variables (plant height, number of tillers, number of productive tiller, grain content per panicle, grain weight per clump, and 1000 grain weight) and no interaction between the two factors. However, in the dry weights of Crops variables, the ameliorant type was not significantly different but the biochar application was significantly different and there was an interaction between these factors.

Table 1. High Rice Crops due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)			Average
	Amelioran	Urea Coatings	Filter	
	......................cm........................			
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	111.37	112.63	110.23	111.41 A
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	112.00	108.37	111.87	110.74 A
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	111.97	109.40	110.77	110.71 A
Average	111.8 a	110.13 a	110.9 a	

BNT A= 2.75; BNT B= 2.75 BNT (AxB) = 4.75

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

Table 2. Number of tillers due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)			Average
	Amelioran	Urea Coatings	Filter	
	......................piece........................			
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	16.33	17.08	16.13	16.52 A
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	16.78	16.93	15.92	16.54 A
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	16.65	16.38	17.50	16.84 A
Average	16.6 a	16.8 a	16.5 a	

BNT A= 2.11; BNT B= 2.11 BNT (AxB) = 3.65

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

Table 3. Number of Productive Tillers Due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)			Average
	Amelioran	Urea Coatings	Filter	
	..........................piece...........................			
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	13.06	13.93	14.13	13.71
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	14.90	14.30	13.86	14.35
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	13.93	14.80	15.66	14.80
Average	13.97	14.34	14.55	

BNT A= 1.86; BNT B= 1.86 BNT (AxB) = 3.23

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

Table 4. Grain of Contents / Hollow per panicle due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)			Average
	Amelioran	Urea Coatings	Filter	
	..........................piece...........................			
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	182.82/6.02	150.35/5.32	148.01/5.62	160.39 A / 5.65 A
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	157.50/5.86	157.73/5.78	173.81/12.6	163.02 A / 8.08 A
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	159.86/13.18	158.41/6.40	161.26/6.98	159.85 A / 8.85 A
Average	166.7a/8.35a	155.5a/5.83a	161.03a/8.40a	

BNT A= 25.26/ 4.59; BNT B= 25.26/4.59 BNT (AxB) = 43.76/7.96

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

Table 5. Weight of Grain per Plant Crop due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)			Average
	Amelioran	Urea Coatings	Filter	
	..........................gram...........................			
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	63.85	77.27	69.98	70.37 A
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	74.55	70.85	79.28	74.89 A
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	76.46	81.31	78.98	78.92 A
Average	71.62 a	76.48 a	76.08 a	

BNT A= 16.16; BNT B= 16.16 BNT (AxB) = 27.98

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

Table 6. Weight of 1000 Grains due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)			Average
	Amelioran	Urea Coatings	Filter	
	..........................gram...........................			
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	28.40	28.26	27.33	28.00 A
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	27.80	28.26	29.13	28.40 A
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	28.53	28.13	28.73	28.47 A
Average	28.24 a	28.22 a	28.40 a	

BNT A= 0.81; BNT B= 0.81 BNT (AxB) = 1.41

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

Table 7. Dry Weights of Crops due to Differences Amelioran Type and Application Method of Biochar

Type of Ameliorant (A)	Application Method of Biochar (B)		
	Amelioran	Urea Coatings	Filter
	........................gram..........................		
a_1 = Manure 20 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. Dolomit 2 tons.ha^{-1}	45.77 B b	36.87 A a	35.80 A a
a_2 = Straw compost 50 tons.ha^{-1}. zeolit 2 tons.ha^{-1}. dolomit 2 tons.ha^{-1}	36.70 A a	35.87 A a	38.57 A a
a_3= Straw compost 75 tons.ha^{-1}. zeolit 3 tons.ha^{-1}. dolomit 3 tons.ha^{-1}	46.30 B b	36.80 A a	38.70 A a

BNT interaction = 5.44 %

Note: The numbers followed by the same letter (capital letters are column, lower letters are row) are not significantly in the 5% BNT test.

The BNT test for dry weight of crop (Table 7) showed that ameliorant type factor depends on the level of biochar application, on the contrary. In biochar applications as urea and filter coatings, the different of dry weight of crop showed no significant. However, if the biochar is applied as an ameliorant, the effect on dry weight depends on the type of ameliorant. The experimental results showed that the type ameliorant a_1 (manure 20 tons.ha^{-1}, zeolite 2 tons.ha^{-1}, dolomite 2 tons.ha^{-1}) had the same effect as a_3 (compost straw 75 tons.ha^{-1}, zeolite 3 tons.ha^{-1}, dolomite 3 tons.ha^{-1}) in increasing dry weight and higher compared to a_2 (composted straw 50 tons.ha^{-1}, zeolite 2 tons. ha^{-1}, dolomite 2 tons. ha^{-1}).

The result of this experiment showed similar results on all variables growth and yield of rice crops, namely:

1. Amelioran factor has no significant effect on all observation variables.
2. Biochar Application Factor has significant effect only on dry weight of crop and no significant effect on the others variable.
3. There is no interaction between ameliorant and biochar application on all observational variables, except on dry weighted weights.

The effect of this ameliorant factor is not significant because the type of ameliorant applied is the best ameliorant from the previous experimental results, so the range is relatively close. Although the type of ameliorant has no significant, there are important things resulting from this study that composted rice straw and then combined with zeolite and dolomite, can be used as a substitute for manure.

Biochar application with various methods in this study, did not give any significant effect on all observed variables except dry weight of trim. This is thought to be due to the insufficient timeframe required to alter the soil characteristics associated with soil physical properties such as the decrease of Bulk Density (BD) which can serve as an indicator of soil structure improvement or aggregation, and soil aeration. From laboratory experiments [5] showed that BD soil column decreased from 1.66 to 1.53 g/cm^3 on biochar-treated soil and significantly different from control soil. According to [6], after 3-year field study, biochar applications lowered BD from 0-7.5 cm of soil layer by 4.5% and 6.0% respectively for biochar applications 0.23 kg/ m^2 and 0.45 kg/m^2. [7] study on field study for 2 years ground decrease BD ± 2,2% with application of biochar 9.4 kg/m^2. Thus, when there is a decrease in soil BD due to biochar application, there is an increase in soil structure (soil aggregation) and soil aeration, so the total porosity (micro and macro-pore) is higher.

In addition, [8] suggest that derivatives of coal humic acid may increase water retention, available water capacity and inherently degraded soil aggregate stability. However, the effects of biochar on water retention also depend on soil texture. [9] reported that biochar applications increased the available water capacity in sandy soil, had no effect on clay, and decreased moisture content in clay. This response can be attributed to the hydrophobic nature of the charcoal.

However, the effect of biochar on soil physical properties is highly dependent on the characteristics of biochar applied. According to [10] and [11], the biochar characteristics other than determined by the raw material (species of biomass species), are also determined by certain conditions when pyrolysis is, the end of the pyrolysis temperature or the peak temperature, the scorch level or path rate, and the duration of burning time . The relationship between the peak firing temperature and the surface of the morphological parameters (ie, surface area, pore diameter and volume) of the biochar produced is very complex. In general, the surface area increases with the increase in peak temperature of biochar production [12].

The experiment of [7] showed that biochar significantly improves rice yield. In this experiment, the addition of biochar with different application methods significantly affected dry weight. With the method of biochar mashed then applied a week before planting (as ameliorant) it shows higher dry dry weight than if the biochar is not mashed (as filter) or smoothed first, but applied when urea fertilization (as urea coating). Many studies have reported benefits from biochar as a soil enhancer (amelioran) to improve soil quality and crop productivity [13,14,15]. [16] and [17] explain that biochar as ameliorant in agricultural areas has been shown to slow down the decomposition of C and N, this is related to the high organic carbon content in biochar and along with microbial activity affecting soil properties.

IV. CONCLUSION

The result of this research showed that: (1) there is a tendency that the type of ameliorant a_1 (manure 20 tons.ha^{-1}, zeolite 2 tons.ha^{-1}, dolomite 2 tons.ha^{-1}) give relative influence as well as the amelioran a_3 (75 tons.ha^{-1} straw composted, zeolite 3 tons.ha^{-1}, dolomite 3 tons.ha^{-1}) in increasing rice yield and yield, (2) Biochar application method refined was better influence the growth and yield of rice crops, (3) Interaction only in dry weight variables.

REFERENCES

[1] Handayani, E.P., 2015. Dampak Ameliorasi Tanah Sawah terhadap Emisi Gas CO_2,CH_4 dan N_2O serta Produksi Padi (Oryza sativa, L). Prosiding Seminar Nasional Lahan Suboptimal yang bertema "*Pengembangan Teknologi untuk Pengelolaan Lahan Suboptimal yang Produktif, Inklusif dan Ekonomis*". Palembang tanggal 8-9 Oktober 2015. ISBN: 979-587-580-9, halaman 564-571.

[2] Hadi, R. 2011. Sosialisasi Pembuatan Arang Limbah tongkol jagung dengan Pembakaran Sistem Suplai Udara Terkendali.Buletin Teknik Pertanian Volume 16 No 2: 77-80.

[3] Widiastoety,D., Santi, A., Solvia, N. 2012. Pengaruh Myoinositol dan Biochar terhadap Pertumbuhan Plantet Anggrek Dendrobium dalam Kultur In Vitro. J. Hort. 22 (3):205-209.

[4] Dewi T dan Hindersyah, R. 2009. Konsentrasi Cadmium dan Timbal pada Tanman Mendong yang Ditanam di Tanah Sawah dengan Aplikasi Azotobacter dan Biochar.Jurnal Agricultura (20)3: 185-190.

[5] Mankasingh, U.; Choi, P.C.; Ragnarsdottir, V. 2011. Biochar application in a tropical, agricultural region: A plot scale study in Tamil Nadu, India. *Appl. Geochem. 26*, S218–S221.

[6] Chen, B.; Yuan, M. 2011. Enhanced sorption of polycyclic aromatic hydrocarbons by soil amended with biochar. *J. Soils Sediments*, *11*, 62–71.

[7] Zhang, A., Cui, L., Pan G , Li L, Hussain Q, Zhang X, Zheng J, Crowley D. 2010. Effect of biochar amendment on yield and methane and nitrous oxide emissions from a rice paddy from Tai Lake plain, China. Agriculture, Ecosystems and Environment 139: 469–475

[8] Piccolo, A.; Pietramellara, G.; Mbagwu, J.S.C. 1996. Effects of coal derived humic substances on water retention and structural stability of mediterranean soils. *Soil Use Manag. 12*, 209–213.

[9] Glaser, B.; Lehmann, J.; Zech, W. 2002. Ameliorating physical and chemical properties of highly weathered soils in the tropics with charcoal—A review. *Biol. Fertil. Soils*, *35*, 219–230.

[10] Mukherjee, A. Physical and Chemical Properties of a Range of Laboratory-produced Fresh and Aged Biochars. 2011. Ph.D. Thesis, University of Florida, Gainesville, FL, USA.

[11] Zimmerman, A.R. 2012. Environmental stability of biochar. In *Biochar and Soil Biota*; Ladygina, N., Rineau, F., Eds.; CRC Press: Boca Raton, FL, USA, 2012.

[12] Chen, B.; Zhou, D.; Zhu, L. 2008. Transitional adsorption and partition of nonpolar and polar aromatic contaminant by biochars of pine needles with different pyrolytic temperatures. *Environ. Sci. Technol*. *42*, 5137–5143.

[13] Lehmann, 2007; Lehmann et al., 2006, 2008; Yamato et al. 2006; Marris, 2006; Chan et al., 2008). Glaser et al., 2002 and Lehmann et al., 2007

[14] Glaser, B.; Haumaier, L.; Guggenberger, G.; Zech, W. 2001. The 'terra preta' phenomenon: A model for sustainable agriculture in the humid tropics. *Naturwissenschaften*, *88*, 37–41.

[15] Lehmann, J. 2007. Bio-energy in the black. *Front. Ecol. Environ. 5*, 381–387.

[16] Lehmann, J.; Gaunt, J.; Rondon, M. 2006. Bio-char sequestration in terrestrial ecosystems—A review. *Mitig. Adapt. Strateg. Glob. Change*, *11*, 395–419.

[17] Lehmann, J.; Sohi, S. 2008. Comment on "Fire-derived charcoal causes loss of forest humus". *Science*, *321*, 1295

[18] Chen, B.; Zhou, D.; Zhu, L.; Shen. Y. 2008. Sorption characteristics and mechanisms of organic contaminant to carbonaceous biosorbents in aqueous solution. *Sci. China Ser. B Chem*., *51*, 464–472.

[19] Glaser et al 2001, 2002, Mann, 2002; Lehmann, 2007; Lehmann et al., 2006, 2008; Yamato et al. 2006; Marris, 2006; Chan et al., 2008). Glaser et al., 2002 and Lehmann et al., 2007.

G.5

FLOOD HANDLING SOLUTION BASED ON FLOOD RATE REVIEW AND EFFECTIVE CAPACITY OF RIVER (CASE STUDY OF KRUENG PEUSANGAN WATERSHED)

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ABSTRACT

If the functional and structural relationship of space in a watershed does not accordance with the spatial plan, the flood disaster will occur. Uncontrolled space use, such as the reduction of upstream conservation areas, will have an impact on the downstream, such as flooding during the rainy season and dry season drought. Floods that always occurred inevitable since 2010 until now, and it needs to be analyzed, how to avoid the flood that always occurs at Krueng Peusangan Hilir and review the parameters that cause flooding either directly or indirectly. The result of this research indicates that flood hazard will occur continuously every year and tends to increase. This event is caused by the reduction of river and sewer capacity by sedimentation and garbage which increases annually. This is due to the increasingly poor quality of the watershed. From the results of the analysis by powersim software show before the flood control policy was adopted, the flood rate continued to increase from year to year and this was due to the decrease in the effective capacity of the river due to the silting of rivers in the Krueng Peusangan watershed region. In order to prevent the occurrence of effective river degradation, policy is needed to dredge sedimentation and other materials in the river routinely every year, besides socialization done not to dispose of garbage into rivers, and to do land rehabilitation. By continuously implementing the policy every year it decreases the flood level. By 2019 the level of flooding begins to fall with effective river capacity starting constant at 0.968. These conditions provide information on the balance between the ability of the capacity of the river flow with the large amount of water that flows into the sea. Although it costs a lot every year, the seriousness of decision makers and community participation in managing the environment can reduce flood levels.

Keywords : flood, capacity of river, sedimentation, powersim, management.

I. INTRODUCTION

As a hydrological unit, the watershed is bounded by the highest topographic lines, where all the water inputs fall through the tributaries (Sub Watershed) flowing at the lowest points downstream of the river (estuary) as the output point. The watershed has its characteristics in receiving or absorbing water and flowing it. The most important factors affecting flooding are rainfall, water catchment and flow topography. Forest cover can also affect flood levels depending on the area of the watershed [1].

In this connection, each watershed has a water system called hydrological response that is the ratio of the amount of surface flow to the amount of rainfall that falls on the watershed in a given period. Floods and droughts show the phenomenon of changes in water system as a natural response to humans. This can be captured as a phenomenon of natural resource management by humans has caused damage to the water cycle, where rainwater that falls on the earth quickly becomes the flow of the surface and directly into the river. On the contrary, few are seeping into the ground. If the rain is an uncontrollable factor, then the water system will depend largely on the watershed condition. Within the watershed itself there is a variety of land uses. Among other forests, dryland farming, rice fields, settlements, industrial estates, plantations, and so forth. Mechanism of running rain water to become river water at outlet following cycle water process (hydrological cycle). So also the erosion and sedimentation that occurs in the river will increase, and the capacity of the river to the volume of water becomes reduced so that the river water overflows [2].

Land use in the Krueng Peusangan Sub-waters has been recently updated and is the most important of all the hydrological regimes. The permanent alteration of native vegetation and deep roots with shallow-rooted a vegetation including permanent grasses, annual grasses, and annual crops result in major changes to the evapotranspiration of catchment areas in general and watersheds. In which, finally will result in the water balance so that it will obtain the flood index that occurs in the area.Although this is an overview, several studies of the relationship between flood increase are short-term changes in intense rainfall events [3]. Conversion of forest land and wetlands also reduces the role of these ecosystems in buffering flood events [4].

Mountain dredging activities are also found around Krueng Peusangan Sub-watershed, which is done by heavy equipment. Dredging is not only done on vacant land, but also on land that has vegetation. As a result of these activities resulted in the land area of 10333.4331 ha in sub Krueng Peusangan watershed included in the class of very severe erosion hazard level. One alternative to control flood or overcome the flood is to increase the public awareness movement not to throw garbage into the river, to maintain the effectiveness of the river capacity periodically and to improve the greening in the upper part of Sub Das Krueng Peusangan. Based on the above, it is necessary to study the level of flood hazard in Krueng Peusangan sub-watershed based on river condition in this paper to maintain the effective capacity of the river by conducting river dredging periodically so that Krueng Peusangan Sub DAS to be free from Flood disaster.

II. MATERIALS AND METHODS

The Watershed of Krueng Peusangan is located between 5°16'34'' NL - 96°27'12 "E, and the 4°30'38" N - 97°02'40 " L with an area of 2557.80 km^2 (Fig. 1). Precipitation data were conducted from Stations of Meteorology and Climatology of Lhokseumawe and Bebesan Takengon. The data as used in this study were stream flow data issued by the Office of Water Resources and Headquarter of Krueng Aceh Watershed, Aceh Province (NAD).

Fig. 1. Krueng Peusangan watershed

The analysis of this paper is done with powersim software by plotting the simple causal diagram. The research method using Dynamics system method using Powersim 2.5 Simulation software resulted in Powersim equation, causal causal diagram, flow chart, time chart, and time table [5]. The simulation results were analyzed qualitatively. According to [6] variables in system dynamics are grouped into two types: level (stock) and rate. Level states the condition of the system at any time (state variable system) rate declares system activity. The modeling process is required in system research that is because using the model can save research costs and save time [7].

The causal loop diagram (Fig. 2) describes the flood levels in the Krueng Peusangan Sub-watershed based on the increased flood index due to Watershed damage, the water containment or the amount of pervasive water decreases so that the runoff increases. The higher the flood index, the flood rate will increase so that the potential for higher flooding. In this case a positive loop builds up.

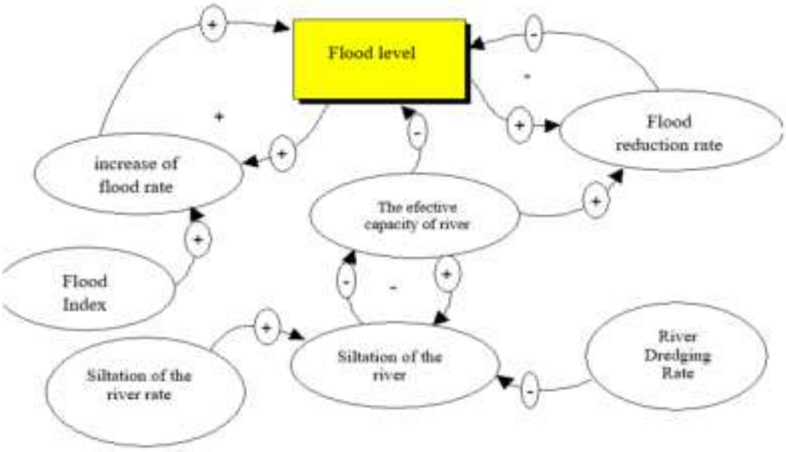

Fig. 2. Causal Diagram

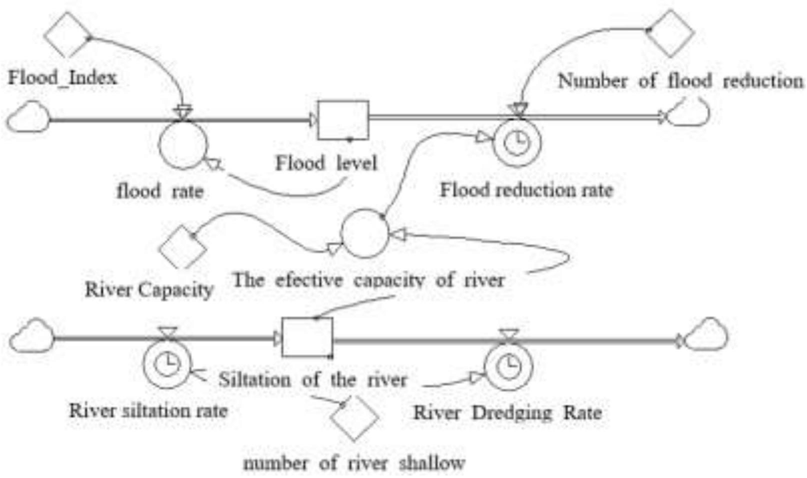

Fig. 3. Flow Chart as Flood Solution

Siltation of the river caused by the high rate of siltation of the river (due to erosion and sedimentation) must be accompanied by the dredging of sediment or material that drifts in the river so that the siltation of the river decreases. Because one of the policies implemented through PROKASIH program in overcoming the flood is river dredging. It is intended that the river's effective capacity to accommodate water volume would be increased. So if the river effectiveness capacity increases then the rate of flood reduction also increases, and the flood level will decrease (in this case the negative build is formed).

Powersim Equation

init Siltation_of_the_river = 115

flow Siltation_of_the_river = -dt* River_Dredging_Rate
+dt*Siltation_of_the_river

doc Siltation_of_the_river = The height of siltation of the river due to various drifting materials or deposited material in the river

init Flood_level = 105

flow Flood_level = -dt*Flood_reduction_rate
+dt*flood_rate

doc Flood_level = the rate of flood in krueng peusangan

aux flood_rate = Flood_Index*Flood_Level

aux Siltation_of_the_river = IF(TIME>=2010, number_of_siltation_of_the_river, 1)

doc Siltation_of_the_river = Accumulation of sediment /material in the river

aux River_Dredging_Rate = TIMECYCLE(2012,1)* Siltation_of_the_river

doc River_Dredging_Rate = River dredging rate is the effort to reduce flooding with the reduction of sedimentation

aux Flood_reduction_rate=IF(TIME>=2012, The_efective_capacity_of_river*Angka_penurunan_banjir, 1)

aux The_efective_capacity_of_river=(River_Capacity-River_Shallow)/River_Capacity

doc The_efective_capacity_of_river = The height of water that can be accommodated by the river Krueng Peusangan Sub Watershed

const number_of_river_shallow = 1250

const Number_of_flood_reduction_rate = 16
const Flood_Index = 0.11
doc Flood_Index = The constant increase of flood per year caused by the decreasing of land as water absorption
const River_Capacity = 40000
doc River_Capacity = The constant volume of water that can flow through existing streams and channels

Dimension Analysis

- River_Shallow = -dt* River_Dredging_Rate
- +dt* River_Shallow_Rate
- Flood_level = -dt* Flood_reduction_rate +dt* flood_rate
- River_Dredging_Rate = TIMECYCLE(2012,1)* River_Shallow
- Flood_level = Flood_Index * Flood_level

III. RESULTS AND DISCUSSION

Floods are affected by drainage water conditions, river water height, character and soil status (permeability, soil moisture content and vertical distribution), urbanization rate, embankment buildings, dams and reservoirs. The proximity of the area to sea level, river flooding can coincide with storm surges or tidal events [8].

The drainage pattern is strongly influenced by the type and structure of the existing soil. Each watershed has a different drainage pattern, can be grouped three patterns namely dendritic, parallel, and rectangular [10]. The drainage pattern analysis is based on river network map data. The results show that Krueng Peusangan watershed has a branch-shaped flow pattern that can be classified into dendritic flow patterns. Dendritic patterns generally occur in areas with uniform rocks and wide distribution. In several sub watersheds are encountered streams with parallel patterns and dendritic and rectangular combinations.

The length of the river is the distance on the earth's surface as measured from the river mouth upstream and the width of the river is the distance from one side to the other side of the river. In general, the longer the river, the difference between the width of the upstream and downstream rivers will be greater. River slope factors also affect the width of the river where the more rapid a river the river will tend to widen. The length of the river is calculated from the point oulet Laut Tawar Lake up to the estuary of approximately 130 km. The width of the Krueng Peusangan River is relatively uniform, i.e 49 m upstream, 51.8 m in center and 54 m downstream.

Functional and structural relationship of space in a watershed, if not by the spatial plan that has been established with the legislation then the flood disaster will occur. Added with the uncontrolled use of space such as the reduction of upstream conservation areas, will have an impact on the downstream such as flooding in the rainy season and drought during the dry season. Flood problems are generally caused by three main issues, which are :

- River water flows due to the discharge of rainfall that flows into the river which exceeds the capacity of the river channel and the non-functioning of the water catchment area, green spaces and puddles that exceed the capacity of its capacity.
- At the time of the tide along with the rainfall overflowing river water.
- High rainfall and insufficient water flow in the drainage canal and exacerbated by a malfunctioning sanitation system.

The problem can not be solved by land use arrangements and planning, river dredging. Because the dynamics of regional development must be by changing land use or land conversion. And not infrequently. Therefore there should be other alternatives to avoid flooding as a result. One of them is with the construction of buildings or spatial can also be done on this flood solution can be done by maintaining the effectiveness of the existing river in the Watershed.

The slope of the river greatly affects the flow rate, damage, and erosion. The greater the slope of a river the greater the energy possessed by the river flow which in the drainage will have an impact on water buildings as well as abrasion on the banks of the river. Also, the slope of a river is also closely related to the length of water flowing from a point furthest downstream. The increasing volume of runoff will cause the high failure of the dam function as well as the environmental and socio-economic damage is also high [10].

Different river slope for each tributary is the slope of river Krueng Peusangan 0.002% the greater the slope of a river, the greater the flow rate of the river to increase the risk of river cliffs that cause erosion and sedimentation. Krueng Peusangan watershed has a drainage density that can be classified into medium category with a density index of 0.84. While the density index of the sub-watershed ranges from 0.37 to 1.39. The drainage density obtained for each basin is smaller than 1.74, this means that Krueng Peusangan watershed has ugly surface drainage characteristics, many occurrences of puddles and frequent floods are also sedimentation zones.

Floods that always occur inevitable since from 2010 until now so it needs to be analysis, how to avoid the flood that always hit in Krueng Peusangan. It is therefore necessary to review appropriately the parameters that cause floods either directly or indirectly. Factors that cause flooding in a watershed are:

- The occurrence of silting the river channel, the slope of the river slope and the narrowing of the river channel, caused by sedimentation and erosion due to illegal logging and forest fires. Disturbance of drainage and sanitation system due to garbage dumping, due to undisputed use of river banks as embedded land and as residential areas.
- Reduction of land that serves as an airborne area due to land conversion / spatial change.
- Illegal logging and forest fires on protected forests result in changing water conditions.
- The impact of climate change where rainfall is very high, the increase of sea water from the tide.

Table 1. Relation time, flood level and the effective capacity of river from simulation

Time	Flood Level	The Efective Capacity Of River
2.010	105,00	0,997
2.011	116,13	0,966
2.012	128,55	0,935
2.013	127,42	0,952
2.014	126,01	0,96
2.015	124,35	0,964
2.016	122,47	0,967
2.017	120,35	0,968
2.018	117,97	0,968
2.019	115,32	0,968
2.020	112,35	0,969
2.021	109,04	0,969
2.022	105,34	0,969
2.023	101,21	0,969
2.024	96,60	0,969
2.025	91,46	0,969

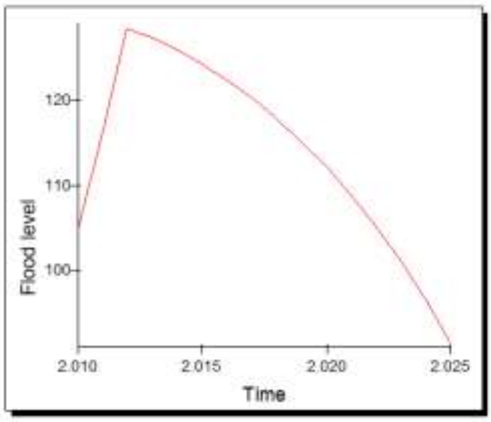

Fig. 4. Simulasi food level for time

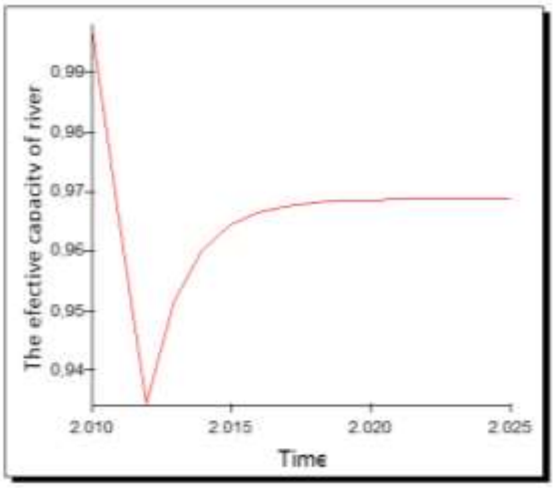

Fig 5. Simulation of the effectiveness capacity of the river for time

From the analysis results seen in the time table (Table 1), simulation (Fig. 4 and Fig. 5) before the flood control policy was adopted, the flood rate continued to increase from year to year and this was due to the decrease in the effective capacity of the river due to the silting of rivers in the Krueng Peusangan watershed region. To prevent the decrease of river's effective capacity in the year 2012 then the policy is taken to undertake the dredging of sedimentation and other materials in the river regularly every year, besides socialization done not to throw garbage into the river, and to do reforestation movement. In general, peak discharge in urban areas is higher with a shorter time than in rural areas [11], [12].

Sub watersheds that have high drainage densities will be better hydrological conditions when compared with low drainage density watersheds. This is due to the increasing drainage density, rain water will be spread evenly into the tributaries, and before entering the main river the water has a longer time and more seep into the soil which will ultimately increase the availability of underground water.

As a result of these activities seen from the simulations conducted by using powersim in 2012 the effective capacity of the river began to show an increase with the dredging of sedimentation in the river. By continuously running the policy it is seen in the time table every year decreased the flood level. By 2019 the level of flooding begins to fall with effective river capacity starting constantly at 0.968. This means that the prokasih program that began to show results in 2019. The condition also provides information on the balance between the ability of the flow capacity the river, same as the number of water that flows into the sea, so there is no water that overflows as a flood. Even though it costs huge amounts every year, the river dredging policy can reduce the flood rate.

IV. CONCLUSION

The modeling results for this case indicate the dangers of flooding will occur continuously every year and tend to increase. This event is caused by the reduction of river and sewer capacity by sedimentation and garbage which increases annually. This is due to the increasingly poor quality of the watershed and the changing climate. In this simulation the climate change factor and the quality of the watershed are not precisely specified coefficients because it is assumed to be the rate of flood increase that is influenced by the flood index that is estimated at the Peusangan river.

The policy actions taken by dredging the sedimentation that occurs in the rivers seem to result. However, any policies taken in dealing with floods will depend on the seriousness of the decision makers and the participation of the community in managing the environment.

REFERENCES

[1] FAO and CIFOR, *"Forests and Floods: Drowning in Fiction or Thriving on Facts?,"* RAP Publication 2005/03, Forest Perspectives 2, 2005.

[2] M.H. Eisenbies, Aust, W.M., Burger, J.A. and Adams, M.B. "Forest operations, extreme flooding events, and considerations for hydrologic modelling in the Appalachians- A review," *Forest Ecology and Management,* 2007, 242, p 77-98.

[3] F Q Jiang, Zhu C, Mu G Jet al., "Magnification of flood disasters and its relation to regional precipitation and local human activities since the 1980s in Xinjiang, northwestern China," *Natural Hazards,* 2005, 36(3): 307-330.

[4] Bradshaw, C.J.A., Sodhi NS, Peh KSH, Brook BW., "Global evidence that deforestation amplifies flood risk and severity in the developing world," *Global Change Biology*, 2007, 13, 1–17.

[5] Roberts, Edward B. *System Dynamics . An Introduction*, *Manageria. Aplications of System Dynamics.* Roberts, E.B.(ed.), The MIT Press, Cambridge, 1978.

[6] Ford, Andrew, "Modeling the Environmen:. An Introduction to System Dynamics Models of *Environmental System*", Island Press, Washington, 1999.

[7] J.W. Forrester," Principles of Systems, 1968, MIT Press, Massachussets.

[8] G.R. Brakenridge, J. P. M. Syvitski, I. Overeem, S. A. Higgins, A. J. Kettner, J. A. Stewart-Moore & R. Westerhoff, " Global mapping of storm surges, 2002–present and the assessment of coastal vulnerability," *Natural Hazards*, 2013,66 (3), 1295–1312. doi:10. .1007/s11069-012-0317-z.

[9] Lily Montarcih Limantara,"Reliability Performance of Tambak Pocok Small DAM, Bangkalan of Indonesia," *Asian Journal of Natural and Applied Sciences, 2012, ISSN: 2186-8476, 2186*-8468 Print, Vol 1 No.2, Juni 2012, www.ajsc-leena-luna.co.jp.

[10] M.Rico, G. Benito, A.R Salgueiro, A. Diez-Herrero, H.G Pereira "Reported tailings dam failures. A review of the European incidents in the worldwide context," *Journal of Hazardous Materials*, 2008,152, 846–852.

[11] Kundzewicz, Z.W.,"Trend detection in river flow time-series: 1. Annual maximum flow,"*Hydrological Sciences Journal*, 2005, 50 (5), 797–810.

[12] Kundzewicz, Z.W., ed.,"*Changes in flood risk in Europe.*" Wallingford: IAHS Press, 2012.

G.6

UTILIZATION OF PADDY WASTE AS A SOIL AMENDMENTS AND IT IS EFFECT ON SOIL PROPERTIES OF ULTISOLS UPLAND EAST LAMPUNG

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ABSTRACT

The study aims to investigate the effect of paddy waste as compost and biochar on soil properties on upland Ultisols in East Lampung conducted in 2015. The amandment treatments were A. control; B. 5 t rice husk biochar ha^{-1}; C. 5 t straw compost ha^{-1}; D. 10 t rice husk biochar ha^{-1} ; E. 10 t straw compost ha^{-1}; The treatments were arranged in randomized block design with four replicates. After incubation for about one month, disturb and undisturbed soil samples were taken at 10–20 cm depth for laboratory analyzes. Analyses of soil chemical properties (Organic-C, Total-N, pH, and CEC); and physical properties (bulk density, and soil water condition).The results showed that biochar and compost improved soil chemical and physical properties with different influences. Biochar or compost applications only slightly increase soil pH. Application of husk biochar or straw compost increase soil pH highest only 3 % from 4,63 (control) to 4,76 (straw compost 10 t ha^{-1}). Soil Organic C and CEC increase 19 % and 12 % due to 10 t ha^{-1} straw compost application. Application compost or biochar 10 t ha^{-1} decrease 7.5% soil BD and increase soil water content compared to control.

Keywords : Husk Biochar, Straw Compost, Soil Properties

I. INTRODUCTION

Most of agricultural soils in Indonesia are poor in organic matter due to high rate of turnover as a result of high soil temperatures and moisture and repeated cultivation, So most of them are Ultisol type with C-Organic content <2% (Nurida et al., 2013; Barus, 2016). Changes in land use to more intensive cultivation have been a major factor influencing the loss of soil carbon on farmland (Bellamy et al., 2005; Lal, 2009). Therefore the management of organic matter means striving for a balance between the rate of addition and decomposition, supporting low input agriculture systems and improving soil quality (Bot and Benites, 2005). Recycling of organic wastes in agriculture is much needed and returns the organic matter into the soils after harvest.

Soil organic matter is essential importance for improving biological, physical and chemical of soil; it consists of a variety of simple and complex carbon compounds (Fisher and Glaser, 2012). The organic materials in the soil is very important that as the primary granules soil into a binder in the formation of stable aggregates. To physical soil, organic matter affects the bulkdensity (..), porosity (..), and improved water retention or soil water content (Evanylo et al., 2008; Yatno, 2011).

Lampung is one of the largest rice producing provinces in Indonesia, with rice grains yielding more than 3 million tons, which is expected to produce more than 3 million tons of paddy straw and rice husk more than 600,000 tons (estimated data based on BPS, 2015). Paddy wastes as straw and husk can be made into compost and biochar. Biochar is produced by thermal treatment at oxygen deficiency (pyrolysis or gasification), resulting in three products: char, gas and tarry oils (Fischer and Glaser, 2012). Composting is the biological decompozition and stabilisation of organic matter derived fromplants, animals or humans through the action of diverse microorganisms under aerobic conditions (Smith & Collins, 2007). Feedstock, compost maturity and compost quality can influence intensity and degree of effects on soil physical, chemical and biological properties. Application may trigger short-term improvements such as increasing microbial activity. Long-term effects on soil properties could be achieved by preservation and increase of the stable SOM pool (Amlinger et al., 2007).

Several research results have been reported related to the influence of biochar to increase bioavailable water, build soil organic matter, enhance nutrient cycling, lower bulk density, and reduce leaching of pesticides and nutrients to surface and ground water (Laird, et al., 2009), improves soil fertility, and mitigate climate change (Woolf *et al*., 2010; Lehmann et al., 2011), increase soil water retention (Brantley *et al.*, 2014), significantly reduced soil loss (Jien and Wang, 2013), for long-term soil C sequestration (Fang *et al.,* 2014) and has high C sequestration potential in soils (Qayyum *et al.,* 2014, Schulz *et al.* 2013).

The study aims to investigated the effect of paddy waste as compost and biochar on soil properties (chemicals and physics of soil) on upland Ultisols type in East Lampung.

II. MATERIALS AND METHODS

A. Rice husk biochar and Straw compost Preparation

Rice husks biochar were produced through low temperature pyrolysis at (200–300 °C) using drum oil which on the bottom has been fitted with cavities. Rice husk were burned separetely for about 6-8 hours. For composting, firstly rice straws were chopped and incubated with effective microorganisms (EM) for one month.

B. Field Experiment

The study conducted at Ultisols (upland) East Lampung, Maret - Juni 2015. The paddy waste amandment treatments were A. control; B. 5 t rice husk biochar ha^{-1}; C. 5 t straw compost ha^{-1}; D. 10 t rice husk biochar ha^{-1} ; E. 10 t straw compost ha^{-1}; The treatments were arranged in randomized block design with four replicates. Compost and biochar applied evenly according to the treatment doses on the soil with a depth of 10-20 cm. The plot size of each treatment was 5 x 6 m.

After incubation for about one month, disturb and undisturbed soil samples were taken at 10–20 cm depth for laboratory analyzes. The soil samples were analyzed in the BPTP Lampung Laboratory, analyses of soil chemical properties (Organic-C, Total-N, pH, and CEC); and physical properties (bulk density, and soil water condition).

C. Statistical Analysis

The collected data was statistically analyzed using analysis of variance (F-Test) at level ($P< 0.05$) and differences in each treatment were adjudged by Tukey's test ($P < 0.05$) using Minitab Version 12.

III. RESULTS AND DISCUSSION

Chemical compositions of rice straw (fresh and compost) and husk (fresh and biochar) are shown in Table 1. The highest level of organic-C is on fresh husk. Husk biochar lowest Organic-C content, due to its recalcitrance against microbial degradation, biochar is very stable in soil compared to other OM additions, making its application to soils a suitable approach for the build-up of SOM and thus, for C sequestration (Fisher and Glaser, 2012). The lowest C/N ratio was in straw compost and the highest was in husk biochar. The highest content of P and K was in fresh husk and the lowest was in straw compost.

Table 1. Chemical composition of paddy waste (straw and rice husk)

Type of Analysis	Rice straw		Rice husk	
	Fresh[1)]	Compost	Fresh[2)]	Biochar
Organic-C (%)	39,23	25,35	46,00	6,38
Total N (%)	0,64	1,08	0,63	0,14
C/N	61,3	23,47	73,01	45,57
P (g·kg^{-1})	2,10	0,33	29,83	1,5
K (g·kg^{-1})	11,20	0,89	85,02	3,1
CEC (me/100 g)	16,72	-	-	7,24

Note :[1)] Lokman *et al.* (2013); [2)] Prakongkep *et al.*, 2013

The effect of husk biochar and straw compost on soil chemical properties (n = 4) are shown in Table 2. Application of husk biochar or straw compost increase soil pH highest only 3 % from 4,63 (control) to 4,76 (straw compost 10 t ha^{-1}). Soil Organic C and CEC increase 19 % and 12 % due to 10 t ha^{-1} straw compost application. Similar result has been reported by Abdel-Rahman (2009), application straw compost 5 t ha^{-1} increase soil pH and CEC. As reported by Barus (2016), the application of straw compost 10 t ha^{-1} increases the C-organic and KTK respectively 8%. However, based on Table 2, improvement of soil chemical properties with the application of straw compost and biochar was not statistically significant ($p <0.05$), this was due to incubation of the organic material only one month after application.

Table 2. The values of soil chemical properties after husk biochar and straw compost application

Soil Chemical Properties	Control	Husk Biochar		Straw Compost t ha^{-1}	
		5 t ha^{-1}	10 t ha^{-1}	5 t ha^{-1}	10 t ha^{-1}
pH H2O	4,63±0,059	4,69 ±0,064	4,73±0,069	4,72±0,071	4,76±0,074
Organic-C (%)	1,24±0,025	1,36±0,034	1,35±0,026	1,44±0,047	1,48±0,036
Total-N	0,11±0,006	0,12±0,006	0,13±0,007	0,13±0,008	0,15±0,008
C/N	11,27±0,00	11,33±0,00	10,38±0,00	11,07±0,00	9,87±0,00
CEC (cmol kg^{-1})	7,24±0,354	7,45±0,234	7,47±0,154	7,68±0,268	8,12±0,301

The effect of applications biochar and compost on physical properties shown on table 3. Return straw compost or husk biochar were able to reduce soil bulk density (BD). Application compost or biochar 10 t ha^{-1} decrease 7.5% soil BD compared to control. Soil bulk density is affected by soil organic matter content as reported by Busscher et al. (2011), that increasing total organic carbon by the addition of organic amendments in soils can significantly decrease BD.

Bulk density has a strong relationship with organic matter. Generally, the higher the level of organic matter, the lower the bulk density. Higher aggregate stability associated with higher levels of soil organic matter increases soil porosity which results in a lower bulk density. However bulk density is also affected by other soil properties such as soil texture, clay mineral type, sodicity and exchangeable cations, and the presence of iron and aluminium oxides (Murphy, 2014).

Application of biochar and compost increase water content at pF 2.54 (field capacity), pF 4.2 (permanent wilting point), and available water for plant (the value among pF 2.54 and pF 4.2) compared to control. During the trial period, the rainfall is rather low (100 - 200 mm) so that generally the water content is also low. Application of biochar and compost have synergistic benefits to soil organic matter (SOM) and water holding capacity (WHC) (Liu et al., 2012). Compost application increase field capacity and improved water retention (Fisher and Glaser, 2012). The same results reported by Bass et al. (2016) showed that application of 10 t biochar/ha and 25 t compost/ha significantly increased soil water content compared to control at trial mid-point.

Table 3. The values of soil physical properties (avarage and standart deviation) after biochar and compost application

Treatments	BD	Soil water (% volume)		
		pF 2,54	pF 4,2	Available water
Control	1,23 ± 0.08	20.63 ± 2.69	11.42 ± 1.93	9.21 ± 1.64
Husk biochar 5 t ha^{-1}	1,14 ± 0,11	23.60 ± 0.41	12.75 ± 0.66	10.85 ± 0.63
Husk Biochar 10 t ha^{-1}	1,12 ± 0,09	25,48 ± 2,07	13.43 ± 3,35	12.45 ± 2.26
Straw compost 5 t ha^{-1}	1,18 ± 0,12	22,64 ± 2,86	12, 28 ± 3,18	10,36 ± 2,62
Straw compost 10 t ha^{-1}	1,12 ± 0,11	24.92 ± 3.44	13,18 ± 2,98	11,74 ± 3,08

IV. CONCLUSION

Return of paddy wastes as straw compost or husk biochar on Ultisol upland improved soil chemical (pH, Organic-C, total-N, and CEC) and physical properties (bulkdensity and soil water content).

REFFERENCES

Abdel-Rahman, G. 2009. Impact of compost on soil properties and crop productivity in the Sahel North Burkina Faso. *American-Eurasian Journal of Agricultural and Environmental Science*, *6* (2) : 220-226.

Amlinger, F., Peyr, S., Geszti, J., Dreher, P., Karlheinz, W., & Nortcliff, S. (2007). Beneficial effects of compost application on fertility and productivity of soils. *Federal Ministry for Agricultural and Forestry, Environment and Water Management*.

Badan Pusat Statistik (BPS). 2015. Lampung dalam angka. Badan Pusat Statistik Provinsi Lampung.

Barus, J., 2016. Effectivity of biochar and compost of plant waste on soil chemical properties and soybean yield. *Journal of Tropical Soil 21(1) : 1-7*

Bass, A.M., Bird, M.I., Kay, G. and Muirhead, B. 2016. Soil properties, greenhouse gas emissions and crop yield under compost, biochar and co-composted biochar in two tropical agronomic systems. *Science of the Total Environment* 550 : 459 – 470.

Bellamy, P.H., P.J. Loveland, R.I Badley, R.M. Lark, and G.J.D. Kirk. 2005. Carbon losses from all soils across England and Wales 1978-2003. Nature 437:245-258.

Bot and Benites 2005. The importance of soil organic matter. Key to drought-resistant soil and sustained food and production. Food and agriculture organization, Rome.

Brantley KE, KR Brye, MC Savin and DE Longer. 2015. Biochar Source and Application Rate Effects on Soil Water Retention Determined Using Wetting Curves. *Open J Soil Sci* 5: 1-10.

Busscher, W., Novak, J.M. and Ahmedna, M. 2011. Physical effects of organic matter amendment of a southeastern US coastal loamy sand. *Soil Science* 176 : 661–667.

Evanylo, G., Sherony, C., Spargo, J., Starner, D., Brosius, M., and Haering, K. 2008. Soil and water environmental effects of fertilizer, manure, and compost-based fertility practices in an organic vegetable cropping system. *Agriculture, Ecosystems & Environment* 127: 50-58.

Fang Y, B Singh, BP Singh and E Krull E. 2014. Biochar Carbon Stability in Four Contrasting Soils. *Eur J Soil Sci* 65: 60-71

Fischer, Daniel, and B. Glaser. 2012. "Synergisms between compost and biochar for sustainable soil amelioration." *Management of Organic Waste* 10 (2012): 167-198.

Jien SH and CS Wang. 2013. Effects of biochar on soil properties and erosion potential in a highly weathered soil. *Catena* 110: 225-233.

Karberg, N.J., N. A. Scott, and C.P. Giardina. 2008. Methods for Estimating Litter Decomposition *in* Field Measurements for Forest Carbon Monitoring: A Landscape-scale Approach. C.M. Hoover (ed) Springer science + media B.V. pp.103 – 111

Laird DA, RC Brown, JE Amonette and J Lehmann. 2009. Review of the pyrolysis plat-form forco-producing bio-oil and biochar. *Biofuels Bioproducts and Biorefining* 3: 547-562.

Lal, R. (2009). Sequestering carbon in soils of arid ecosystems. *Land Degradation & Development*, *20*(4), 441-454.

Lehmann J, MC Rillig, J Thies, CA Masiello, WC Hockaday and D Crowley. 2011. Biochar effects on soil biota –A review. *Soil Biol Biochem*43:1812-1836.

Liu J, H Schulz, S Brandl, H Miehtke, B Huwe and B Glaser. 2012. Short-term effect of biochar and compost on soil fertility and water status of a Dystric Cambisol in NE Germany under field conditions*. J. Plant Nutr Soil Sci.* 175: 698-707

Lokman, M., C. Jusoh, L. A. Manaf, and P. A Latif. 2013. Composting of rice straw with effective microorganism (EM) and its influence on compost quality. Journal of enviromental health sciences & engeneering 10 (17) : 1 - 11

Murphy, B, W, (2014) Soil Organic Matter and Soil Function – Review of the Literature and Underlying Data. Department of the Environment, Canberra, Australia.

Nurida, N.L., Ai Dariah, Achmad Rachman. 2013. Peningkatan Kualitas Tanah dengan Pembenah Tanah Biochar Limbah Pertanian. Jurnal Tanah dan Iklim 37 (2) : 69 – 78

Prakongkep, N., Gilkes, R. J., Wiriyakitnateekul, W., Duangchan, A., & Darunsontaya, T. (2013). The effects of pyrolysis conditions on the chemical and physical properties of rice husk biochar. *International Journal of Material Science*.

Qayyum MF, D Steffens, HP Reisenauer and S Schubert. 2014. Biochars influence differential distribution and chemical composition of soil organic matter. *Plant Soil Environ* 60: 337-343.

Schulz H, G Dunst and B Glaser. 2013. Positive effects of composted biochar on plant growth and soil fertility. *Agron for Sustain Develop* 33: 817-827.

Smith, J.L., Collins, H.P., 2007. Management of organisms and their processes in soils. In: Paul, E.A. (Ed.), Soil Microbiology Ecology and Biochemistry, third ed. Academic Press, Elsevier Ltd., Burlington, MA, USA, pp. 471–502

Woolf, D., Amonette, J. E., Street-Perrott, F. A., Lehmann, J., & Joseph, S. 2010. Sustainable biochar to mitigate global climate change. *Nature communications*, *1*, 56.

Yatno, E. (2011). Peranan bahan organik dalam memperbaiki kualitas fisik tanah dan produksi tanaman. *Jurnal Sumberdaya Lahan*, *5*(1), 175-182.

G.7

UTILIZATION OF SCIENCE AND TECHNOLOGY FOR EMPOWERMENT OF CLIMATE CHANGE-TRIGGERED DISASTER VICTIMS

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ABSTRACT

This article reveals how science and technology (ST) are utilized in empowering victims of climate change-triggered disasters. Disaster can be a consequence of environment degradation and technology innovation factors. Therefore, a disaster management, one of the stages in disaster recovery, is required. The Indonesian Institute for Sciences (IIS) as a center of excellence in science has played roles in a number of efforts for disasters recovery of community groups and regions experiencing disasters through ST Utilization for Regional Development (Iptekda). The Iptekda program synergizes IIS, research and development (R&D) institutions and universities in regions to provide maximal support of ST for small and medium scale enterprises (SMEs), mostly the guided ones, so that the innovation process can be escalated using effective and efficient production and operational costs. The utilization of ST has been implemented in Aceh, Yogyakarta and other regions in Indonesia. This article describes cases in Aceh and Yogyakarta, which had been empowered with Iptekda Program. Production increase, its quality, marketing and also human resource or skill were factors measured to identify the empowerment achievement. Before the program was implemented, there were some stages to be done including a tight selection of proposal proposed followed by interviewing the person in charge, lecturers of the universities or competent IIS' researchers including the owner of the SME empowered to be by a selected interviewer panel. It was expected that the tight selection and monitoring twice a year during the in progress activity would make the Iptekda achievement better. In the early implementation, many of the activities did not sustain, however, after several years learning from the unsuccessful implementation, more than 67 percent of the activities got sustained.

Keywords: climate change, empowerment, regional development, science and technology utilization

I. INTRODUCTION

"Disaster", a very common word and often heard during the last decade (Putera, 2009), is generally interpreted as a major catastrophic disruption of function in society, which resulted in many fatalities. A disaster can also cause material loss or environment damage, beyond the capabilities of the concerned community. Disaster occurs as a result of improper handling of negative consequences threats.

Indonesia has many vulnerable areas of disasters, both natural disasters and disasters caused by human activities. Disasters can be caused by several factors such as geography and geology conditions, climate or other factors such as social, cultural and political diversities (Bappenas and the National Agency for Disaster Management Coordination, 2006). Geographically, Indonesia, which is an archipelagic country, has been already familiar with the various kinds of disasters such as earthquakes, tsunamis, volcanic eruptions, floods, droughts, and landslides. Indonesia's territory is included into a state, which is very vulnerable to disasters, particularly disasters caused by nature of the geological elements. This is because the position of Indonesia lies at the confluence of three tectonic plates of the world; namely the Australian plate in the Southern region, Euro-Asian plates in the West and the Pacific Ocean plate in the Eastern region of Indonesia (Putera, 2015). Data show that Indonesia is one of countries having a high level of seismicity in the world, more than 10 times the level of USA's seismicity (Arnold, 1986).

In addition, Indonesia is located in tropical climate with two seasons, dry and rainy and its characteristic changes in weather, temperature and wind direction, which are quite extreme. Such climatic conditions coupled with the surface topography and rock, which are relatively diverse both physically and chemically, generate fertile soil conditions. In contrast, it may cause some bad consequences for humans such as hydro-meteorological disasters among others: floods, landslides, forest fires and long drought. Along with time and growing human activity, environmental degradation tends to get worse and lead to increasing number of occurrences and intensity of the hydro-meteorological disasters occurring in turns in many regions of Indonesia. Another appearing issue, as impacts of development in Indonesia, there were many of environmental and ecological damages. This condition is not an issue per se, because the development carried out over the time had relied on the exploitation of natural resources (especially large scale) lead to a loss of carrying capacity of the resource to sustain community life.

The above mentioned conditions are closely related to climate change and disaster. Indonesia is vulnerable to disasters, which will give significant impacts to the citizens, especially in rural areas (Sirimorok, 2013a). At international level, the position of the rural areas is the most vulnerable to the threat of climate change impacts needs special attention (Sirimorok, 2013b). Salih (2009) emphasizes that the majority of the poor living in rural areas and depend on natural resources for their livelihoods, so that the agendas of Environment and development in developing countries should not be separated from the negative impacts of climate changes.

The efforts of the Indonesian government to minimize the impact of catastrophic vulnerability has been done by issuing a disaster regulatory framework, through Act No. 24 of 2007 and Government Regulation No. 21 of 2008. However, it was unfortunate that not any single article mentioned about climate change aspects significantly. On the other hand, there were many appearing problems dealing with bureaucratization of post-disaster management and qualified implementing personnel in the field (Chamsyah, 2007).

Post disaster management was primarily related to recovery efforts. Kusumasari (2014) assessed that recovery activities included decisions and actions taken after a disaster occurred with a purpose to restore or improve pre-disaster living condition of the affected communities. At the same time these activities encouraged and facilitated some needed adjustment to reduce the long-term disaster's risk such as economic impact on the affected communities.

Dynamic developments at the national level as well as international levels, including climate change, disaster vulnerability and post-disaster recovery needs the role of ST. It is then repositioning and revitalizing the role of LIPI (Indonesian Institute of Sciences/IIS) is required to guide the science and technology (ST) development. In response, LIPI has formulated and clarified the responsibilities, both to the world of science, society, as well as to stakeholders. Therefore LIPI should have contributed in strengthening and promoting the competitiveness of society through ST Utilization for Regional Development (hereinafter referred as Iptekda LIPI). Fig. 1. This article would explore the role of LIPI in providing ST solutions for society, especially for post-disaster management related to the recovery efforts in Aceh and Yogyakarta.

Fig. 1. Location distribution of Iptekda LIPI Activities Year 2005-2014

II. WRITING METHOD

A study literature was applied as the writing method of the paper. Secondary data in the form of reference materials derived from Iptekda LIPI activity reports, books, magazines, journals and literature related to the purpose of writing were used. Documentation study was also applied in addition to literature study.

III. IPTEKDA LIPI PROGRAM

Activity of ST Utilization for Regional Development was initiated by LIPI. This activity was funded with the LIPI's state budget and the objectives was to strengthen Small and Medium-scale Enterprises (SMEs) by providing inputs of ST and its transfer, so that the involved SMEs could be more competitive and economically improved. The budget was used to purchase some tools/machineries, raw materials, limited capital to support the business operations using new means facilitated by Iptekda LIPI. (Fig. 2)

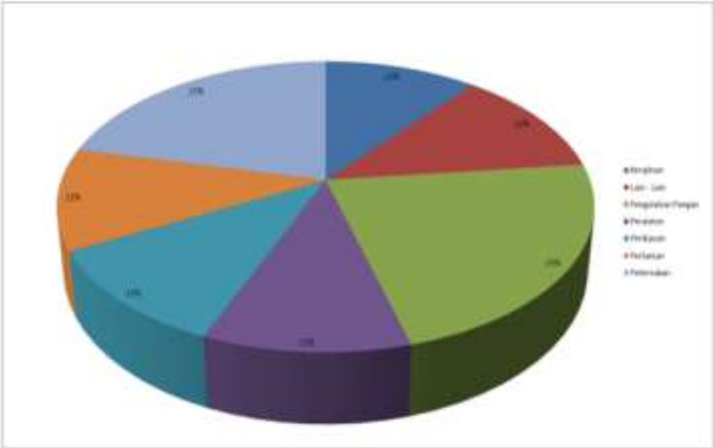


Fig. 2. IPTEKDA activities 2003 - 2011 per fields based on numbers of funding

The activity was not only an effort to carry out the commercialization of products resulted by research and development (R & D) in a business perspective, but also become one of the three responsibilities carried by LIPI, the responsibility to society. Additionally, LIPI as a national institution provided broad-based services, not only for internal LIPI's purposes but also for the community.

In this program, a technology provider to introduce, implement and disseminate well proven appropriate technology innovation comprehensively to users, in this case SMEs. Dissemination of the appropriate technologies was in context to solve the problem (Khusnawati & Prasad, 2016).

Iptekda LIPI activities were designed to be one of solutions in poverty alleviation through SMSs empowerment. It was a form of empowerment emphasizing a combination of ST support, financing, sustainable business, and it was expected to be more beneficial to society through innovative schemes. The objective of Iptekda LIPI was to strengthen SMEs by introducing ST, as well as providing the initial limited funds, but managed sustainably. Sustainable was meant that the businesses may have a multiplier effect by utilizing the facilities provided by Iptekda LIPI activities. The facility was expected to be revolved to other SMEs. (Fig. 3)

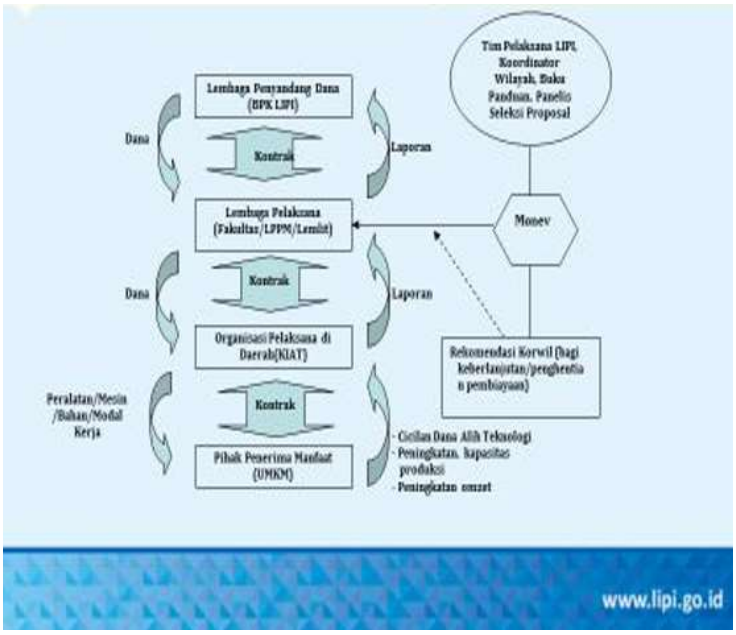
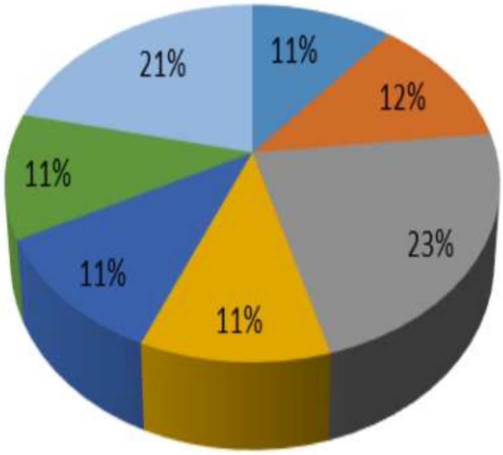


Fig. 3. Scheme of IPTEKDA

Other consideration related to the Iptekda LIPI activity scheme was the effort to encourage the potential of local resources to be a superior product. Iptekda LIPI activities was conducted by involving regional universities/R & D institutions. Through strategic cooperation program, it was possible to provide optimal ST support to guide SMEs so that the innovation process could be accelerated by more effective and efficient production and operation cost due to more decentralized nature. According to the survey of the Economic Research Center of LIPI (2005) results, it showed that Iptekda LIPI activities had been able to empower more than 67 percent of fostered SMEs into profitable and productive business, employment opportunities, and regional innovative activities.

According to the National Agency for Statistics, the Micro, Small and Medium Enterprises, who were partners in the Iptekda LIPI activity, were micro enterprises employing 1 to 10 persons with a turnover up to IDR 300 million and maximum assets of IDR 50 million. Small businesses employed 11 to 20 persons with a maximum turnover of IDR 2.5 billion and maximum assets of IDR 500 million. Medium-sized businesses employed 21 to 100 persons with a turnover of IDR 50 billion and IDR 10 maximum assets.

The following were the objectives of Iptekda LIPI activities application: (1) to utilize the ability of ST research and engineering to promote regional SMEs' technology/ economy and employment opportunity; (2) to build an interaction relationship between research world and business world; (3) to encourage SMEs to keep up with ST development so that the business would be growing and sustainable; and (4) improve SMEs' competitiveness by applying ST inputs, training on technology skills, business management guidance, marketing expansion, and strengthening the limited venture capital (LIPI, 2015). (Fig. 4)



Legend :
Craft = 11%
Others = 12%
Food Processing = 23%
Tools = 11%
Fisheries = 11%
Agriculture = 11%
Livestock =11%

Fig 4. IPTEKDA activities 2003 – 2011 per fields based on numbers activities

IV. PROGRAM ACHIEVEMENT

In the implementation of the IPTEKDA program since 1998, it is recognized that not everything is going in line with expectations especially in the early years of the implementation of activities, many things are improved and refined in particular related to SOP (Standard Operation Procedure). It was of course not every single of the Iptekda implementations since 1998 run as expected, especially for those of initial years. It was then improved and equipped with some Standard Operating Procedures (SOP). It was expected that the tight selection and monitoring twice a year during the in progress activity would make the Iptekda LIPI achievement better. In the early implementation, many of the activities did not sustain, however, after several years learning from the unsuccessful implementation, more than 67 percent of the activities got sustained. In this paper submitted several success stories that can be part of the community empowerment, especially SMEs in the affected areas in this case in Aceh and Yogyakarta. In other areas Iptekda LIPI program is done by involving the University area in the implementation, development and monitoring. Some success stories Iptekda LIPI activities are as follows: This article delivers several success stories, which could be parts of community empowerment, especially for SMEs in a disaster impact areas, in this case were Aceh and Yogyakarta. In other areas, the Iptekda-LIPI program were conducted by involving local universities for its implementations, guidances and monitorings. The followings were some success stories of the Iptekda-LIPI:

A. Success Story in Aceh

Iptekda LIPI program in Aceh was implemented for tsunami disaster recovery. The tsunami occurred in 2014, followed a quite big earth quicke.

Shan's Rumoh Aceh Branded

Shan's Rumoh Aceh Branded was a family business engaging in instant food seasoning production. Rahayuningtyas, Carlos, & Kumalasari (2012) explained that the business had experienced decrease in production and sales turnover by 97 percent post-earthquake tsunami that hit Aceh in 2004. The tsunami had destroyed many Shan's spice Factory infrastructures. This causes the business stopped because almost all production equipment and factory buildings were badly damaged. In order to support postdisaster recovery, Iptekda LIPI's revolving program lent a hand in 2008.

The ST support was a simple drying rack type technology for drying spices of SMEs Shan's Rumoh Aceh Branded. This technology was selected because it was more saving time, fuel and it was able to dry the spices evenly on the arranged shelves. Usual drying needed two days for one drying process (5 kg), while the simple drying rack technology only took 5 hours using 3 kg LPG. The drying rack had two separate spaces with 10 pieces of racks in each space. The dryer owned drying capacity of 20 up to 40 kg/shift. The Iptekda LIPI achievements was also reported by Daud (2012) and Marlina (2014), who run business of duck rearing and fish processing. Daud as an Iptekda LIPI implementator, has reared duck successfully using local feeds, while Marlina has proceessed captured marine fish to proccesse for dried fish, which has longer preservation and storage capacity and marketed to other areas.

B. Success Stories in Yogyakarta

Iptekda LIPI program in Yogyakarta region was implemented to get involved in post disaster recovery of the earthquake struck Yogyakarta and the surrounding region in May 2006.

1. Soemarso Ceramics

"Soemarso Ceramics" is one of the SMEs located at Gadungan Kepuh Hamlet, Canden Village, Jetis, Bantul District. It engaged in terracotta ceramic manufacture. The business had been run since 1997, but had stopped following the earthquake struck. The SMS then starting in 2008 SME was able to start to produce ceramics again with various hardship situations. Currently the daily production reaches 150 pieces of ceramic with a large (L), medium (M) and small (S) sizes. The product marketing area of "Soemarso Ceramics" SME was not only in Yogyakarta Region but also included several areas in Jakarta. Even the products had been exported to Japan. Currently, the demands both from national and international parties rely very much on collaboration with trading enterprises.

ST support for Iptekda LIPI program in 2010 implemented for Soemarso Ceramic SME was in collaboration with Research Center of Yogyakarta State University. The ST supports were ceramic design, tools and machinery for ceramics production and product quality, as well as technology application of ceramic burners using LPG with temperature reached 1,250^{o} C.

2. Mighty Merapi

"Merapi Mighty" is one of SMEs located in Girikerto, Turi, Sleman District. It engaged in manufacturing of charcoal briquettes wood/coconut shell, and furnaces. The business is already run two (2) years and five months and founding a lot of attention, especially from Sleman Regent. Daily briquettes production was around one ton. Marketing area of the "Mighty Merapi" SME was not only in the region of Yogyakarta, but also includes some areas in East Java. Even the SME had exported its products to Korea, and tried a marketing pioneering opportunities in Saudi Arabia. Domestic demand was estimated less than international demand.

The activity of ST Utilization for Regional Development tried to provide alternative solutions to problems faced by the "Mighty Merapi" SME, through: (1) an increase in briquette production to meet market demand; (2) management restructuring system to improve customer satisfaction and financial management improvement; (3) product marketing expansion to increase "Mighty Merapi" SME's turnover.

The ST contribution given was an additional production equipment to increase production in order to meet the market demand. It included mixer machine, extruder machine/printer machine, briquette drying machine (oven) and a conveyor machine/ briquette cutting machine.

Iptekda – LIPI program in Yogyakarta was reported also by Rachmawaty et al (2010) related to petit herbal trader empowerment, which introduced better and more preserved herbs, so that the price and its marketable natures could be improved.

V. CONCLUSION

The Iptekda – LIPI Program was an empowering community program, especially SMEs and it was a great assisstance to escalate the SMEs' capacity in areas with disaster impacts liked Aceh dan Yogyakarta. The SMEs, who lost their assets and capital were aided and recovered to redevelop and rerun their businesses and increase their productions. The program sustainability could increase the SMEs' ability in improving their business by marketing their products to other areas.

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REFERENCES

[1] Arnold, C. W. (Winter, 1986). Overseas Workers' Remittances in Asian Development. International Migration Review: 899-925.

[2] Bappenas & Badan Koordinasi Nasional Penanganan Bencana. (2006). Rencana Aksi Nasional Pengurangan Risiko Bencana 2006-2009. Jakarta: Bappenas & Badan Koordinasi Nasional Penanganan Bencana.

[3] Chamsyah, E.B. (2007). Mainstreaming Disaster Risk Reduction in National Policies and Programmes: An Overview of National Action Plan for Disaster Risk Reduction in Indonesia. Paper Presentation, Delivered to the 2nd Asian Ministerial Conference on Disaster Risk Reduction 7-8 November 2007, New Delhi, India.

[4] Khusnawati, E., & Yanu Endar Prasetyo. (2016). Difusi dan Adopsi Teknologi Tepat Guna Pada Usaha Mikro, Kecil dan Menengah: Observasi Pada Kegiatan Iptekda LIPI di Kabupaten Subang. Seminar Nasional IENACO 2016: 753-760.

[5] Kusumasari, B. (2014). Manajemen Bencana dan Kapabilitas Pemerintah Lokal. Penerbit Gava Media: Yogyakarta.

[6] LIPI. (2015). Panduan Penyusunan Proposal Kegiatan Penerapan dan Pemanfaatan Ilmu Pengetahuan dan Teknologi di Daerah (Iptekda) XIX LIPI Tahun 2016: (Untuk Lingkungan Perguruan Tinggi). Jakarta: LIPI.

[7] Putera, P.B. (2015). Iptek dan Inovasi: Kunci Merentas Jalan Menuju Kemandirian Bangsa. Yogyakarta: Graha Ilmu.

[8] Putera, P.B. (2009). SIM Logistik Tanggap Bencana. Majalah Biskom, edisi Oktober 2009.

[9] Rahayuningtyas, A., Haryanto, A., & Kumalasari, R. (2012). Perencanaan dan Uji Performansi Pengering Tipe Rak Pada UKM Shan's Cap Rumoh Aceh. Prosiding SNaPP 2012: Sains, Teknologi, dan Kesehatan: 7-12.

[10] Salih, M.A.M (editor). (2009). Climate Change and Sustainable Development: New Challenges for Poverty Reduction. Cheltenham & Massachusetts: Edward Elgar.

[11] Sirimorok, N. (2013a). Menuju Ekonomi Politik: Sketsa Kajian Perubahan Iklim dan Kebencanaan di Indonesia. Wacana: Jurnal Transformasi Sosial, Nomor 29, Tahun XV, 2013: 17-42

[12] Sirimorok, N. (2013b). Desa, Bencana, dan Perubahan Iklim dalam Bingkai Ekologi Politik. Wacana: Jurnal Transformasi Sosial, Nomor 29, Tahun XV, 2013: 5-16.

[13] Daud, M , M, Yaman, Zulfan and C A Fitri, 2012. Aplikasi teknologi Pengolahan Pakan dalam Bentuk Wafer dengan berbaai formula. Laporan Akhir IPTEKDA. Unsyiah, Banda Aceh

[14] Rachmawaty P, N J Faraz, and Gunarti, 2010, Pemberdayaan Perempuan Pengrajin Jamu Gendong di Dususn Kiringan, Canden, Jetis Kabupaten Bantul, UNY, Jogyakarta.

[15] Marlina, 2014, Diversifikasi Produk Ikan Olahan di Provinsi Nanggroe Aceh Darussalam Laporan Akhir IPTEKDA. Unsyiah, Banda Aceh.

G.8

THE LAND CONSERVATION EFFORTS FOR WATERSHED'S HYDROLOGICAL FUNCTION

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ABSTRACT

The conversion of land-use gives a dominant influence to the watershed's hyodrological functions. The relationship between land-cover and hydrological function can be seen by the watershed's total produced water and resistance against the peak debit at various timescales. The aims of this study was to simulate the peak discharge in some scenarios of land conservation in Awo Watershed, South Sulawesi. This study was done by rainfall frequency analysis and peak discharge predict by using the Watershed Modelling System TR 55. Input data of the model consists of: watershed area, time consentration and SCS Curve Number of land hydrological group data, land cover specification and soil moisture condition. Simulation of land use and land conservation scenarios are done on this model. The peak-disharge simulation result with 2, 5 and 10 years return period rainfall were 240.72, 804.41, and 1387.68 m^3/sec. Conservation efforts by contour and terraced planting can reduce the Awo watershed's peak discharge up to 13.50%.

Keywords : peak discharge, land conservation, watershed modelling system.

I. INTRODUCTION

Watershed is important as a rain catchment area that serves as a provider of water and flood control. Hydrologically watershed management seeks to manage the Earth's surface biophysical conditions, in such a way as to obtain a maximum water yield and has an optimum flow regime, which is distributed evenly throughout the year.

Along with the increase in human numbers and activities, the need for land has also increased. As a result, people tend to use the land towards more potential. Efforts to increase the utilization causes the change of land use, especially forests.

Land use change has a dominant influence on the hydrological functions of watersheds (Verrina et al., 20130; (Pratama and Yowono, 2016) (de la Cretaz & Barten, 2007). The relationship of land cover to hydrological function can be seen from the aspect of total water yield and buffer power watershed to peak discharge at various time scale (Noordwijk et al., 2002). Land use change without the application of land conservation principles, causing most of the rainfall to be a direct runoff, thus increasing the potential for flooding due to the loss of soil ability to absorb rain water (Lipu 2010).

Land conservation is defined as the effort to utilize the land in accordance with its capability and provide treatment in accordance with the conditions required to avoid damage (Arsyad, 2006).

The hydrological model is designed to study the functions and responses of a watershed from various inputs of the watershed. The hydrological model is a simple illustration of an actual hydrological system. One of the hydrological models of river flow prediction, developed to simulate watershed conditions is Watershed Modeling System (WMS). WMS is a graphical modeling software for all hydrologic and hydraulic phases of a watershed. WMS can perform an automatic depiction of watersheds, geometry parameter calculations, curve number calculations which are soil type parameters (Sadrolashrafi et al., 2008); (Sharkh, 2009). Technical Release (TR 55) WMS, is a flood hydrograph used to model rainfall processes. With the use of TR 55, the model can be built with triangulated irregular network (TIN) used to describe the river and its boundaries and calculate geometric data or watershed characteristics. This aims of this study was do simulate peak discharge of the watershed, for some forms of land conservation using Watersheed Modeling System TR 55, in an effort to maintain the hydrological function of Awo Watershed, South Sulawesi.

II. MATERIALS AND METHODS

This study was do at the DAS Awo in the district of Sidenreng Rappang in the Indonesian province of South Sulawesi. The research location can be found at 3o 54'S latitude, 119o 48' longitude, with the watershed area 343,49 km^2

A. Analaysis Rainfall Frequency

Analaysis rainfall frequency was done as follows:

1. Calculates the distribution with the Gumbel distribution model and the Pearson Type III Log based on the calculated statistical parameters.
2. Selecting a distribution model appropriate to the Chi-Square method.
3. Calculates design rainfall with 2, 5 and 10 return period based on the appropriate distribution model.

B. Calculate Maximum peak discharge

Calculation of peak discharge is done by using Watershed Modeling System Model Technical Releases 55. Data input of WMS TR 55 consists of:

1. Watershed area , calculated using the facilities contained in the WMS
2. SCS Curve Number, determined by considering 3 factors is land hydrological group, land cover classification and soil moisture condition. The hydrological group of land in this study, determined based on soil texture
3. The concentration time (Tc), calculated in WMS by using the Kerby equation.

III. RESULTS AND DISCUSSION

A. Analysis Rainfall

Based on the interpretation of chi-squared test results on distribution calculations of Gumbel and Log Pearson Type III, the most appropriate rainfall distribution for the Awo Watershed region is the Pearson Log distribution III. So that the rainfall of design with the 2, 5 and 10 years return period based on the Log Pearson III of distribution , is presented in Table 1.

Table 1. Rainfall design with Method Log Pearson Type III

Return period (years)	rainfall of design daily (mm/day)
2	42,69
5	73,52
10	99,40

B. Parameters watershed

Input the WMS model of the TR-55 method is a watershed parameter consisting of area, curve number (CN) and time of concentration. CN values are based on land use and hydrological groups of land. The hydrological group of land is determined based on soil texture. The following are presented of land uses, land hydrological groups and CN values on the Awo Watershed.

Land use and land hydrological groups that the potential to cause surface runoff are areas of high CN value. The dryland farming on litosol soil has the highest CN value of 89, with the land hydrological group D having infiltration rate 0 - 1 mm / sec (Asdak, 2010). Soil lithosol is type of soil a rocky with a layer of soil that is not so heavy and very little nutrients, so have the capacity and rate of small infiltration, resulting in the availability of water in the dry season a little.

Table 2. Parameters model WMS Awo Watershed

No	Land use	Type of soil	Area (km^2)	Land hydrological groups	CN
1	Forest	Laterit	196,73	C	77
2	Forest	Podsolik	2,96	D	79
3	Dryland farming	Laterit	72,87	C	85
4	Dryland farming	Litosol	39,48	D	89
5	Dryland farming	Podsolik	1,75	D	88
6	Bush	Laterit	12,19	C	71
7	Bush	Podsolik	2,26	D	79
8	paddy	Litosol	15,25	D	84

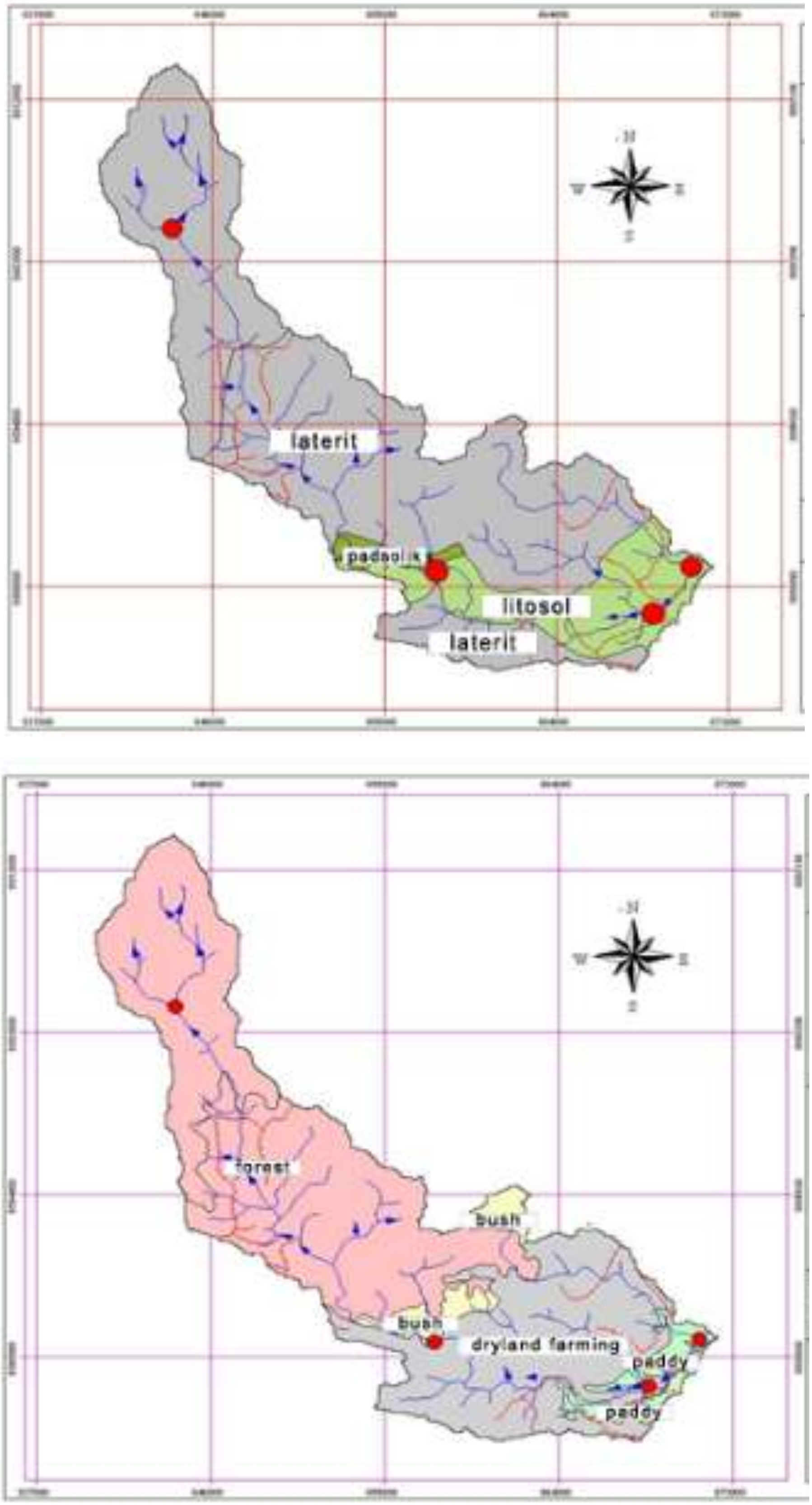


Fig. 1. Map type of soil and land use of Awo Watershed

C. Hydrograph Peak discharge

The flow discharge represents the response of the DAS system to the overall rainfall input. The amount of flow discharge in a watershed, in addition influenced by watershed characteristics, also by rainfall. The results of the peak discharge calculations with the WMS model, based on the design rainfall from the Log Pearson III distribution are presented in Fig. 2, each with a return period of 2, 5 and 10 years.

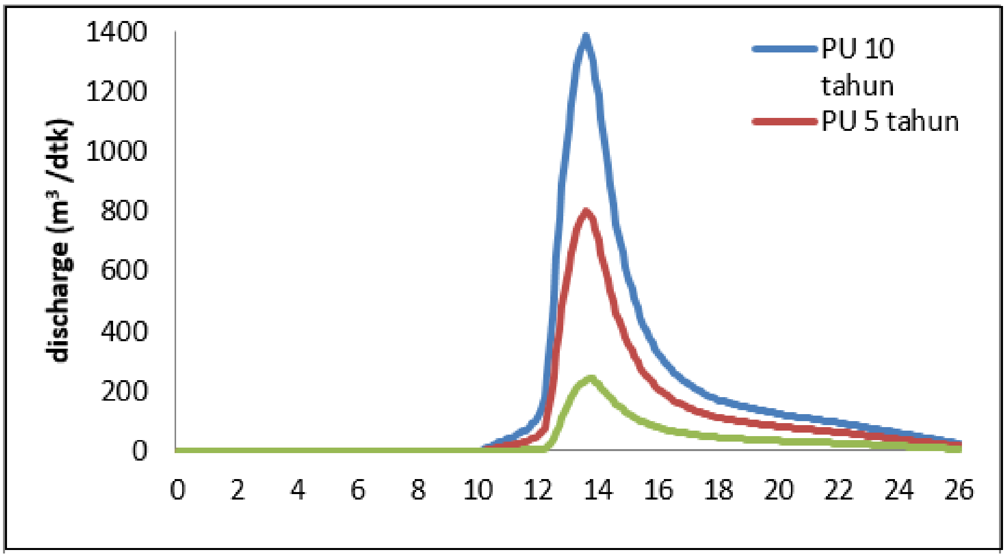


Fig. 2. The peak discharge hydrograph on the Awo Watershed

In Fig. 2., the above shows the peak discharge in Awo Watershed, for the 10th return period of 1387.68 m3 / sec. The Awo watershed is dominated by type of laterite soil (82%). laterite soil or often called to as red soil, formed in humid, cold, and possibly waterlogged environments. This soil has a permeable profile and easy to absorb water (Mustapha et al., 2014). So, indicate the existence of forest damage to the watershed.

The Awo Watershed has 114.1 km2 (33%) of dryland farming, so the conversion of land from forests to dryland farming negatively impacts the function of forests as a regulator of water systems in watershed ecosystems. Forest conversion and land-use change result in land degradation in the form of loss of soil's ability to retain rainwater, thus increasing surface runoff and flood potential (Lipu, 2010).

D. Improvement hydrological condition of the Awo Watershed

Land conservation is basically an effort to maintain the watershed hydrology function. Land use change with minimal soil and water conservation measures can affect flow volume and peak discharge. The rain is more flowing on the surface than it infiltrate into the soil (Baniva et al., 2013).

Simulation of land conservation to improve hydrological function of Awo Watershed is done with several scenarios:

Scenario 1 improvement the management of dryland farming into a good straight-line up land
Scenario 2: practice of contour planting.
Scenario 3: practice of planting by a good contour and terraced

Simulation of land conservation efforts to peak discharge on Awo Sub Watershed is presented in Fig. 3 and Fig. 4.

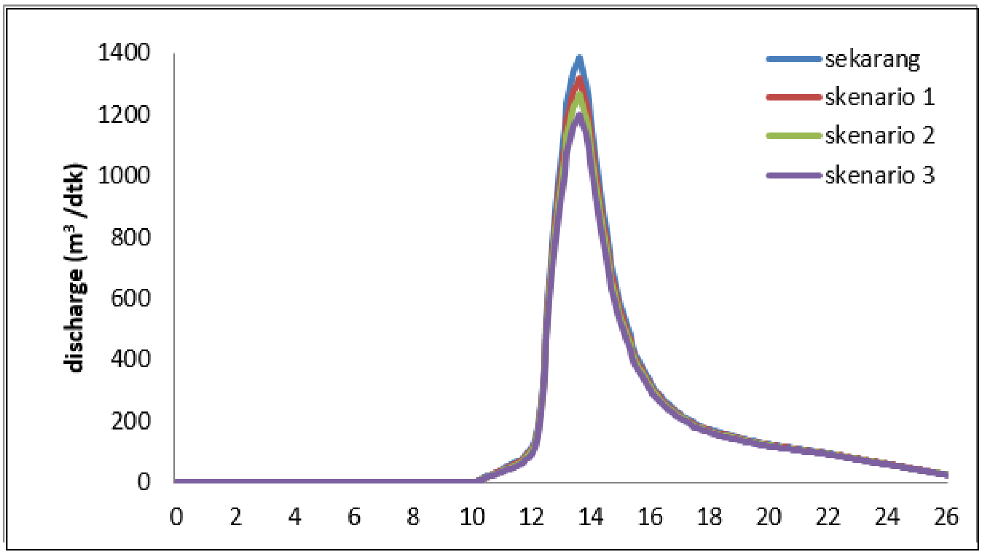
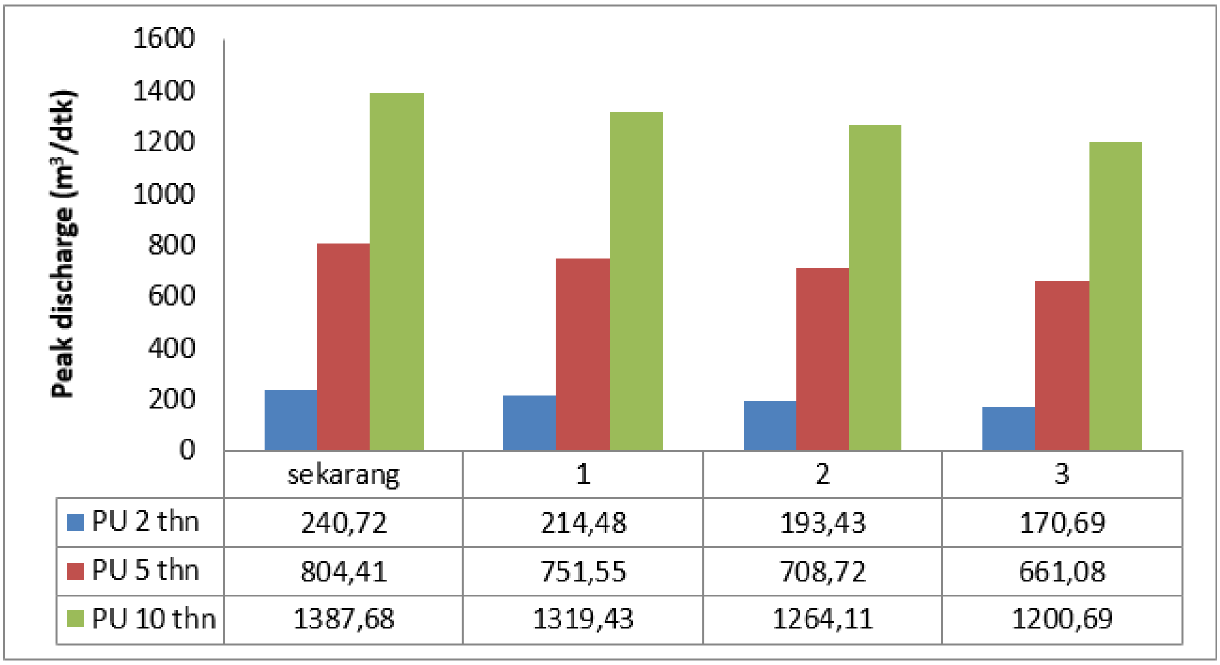


Fig. 3. Hydrograph peak discharge on some land use

The effort of land conservation decreases the peak discharge of Awo watershed, from the existing condition 1.387,68 m^3/ sec to the ideal condition that is practice of contour and terrace 1.200,69 m^3 /sec. Such conservation efforts affect CN value and peak discharge of Awo Watershed. A low CN value indicates an increase in watershed capability in regulating the water system, the amount of infiltration is greater so reducing surface runoff and flood potential.



	sekarang	1	2	3
PU 2 thn	240,72	214,48	193,43	170,69
PU 5 thn	804,41	751,55	708,72	661,08
PU 10 thn	1387,68	1319,43	1264,11	1200,69

Fig 4. Peak discharge on the various return periods

The decrease in peak discharge for scenario 1 with conservation of good straight-line up land was 4.9%. For scenario 2 with contour practice was 8.9%. The main advantages of contour system planting are the occurrence of temporary water reservoirs allowing water absorption, so can reduce of surface runoff (Suripin, 2001); (Marhendi, 2014).

While scenario 3 with conservation practice of contour and terrace is 13,5%.The terrace function to reduce the length of the slope and retain water so as to reduce the velocity and the amount of surface runoff, and allow increase the amount of water infiltre into the soil (Marhendi, 2014). In addition to land conservation efforts, physical conditions and watershed characteristics also affect the discharge produced (Asdak, 2010); (Maria and Lestiana, 2014).

IV. CONCLUSION

The Awo watershed is dominated by laterite soil (82%) with forest (58%) and dryland farming (33%). The peak discharge of the Awo watershed based on the Watershed Modeling System (WMS) for a 10-year return period is 1387.68 m^3/sec. Efforts to conserve land with the practice of contours and terraces on dryland farms can reduce peak discharge by 13.5%.

REFERENCES

[1] G.P.Verrina, D.D. Anugrah and Sarino. Analisa Runoff Pada Sub DAS Lematang Hulu. Jurnal Teknik Sipil and Lingkungan. Vol.1 No.1. 2013

[2] W. Pratama and S.B. Yuwono. The Analaysi of The Land Use Change to Hydrologis Characteristic of Bulok Watershed. Jurnal Sylva Lestari Vol.4 No. 4 2016.

[3] A.L. de la Crétaz and P.K. Barten. Land Use Effects on Streamflow and Water Quality in the Northeastern United States. CRC Press. Florida-USA. 2007

[4] S. Lipu. Analisis Pengaruh Konversi Hutan Terhadap Larian Permukaan Dan Debit Sungai Bulili, Kabupaten Sigi. Media Litbang Sulteng, 3 (1), p: 44-50. 2010.

[5] S. Arsyad. Konservasi tanah dan air. Bogor: Jurusan Tanah, Institut Pertanian Bogor. 2006

[6] S.S.Sadrolashrafi, T.A. Mohamed, A.R.B. Mahmud, M.K. Kholghi and A. Samadi. Integrated Modeling for Flood Hazard Mapping Using Watershed Modeling System. Am. J. Eng. Applied Sci., 1: 149-156. 2008.

[7] M.S. Sharkh. Estimation Runoff for Small Watershed Using Watershed Modelling System and Geografic Information System. Thirteenth International Water Technology Conference, IWTC 13. 2009.

[8] C. Asdak. Hidrologi dan Pengelolaan Daerah Aliran Sungai. Gadjah University Press, Yogyakarta. 2010

[9] A.M. Mustapha, R.Jibrin, N.M. Etsuworo and M. Alhassan. Stabilization of A-6 Lateritic Soil using Cold Reclaimed Asphalt Pavement. International Journal of Engineering and Technology. Vol. 4. No. 1. January, 2014.

[10] R. Baniva, Sobriyah and Susilowati. Simulasi pengaruh tata guna lahan terhadap debit banjir di DAS Keduang. E-Jurnal Matriks Teknik Sipil. 149(1):102--110. 2013.

[11] Suripin. Pelestarian Sumberdaya Tanah dan Air. Penerbit Andi Yogyakarta. 2001

[12] T.Mahendi.. Teknik Pengendalian Erosi Lahan (Technology of Land Erosion Management). Techno Vol 15. No.1. 50-64.2014.

[13] R.Maria and H. Lestiana. Effect of Landuse on Groundwater Conservation Function in Cikapundung Sub-Watershed. RISET Geologi dan Pertambangan. Vol. 24. No. 2. 77-89. 2014.

G.9

OPTIMIZATION OF BIOFILTRATION PROCESS FOR PRE-TREATMENT OF RAW WATER FROM POLLUTED RIVER WATER

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ABSTRACT

Agricultural, industrial and domestic waste waters contain many pollutants such as organic, nutrients, dissolved and suspended solids. Discharge of the waste waters causes river water pollution, disrupts equilibrium of aquatic ecosystems, and disturbs aesthetics and human health. Efforts to control the pollution have not been successful. In many cases, the polluted river water is used as raw water in the provision of clean or drinking water. This causes the higher cost of water treatment and increased public health risks. An alternative to eliminate these pollutants from raw water is the biofiltration process, i.e. a process that utilizes a grown microorganism attached to a solid matrix to form a biological layer (biofilm). This study aims to examine the performance of the biofilftration process with a bioball plastic as biofilter medium for the removal of organic materials, ammonium, and physical pollutants from raw water. Furthermore, this study aims to obtain the optimum hydraulic residence time (HRT) and recirculation rate (R) in the context of water quality improvement. The biofilter unit for the experiments was designed on a 1000 L scale with a working volume of 676 L. The acclimation process was achieved after an operation time of about 5 weeks in view of the stable efficiency of TSS, turbidity, color, and COD removal. The optimization process has been done using surface response method (RSM) with two factors, namely HRT and R. Based on the RSM analysis, the optimum conditions of the biofiltration process were obtained at HRT of 2.41 hours and R of 0.3.

Key words: biofiltration, optimization process, organic removal, polluted river water, raw water, response surface method

I. INTRODUCTION

The increased pollution of river water leads to decrease of the ability of itself natural regeneration. The water quality monitoring of Asian Development Bank (2016) and the Ministry of Environment (2013) showed that more than 50% of monitoring results do not meet water quality Class I according to Regulation No. 82 of 2001. More than half of the river water does not meet the water quality criteria Class II as raw water for drinking water supply. This leads to an increase in water treatment costs and public health risks. This condition requires curative efforts in the form of pre-treatment of the surface water as raw water for clean water both for industrial water and for household needs.

One of the raw water treatment alternatives is the biological process utilizing the activity of microorganisms in the biofiltration system. The basic principle of the biofiltration process is biofilm processes in which microorganisms grow forming biofilms on solid media surface and degrade dissolved organic matter to carbon dioxide, water, and other simple chemical compounds (Swanson and Raymond, 1997; Davis, 2011). Biofilms are formed by excretion epoxysaccharyde by microorganisms causing microorganism can grow and attached to form a thin layer (biofilm) on a solid surface filter media (Metcalf and Eddy, 2003). As filter media can be various types of filter media, such as power sand, pumice, plastic waste, and plastic bioball plastic (Masłon et al., 2015). The biofiltration process is also studied for removal of ammonium, Fe and Mn (Widayat at al., 2010; Tekerlekopoulou et al., 2012; Tabis and Wojciech, 2014).

Ladu et al. (2013) reported that various factors influence the biological pollutant removal efficiency in biofilm process, such as hydraulic residence time (HRT), and temperature. The higher the HRT and temperature the higher is the efficiency of pollutants removal. Furthermore, Devis (2011) reported that effluent recirculation can increase the efficiency of removal of various pollutants. However, the increased HRT and recirculation lead to the increased investment costs (due to the biofilter unit size) and operating costs (due to the energy consumption for effluent recirculation). Therefore, HRT and recirculation optimization need to be performed to maximize the rate of pollutant removal.

A method for process performance optimization is Response Surface Method (RSM). This method is a set of mathematical and statistical techniques to analyze the problems of some independent variables that affect response variables. The ultimate goal of this method is to optimize response variables (Montgomery, 2013). By constructing a mathematical model, it is possible to identify the optimum independent variables that result in the optimum response variable (Nuryanti and Salimy, 2008). Analysis of the response variables on RSM can be done easily with application of Design Expert 10.0.1. With the help of the software, the effect of independent variables on various response variables can be known through a series of statistical tests. The relationship between independent variable and dependent variable can then be known by using this method of analysis. The suggested model can be used to determine the optimum point for achieving the maximum response variable.

The objectives of this research work are optimization of HRT and recirculation rate for maximizing the performance of the biofiltration process for the pre-treatment of raw water from polluted river water.

II. MATERIALS AND METHODS

A. *Equipment's and Materials*

The materials used in this study include river water Cihideung River located in the complex of Bogor Agricultural University (IPB) campus. Bioball plastic was used as packing media of the biofilter unit. The bioball has the following specifications: Type *deluxe,* made of PVC material, black color, ball-shaped, diameter of 4 cm, Porosity of 0.92, and specific surface area of about 220 - 230 m^2/m^3.

The chemicals for water quality analysis are ferroin indicator, ferro-aluminum sulphate (FAS), $K_2Cr_2O_7$, Potassium dihydrogen phosphate (KH_2PO_4), HCl, phenol (C_6H_5OH), sodium nitroprusside ($C_5FeN_6Na_2O$), alkaline citrate, sodium hypochlorite, the standard solution of potassium permanganate ($KMnO_4$), H_2SO_4, HNO_3, and others.

The total volume of the biofilter unit is 1000 L with a working volume of 676 L. Fig. 1 shows the schematic diagram of the experimental apparatus. Bioball plastic is chosen as filter media because of its advantages such as highly specific area of considerable (200-235 m^2/m^3), random form, and easy in installation (Said 2005). El-Harbawi et al. (2010) reported that bioball plastic is lightweight, durable, and easy to be washed.

The biofilter is in principle similar to the packed bed reactor (Davis 2011). In this type, the biofilm was grown on a filter material (in this case is the bioball plastic). Air oxygen is supplied through the diffused-air aeration. The aeration system works through diffusers submerged at below the filter media (Casey, 2009). The aeration system is intended to reduce the risk of filter blockage, provide water and microorganism with oxygen, and therewith improve the performance of the filtration (Shofia, 2003). The biofilter unit is operated continuously in which water flows downward and air flows upward (counter current flow).

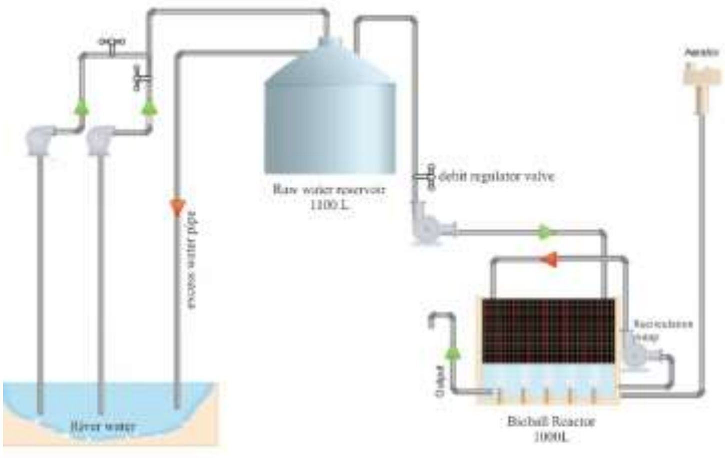


Fig. 1 Schematic diagram of the experimental apparatus

B. *Acclimation Process*

Acclimatization is done by culturing the microorganisms naturally by flowing raw water continuously into the biofilter unit through the media to form biofilms attached at the media surface to reach a steady state condition (Widayat et al. 2010 and Said 2006). Steady state conditions is determined by observing some parameters of the input and the output of the biofilter unit, including pH, Chemical Oxygen Demand (COD), ammonium, nitrate, as well as physical parameters of TSS, color, and turbidity. The laboratory analysis was conducted according to the standard method (APHA, 2012). The operating condition was maintained at dissolved oxygen (DO) of 3-6 mg / L and a pH of 6-9. The acclimatization was realized for up to 5 weeks with a HRT of 2 h without recirculation. HRT is calculated based on empty bed retention rime.

C. Optimization Process

After steady state is reached, an experimental process of optimization is performed to determine the optimum HRT and recirculation. The optimization process was done using response surface method. The experimental design used in this experiment is the Central Composite Design (CCD) with two variable factors: X_1 (hydraulic residence time, HRT) and X_2 (recirculation ratio, recirculation rate (Q_r) / inflow rate (Q_i) ratio). Factor level of 0 is determined based on a preliminary study. Table 1 shows the coded and actual levels of treatment factors for optimization of HRT and recirculation.

Table 1. Coded and actual levels of treatment factors for optimization of HRT and recirculation rate

Space Type	Coded		Actual		Inlet, Q_i (L/h)	Recirculation rate, Q_r (L/h)
	X_1	X_2	X_1	X_2		
Axial	-1.414	0	1.79	1.00	556	556
Factorial	-1	-1	2.00	0.50	500	250
Factorial	-1	1	2.00	1.50	500	750
Axial	0	-1.414	2.50	0.29	400	120
Center	0	0	2.50	1.00	400	400
Center	0	0	2.50	1.00	400	400
Center	0	0	2.50	1.00	400	400
Axial	0	1.414	2.50	1.70	400	680
Factorial	1	-1	3.00	0.50	333	167
Factorial	1	1	3.00	1.50	333	500
Axial	1.414	0	3.20	1.00	313	313

In this study optimization is discussed focusing on the COD and color removals. Sampling was performed three times with distance sampling according to the defined HRT for each combination. Laboratory testing's carried out in duplicate according to standard methods (APHA 2012). The measured data was analysed with Design Expert 10.0.1 on central composite design choice. The software provides a model response analysis polynomial corresponding to each response measurement. HRT and recirculation are chosen as dependent variables and COD and color as response variables. Validation is performed through the operation of the reactor at the optimum HRT and recirculation resulted from the optimization analysis with Design Expert 10.0.1. The experimental results were compared with the theoretical results calculated from Design Expert 10.0.1.

III. RESULTS AND DISCUSSION

A. Acclimatization

Acclimatization of microorganisms is realized naturally by flowing raw water continuously through the biofilter system to allow forming biofilm on surface of the filter media. The biofilters are operated with a HRT of 2 hours to reach a steady condition. The HRT of 2 h is chosen based on the previous study. The steady state condition is determined by measurement of color, turbidity, TSS and COD removal efficiencies.

During the acclimation process, the performance of the biofilter with bioball plastic as matrix shows an increase as indicated by increased pollutants removal efficiency with increasing operating time. In this research, steady state (acclimated) condition is achieved at operation time of about 35 days. In the acclimated condition, the microbes attached on the bioball plastic surface reached a maximum thickness and a maximum metabolism activity, so that the amount of biomass formed and the organic material removal reaches the optimum level. In this condition, is assumed that the lag phase has been exceeded and the microbial metabolism is relatively constant. At the end of acclimatization, the color removal value reached about 52% and turbidity removal reached 58.74%

B. Optimization

Optimization is focused with case studies of COD and color removal for illustration of the optimization process.

1. COD Removal

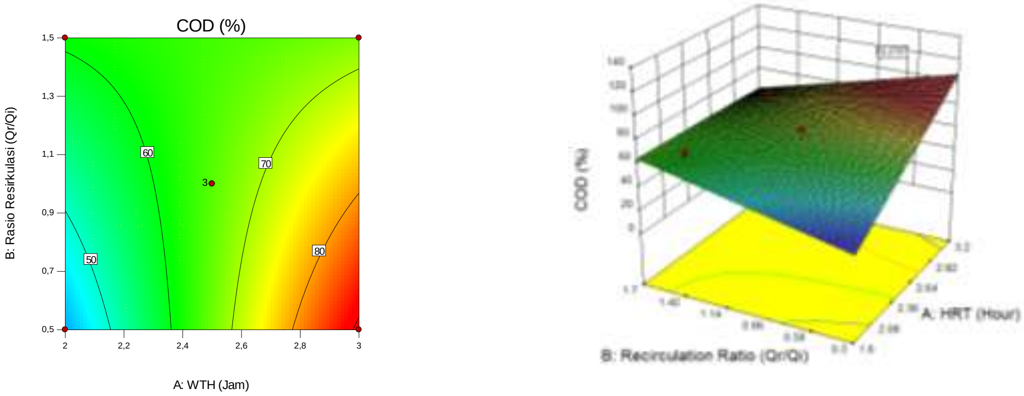
The appropriate model for optimizing the COD removal is identified as polynomial model of the interaction of the two studied factors (2FI). The influence of the factors is significant in COD removal and characterized by R^2 of 0.69 (p-value is more than 0.05). The suggested model for COD removal is as follows:

$$Y = -105 + 69X_1 + 102X_2 - 42X_1X_2 \tag{1}$$

where :
Y = COD removal (%)
X_1 = HRT (h)
X_2 = recirculation ratio (Q_r/Q_i)

Based on the equation (1), COD will increase with increasing HRT and recirculation or vice versa. This is consistent with the research results of Ladu et al. (2013). This is also in line with Davis (2011) which reported that the recirculation is too high will not improve the pollutant elimination.

The response equation can be visualized in graphic form as presented in Fig. 2. From the two graphs, the optimum level can be identified. The Design Expert 10.0.1 recommends for maximum single response of COD removal is at X_1 of 2.41 h and X_2 of 0.3 resulting in a COD removal of 62.26%.



(a) (b)

Fig. 2. Contour of color removal (a) and response surface of COD removal (b) at different HRTs and recirculation's

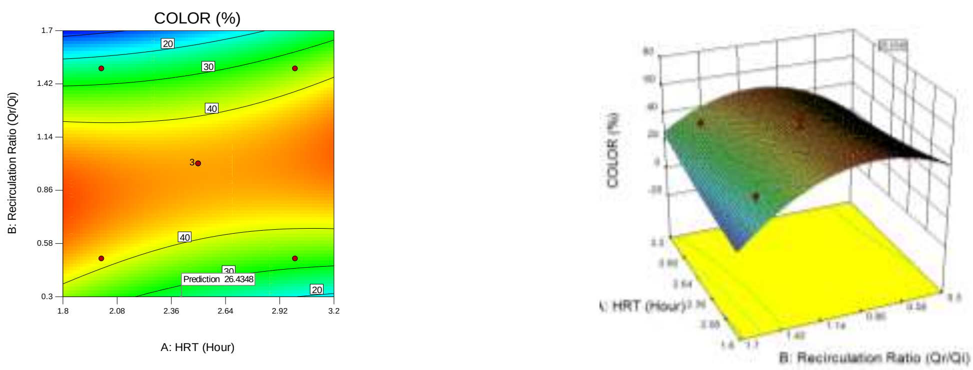
2. Color Removal

The optimization result shows that color removal is in between 7.61% - 52.43%. Based on the results of surface response analysis, lack of fit, R^2, and adjusted-R^2, the appropriate model for optimizing the response of color removal is a quadratic polynomial model. The suggested model for color removal is as follows:

$$Y = +80 - 44X_1 + 47X_2 + 19X_1X_2 + 5X_1^2 - 51X_2^2 \quad (2)$$

where :
Y = color removal (%)
X_1 = HRT (h)
X_2 = recirculation ratio (Q_r/Q_i)

The value of R^2 is calculated as 0.581. Fig. 4 shows contour of color removal (a) and response surface of color removal (b) at different HRTs and recirculation's. Based on Fig. 3, the best response would be obtained at the combined factors along the red area. For X_1 = 2.41 h and X_2 = 0.3, the color removal will be 53.08%.



(a) (b)

Fig. 3. Contour of color removal (a) and response surface of color removal (b) at different HRTs and recirculation

C. Model Validation

The goal of optimization is to minimize the costs and maximize the benefits. Table 2 shows the optimization components and the level of interest. For this illustration, the desired goals are is maximize the COD and color removal. The response of COD removal is given the greatest importance (+++++) and the response of color removal is moderate (+++). The valuation is based on the important level of each pollutant in the sample. With the given interest level, the recommended optimization solution results in a HRT of 2.41 h and a recirculation of 0.3.

Table 3 shows the comparison between the predicted value and the actual value of COD and color removals at the optimum HRT and the optimum recirculation rate. From the table it is seen that the prediction value (model) approaches the observation value (experiment) with deviation value less than 4% for COD removal and less than 20% for color removal.

Table 2. Factors and response variables to be optimized

Parameters	Unit	*Goal*	Lower limit	Upper limit	Relative importance level
HRT	h	In range	2.00	3.00	+++
Recirculation (Q_r/Q_i)	-	In range	0.50	1.50	+++
COD removal	%	Maximize	32.94	88.33	+++++
Color removal	%	Maximize	34.31	62.35	+++

Table 3. Comparison between the predicted value and the actual value of COD and color removals at the optimum HRT and the optimum recirculation rate

Response	Unit	Actual (Experiment)	Prediction (Model)	Deviation (%)
COD removal	%	60.01	62.26	3.75
Color removal	%	44.24	53.08	19.98

IV. CONCLUSSION

The biofilter system is able to reduce raw water pollutants, such as COD, ammonium, TSS, color, and turbidity. In the cases of COD and color removals Optimization process using Response Surface Method (RSM) and central composite design suggested an optimum solution at a HRT of 2.41 h and a recirculation rate of 0.3. At the optimum point, the predicted COD and color removal will be 62% and 53%, respectively.

Further optimization needs to be done by involving other factors, such as the ratio of volume of filter media to total volume and the quality of treated raw water.

ACKNOWLEDGEMENT

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REFERENCES

[ADB] Asian Development Bank. 2016. Indonesia: Country water assessment. Manila (PH): Asian Development Bank.

[APHA]American Public Health Association. 2012. Standard Method for Examination of Water and Wastewater. Washington (US): American Public Health Association.

[KLH]Kementerian Lingkungan Hidup. 2013. State of the Environment Report Indonesia: Pillars of the Environment of Indonesia. Jakarta (ID): Ministry of Environment of the Republic of Indonesia.

Casey TJ. 2009. Diffused air aeration systems for the activated sludge process: Design performance testing. Dublin (IE): Aquavarra Research Limited.

Davis ML. 2011. Water and Waste Water Engineering: Design Principal and Practice. New York (US): McGraw Hill.

El-Harbawi M, Aida Azwana Bt. Sabidi, Ezzah Bt. Amarudin, Amiran B. Abd Hamid, Suhaizal B. Harun, Ahmad B. Nazlan, Chin Xi Yi. 2010. Design of a portable dual purposes water filter system. Journal of Engineering Science and Technology 5(2): 165-175.

El-Harbawi M, Aida Azwana Bt. Sabidi, Ezzah Bt. Amarudin, Amiran B. Abd Hamid, Suhaizal B. Harun, Ahmad B. Nazlan, Chin Xi Yi. 2010. Design of a portable dual purposes water filter system. Journal of Engineering Science And Technology 5(2): 165-175.

Giuseppe B. 2009. Integrated anaerobic/aerobic biological treatment for intensive swine production. Bioresource Technology 100(2):5424-5430 doi:10.1016/j.biortech.2008,12,005

Ladu JLC, Zheng M, Demetry PL, Lu X. 2013. Effect of hydraulic retention time and recirculation ratio on anoxic/oxic bioreactor and artificial wetland performance for domestic wastewater treatment. Current World Environment 8(2):165-168. Doi: http://dx.doi.org/10.12994/CWE.8.2.01

Masłon A, Tomaszek JA. 2015. A study on the use of the bioball_ as a biofilm carrier in a sequencing batch reactor. Bioresource Technology 196: 577–585

Metcalf, Eddy. 2003. Wastewater Engineering: Treatment and Reuse. Singapore (SG): Mc.Graw Hill.

Montgomery DC. 2013. Design and Analysis of Experiment. Hoboken (US): John Wiley and Sons.

Nuryanti, Salimy DH. 2008. Metode permukaan respon dan aplikasinya pada optimasi eksperimen kimia. Risalah lokakarya komputasi dalam Sains dan teknologi nuklir: 373-391.
Said NI. 2005. Aplikasi Bioball Untuk Media Biofilter: Studi Kasus Pengolahan Air Limbah Pencucian Jeans. Jurnal Air Indonesia 1(1):1-11.
Said NI. 2006. Aplikasi Proses Biofiltrasi dan Ultra Filtrasi untuk Pengolahan Air Minum. Jurnal Air Indonesia 2(1): 30-42.
Shofia A. 2003. Engineering Design Approaches for Minimum Fouling in Submerged MBR. Elsevier 160: 67-74.
Swanson WJ, Raymond CL. 1997. Biofiltration: Undamentals, Design and Operations Principles, and Applications. Journal of Environmental Engineering 123: 538-546.
Tabis BS, Wojciech SS. 2014. Advantages of The Application of Fluidized Bed Bioreactors To A Microbiological Nitrification Process. Warsawa(PL): Cracow University of Technology.
Tekerlekopoulou AG, Pavloub S, Vayenasa DV. 2012 . Removal Of Ammonium, Iron and Manganese from Potable Water in Biofiltration Units: A Review. Journal Chem Technol Biotechno l(88): 751–773 doi:10.1002/Jctb.4031.
Widayat, Suprihatin, Arie H. 2010. Penyisihan Amoniak Dalam Upaya Meningkatkan Kualitas Air Baku pada PDAM-IPAL
Bojong Renged dengan Proses Biofiltrasi Menggunakan Media Plastik Tipe Sarang Tawon. Jurnal Air 6 (1) :64-76.

G.10

LAND MANAGEMENT FOR FULFILLING REQUIREMENT AND AVAILABILITY OF GRAIN FOOD

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ABSTRACT

Indonesia is an agrarian country with food as staple foods. However, the fact is Indonesia experiencing from food shortage, this is in line with the increasing of total population and land agricultural conversion so that becomes set of problem in facing food security. The amount of harvested area and food production in Aceh Besar District was fluctuate from year to year due to the conversion continuous of wet land and difficult to avoid. Paddy field conversion is a serious threat which has an impact on food problems that are permanent, cumulative, and progressive. This research aims to project the requirment and availability of land for food due to land conversion. Based on the research results obtained an increase in energy requirement sourced from food. Food requirement can be fulfilled until 2020 if land area production existing didn't run into land conversion either agricultural or non-agricultural. The energy availability ratio obtained was R <1 of 314,913 million/Kcal. This means that the energy availability was more than the requirement but the energy availability of grain food was still sufficient for the population of Aceh Besar District requirement. The high contribution of grain food to the energy requirement fulfillment so that it was needed an effort to protect the paddy field conversion into non-paddy field for the food requirement of grain can be fulfilled.

Keywords : Food, food requirement, land availability, population, Aceh Besar District.

I. INTRODUCTION

Indonesia is an agrarian country with food as the staple food of society. However, in fact, Indonesia is experiencing a shortage of food, this is due to the increasing population with population growth rate of 1.38% per year (BPS, 2016) and the rampant conversion of agricultural land with a deficit of 80 thousand ha (BPS, 2013) In the face of food security. In Aceh, rice is cultivated by about 60% of Aceh's inhabitants and contributes about 42% to Aceh's gross domestic product (GDP). Rice demand for rice continues to increase in line with increasing population and increasing per capita consumption due to increased revenue. So that required a development and management in agricultural development.

Efforts to meet the food and nutritional requirement of the population according to Karsin (2004) in Sumarlin et al. (2009) can be achieved through increased production and availability of food, pricing and food reserves, food industry, food industry supervision, and community participation. In addition, according to Ariani et al. (2003) in Sumarlin et al (2009) increased production and availability of food affected by available land area, land productivity, crop index, food prices, and prices of production facilities. According to Augustine (2011), although the availability of food in the area is sufficient enough as macro, it is not guaranteed that the food can be sufficiency at the household and individual levels, as food security in the region is also determined by geographical, demographic, resource, economic, socio-cultural With the amount of food production, the ease of access of consumption and the affordability of quality safe food, as well as the smooth distribution of food up in remote areas.

The food requirement of a region is assessed based on the Recommended Dietary Allowances (DRA) and the population according to sex and age group. The availability of food can be determined based on the level of food production and nutrition (Hardiansyah, 1998). Aceh Besar District has a population of 392,584 people with a population growth rate of 2.07% per year. To know the potential of food capacity and area of paddy field needed by Aceh Besar District in order to produce food according to the food and nutrition requirement of its population, it is necessary to do an analysis to the need of agricultural land area of food of Aceh Besar District in fulfilling requirement of food and nutrition of its population.

Food sub-sectors covering paddy rice, paddy fields and maize are one of agriculture sub-sector and as a mainstay sector in Aceh Besar District. The area of harvested rice in Aceh Besar District in 2015 is 44,738 Ha with production of 230,978 tons, the area of harvest of paddy field in the year 2015 is 3 ha with the production of 6,696 tons, and the corn harvest area in the year 2015 of 662 Ha with the production of 2,828 Ton (Dinas Pertanian Tanaman Pangan Kabupaten Aceh Besar, 2015). The amount of harvested area and food production in Aceh Besar District has fluctuated from year to year, this is due to the continuous and unavoidable conversion of paddy fields. Conversion of paddy fields is a serious threat that affects food problems that are permanent, cumulative, and progressive. This study aims to identify the development and projection of land requirement and availability for food due to land conversion.

II. MATERIALS AND METHODS

A. Time and Place

The study was conducted in Aceh Besar District which is agriculture area with mainstay sector in agriculture sector where 13,52% is paddy field potential rice producer. Food crops included in this research are grain food in the form of paddy rice, paddy fields and maize.

B. Data Collection

Administration map, land cover map, existing rice field map, rainfall map, and land suitability map of Aceh Besar crops; Population growth data of Aceh Besar District by age group, sex ratio obtained from BPS of Aceh Province; Data on the development of agricultural production of rice crops in the form of paddy rice, paddy fields and maize.

C. Data Processing

1. Food energy requirement

The projected grain energy requirement is calculated based on the Recommended Dietary Allowances (DRA), adjusted for age group sourced from BPS and Bappenas. Average daily energy requirement of male is about 2,166 Kcal and woman 1,775 Kcal. Daily food energy requirement in a certain region can be calculated based on the following equation Setiawan and Purwanto (2006):

$$E^D = \left[\sum_i^n a_i^{\,p} . N_i^{\,p} + \sum_i^n a_i^{\,w} . N_i^{\,w} \right] \tag{1}$$

Sufficiency means the fulfillment of daily food energy requirement within the range, while the balance of energy contains the meaning of the composition of energy from various recommended sources. The recommended energy composition refers to the Desirable Dietary Pattern (DDP) 2020, in which the composition of food energy in the form of minimum grains of 40% and maximum of 60% (Hardinsyah, et al., 2002). The recommended energy composition refers to the Desirable Dietary Pattern (DDP) 2020, as presented in Table 1.

Table 1. Energy Composition of Foodstuffs Group (DDP 2020)

Num	Groups	Consumption (Kcal)	Availability (Kcal)	Minimum	Maximum
1	Grain	1075	1250	40,0%	60,0%
2	Animal food	329	382	5,0%	20,0%
3	Fats and oils	215	250	5,0%	15,0%
4	Tubers	108	125	0,1%	8,0%
5	Vegetables and fruits	108	125	3,0%	8,0%
6	Nuts and beans	108	125	2,0%	10,0%
7	Sugar	144	168	2,0%	8,0%
8	Fruits and oily beans	63	75	0,1%	3,0%
9	Etcetera	-	-	0,1%	5,0%

Source: Hardinsyah, et al., 2002; Anwar, et al., (2002)

To calculate the availability of nutrition, the Food Contents List (FCL) table is shown as Table 2.

Table 2. The Nutritional Content of Rice Groats and Yellow Maize per 100 Grams

Food	Energy	Protein	Fat	Carbohydrate
Paddy Rice	339	7,7	4,49	73
Field Rice	339	7,7	4,49	73
Corn	366	9,8	7,3	69,1

Source: Depkes RI,1995

2. Energy availability

The availability of grains is the amount of energy available based on the production of grains in a region. According to Setiawan, et al., (2007), energy availability can be calculated based on the following equation:

$$E^S = \sum_{i=1}^{9} E_i^S \tag{2}$$

$$E_i^S = \sum_{j=1}^{3} \sum_{k=1}^{n} \beta_{ijk} . \gamma_{ijk} . W_{ik} \tag{3}$$

3. Projected production and land area

The calculation of grain availability and consumption using a based approach Recommended Dietary Allowances (DRA) to Desirable Dietary Pattern (DDP) 2020 targets. Burghes and Borrie (1981) developed a model for projecting the production and area of land using the Verhults growth model as follows:

$$P_t = P_\infty \left[1 + \left[\frac{P_\infty}{P_0} \right] \cdot e^{-\lambda t} \right]^{-1} \tag{4}$$

4. Ratio of availability and demand of food energy

The optimum energy is the amount of energy needed to meet food requirement. The optimum energy is equal to the energy requirement based on population, sex and age group. Optimum production requirement are calculated based on the ratio of food availability and demand with the following equation (Mustafril, 2010):

$$R = \frac{E^D}{E^S} \tag{5}$$

If R> 1, it means that the availability of food energy is less than the requirement, R <1 is more availability compared to requirement, and if R = 1 then the availability of energy is equal to requirement or enough.

III. RESULTS AND DISCUSSION

The district of Aceh Besar is located in Aceh Province with 297,411 Ha (2,974.11 km^2) or 5.24% of the total area of Aceh Province consisting of 23 sub-districts, 68 settlements and 604 villages. Most of the area is on the mainland and a small portion is in the archipelago. About 10% of villages in Aceh Besar District are coastal villages and geographically located on the 5 ° 2'- 5 ° 8 'North Latitude and 95 ° 80'- 95 ° 88' East Longitude lines. The majority of residents of Aceh Besar District work as farmers.

The population of Aceh Besar District in 2005 reached 281,399 people with a population of 137,975 people and a population of 143,424 people and the projection in 2020 was 508,127 people with 262,455 male and 245,672 female inhabitants. The result of population growth projection in Aceh Besar District from 2005-2020 using Verhults Equation can be seen in Table 3 and the result of population projection of Aceh Besar District in 2020 can be seen in Fig. 1.

Table 3. Equation Projection Total Population of Aceh Besar District

Equation	Parameters			
	P_t [P_{2020}] (soul)	P_o [P_{2005}] (soul)	γ [Verhults], r	R^2
Verhults	508.127	281.399	0,056	0,874
Geometric	539.191	281.399	0,043	0,872
Exponential	539.192	281.399	0,042	0,872

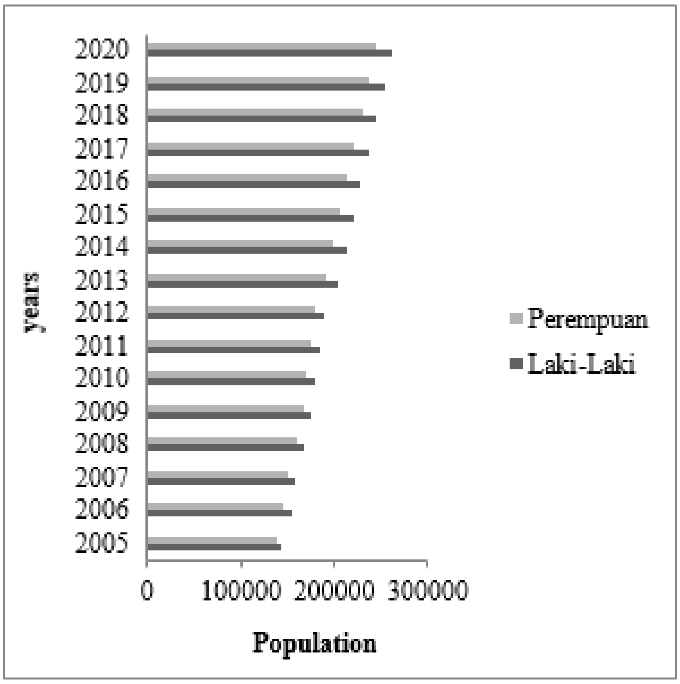

Fig. 1. Population Projection of Aceh Besar District from 2005-2020

The projected population growth using the Verhults equation is more accurate than the other equation, with the value of R ¬2 reaching 0.8744 which is the approximate projection value corresponding to the actual data, if the value of R2 is closer to 1, then the value is the most significant. Based on the results of this projection, it is found that population based on age group and gender in Aceh Besar district keep increasing, so that the energy demand from food of grain will also increase. It can be said that the demand of food grains of food gradually increase along with the increase of population growth.

Aceh Besar grain food production from the period of 2005-2012 can be seen in Fig. 2.

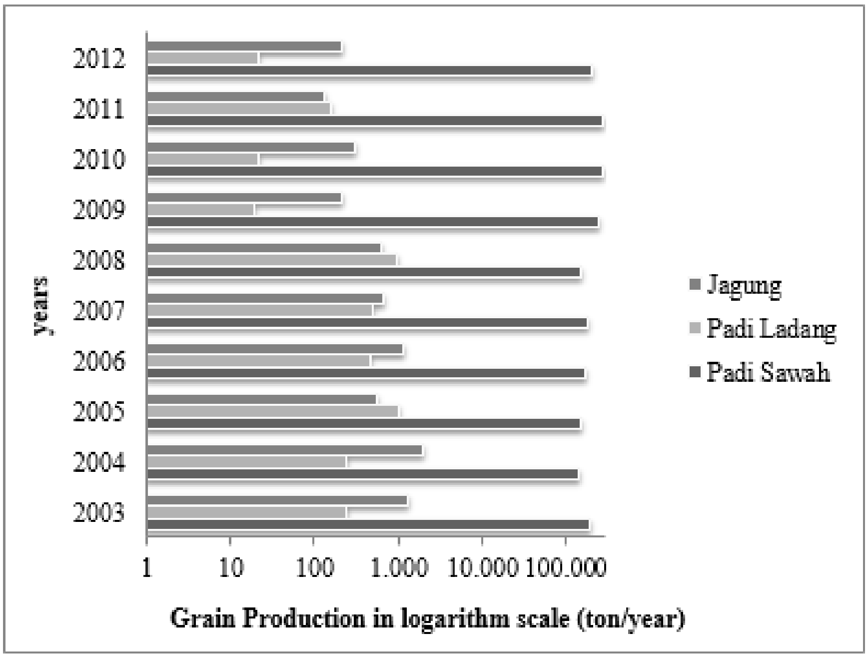

Fig. 2. Grain Production in Aceh Besar District 2005-2012

The development of grain production in Aceh Besar District from 2005-2012 found that the rice production had been fluctuated. But the amount of production is still able to meet the requirement of grain food residents in Aceh Besar District. The yield of paddy fields has decreased due to the limited area of land suitable for planting rice fields. While corn production also decreased. Although the production of grain food has decreased, but this amount of production still can fulfill the requirement of grain food of Aceh Besar District.

A. *Projection of Aceh Besar District Population from 2005-2020*

The development of the population of Aceh Besar District from 2005-2020 is presented in Fig. 3.

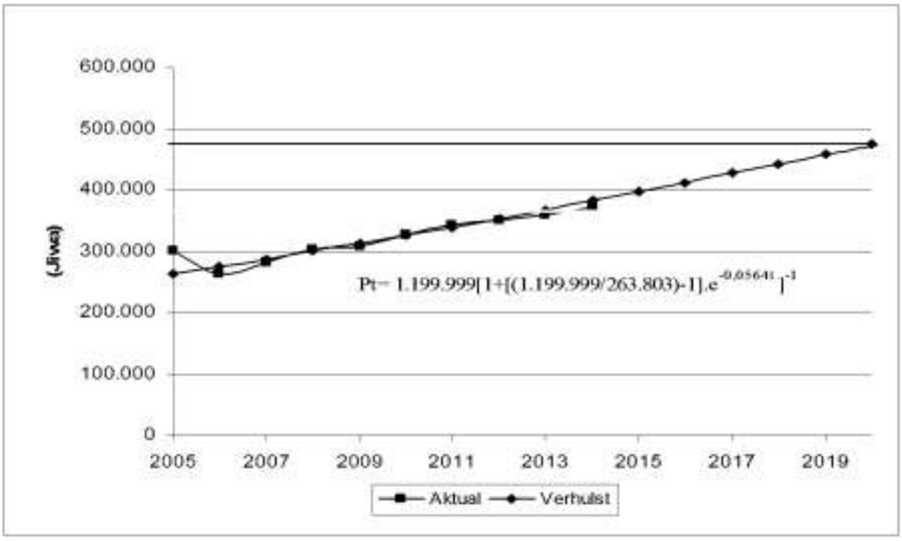

Fig 3. Population Projection of Aceh Besar District

B. Energy Requirement and Availability

1. Energy Availability 2005- 2012

The available annual energy of grain yield is presented in Table 4.

Table 4. Availability of Energy in Aceh Besar District 2005-2012

Year	Production of Food (Ton)			Energy Availability (million/ Kcal)			Total (million/ Kcal)
	Rice	Rice Field	Corn	Rice	Rice Field	Corn	
2005	153.446	994	541	326.362	2.114	1.980	330.456,00
2006	169.000	464	1.117	359.444	987	4.088	364.518,82
2007	185.647	494	655	394.850	1.051	2.397	398.297,98
2008	146.192	944	629	310.934	2.008	2.302	315.243,63
2009	247.986	19	208	527.438	40	761	528.239,64
2010	274.461	21	303	583.747	45	1.108	584.900,90
2011	273.517	155	131	581.747	330	479	582.548,60
2012	203.497	21	216	432.815	45	791	433.650,14

The available energy demand from grain food production is increasing every year, so it will affect the increasing availability of grain production. The total availability of grain food type of food has decreased in 2008 with the number reached 315,243 million / Kcal compared to the previous year of 398.297 million / Kkal and in 2012 energy availability also decreased with numbers reaching 433.650 million / Kcal compared to the previous year around 582,548 Million / Kcal. Although the availability of energy in 2008 and 2012 has decreased the value, but its still sufficient for energy requirement of food sourced from grains in the form of rice fields, rice fields and corn.

2. Projected Energy Availability 2013-2020

The projected energy availability for 2013-2020 is presented in Table 5.

Table 5. Projection of Energy Availability in Aceh Besar District 2005-2012

Year	Kind of Food (million/ Kcal)			Total (million/Kcal)
	Rice	Rice Field	Corn	
2013	540.177	244	589	541.011,85
2014	563.348	187	464	564.000,28
2015	586.580	142	362	587.085,11
2016	616.171	108	285	616.565,59
2017	632.916	82	223	633.222,81
2018	655.878	127	172	656.178,10
2019	678.608	48	135	678.792,84
2020	701.038	36	106	701.180.94

Based on the projection of energy availability year to year 2020 it is found that the availability of energy is increasing every year. This can be seen in the year 2005 the availability of grain energy reached 330.456 million / Kcal while the need for grain energy is only about 121.328 million / Kcal. In the year 2008 the availability of energy reached 315,243 million / Kcal and energy requirement is only about 132.663 million / Kcal.

3. Comparison of Energy Requirement and Availability

Energy requirement increase every year so that the amount of grain production requirements will also increase. The composition value used to calculate energy demand based on the Food Security Agency of the Ministry of Agriculture (2014) is 60.29%. The comparative value of energy demand and availability of grains from 2005-2012 is presented in Table 6.

Table 6. Comparison of the Requirement and Availability of Grain Energy in 2005-2012

Year	TER (million/Kcal)	GERC (million/Kcal)	EA (million/Kcal)	Ratio EA
2005	203.069	121.841	330.456	0,3
2006	223.357	134.014	364.518	0,3
2007	220.591	132.355	398.297	0,3
2008	243.625	146.175	315.243	0,4
2009	251.501	150.901	528.239	0,2
2010	255.663	153.398	584.900	0,2
2011	261.516	156.910	582.548	0,2
2012	263.457	158.074	433.650	0,3

Information :
TER = Total Energy Requirement
GERC = Grain Energy Requirement Composition
EA = Energy Availability

Humans need food to grow and move. The availability of grain food must be fulfilled. Although energy demand is increasing, but energy availability can still meet the energy requirement sourced from grain food. Based on the ratio of energy availability, the value of R <1. This means that the availability of energy is more than the energy requirement. The high contribution of grain food to the fulfillment of energy requirement in Aceh Besar district resulted in wetlands need to be protected so that there is no conversion from paddy fields to non-rice fields that have an impact on the inability to meet the requirement of grain food.

C. Projection of Harvest Area and Wetland Rice Production

The need and availability of grain land is needed to know the production potential and the area of grain land needed to produce grains according to the requirement of the population. Projection of harvested area and paddy field production of Aceh Besar District from 2005-2020 is presented in Fig. 4a and Fig. 4b.

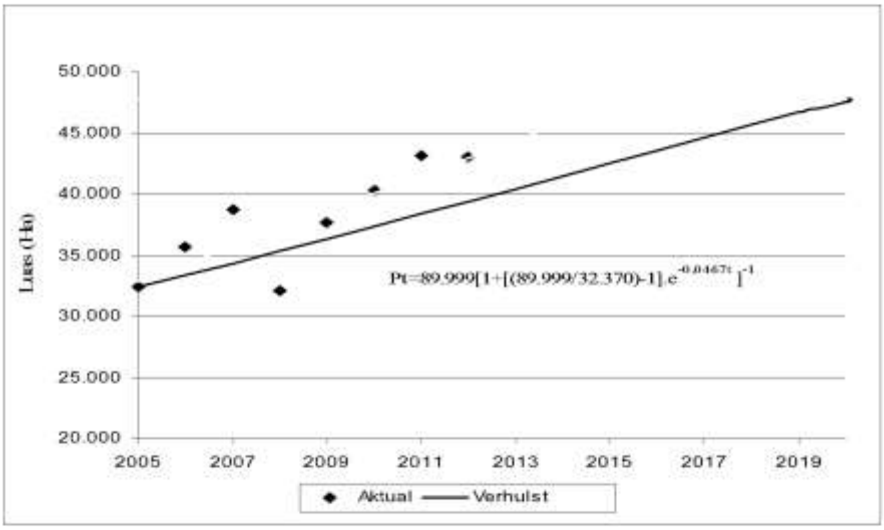

Fig 4a. Projection of Rice Harvest of Rice Field in Aceh Besar District

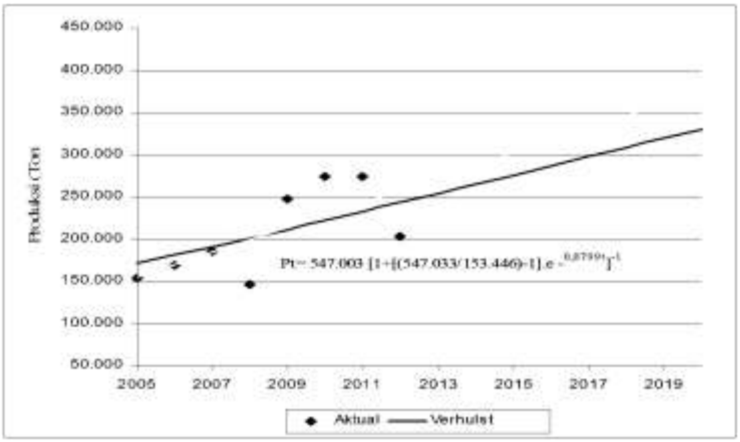

Fig 4b. Projection of Aceh Besar Wetland Rice Production

Based on the results of projected data of harvested area from 2005-2012 using the Verhults method it is found that the area of paddy rice harvest for 2020 area increases with the harvested area reaching 49.872 Ha. Fig. 4b shows that the area of paddy crop harvest shows a good increase, so it is still sufficient for the requirement of the people of Aceh Besar District. Harvested area of projection result compared with actual result from Year 2005-2020 got value of R2 = 0,6881 and value of Error = 0,04. This means that the projected value obtained from the Verhults Equation has a value of accuracy of 68.81% or in other words close to the actual value. The projection of paddy field production has the highest increase in the year 2010 with the production of 274,461 tons. If the data of rice production is used as the basic data projected rice production until 2020, then obtained the production of rice reached 218,135 tons. The projected output is compared with the actual result of the Year 2003-2020, having R2 = 0, 4430 and the value of Error = 0.017. This means that the production of paddy rice is still sufficient.

D. Projection of Harvest Area and Production of Paddy Field

Projection of harvested area and paddy field production from 2005-2020 is presented in Fig. 5a and Fig. 5b.

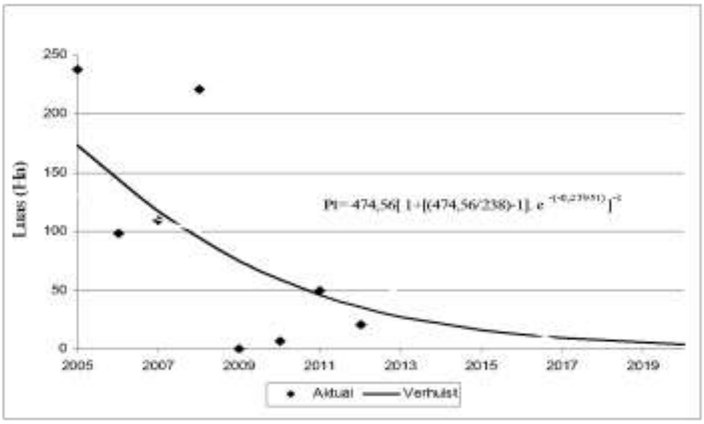

Fig 5a. Projected Area of Harvest of Paddy Field

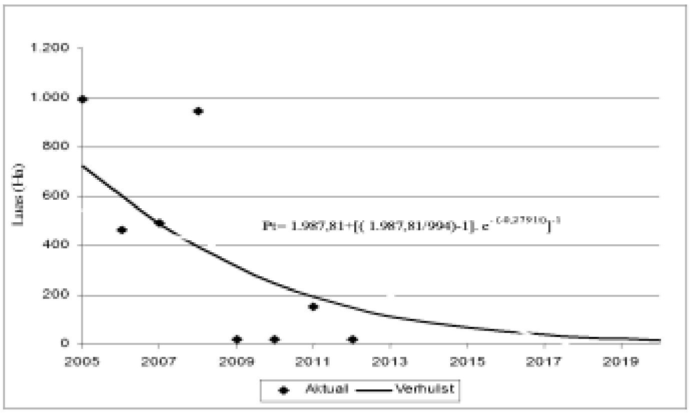

Fig 5b. Projection of Paddy Field Production of Aceh Besar District

Based on the results of projected data of harvested area from 2005-2012 using Verhults method it is found that the area of paddy rice harvest for 2020 area decreased with harvested area about 4 Ha. The projection of paddy fields production increased the highest in the year 2008 with the production of 944 tons. If the paddy field production data is used as baseline data to project paddy fields production until 2020, the production of paddy fields reaches 17 tons. The result of projection of production compared with actual result from Year 2005-2020 got value R2 = - 0, 59 and Error value = 0,005.

E. Projection of Harvest Area and Maize Production

Projection of corn harvested area and production Year 2005-2020 is shown in Fig. 6a and Fig. 6b.

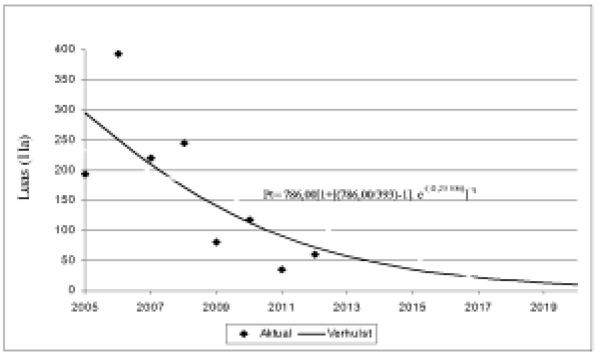

Fig 6a. Projection of Harvest Corn Area

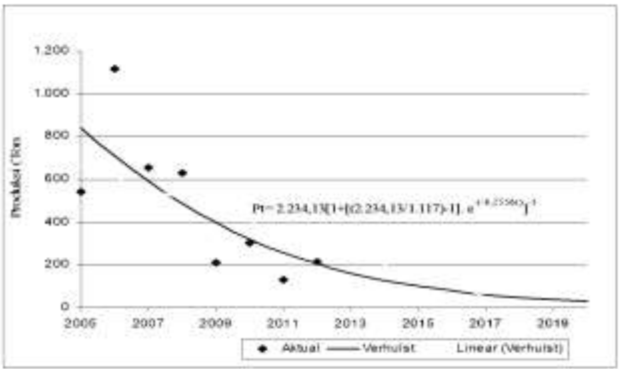

Fig 6b. Corn Production Projection of Aceh Besar District

Based on the results of projected data of harvested area from 2005-2012 using Verhults method it is found that the area of paddy rice harvest for 2020 area decreased with harvested area of 10 Ha. The projection of paddy field production has the highest increase in 2006 with the production of 1,117 tons. If the paddy field production data is used as baseline data to project paddy fields production by 2020, the production of paddy fields decreases with production to 29 tons. The result of production projection compared with actual result from Year 2005-2020 got value R2 = - 0, 704 and Error value = 0.0007.

F. Land Suitability For Grain

Land suitability for grains in Aceh Besar District can be seen in Table 7.

Table 7. Table Area of Land Suitability for Grains Area

Grade of Land Suitability	Rice		Rice Field		Corn	
	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%
Highly Suitable	-	-	-	-	-	-
Moderately Suitable	85.929	28,89	0	0	3.141	1,0
Marginal Suitable	53.340	17,93	133.094	44,75	60.894	20,47
Currently Not Suitable	9.432	3,17	40.270	13,54	87.864	29,54
Permanent Not Suitable	148.712	50,00	124.046	41,70	145.510	48,92
Total	297.411	100	297.411	100	297.411	100

Land in Aceh Besar District for planted wetland rice with moderately suitable and marginal suitable category still wide availability of 139,269 Ha (46,82%) from total area. This is due to wetland rice suitable for planting on land with climatic conditions such as in Aceh Besar District, which has the ability and suitability of land needed rice fields. The same thing is also found on land for cultivation of rice fields with a marginal suitable category is still very wide available for 133.094 Ha (44.75%) of the total area. While the land for corn planted with moderately suitable and marginal suitable obtained for 64.035 Ha (21.47%) of the total area. Optimum and sustainable land use, it is necessary to take corrective actions according to the limiting factors that exist in each class of land suitability. Determination of actions effort or improvements that need to be done should consider the characteristics of land incorporated in each land quality.

G. Requirement and Land Availability of Grains

The availability of land in 2005 for the grain area of 34,313 hectares with an area of 32,802 ha of harvest, and the need for an area of 12,453 hectares. Increased in 2006 as wide as 3,421 H. In 2016 the area of cereals grew to 39.5% (45,726 Ha) compared to the harvested area in 2005, with the need for grain area reaching 17,884 Ha. Based on the projected area of cereals harvest increased in Year 2020 amounted to 49,886 hectares, with the need for cultivated land reach 19,526 Ha. The comparison of requirement and availability of land for grain food in 2005-2020 is presented in Fig. 7.

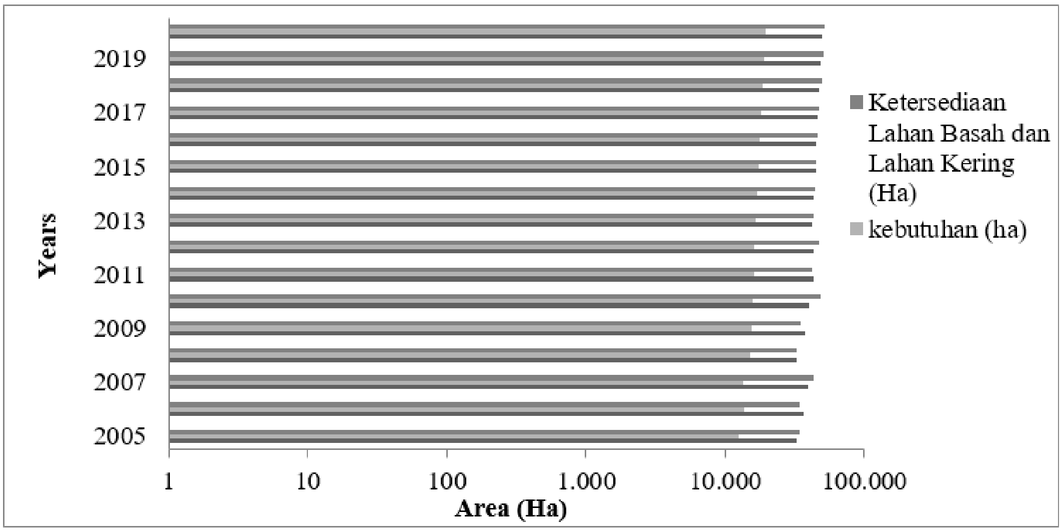

Fig 7. Comparison of Requirement and Land Availability for Grains

The harvested area of cereals can still meet the requirement of grain food in Aceh Besar District. This means that until the year 2020 the availability of grains surplus to the requirement of grain food community with a surplus of harvest area reached 30,360 ha. In order for grain food requirement can be done from the existing land area, it is assumed that there is no conversion of paddy fields into non-paddy fields both agricultural and non-agricultural. This is in accordance with Rustiadi and Wafda (2008) statements that these conditions require government attention to hinder the occurrence of land conversion, improving agricultural infrastructure, especially irrigation and increasing land productivity. Sumarlin et al (2008) stated that the need for wetland paddy field will be higher if the population consumption pattern is not improving toward sufficient and balanced nutrition consumption pattern and not the increase of land productivity and crop index.

IV. CONCLUSION

Grain-fed food production in an effort to meet the food requirement of grains in Aceh Besar District by 2020 is projected that the availability of grain food is still meet (fulfilled) the requirement of the community. The availability of land with moderately suitable category also still experience surplus or excess reach 30,360 Ha with projection area of 49,886 Ha and requirement of 19,526 Ha. The ratio of energy requirement and availability also found that until 2020 the availability of energy from grain food is still sufficient for the requirement of the people of Aceh Besar District with the value of energy requirement ratio and less than 1 (R <1) of 314.913 million / Kcal. Food requirement can be fulfilled until 2020 if the existing production area does not experience land conversion either agriculture or non-agriculture. The availability of energy is greater than the demand but the energy availability of grain food is still sufficient for the requirement of the people of Aceh Besar District. Contribution of high-grain food to the fulfill\ment of energy requirement, so it is necessary to minimize the conversion of paddy fields into non-paddy fields land so that the fulfillment of food requirement of grain can be achieved.

REFERENCES

[1] Agustinus, A.K.A. 2011. Aplikasi Sistem Informasi Geografis (SIG) untuk Menentukan Daerah Potensi Rawan Pangan Guna Mendukung Informasi Ketahanan Pangan (Studi di Kabupaten Malang, Propinsi Jawa Timur). Tesis. Program Pascasarjana Universitas Gadjahmada, Yogyakarta.

[2] Anwar, S., Mukson., dan D. Rahmadi. 2002. Analisis Potensi dan Ketersediaan Pangan dalam Kaitannya dengan Ketahanan Pangan di Jawa Tengah. Jurnal Litbang Universitas Muhammadiyah Semarang. 5-17.

[3] BPS [Badan Pusat Statistik]. 2013. Aceh dalam Angka. Badan Pusat Statistik, Aceh.

[4] BPS [Badan Pusat Statistik]. 2016. Aceh dalam Angka. Badan Pusat Statistik, Aceh.

[5] Davis, K. 1976. Land Use. Mac Graw Hill, New York.

[6] Depkes RI [Departemen Kesehatan Republik Indonesia]. 1995. Daftar Kandungan Bahan Makanan. Departemen Kesehatan, Jakarta.

[7] Dinas Pertanian dan Tanaman Pangan Propinsi Aceh. 2014. Perkembangan Luas Lahan dan Produksi Palawija. Dinas Pertanian, Banda Aceh.

[8] DKP-Deptan RI [Dewan Ketahanan Pangan Departemen Pertanian Republik Indonesia] dan WFP-UN [World Food Programe United Nation]. 2005. Peta Kerawanan Pangan Indonesia DKP-Deptan dan WFP-UN. Departemen Pertanian, Jakarta.

[9] Hardiansyah. 1998. Kelembagaan Ketahanan Pangan dan Gizi. Pusat Studi Kebijakan Pangan dan Gizi. Bogor.

[10] Kasryno, F. 2004. Kebijakan Pembangunan Pertanian dalam Era Globalisasi dan Otonomi: Ketahanan Pangan dan Penanggulangan Kemiskinan: Dalam Widyakarya Nasional Pangan dan Gizi VIII (eds. *et al.*). LIPI. Jakarta.

[11] Kurtanti. 2004. Angka Kecukupan Gizi bagi Orang Indonesia. [terhubung berkala].http://staff.ui.ac.id/system/files/users/kuntarti/material/akg2004. pdf. Tanggal akses 28 Februari 2014.

[12] Mustafril. 2010. Optimalisasi Pemanfaatan Sumberdaya Hayati untuk Memenuhi Kebutuhan Pangan Studi Kasus Kabupaten Aceh Selatan-NAD. Disertasi. Program Studi Ilmu Keteknikan Pertanian. Program Pascasarjana. Institut Pertanian Bogor, Bogor.

[13] Mustafril, B.I. Setiawan, M.Y.J. Purwanto, L.B. Prasetyo, dan D. Martianto. 2006. Pengelolaan Sumberdaya Hayati Bagi Pemenuhan Kebutuhan Pangan dan Gizi. Jurnal Keteknikan Pertanian 20 (2) : 95-101.

[14] PPH [Pola Pangan Harapan]. 2002. Komposisi Zat Gizi Makanan Indonesia. Badan Penelitian dan Pengembangan Kesehatan. Penyusun Hardiansyah, M. Karmini, Hermana, Komari.

[15] Rustiadi, E. dan R. Wafda 2008. Urgensi Pengembangan Lahan Pertanian Pangan Abadi dalam Perspektif Ketahanan Pangan. Yayasan Obor Indonesia, Jakarta.

[16] Serageldin, I. and G.J. Persley. 2000. Promethean Science. Agriculture Biotechnology the Environmental, and the Poor. Consultative Group on International Agricultural Research. Washington D.C, USA.

[17] Setiawan,. B.I. dan H. A. Purwanto. 2006. Optimalisasi Diversifikasi Pangan Suatu Pendekatan Menuju Ketahanan Pangan Nasional. Jurnal Keteknikan Pertanian. 20:197-204.

[18] Setiawan, B. I, M.F. Syuaib, dan H. A. Purwanto. 2007. Optimalisasi Diversifikasi Pangan Menuju Pola Pangan Harapan Nasional 2020. Seminar Nasional Ketahanan Pangan 2007. Peningkatan Peran Keteknikan Pertanian dalam mewujudkan Ketahanan Pangan. PERTETA. Bandar Lampung,15- 17 November 2007.

[19] Siregar. 1981. Aspek Kesehatan dan Gizi dalam Ketahanan Pangan. PT. Surya Multi Grafika, Jakarta.

[20] Sitorus, S.R.P. 2004. Pengembangan Sumberdaya Lahan Berkelanjutan. Edisi Ketiga. Laboratorium Perencanaan Pengembangan Sumber Daya Lahan. Jurusan Tanah. Fakultas Pertanian. Institut Pertanian Bogor, Bogor.

[21] Soeriaatmadja, R.E. 2000. Pembangunan Berkelanjutan yang Berwawasan Lingkungan. Direktorat Jenderal Pendidikan Tinggi Departemen Nasional, Jakarta.

[22] Soesatro, H. 2012. Pemikiran dan Permasalahan Pangan di Indonesia. Kanisius, Yogyakarta.

[23] Soetrisno, N. 1996. Ketersediaan dan Distribusi Pangan dalam Rangka Mendukung Ketahanan Pangan Rumah Tangga. Makalah pada Lokakarya Ketahanan Pangan Rumah Tangga. Yogyakarta.

[24] Sumarlin., Y.F Baliwati., dan E. Rustiadi. 2008. Analisis Kebutuhan Luas Lahan Basah Pertanian Pangan Dalam Pemenuhan Kebutuhan Pangan Penduduk Kabupaten Lampung Barat. Jurnal Gizi dan Pangan. 3(3) ; 198-204

[25] Suryana, A. 2003. Strategi Percepatan Pencapaian Ketahanan Pangan Mandiri. Makalah Utama pada Seminar Nasional Inovasi Teknologi Sumberdaya Tanah dan Iklim, 14-16 Oktober 2003, Bogor.

G.11

AGROTECHNOLOGY APPROACH OF LABORATORIUM LAPANG TERPADU FACULTY OF AGRICULTURE UNIVERSITY OF LAMPUNG BY LAND UNITS

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ABSTRACT

Laboratorium Lapang Terpadu Faculty of Agriculture, University of Lampung is required to support Lampung University Vision, Mission and Vision of the Faculty of Agriculture Lampung University. Aside from being a supporter of the the learning process and research, can also be used as a showcase (show window). This study aims to studying alternative approach to land management with land units. The method used is a survey method that consists of the preparation phase, a preliminary survey, primary survey, soil analysis in the laboratory, and data analysis. Evaluation of erosion using the Universal Soil Loss Equation (USLE). The results showed that the erosion of the land unit no.2 is still well below the Tolerable Erosion. Erosion on the land units No.3 with 8-15% slope by using a mixture of garden soil and pasture that is 100.29 t / ha / yr. Erosion on land units no.4 and no.5 respectively of 831.74 t / ha / yr and 381.81 t / ha / yr. Erosion on land units 3,4, and 5 have exceeded the value of erosion that can still be tolerated and require agrotechnology. Agrotechnology approach for land units no.3 is P0 (patio bench without plants) or a combination of bench terraces and swidden (P1C6). Land units 4 with the perfect combination of bench terraces and not in the specified moor (P1C2), or patio bench is perfect and good pasture (P1C1). 5 land units with a combination of bench terraces and a high density of annual plants (P1C3) or with an annual plant density is (P1C4).

Keywords : land unit, agrotechnology approach, erosion, C-organic, land use

I. INTRODUCTION

Laboratorium Lapang Terpadu of the Faculty of Agriculture , University of Lampung is needed to support the vision of the University of Lampung and Vision and Mission of the Faculty of Agriculture , University of Lampung. According Banuwa , Syam and Wiharso (2011), an integrated field laboratory of the Faculty of Agriculture, University of Lampung in addition to support teaching, learning and research, can also be used as a showcase (show window). The existence of a unified field laboratory of the Faculty of Agriculture, University of Lampung is expected to build a new image in the field of agriculture , especially for the younger generation , that agriculture is not inferior to other fields, can be an attractive profession, prospectively, and honorable.

From the results of previous studies, this laboratory has a very diverse class slopes. In general the dominant slope is slightly slanted / wavy with slopes of 8-15 % (65 % of the total area), followed by a gentle slope / choppy (20% of the total area), flat (8% of the total area), rather steep (6% of the total area), and the remaining one percent steep slope (Banuwa, *et al.*, 2011) .

Laboratorium Lapang Terpadu of the Faculty of Agriculture , University of Lampung , with an area of approximately 6.784 hectares located in the complex of Lampung University campus. This laboratory, as intended, is used to perform a variety of research related to agricultural science. With dominant ramps to undulating contour, as well as high rainfall, the estimated erosion potential is also large enough so that it is feared will be a decline in soil fertility and loss of topsoil (top soil), if not managed properly.

The erosion problem will lead to land degradation, which will affect the sustainability of integrated field laboratory of the Faculty of Agriculture, University of Lampung, so that the necessary soil and water conservation efforts in accordance with the rules of science. Soil conservation is defined as the placement of each field on how to use the land in accordance with the ability of the soil and treat it in accordance with the requirements necessary to avoid damage to the land. While water conservation principle is the use of water that falls to the ground as efficiently as possible, and the timing of the flow so that no destructive floods and there is enough water during the dry season (Arsyad, 2010).

Soil conservation does not mean suspension or ban the use of land, but with the ability to customize the type of land use and provide treatment in accordance with the conditions required in order to work the land sustainably. Each treatment was given on a piece of land will affect the water system, so efforts to conserve land is also a water conservation (Priyono and Cahyono, 2004).

Main goal of this research is to get each management alternative land units in the integrated field laboratory of the Faculty of Agriculture, University of Lampung.

II. MATERIALS AND METHODS

A. Place and Time Research

This study was conducted in Laboratorium Lapang Terpadu of the Faculty of Agriculture, University of Lampung, Jl. Sumantri Brojonegoro No. 1 Gedung Meneng Bandar Lampung.

Study determined the location intentionally (purposive), given the Laboratorium Lapang Terpadu of the Faculty of Agriculture, University of Lampung is home Unila academics doing research, experiment, practice and other activities related to the development of education and community service.

B. Determination of Land Unit

Land units is determined based on the results of the class map overlaying slope, soil type maps and land use maps. Acquired land units used as the object of observation. After conducting a preliminary survey (field assessment), carried out observations of the existing land units.

C. Data Collections

1. Soil

Soil data obtained from field observations and laboratory analysis of soil samples in soil and in Lampung State Polytechnic Laboratory of Soil Science, Faculty of Agriculture, University of Lampung. Soil sample taken consisted of intact and composite soil samples. Intact soil samples taken by 5 (five) points, each taken at a depth of 0-20 cm and 20-40 cm with two replicates representing each land unit. Intact soil samples used for the analysis of soil physical properties such as bulk density and soil texture. While the composite soil samples used for the analysis of soil properties.

2. Vegetation

Vegetation data required include: type of vegetation, the estimated amount, approximate cover has, and spread in the research area visually.

3. Rainfall

Rainfall data obtained from rain Kemiling graduated station. Data from this station is obtained through the Meteorology and Geophysics Agency (BMKG) Masgar, Tegineneng, Pesawaran District.

D. Data Analisys

1. Erosion

Erosion is calculated using the USLE (Wischmeier and Smith, 1978):

$$A = R \times K \times L \times S \times C \times P \quad (1)$$

where:
A = number of eroded soil (t / ha / yr)
R = rainfall erosivity factor index
K = soil erodibility
L = slope length factor
S = slope steepness factor
C = factor of vegetation ground cover and crop management
P = factor specific measures of soil conservation

2. Rainfall erosivity factor (R)

Determination of rainfall erosivity factor (R) is the sum of the values of monthly rainfall erosion index and is calculated by the equation:

$$R = \sum_{i=1}^{12} (EI30)i \quad (2)$$

EI30 determination, prediction equation uses Bols (1978, in Arsyad, 2010), as follows :

$$EI30 = 6{,}119\ (\text{Rain})^{1,21}(\text{Days})^{-0,47}(\text{Maxp})^{0,53} \quad (3)$$

Where :
EI30 = monthly rainfall erosion index
Rain = precipitation monthly averages (cm)
Days = number of rainy days per month on average
Maxp = maximum rainfall during 24 hours in the month (cm)
Annual EI_{30} is the sum of monthly EI_{30}

3. *Soil Erodibility Factor (K)*

Soil erodibility value was calculated by using the formula Wischmeier and Smith (1978) :

$$100K = \{1{,}292\ (2{,}1\ M^{1{,}14}\ (10^{-4})(12 - a) + 3{,}25\ (b - 2) + 2{,}5\ (c - 3)\} \quad (4)$$

Where :
K = soil erodibility
M = grade soil texture (% silt +% dust) (100 -% clay)
a =% organic matter
b = the soil structure code
c = code permeability of the soil profile

4. *Length and slope factor (LS)*

Length and slope factor is calculated according to the formula (Wischmeier and Smith 1978) remedy the slope is less than 12 percent:

$$LS = \sqrt{X\,(0{,}0138 + 0{,}00965\,S + 0{,}00138\,S^2)} \quad (5)$$

For slopes over 12 percent using the formula according to Eppink (1985) as follows:

$$LS = (X/22)^{0.50}\ (S/9)^{1{,}35} \quad (6)$$

Where :
X = length of slope (m)
S = slope steepness (%)

5. *Plants and Land Management Factor(C)*

Determination of factors Plants and Land Management (C) based on various studies that have been done before.

6. *Conservation factor (P)*

Factors conservation measures are also determined based on the various studies that have been done before.

7. *Erosion can be tolerated (Etol)*

Tollerable soil loss (Etol) is calculated based on the equation proposed by Wood and Dent (1983, in Banuwa, 2008) which takes into account the minimum depth of the soil, the rate of soil formation, a depth equivalent (equivalent depth), and age in order to land (resources life). The rate of soil formation used was 2 mm / yr with age to use (UGT) for 400 years (Arsyad, 2010), a factor of 0.8 with a soil depth of effective soil depth varies between 720 mm to 1200 mm. The equation is as follows :

$$E_{tol} = \frac{D_e - D_{\min}}{UGT} + LPT \quad (7)$$

Where :
De = depth of equivalent
= Effective soil depth (mm) x depth of soil factors
Dmin = minimum depth of soil (mm)
UGT = Land use age (years)
LPT = rate of formation of soil (mm / yr)

8. *Agrotechnology*

Selection of Agrotechnology set based on the criteria used to determine the maximum value of CP. Alternative agro technology is resulting in erosion of the value of CP is less than or equal to the erosion that can be tolerated.

Selection of Agrotechnology set based on the criteria used to define the maximum CP value is used as an alternative agro technology is resulting in erosion of the value of CP is less than or equal to the erosion that can be tolerated. These criteria can be written as follows (Banuwa, 2008) :

$$A \le E_{tol} \text{ atau } RKLSCP \le E_{tol} \quad (8)$$

$$CP \leq \frac{E_{tol}}{RKLS} \text{ atau } CP \leq CP_{max} \quad (9)$$

III. RESULTS AND DISCUSSION

A. General Situation Research Sites

1. Geography condition

Geographically, the study site is located between 526,650 mT and 9,406,450 mU to 527,200 mT and 9,406,850 mU (UTM coordinates) or 5^{0} 22 '11.38 "latitude and 105^{0} 14' 25.96" E to 5^{0} 21 '58.35 "latitude and 105^{0}14 '43.83 "East. Altitude between 110 -130 m above sea level. (The Worldwide Coordinate Converter, 2012). Administratively, the study site is located in the Village gedong Meneng, Rajabasa District, the city of Bandar Lampung. The lowest part is located in the middle of the location, and the flow of water from the west toward the east. At the time of the study, in the east there are several ponds / lebung, which serves as a reservoir and storage of runoff water and used as a place of pisciculture.

2. Slope Class

FP unified field laboratory Unila dominated by undulating slopes (8-15%) and only a small part rather steep slope (30-45%). It is also in accordance with results of previous studies, that the slopes 8-15% reaching 65 percent and the total area is rather steep slope is only about six percent.

3. Rainfall

Based on data from Masgar Climatology Station, Tegineneng, annual rainfall average of the last six years at the study site is at 2,156 mm, with the highest annual rainfall in the year 2010 amounted to 3,297 mm. While the monthly rainfall average ranges between 78 mm (August) to 297 mm (February). Wet month in December to May (6 months), and the dry months (<100 mm) occurred in August and September. The average monthly number of rainy days was 8 days, with the highest number of rainy days is 13 days which occurred in January, and the lowest was 4 days in August and September. The maximum amount of daily rainfall average is 49 mm, with the highest daily maximum rainfall occurs in December in the amount of 82 mm and the lowest occurred in August which is 28 mm.

Rainfall annual average over the last six years to reach 2,156 mm with 13 rainy days the number of days in a month. The maximum amount of daily rainfall averaged over the last six years to reach 82 mm which occurred in December. These three components are crucial rainfall erosivity rainfall (rainfall ability to cause erosion).

4. Soil

a. Soil Fertility

The results Banuwa, Sham and Wiharso (2011), soil fertility status FP Unila unified field laboratory is low, with a pH of 5.12 to 5.63, the total nitrogen content of between 0.310 to 0.469% (classified as moderate), Phosphate content of between 5.301 - 8.573 ppm (classified as very low), the content of exchangeable potassium (K-dd) ranged from 0.165 to 0.760 g me/100, content of calcium (Ca-dd) can be exchanged relatively low (2.298 to 3.612 g me/100), Magnesium content exchangeable (Mg-dd) is low (.374 to .553 me/100 g), the value of Cation Exchange Capacity (CEC) ranged from 8.740 to 13.821 g me/100 (relatively low). Laboratory analysis showed that the levels of Carbon (C) organic soil ranged from 1.51 to 1.96%.

b. Physical properties of soil

From the survey and laboratory analysis, field laboratory Unila integrated FP can be classified in the group with the Ultisol soil parent material igneous / volcanic. Effective soil depth ranged from 72 cm - 136 cm. Water table is more than 72 cm. In general, the study site has good drainage. Of all land units, soil structure type is type 4 (blocky, plates, and solid: blocky, platy, and massive). Permeability class (moderate) and moderate to slow (moderate to slow). C-organic content of the soil at the study site ranged from 1.51 to 1.96 percent. Bulk density ranged from 1.13 to 1.21 g / cc.

In general, the soil in the study area is classified as a fine-textured clay, with a structure belonging to already developed. Soil structure cuboid angle with medium to coarse. On the top layer in a particular place is rounded cube, this is because they are influenced by the organic matter content.

Land in locations such studies are closely related to plasticity plastic classified according to soil texture that contains clay . Soils containing clay soil is a little bit dense , but the ability of soil to hold water is still quite high .

In the valley areas in the central part of the study area there is still a pool of water which resulted in somewhat poor drainage . Soil inundation of land in this area are generally gray , while the other part was relatively good drainage , marked with bright colors and a homogeneous soil.

Land belonging to the depth (more than 72 cm) , so that roots can still plant roots develop properly .

Soil bulk density in the study area that is not too varied between 1.13 to 1.21 g / cc with a total pore space analysis is ranged between 54.34 to 57.36 %.

Topsoil permeability between 4.10 to 11.53 cm per hour , which is slow to moderate and moderate . As for the bottom layer ranged from 0.77 to 6.73 cm / hour , which is slow to moderate.

5. Land Use

Land use at the time of this study there are several types . In the middle section extends from west to east, there are some lebung / ponds are partially flooded . in the northern and central parts , used as a student / researcher doing research and prakrik various types of crops such as corn , peanuts , beans, forestry plants , spinach , kale land , and others . In the western part of the garden is a mix that is not too tight and there are a variety of crops such as bananas , cocoa , Tangkil , coconut , palm , bamboo , rosewood , papaya , and others . In the southeast there are some palm trees and there are mounds and traditional terraces .

In the southern part which is the main entrance , there are several permanent and semi- permanent buildings, livestock barns , greenhouses , office , residential guard , tower , and others . Along the boundary fence of integrated FP Unila field laboratory equipped with the inspection using the paving block with a width of approximately 150 cm . Around the yard office is also covered by paving block.

6. Land Unit

Based on the results of field survey and analysis of soil samples and the slope class map, then the set 5 land units in integrated FP Unila field laboratory. Land units determined by the properties or characteristics of a homogeneous land. As the differentiating factor is (1) the type of soil, (2) land cover, (3) climate rainfall in this case, and (4) slope. Relatively homogeneous soil types for the entire study area, as well as land cover and rainfall. Therefore the slope factor is the only differentiating factor in the determination of land units.

Land unified field laboratory FP Unila dominated by land unit 3 with an area 3.417 ha (50.37%) and 4 units of land with an area of 2.034 ha (29.98%).

Unit 1 is a unit of area of land with a slope of 0-3 percent that at the time the study was conducted in the form of ponds and rice fields are not processed. This vast land unit 1 approximately 0.737 ha. The most extensive land unit is a unit of area 3 (3.417 ha), with a variety of land uses such as garden mix, reeds and cassava. Land unit 5 is the smallest area (0.351 ha). This land has a rather steep slope, overgrown shrubs.

7. Erosion

a. Rainfall erosivity factor (R)

Rainfall erosivity value (R) of 2236, where the highest value of EI30 in December in the amount of 350 and the lowest in August at 71.

b. Soil Erodibility Factor (K)

K value is calculated based on a variety of factors: texture, structure, organic C content, and permeability. K values varied between 0.159 to 0.193.

c. The slope and slope length factor (LS)

LS factor is determined by the slope and slope length. Because of the slope varies from 1-45% and slope length also varies from 1 m to 120 m, then the LS values obtained varied depending on the class of the slope and slope length. LS values ranged from 0.077 to 4.717.

d. Vegetation management factor (CP)

Vegetation management factor (CP) ranged from 0.200 to 0.500. Assignment is consistent with the observations (survey) field, where conditions are very diverse vegetation cover.

The amount of soil erosion in the entire laboratory, field lerpadu FP Lampung University amounted to 330.67 tons / ha / yr . Highest erosion on land units with an area of 2,034 ha 4 , erosion of 831.67 tonnes / ha / yr . Next is a unit of land with an area of 0.351 ha 5 , the erosion is 381.84 tonnes / ha / yr . At least 2 units of land erosion , followed by a land unit 3 , respectively 8.88 and 100.30 tons / ha / yr .

Erosion increases with increasing slope gradient and slope length . Erosion for land unit 2 with slope between 3-8 % is equal to 8.88 ton / ha / yr . Erosion is still below the tolerable erosion to the land unit that is equal to 35.09 tons / ha / yr . This means that the land unit 2 does not require soil and water conservation measures to reduce erosion , requiring only maintenance actions so that erosion can always be maintained under Etol .

Soil erosion prediction for unit 3 on average amounted to 100.30 tons / ha / yr or 2.8 times greater than Etol is equal to 35.83 tons / ha / yr . 4 land units have an average value of erosion of 831.67 tons / ha / yr or 23 times greater than the value that is equal Etol 36.05 tons / ha / yr . While the average erosion on land unit 5 is equal to 381.84 tonnes / ha / yr or 10 times greater than the value of Etol is equal to 37.99 tons / ha / yr .

Three land units with slope 8-15 % , has a value greater erosion of value erosion in laboratory and requires soil and water conservation measures (Agro) to suppress the erosion to be below or equal to the value erosion that can be tolerated .

Unit 4 has a slope of land between 15-30 % and have a greater erosion of value erosion that can still be tolerated. Erosion is very high value is due to land units 4 , in addition to having a hilly slope also has a long slope. Long slope resulting in runoff that has the potential to cause greater erosion along the slope . Land units require soil and water conservation measures are more intensive than the land unit 3 to be able to suppress the erosion that is under or equal to the erosion in laboratory.

Five units of land with a slope of 30-45% with erosion four times greater than the erosion that can still be tolerated. Although the land unit 5 is steeper, but because the slope was relatively short (maximum 23 m), the erosion is lower than 4 land units. However, the land unit 5 also requires soil and water conservation measures that erosion can be reduced. Erosion average for the whole area of integrated FP Unila field laboratory is at 330.67 tonnes / ha / yr with Etol value of 35.89 tonnes / ha / yr.

8. Erosion in laboratory

E_{tol} values ranged from 33.67 tonnes / ha / yr (land units 2) up to 37.99 tonnes / ha / yr (land units 5). Assuming that during the 400 years of the functioning of the laboratory field lerpadu FP Unila still works fine. Because of the erosion rate is well above the value erosion that can be tolerated then need a serious effort to reduce the rate of erosion on each land unit, especially with conservative management efforts so that the value of CP can be reduced to a minimum. Other efforts that can be done is to shorten the length of the slope values (X) by means of terracing and mounds at certain locations.

9. Organic carbon content of soil

Soil organic carbon content reflects the amount of carbon captured by plants through photosynthesis and then go into the soil through the weathering process , and stored in the soil . Organic carbon content also reflects the condition of plants that cover the land in question . On open lands , the ability of plants to capture carbon through the process of photosynthesis is much lower when compared to the sealed area . The greater the organic carbon found in the soil means that the higher the amount of photosynthesis that occurs on the surface of the land where carbon is found.

The amount of organic carbon in the soil on land units 2 , 3 , 4 , and 5 each in succession by 1.96 % , 1.75 % , 1.79 % and 1 , 70 % . Highest organic carbon stocks in land units 2.

Carbon stored , either in the ground or above the ground surface from CO2 (carbon dioxide) in the atmosphere, which is absorbed by plants through photosynthesis . Carbon dioxide is a greenhouse gas (GHG) and was among the major greenhouse gases (CO2 , CH4 , N2O5) . According Hairiah (2007 in Banuwa and Henrie , 2010) , the concentration of the three types of gas late in the atmosphere continue to rise until doubled . Furthermore Banuwa and Henrie (2010) , reported that the amount of carbon stored in each land use varies , depending on the variety , plant density , soil type , management practices , and others.

Carbon stored in the soil is the sum of the percent of soil organic carbon multiplied by the weight of the soil , coupled with soil microorganisms biomass carbon (Banuwa and Henrie , 2010) . In this study the carbon biomass of soil microorganisms are not in the analysis . The amount of carbon stored in the soil at the field laboratory integrated FP Unila soil at a depth of 20 cm is equal to 252.00 tons , or an average of 41.97 tonnes / ha .

Loss of organic carbon in the soil due to erosion is estimated at 38.60 tons / yr (15.32 % of the total organic carbon in the soil) if there is no agro technology is applied to the field laboratory lerpadu Unila FP , or in less than 7 years old then carbon stocks will be depleted by erosion . By applying Agro- suit that has been described above , then the loss of organic carbon from the soil due to erosion can be reduced by 0.851 tons / yr (0.34 %) . Thus, agro technology applied to reduce the loss of soil organic carbon in integrated FP Unila field laboratory at 37.75 tons / year , or are able to maintain the organic carbon stored in the soil by 97.80 %.

10. Analysis of Agrotechnology

Agrotechnology or conservation measures that must be done is in accordance with the characteristics of each land unit. Land unit 2 do not require conservation action because of erosion predictions are still far below the erosion that can be tolerated . Land units 3 , 4 and 5 land units require proper agro technology to reduce erosion is predicted to occur in order to be below the value erosion that can still be tolerated.

Attempts to do is to conduct management activities (P) and planting appropriate vegetation and crop management (C) corresponding to each land unit . By doing the proper management and the selection of appropriate plant species , then the value of C and P factors can be reduced and further value erosion can also be suppressed.

For conservation measures (factor P), there are 5 actions that can be selected and combined with 6 types of vegetation and crop management factor (factor C). Of these two factors is then carried out so that the combination of CP values obtained for each of the land units that meet the criteria of value erosion is lower or equal to the erosion that can still be in tolerance.

The most effective conservation action is to create the perfect bench terraces (P1), with a P value of 0.04 . While the factors that best plants for conservation and grazing is good (C1) or used as a high-density mixed farms (C3). The combination of conservation measures with the choice of plants will give you the best value of CP for each land unit.

a. Land unit 2

Land unit 2 with CP actual value of 0.300 with erosion of 8.88 t / ha / yr only require maintenance actions that do not increase erosion.

b. Land unit 3

Three land units with a value of 0.200 has CP actual erosion of 100.30 tonnes / ha / yr . CP value target should be equal to or less than 0.071 so that erosion can be reduced to less than or equal to the erosion that is still tolerable (Etol = 35.83 tonnes / ha / yr) . Conservation actions that can be performed on land unit 3 is P1 (perfect bench terraces) . Combinations that can be done is with the crop factor C1 (good pasture) , C2 (moor is not specified) , C4 (mixed farms with medium density) , and C6 (shifting cultivation) . Traditional terracing (P2) can also be applied to the land unit 3 , which combined with good pasture (C1) . Most land unit 3 can be used as a useful good pasture for livestock feed ingredients . Erosion that occurs after conservation measures on land unit 3 are presented in Table 4.

c. Land Unit 4

Land unit 4 with a value of 0.500 CP actual erosion yield of 831.67 t / ha / yr. CP value target should be equal to or less than 0,022 so that erosion can be reduced to less than or equal to the erosion that is still tolerable (E_{tol} = 36.05 tonnes / ha / yr). Conservation actions that can be performed on land unit 4 is P1 (perfect bench terraces) and P2 (traditional patio) . Can be combined with crop factor C1 (good pasture) , C2 (moor is not specified) , C5 (low density mixed farms) . For land units 4 , good grass planting can be applied in relation to the location of the cattle pens that require grass as feed . Erosion that occurs after conservation measures on land units 4 are presented in Table 5.

d. Land Unit 5

Five land units with a value of 0.200 with CP actual erosion of 381.84 tonnes / ha / yr . CP value target should be equal to or less than 0,020 so that erosion can be reduced to less than or equal to the erosion that is still tolerable (Etol = 37.99 tonnes / ha / yr) . Conservation actions that can be performed on land unit 5 is the perfect bench terracing (P1) , with a combination of factors C3 plants (garden mixed with high density) and C4 (mixed farms with medium density) . 5 spacious land units less than 0.5 ha and slopes 30-45 % . By making the perfect patio , it can be combined with land 5 mixed garden which contains a variety of forest plants and can be used as an arboretum as a place of study and practice of forestry students . Erosion that occurs after conservation measures on land units 5 are presented in Table 6.

Table 1. Erosion on land unit 3 by a combination of conservation measures

No	Alternatif Tindakan	Nilai P	Nilai C	R	K	LS *)	CP	Erosi (t/ha/th)	Etol (t/ha/th)
1				2.236	0,181	1,239	0,200	100,29	35,83
2	P1C2	0,04	0,700	2.236	0,181	1,239	0,028	14,04	35,83
3	P1C4	0,04	0,200	2.236	0,181	1,239	0,008	4,01	35,83
4	P1C6	0,04	0,400	2.236	0,181	1,239	0,016	8,02	35,83
5	P2C1	0,40	0,040	2.236	0,181	1,239	0,016	8,02	35,83

Table 2. Erosion on land unit 4 by a combination of conservation measures

No	Alternatif tindakan	Nilai P	Nilai C	R	K	LS *)	CP	Erosi (t/ha/th)	Etol (t/ha/th)
1				2.236	0,176	4,227	0,5000	831,74	36,05
2	P1C1	0,04	0,040	2.236	0,176	4,227	0,0016	2,66	36,05
3	P1C2	0,04	0,100	2.236	0,176	4,227	0,0040	6,65	36,05
4	P1C5	0,04	0,200	2.236	0,176	4,227	0,0080	13,31	36,05
5	P2C1	0,04	0,040	2.236	0,176	4,227	0,0016	2,66	36,05

Table 3. Erosion on land unit 5 by a combination of conservation measures

No	Alternatif tindakan	Nilai P	Nilai C	R	K	LS *)	CP	Erosi (t/ha/th)	Etol (t/ha/th)
1				2.236	0,181	4,717	0,200	381,81	37,99
2	P1C3	0,04	0,100	2.236	0,181	4,717	0,004	7,64	37,99
3	P1C4	0,04	0,200	2.236	0,181	4,717	0,008	15,27	37,99

Where: R= rain erosivity, K= soil erodibility, LS = length and slope factor, CP = agrotechnology factor, E_{tol} =erosion can be tolerated.

IV. CONCLUSION

A. Conclusion

From these results it can be concluded:

1. Actual erosion without soil and water conservation measures: 2 land unit is 8.88 tonnes / ha / yr, 3 land units is 100.30 tonnes / ha / yr, 4 land units of 831.67 tons / ha / yr, and the unit 5 land of 381.84 tonnes / ha / yr.
2. With Agro, erosion of land units 3 to 14.04 tonnes / ha / yr (P1C2), 4.01 tonnes / ha / yr (P1C4), 8.02 tonnes / ha / yr (P1C6), and 8.02 tons / ha / yr (P2C1), on land units 4 to 2.66 tonnes / ha / yr (P1C1), 6.65 tonnes / ha / yr (P1C2), 13.31 tons / ha / yr (P1C5), and 2.66 tonnes / ha / yr (P2C1);, and land units 5 to 7.64 tonnes / ha / yr (P1C3), and 15.27 tonnes / ha / yr (P1C4).

B. Suggestion

1. Soil and water conservation measures that need to be done is the perfect bench terracing for land units 4 and 5, whereas for the 3 land units with combined traditional patio with a mix of high density orchard can reduce erosion to be under erosion can be tolerated.
2. Perfect combination of bench terraces with good pasture can be applied to land units 3 and 4, especially those located near the corral.

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REFERENCES

Arsyad S. 2010. Konservasi Tanah dan Air. Serial Pustaka IPB Press. Bogor.

Banuwa, I.S. 2008. Pengembangan Alternatif Usahatani Berbasis Kopi Untuk Pembangunan Pertanian Lahan Kering Berkelanjutan Di DAS Sekampung Hulu. Disertasi Sekolah Pascasarjana IPB. Bogor.

Banuwa, I.S. 2012. Konservasi Tanah dan Pengelolaan DAS. Penuntun Praktikum. Jurusan Agroteknologi Fak. Pertanian Unila. Bandar Lampung.

Banuwa, I.S. dan H. Buchori., 2010. C-tersimpan pada Berbagai Pola Usahatani Berbasis kopi. Prosiding Seminar Nasional Masyarakat Konservasi Tanah dan Air Indonesia. Hal. 3-595 – 3-609. ISBN 978-602-97051-3-3. Jambi.

Banuwa, I.S., T. Syam, dan D. Wiharso, 2011. Karakteristik Lahan Laboratorium Lapang Terpadu FP UNILA (Laporan Penelitian). Bandar Lampung.

Haryati, U., W. Hartatik, dan A. Rachman, 2008. Teknologi Konservasi Tanah dan Air Untuk Usahatani Berbasis Tanaman Hias di Lahan Kering. Prosiding Seminar Nasional dan Dialog Sumberdaya Lahan Pertanian. Buku II: Teknologi Pengelolaan Sumberdaya Lahan. Bogor, 18-20 November 2008. BPPP, Departemen Pertanian.

Juarsah, R.D. Yustika, dan A. Abdurachman. 2008. Pengendalian Erosi dan Kahat Bahan Organik Tanah Pada Lahan Kering Berlereng Mendukung Produksi Pangan Nasional. Prosiding Seminar Nasional dan Dialog Sumberdaya Lahan Pertanian. Buku II: Teknologi Pengelolaan Sumberdaya Lahan. Bogor, 18-20 November 2008. BPPP, Departemen Pertanian.

L.A.A.J. Eppink. 1985. *Soil Conservation and Erosion Control*. Dept. of Land and Water Use, Agric. Univ. Wageningen.

Nurpilihan Bafdal, K. Amaru, dan E. Suryadi. 2011. Buku Ajar Teknik Pengawetan Tanah dan Air. Jurusan Teknik dan Manajemen Industri Pertanian. Fakultas Teknologi Industri Pertanian. Unpad. Bandung. ISBN 978-602-9234-02-2.

Priyono, C.N.S dan S.A. Cahyono. 2004. Teknologi Pengelolaan Daerah Aliran Sungai: Cakupan,Permasalahan dan Upaya Penerapannya.Prosiding Seminar Multifungsi Pertanian dan Konservasi Sumberdaya Lahan. ISBN 979-9474-34-5. Bogor.

The Worldwide Coordinate Converter, 2012. http://twcc.free.fr/converter-en.php. diakses pada 18 Mei 2012 pukul 11.02 WIB.

Wischmeier, W. H. and D. D. Smith. 1978. *Predicting Rainfall Erosion Losses: A Guide to Erosion Planning.* USDA, Washington, D.C.

Attachment

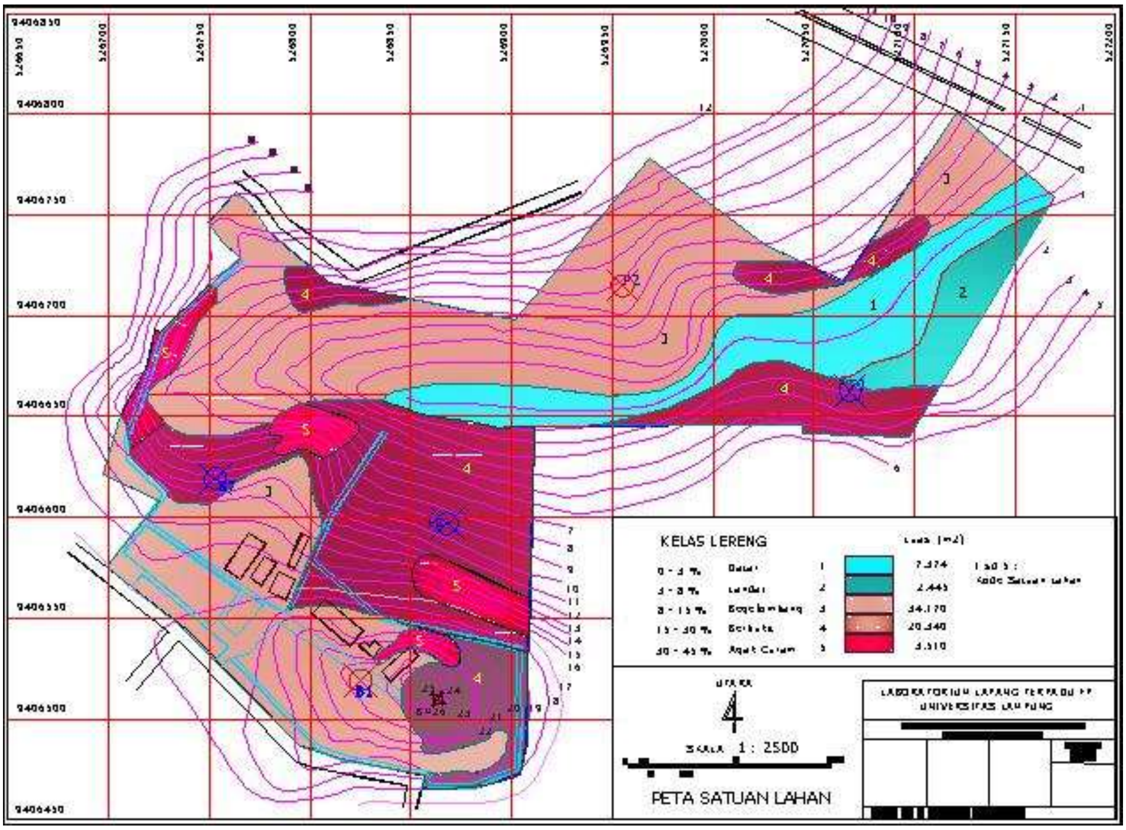

Fig. 1. Map land unit (land units) Integrated Field Laboratory FP Unila

Tabel 1. Land units integrated field laboratory of the Faculty of Agriculture, University of Lampung.

Serial No.	Land Unit	Slope	Land Use / Vegetation	Area		Soil
				Ha	%	Type
1	1	0 - 3 %	Taro and grass, a pool / pond	0,737	10,87%	Ultisol
2	2	3 - 8 %	Imperata grass and shrubs	0,245	3,60%	Ultisol
3	3	8 - 15 %	Grassland and mixed farms, jengkol, etc.	3,417	50,37%	Ultisol
4	4	15 -30 %	Mixed farms, corn, beans	2,034	29,98%	Ultisol
5	5	30 - 45 %	Mixed farms, bamboo, cocoa, bananas, etc.	0,351	5,17%	Ultisol
	Total			6,784	100,00%	

Source: Measurement results topographic maps and field observations.

Table 2. Alternative conservation actions for integrated field laboratory FP Unila.

Code	Value	Alternative conservation actions
P1	0,04	Perfect Bench terraces
P2	0,40	traditional terraces
P3	0,40	*Hill side ditch atau sil pits* (rorak)
P4	0,75	Contour cropping slope of 9-20%
P5	0,90	Contour cropping slope> 20%

Source: Arsyad (2010) and Abdurahman *et al.* (1984) in Banuwa (2008).
Bench terraces perfect
traditional patio
Hill side ditch or seals pits (rorak)
Contour cropping slope of 9-20%
Contour cropping slope> 20%

Table 3. Alternative crop factor used to reduce erosion.

Kode	Value	Crops
C1	0,040	meadows good
C2	0,700	Tegalan not specified
C3	0,100	high density mixed Gardens
C4	0,200	medium density mixed Gardens
C5	0,500	low density mixture Gardens
C6	0,400	Shifting
C7	0,357	Mulch sequential cropping pattern of crop residues

Source: Banuwa (2008).

Table 4. Erosion on land unit 3 by a combination of conservation measures

No	Alternative actions	Nilai P	Nilai C	R	K	LS *)	CP	Erosi (t/ha/th)	Etol (t/ha/th)
1				**2.236**	**0,181**	**1,239**	**0,200**	**100,29**	**35,83**
2	P1C2	0,04	0,700	2.236	0,181	1,239	0,028	14,04	35,83
3	P1C4	0,04	0,200	2.236	0,181	1,239	0,008	4,01	35,83
4	P1C6	0,04	0,400	2.236	0,181	1,239	0,016	8,02	35,83
5	P2C1	0,40	0,040	2.236	0,181	1,239	0,016	8,02	35,83

Source : calculation results

Table 5. Erosion of on land unit 4 with a combination of conservation measures

No	Alternative actions	Nilai P	Nilai C	R	K	LS *)	CP	Erosi (t/ha/th)	Etol (t/ha/th)
1				**2.236**	**0,176**	**4,227**	**0,5000**	**831,74**	**36,05**
2	P1C1	0,04	0,040	2.236	0,176	4,227	0,0016	2,66	36,05
3	P1C2	0,04	0,100	2.236	0,176	4,227	0,0040	6,65	36,05
4	P1C5	0,04	0,200	2.236	0,176	4,227	0,0080	13,31	36,05
5	P2C1	0,04	0,040	2.236	0,176	4,227	0,0016	2,66	36,05

Table 6. Erosion of on land unit 5 with a combination of conservation actions

Serial No.	Alternative actions	P Value	C Value	R	K	LS *)	CP	Erosion (t/ha/th)	Etol (t/ha/th)
1				**2.236**	**0,181**	**4,717**	**0,200**	**381,81**	**37,99**
2	P1C3	0,04	0,100	2.236	0,181	4,717	0,004	7,64	37,99
3	P1C4	0,04	0,200	2.236	0,181	4,717	0,008	15,27	37,99

Description: R = rainfall erosivity, K = soil erodibility, LS = length and slope factor, CP Agrotechnology factor, Etol = erosion that can still be tolerated.

G.12

INTEGRATION OF OPERATION SYSTEM BETWEEN DAM AND WEIR WITH DIFFERENT TIME BASE FOR IRRIGATION

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ABSTRACT

Weir and dam were artificial water resources made for specific purpose which played important role in flood management and concervation, including clean water supply, recreation, navigation, irrigation, and electric power plant. Management of dam and its reservoir should be based on operation and maintenance manual. Operation failure can possibly becaused by climate change or the increase discharge release demand during particular operation cycle.

This study aimed to analyze operation system integration between dam and weir with different time base to meet water irrigation demand based on reliability and resiliency. Research was conducted in six sustainable analysis stages: (1) supply analysis on rain-stream distribution in watershed area between weir and dam; (2) channel routing analysis; (3) analysis on river water availability; (4) analysis on irrigation water requirement and river maintenance; (5) analysis on reservoir routing balance; and (6) analysis on reservoir release requirement. In the final stage of research, analysis on operation system application was conducted through 2 scenario of rainfall simulation and irrigation requirement level.

Results showed that (1) correlation between rainfall and river stream flow in weir and dam could be expressed in linear equation form, (2) reservoir daily operation system could be applied using combination between dam operation system and rule curve policy and standard operation policy, for one operation cycle at normal season condition able to increase supplied planting area during next period dry season to 160% with reliability and resiliency index of 0.91-0.95 and 0.011-0.013, respectively. When dry season occurred during one operation cycle, using reservoir daily operation, reservoir was able to supply 80% planting area of rain season I, 80% planting area of rain season II, and 60% planting area of next year period's dry season with reliability and resiliency index of 0.98 and 0.021, respectively.

Keywords : Integration, dam, weir, operation system, irrigation

I. INTRODUCTION

The reservoir operation pattern for the three main climatic conditions of rainfall follows three curve curves, the upper rule curve, the lower rule curve, and the critical lower rule curve, . The reservoir rule curve is the water surface boundary that must be maintained in the reservoir for one management period after meeting different water requirements. The curve shows the minimum limit of the water level of the reservoir needed at a certain time to be able to meet a requirement either individually or simultaneously in accordance with the purpose and function of the reservoir.

The availability of a dam in the upper reaches of the river and a downstream weir is common in large rivers with potential water resources for the development of irrigated areas. To solve the problem of the reduction of reservoir reservoirs, due to the decrease in water supply from upstream on one side and the greater discharge of reservoirs to meet downstream demand demand on the other side, an effective efficient dam dams concept is proposed through the integration of the dam and dam different operational patterns of bases time with the implementation of 3 (three) risk benchmarks namely reliability, resilience, and vulnerability as operational limits.

The main objective of this research is to produce an integrated operation and operational pattern with operational weirs as presented in the form of hypothetical mathematical equations are:

$$Re_n = \begin{cases} D_{(\Delta t)} + W_n - Y_n - TRO_{\Delta t} & ; W_n \geq Y_n + D_{(\Delta t)} \\ D_{(\Delta t)} - (SSRO + BF)_{\Delta t} & ; X_n \leq W_n < Y_n + D_{(\Delta t)} \\ D_{(\Delta t)} + X_n - W_n - BF_{\Delta t} & ; X_n - D_{(\Delta t)} \leq W_n < X_n \end{cases} \quad (1)$$

Where :

$D_{(\Delta t)}$	= total water requirement on the previous day Δt
$TRO_{\Delta t}$	= total discharge at time lag occurance
SSRO + BF	= the amount of river discharge in the absence of rain
Wn	= availability of water in reservoir on day n
X_n	= lower rule curve
Y_n	= upper rule curve

that are feasible to be implemented by applying three risk benchmarks as operational limits, namely reliability, resilience, and vulnerability.

II. MATERIALS AND METHODS

The development of the integrated reservoir operational pattern was carried out at Way Sekampung River Basin in Lampung Province at 104°30' East until 106°00' East Longitude and from 05°00 ' to 05°05' South Latitude, thus forming a 4,796 sq² rain catchment area. The location of the study is presented in Fig. 1.

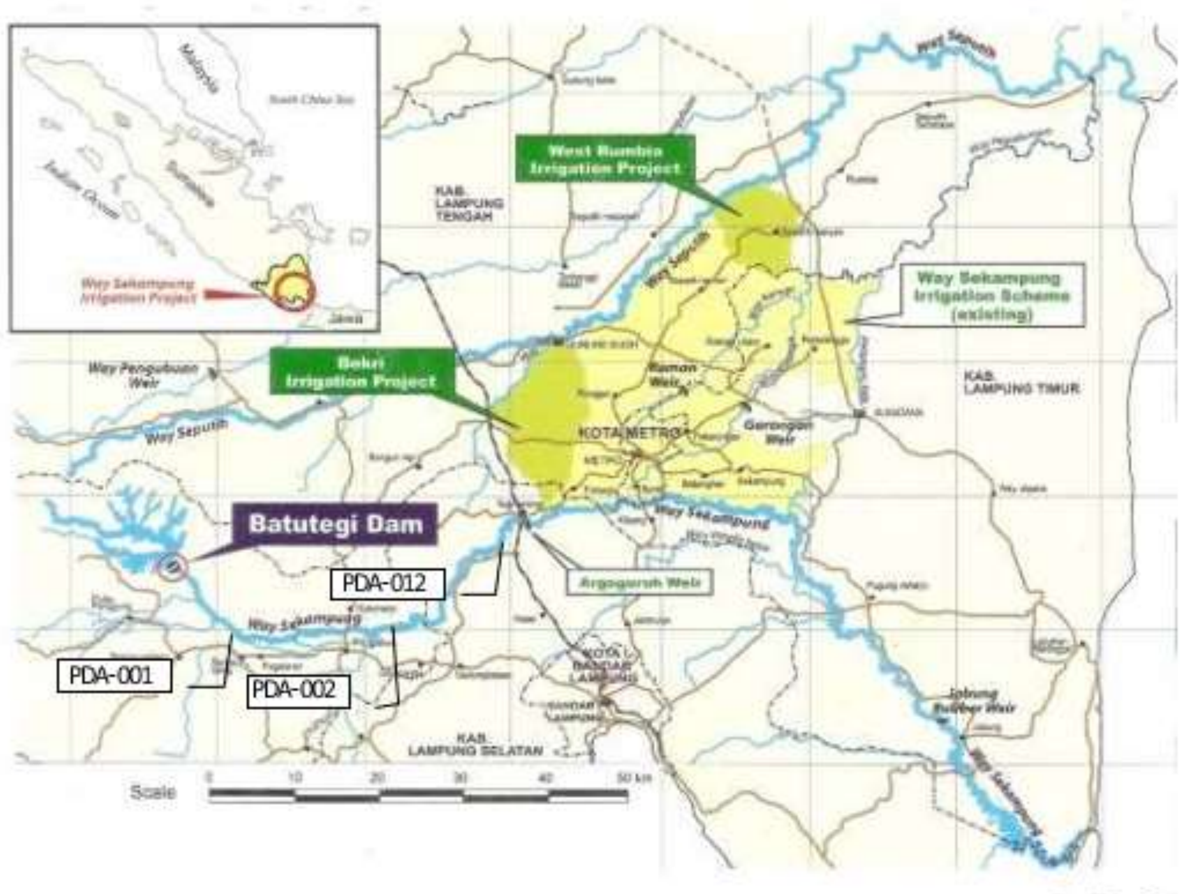

Fig. 1. Configuring the Sekampung Watershed System and Location Orientation of Water Resources Facilities and Infrastructure in the Sekampung Basin of Lampung Province
(Source: Seputih Sekampung Water Resources Development Center)

The variables associated with this study include: rain (system input input), climatological elements, soil type, land use form, land slope, watershed morphometry, reservoir characteristics, weir characteristics, and irrigation area (system / process operator variable), and river flow (output system output). The research procedure is presented in Fig. 2.

Stages of analysis include 1) Calibration and SWAT Model Validation, 2) Analysis of Water Yield (supply), 3) Analysis of channel routing, 4) Analysis of the availability of discharge, 5) Analysis of water demand (irrigation), 6) reservoir release analysis, and 7) Analysis of reservoir water availability (reservoir routing).

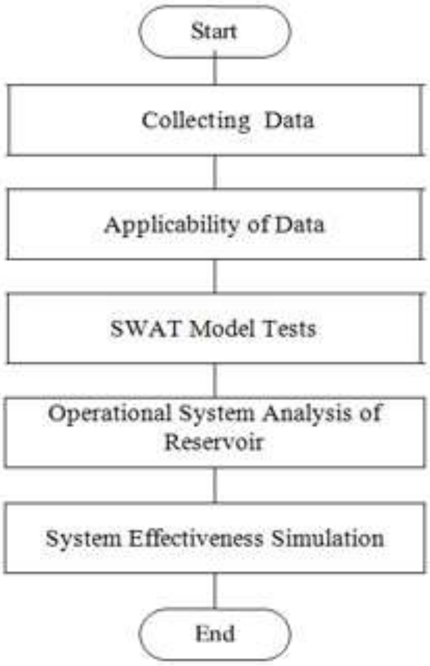

Fig. 2. Flowchart of research implementation

The parameter calibration process is performed to obtain the best output model output. The calibrated model parameters are Surflag (Surface runoff lag coeficient (day)) with range 0 - 4 days, OV-N (coefficient of Manning ground roughness coefficient), CH_N2 (roughness Manning river), ESCO (soil evaporation compensation factor) , 1 - 1.0; EPCO (plant transpiration compensation factor), GW_REVAP (groundwater coefficient), ALPHA_BF (groundwater flow factor), CH_K2 (channel hydraulic conductivity), and SOL_AWC (soil water holding capacity).

For the purpose of calibration SWAT model parameters used two benchmarks namely statistical and graphical values. Statistically the indicator used is the coefficient of determination (R^2) and Nash-Sutcliffe Efficiency (NSE). The goodness-of-fit score of the Nash-Sutcliffe Efficiency Model (NSE) is calculated by mathematical equations:

$$N_{SE} = \frac{\sum_{i=1}^{n}(O_i - \bar{O})^2 - \sum_{i=1}^{n}(P_i - O_i)^2}{\sum(O_i - \bar{O})^2} \quad (2)$$

where n is the number of observations during the simulation period, O_i and P_i respectively are the observed and predicted values of each comparison i, $\bar{O}$ and $\bar{P}$ are the mean values of each observed and predicted data. The value of NSE = 1 indicates a perfect fit. The other range of NSE values refers to the classification of Moriasi *et al.* (2007) in Rossi *et al.* (2009), there are 0.65 up is good, between 0.54 up to 0.65 is sufficien, and less than 0.54 is satisfying.

III. RESULTS AND DISCUSSION

1. Characteristics of the reseach area

The research area covers three sub basin namely Merabung- Ilahan, Way Bulok, and Way Semah sub basin with each area as presented in Table 1.

Table 1. Sub-basin area within the study area

No.	Sub-Basin	Area (Ha)	Area (Sq^2)	Ratio (%)
1.	Merabung-Ilahan	30,642.40	306.424	18.26
2.	Way Bulok	100,934.64	1,009.346	60.13
3.	Way Semah	36,128.91	361.289	21.52
	Total	167,849.52	1,678.490	100.00

Source: Author Analysis, 2014

Based on the result of measurement of Lampung Province River Map scale 1: 350.000 obtained coefficient of form each sub basin in research area as presented in Table 2.

Table 2. Form sub-basin within the study area

No.	Sub-Basin	Long Distance (L, cm)	Area (A, cm^2)	long circumference (P, cm)	c	F	E
1.	Merabung	7.45	30.64	28.51	0.4	0.5	0.8
2.	Way Bulok	7.82	100.93	40.39	0.6	1.7	1.5
3.	Way Semah	6.45	36.12	34.14	0.5	0.9	1.1

Source: Author Analysis, 2014

Land use of sub basin areas within the study area include forest areas, gardens, dryland farms, rice fields, shrubs, settlements, pastures, and water bodies. The distribution of each form of land use by sub-basin is presented in Table 3.

Table 3. Distribution of land use by sub basin

No.	Land Use	Symbol	Unit	Sub Basin			Coverage (Ha)	Portion (%)
				Merabung	Bulok	Semah		
1.	Secondary Forest	HTNS	Ha	1.050,29	1.929,67	255,52	3.235,50	1,93
			%	3,67	2,16	1,13		
2.	Settlements	PRMP	Ha	664,87	7.277,74	6.763,27	14.705,89	8,76
			%	2,33	8,16	29,86		
3.	Open field	TNTB	Ha	0	0	58,96	58,96	0,04
			%	0	0	0,26		
4.	Plantation	KBNP	Ha	334,14	2.530,45	6.404,34	9.268,94	5,52
			%	1,17	2,84	28,28		
5.	Dryland farm	LDNG	Ha	27.194,10	83.181,2	21.283,71	131.679,50	78,45
			%	95,11	93,26	93,98		
6.	Pastures	RMPT	Ha	0	439,26	94,00	533,26	0,32
			%	0	0,49	0,42		
7.	Paddy field	SAWA	Ha	1.066,53	4.578,92	205,10	2.382,61	1,42
			%	3,73	5,13	0,91		
8.	Schrubs	SMBL	Ha	332,43	986,20	1.063,97	5.947,13	3,54
			%	1,16	1,11	4,70		
9.	Water body	WATR	Ha	0	11,10	0	37,60	0,02
			%	0	0,01	0		
	Total Area			30.642,39	100.934	36.128,91	167.849,50	100

Source: Author Analysis, 2014

The podsolic soil type in the Bulok sub-basin only occupies 27.70%, while alluvial soil type covers only 19.19% of the sub-basin area. The podsolic soil type in the Semah basin occupies an area of 28.36% of the sub-basin area, whereas alluvial soil type occupies only 16.44% of the sub-basin area. The soil type of andosol is not found in the Semah sub Basin. The study area has a land slope that ranges from zero to more than 25%. 0-5% of sloped land covers the widest area reaching 72,780.82 hectares (43.36%), followed by slopes larger than 25% to 31,356.84 hectares (18.68%). Based on the distribution of sub-basins, it is known that the Merabung Sub-Basin and the Bulok Sub-Basin have more complete slope diversity and are distributed in a more evenly distributed portion compared to the Semah Sub-Basin, dominated by 0-5% and do not have 8- 15%.

2. Rainfall

The results of characteristic rainfall analysis of each sub basin are presented in Table 4, Table 5, Table 6 and Fig. 3.

Table 4. Monthly average rain distribution and maximum daily rainfall in sub basin Merabung

Paramete	Nov	Dec	Jan	Feb	March	April	May	Jun	Jul	Aug	Sept	Oct
Average	127.7	166.5	341.3	289.9	247.9	190.9	165.1	104.1	96.2	54.1	78.0	99.0
Maks	16.2	19.9	34.6	38.0	29.8	33.0	24.6	22.4	23.0	11.4	15.9	17.3
Day	23	26	27	25	27	24	21	16	16	13	13	19

Table 5. Monthly average rain distribution and maximum daily rainfall in sub basin Bulok

Paramete	Nov	Dec	Jan	Feb	March	April	May	Jun	Jul	Aug	Sept	Oct
Average	94.5	135.8	176.5	151.0	131.8	123.0	81.2	42.8	54.3	57.4	43.8	60.9
Maks	15.1	15.2	20.9	21.2	17.8	21.8	13.7	8.8	12.0	21.1	9.9	10.6
Day	23	26	28	26	27	24	24	17	18	14	15	18

Table 6. Monthly average rain distribution and maximum daily rainfall in sub basin Semah

Paramete	Nov	Dec	Jan	Feb	March	April	May	Jun	Jul	Aug	Sept	Oct
Average	89.8	137.0	192.8	184.1	154.0	126.3	112.5	46.3	58.0	39.6	53.1	64.4
Maks	17.9	22.4	28.0	30.1	27.3	26.3	19.9	12.5	14.4	12.4	20.6	14.2
Day	20	24	26	22	24	21	20	13	14	11	10	15

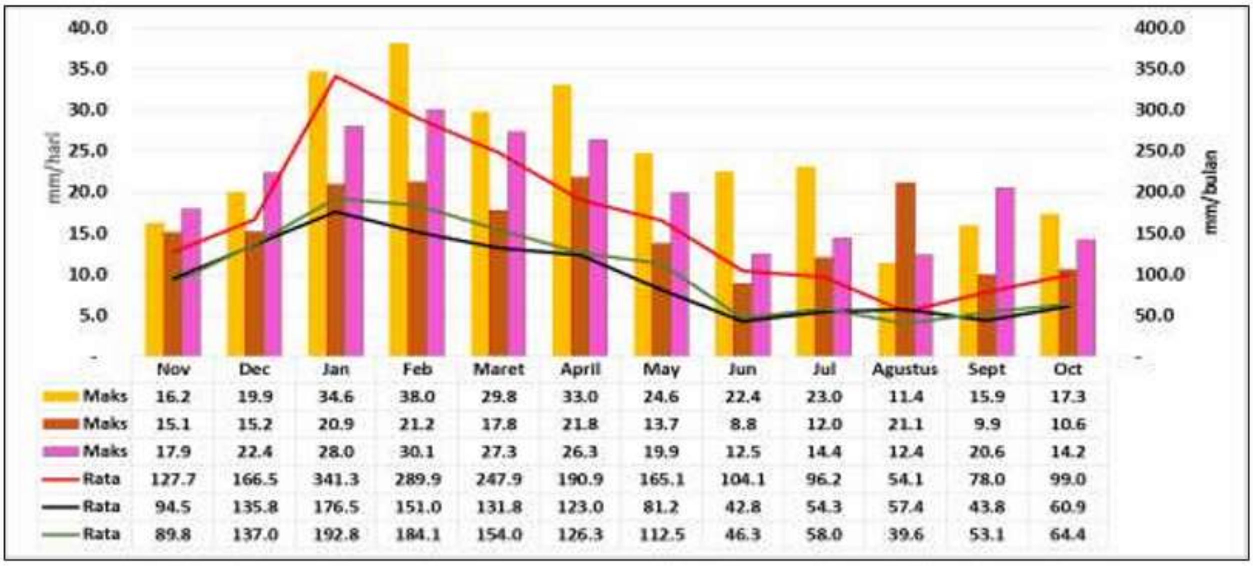

Fig. 3. Sub-basin rainfall distribution

3. *Stream Flow*

The results of the analysis of the average value of the monthly stream flow measured after the Batutegi Dam in certain months become larger than the condition before the Batutegi Dam. The maximum daily river flow after the Batutegi Dam occurred in January (850.50 m^3/sec) while previously occurred in February (584.0 m^3/sec). Minimum daily stream flow after the Batutegi Dam occurred in September to November (0.01 m^3/sec) while previously occurred in January (0.03 m^3/sec).

River flow simulation results using the auto calibrated SWAT model (Arnold, *et al.*, 2010) with the best model parameter values presented in Table 7, Fig. 4 dan Fig. 5 shows that the SWAT model can be used to estimate the amount of river flow that will occur from different rain inputs on each sub basin, with an indicator of R^2 value and NS_E of 0.9 and 0.81 respectively. The prosedure of automatic calibration model using SWAT CUP 2012 version 5.1.6 software with the SUFI-2 approach.

Table 7. SWAT parameter value of calibration result

No	Parameters	Name of SWAT Variables	Calibration value
1.	Time delay Coefficient of flow	SURLAG	6
2.	Manning's constanta of surface	OV-N	0,3
3.	Manning's constanta of surface river	CH-N2	0,075
4.	Compensation factor of surface evaporation	ESCO	0,83
5.	Compensation factor of plant transpiration	EPCO	0,5
6.	Coeffisient of land water lost	GW_REVAP	0,04
7.	Land water flow factor (day)	ALPHA_BF	0,07
8.	Hydrolic conductivity of river channel (mm/day)	CH_K2	76
9.	Land capacity to hold water (mm/mm)	SOL_AWC	0,1

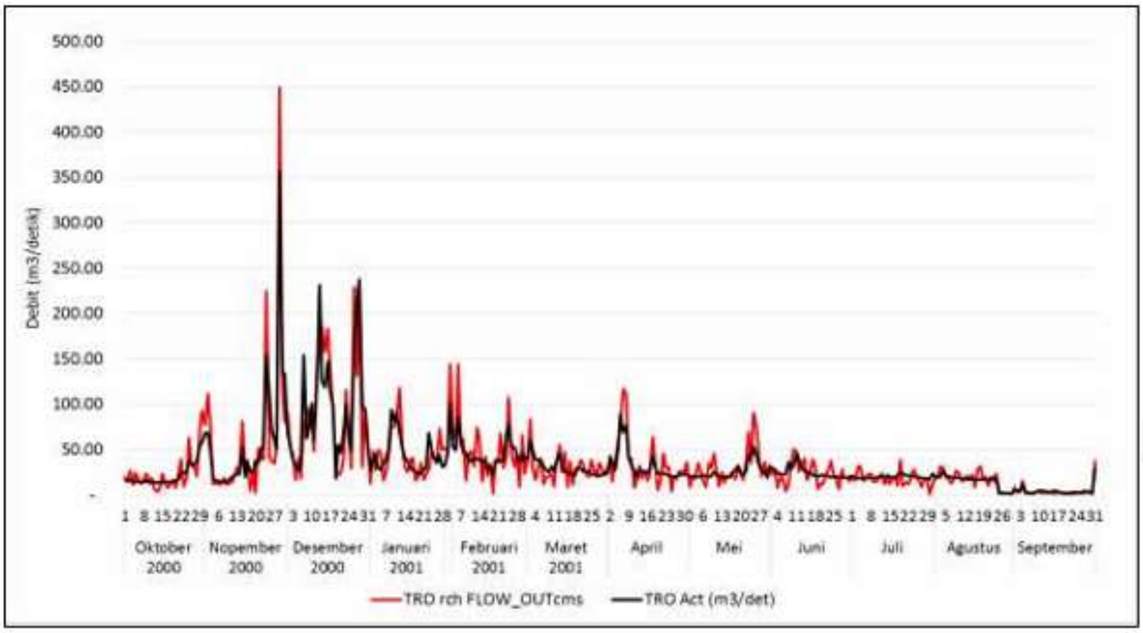

Fig. 4. Actual river flow exposure and prediction of study area after calibration and validation process

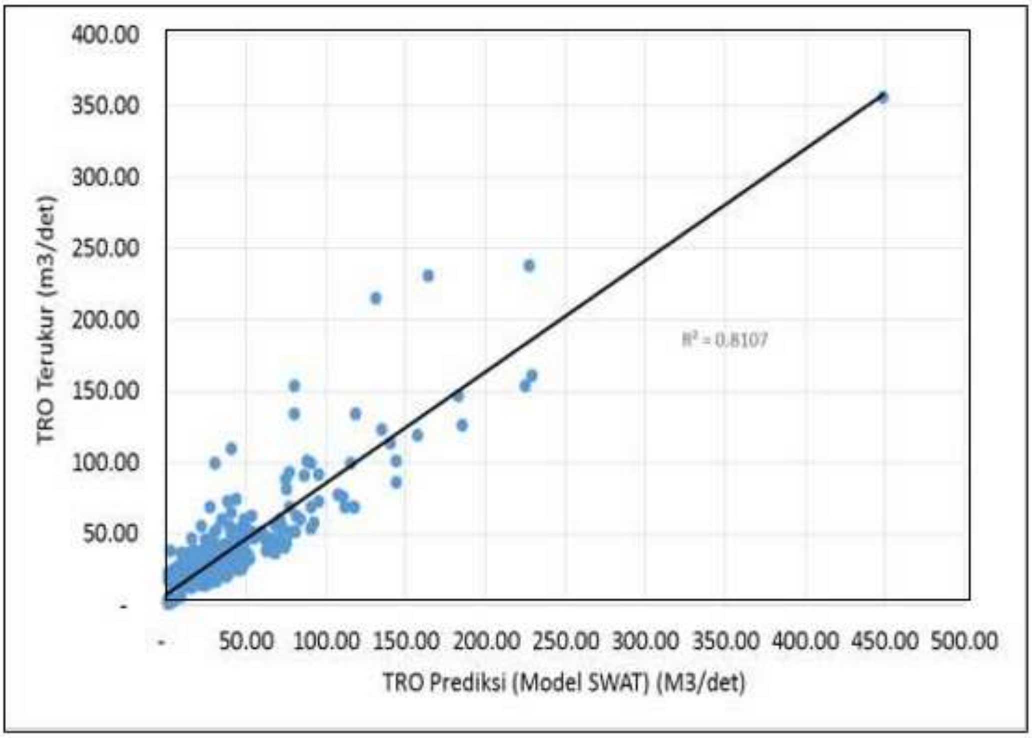

Fig. 5. Scatter plots of measured TRO values and SWAT prediction results
(after calibration and validation process)

4. *Analysis of the Model Concept of Integration of Daily Dam Operation Patterns with Two Weekly Weir Operation Patterns*

a. *Analysis of rainfall duration - intensity – stream flow relationship*

The analysis of rain-discharge linkage is important to know because at the next stage of analysis required information about the availability of river water at the upstream of the weir. In addition, the results of this rain-relationship analysis are useful for the practical needs of subsequent dam operations.

The results of the analysis show the function of the relationship of rain duration (X) and river flow (Y) in the six rain intensity groups are presented in Table 8.

Table 8. The mathematical function of the rain - discharge relationship in various rainfall intensity groups

No.	Rainfall Intensity (mm/Hour)	Classification[1]	Linier Function	Coefficient Correlation (R^2)
1.	$0 < I \leq 5$	Light Rainfall	*Y = 0,4348 X + 19,546*	0,9420
2.	$5 < I \leq 10$	Small Rainfall	*Y = 0,6313 X + 20,928*	0,9569
3.	$10 < I \leq 25$	Moderate Rainfall	*Y = 1,0071 X + 20,864*	0,8892
4.	$25 < I \leq 50$	Heavy Rainfall	*Y = 2,2437 X + 19,09*	0,9542
5.	$50 < I \leq 75$	Very Heavy Rainfall	*Y = 2,1274 X + 23,916*	0,9512
6.	$I > 75$	Torrential Rainfall	*Y = 1,6092 X + 33,002*	0,9799

Y = the estimated value of discharge (m3/sec); *X* = duration of rain (hour)

Sources: 1) Maria-Carmen LLASAT, 2001; Author Analysis, 2014

b. *Analysis of channel routing*

The channel routing is basically an effort to know the depth and flow velocity at each point in the channel (Suprapto, 2008).

Based on this understanding, then in this study channel routing is intended to calculate the duration of water travel from the release by the dam until it reaches the weir gate. The analytical techniques used were the Muskingum and Muskingum-Cunge Methods, both of which belong to the hydrologic routing group (Chow *et al*. 1988).

The result of channel routing analysis using both approaches of analysis method mentioned above can be concluded that the released water from the reservoir will arrive at the weir gate at the fastest 23 hours after discharge with the amount of 65.06 - 81.95% of the amount released by reservoir while the rest is the amount of water stored as a catchment of the river.

c. *River Water Availability Analysis*

The analysis of river water availability is intended to review the adequacy of water in rivers at the weir gate to meet the irrigation needs and management of the daily river environment. If water is available in rivers larger than irrigation needs then the reservoir does not release water (Re = zero). Conversely, if the availability of water in the river is lower than the need for irrigation then the reservoir must release water (Re> zero).

The results of water availability analysis at the weir gate to meet the irrigation water needs and river environmental maintenance can quantitatively be expressed in the availability ratio. The water availability ratio during the one year cycle from 2004-2005 to the 2007-2008 cycle year in the normal climatic conditions was 44.11%, 63.01%, 47.12%, and 46.30%, respectively.

d. *Reservoir Routing Analysis*

The reservoir routing analysis is conducted for the purpose of determining the amount of water that can or should be released by the reservoir to meet water demand at the weir gate as additional water (supplesion) from the river. The availability of daily reservoir water is calculated based on the water balance approach in the reservoir on the n^{th} day (Wn) using Equation (3) (Kumar *et al*, 2006):

$$W(t) = S(t-1) + Qin(t) - Re(t) - E(t) - DS \quad (3)$$

Where :

$W_{(t)}$ = Water reservoir availability of day n (m^3)

$S_{(t-1)}$ = The amount of water stored in the reservoir on the previous day (t-1) (m^3)

$Qin_{(t)}$ = inflow on day t (m^3/sec)

$Re_{(t)}$ = The amount of water released from the t-day reservoir (m^3/sec)

$E_{(t)}$ = Amount of evaporated water from t-d day reservoir (m3 /day)

DS = Minimum reservoir storage capacity for irrigation (m^3)

In the process of analyzing of reservoir routing is used simulation technique of reservoir water reservoir with the position of water level (WL) of reservoir at the beginning of cycle (boundary condition) in four condition that is:

- Flood conditions: WL > URC
- Normal condition: LRC < WL < URC
- Dry conditions: CLRC < WL < LRC,
- Critical condition: WL < CLRC

The simulation results show that the water level of the reservoir will again be within the range of the lower rule curve (LRC) and the upper rule curve (URC) even in the early stages of the water level cycles are in positions above URC or below the critical lower rule curve (CLRC) after removing some water to meet the irrigation and maintenance needs of the river and under minimum inflow discharge conditions.

e. *Outflow Needs Analysis (Release)*

The release needs analysis is aimed at determining the amount of water that must be released by the reservoir every day in order to meet the demand for water at the weir gate for irrigation and downstream river maintenance. The results of the analysis show that the release model for the water level (WL) condition greater than URC will always keep the water balance after release is around the upper curve. At the end of the cycle the water level is relatively equal to the initial condition of the cycles. When the water level (WL) is above upper rule curve (URC) and exceeds the maximum height the amount of water to release is composed of components:

- Excess reservoir storage of WL - WL_{max} = OVERFLOW
- Irrigation needs and maintenance of the river (IRR + Qout) + 20% river storage.

For the initial condition of the cycle where WL is between upper rule curve (URC) and lower rule curve (LRC), the daily release needs analysis is fully to meet 100% of irrigation needs and downstream river maintenance plus 20% river storage. With model release for LRC < WL < URC, then the water level of the reservoir will immediately rise to the upper limit of the upper rule curve (URC) and until the end of the water level cycle will be around of URC.

When the water level of the reservoir is between URC and CLRC, the daily operation pattern of the reservoir should be more careful. The more water spent to meet IRR + Qout, the water level elevation curve will decrease as shown in Fig. 6.

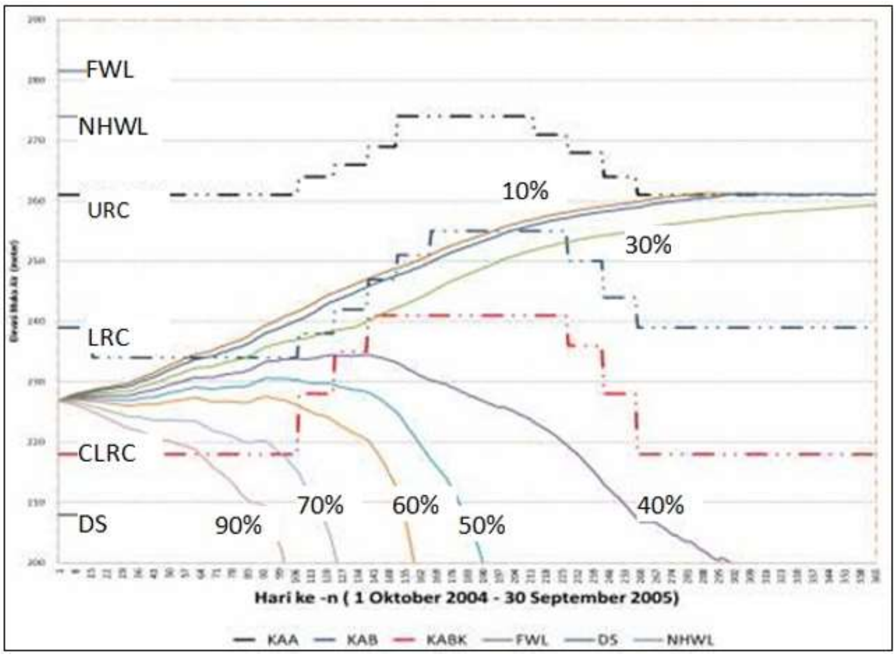

Fig. 6. Decreased water level of reservoirs at various release sizes to meet IRR + Qout requirements on initial condition CLRC < WL < LRC

5. Reliability Test

The reliability test is aimed at assessing the accuracy of the number of releases to the fulfillment of irrigation needs at the weir gate. The results of the model simulation show that in 4 (four) years of normal season and dry season, there is one group of water level of the reservoir located between URC and CLRC or entering the level of resilience. The reliability index of the reservoir operation pattern as presented in Table 9.

Table 9. Reliability index calculation results

No.	Season Condition	The number of days failed	Operational Period (Days)	Reliability Index
1.	Normal without development	76	1,460	0.95
2.	Normal (20% improvement)	77	1,460	0.95
3.	Normal (40% development)	76	1,460	0.95
4.	Normal (60% development)	77	1,460	0.95
5.	Normal (80% development)	92	1,460	0.94
6.	Normal (100% development)	127	1,460	0.91
7.	Dry (combination 80, 80, 60%)	33	1,460	0.98

Reliability test results as presented in Table 6 show that the application of integration of dam and weir pattern of operation is different basetime in normal climatic conditions can increase planting area in next year's rainy season to 80% with a reliability index of 0.94. While the integration of the dam and weir design is different in this time base applied to dry climatic conditions can still provide services to the fulfillment of water requirement each 80% of normal climatic conditions in dry season and 60% of normal climatic conditions in next rainy season, with a reliability index of 0.98.

6. Resiliency test

The index of resiliency test is performed to measure the level of the reservoir's ability to return to the satisfactory state of the failed state. If the faster the reservoir returns to a satisfactory state it can be said that the reservoir is more resilient so that the consequences of the failure are smaller. The opposite condition if the longer the dam is in a state of failure, the smaller the importance and consequences of the failing state will also be greater. Thus, the greater the index value of interest means the faster the reservoir returns to a satisfactory state of a failed or unsuccessful condition. The results of the benefit index test are presented in Table 10.

Table 10. Results of calculation of Resiliency index

No.	Season Condition	The number of days failed	Operational Period (Days)	Resiliency Index
1.	Normal without development	76	1,460	0,013
2.	Normal (20% improvement)	77	1,460	0,013
3.	Normal (40% development)	76	1,460	0,013
4.	Normal (60% development)	77	1,460	0,013
5.	Normal (80% development)	92	1,460	0,013
6.	Normal (100% development)	127	1,460	0,011
7.	Dry (combination 80, 80, 60%)	33	1,460	0,021

Based on Table 8 it is apparent that during normal climatic conditions the integration of the dam and weir patterns of different time bases can provide the benefits of planting area expansion in next year's rainy season to 80% of the previous year's rainy planting season with a magnitude index of 0.013 or takes as much as 92 days to return to satisfactory conditions after a failure of 365 days of operation. In dry climatic conditions, the integration of the dam and weir pattern of different time bases can still provide irrigation services on dry and rainy next year of 80% and 60% of the normal climate conditions respectively, with a magnitude index of 0.021 or only takes time a total of 33 days to return to satisfactory conditions of a failed or unsuccessful condition.

IV. CONCLUSION

1. For a watershed area in which there are two water resources infrastructure in the form of weirs and dams arranged in series in a stream, the management of water resources between them can be done more effectively and efficiently if the weir and dam operation pattern is put together (integrated) to meet a certain water utilization objective.
2. If dams and weirs are arranged in rivers in order to meet irrigation water requirements, then the pattern of dam operations can be carried out daily while the weir operation pattern remains biweekly, with the amount of water released depends on two things ie. a) The availability of water at the weir gate, and b) The water level of the reservoir.
3. The concept of Integration of a daily-based dam-based operation pattern with a bi-weekly weir-based operation pattern is considered feasible to be considered as a pattern of dam operations as it has a reliability index of 0.91-0.95 during the normal season and 0.98 in season dry. as well as the reciliency index of 0.011-0.033 during normal season and 0.021 in the dry season.

REFERENCES

Arnold, J. G., P.M. Allen, M. Volk, J.R. Williams, dan D.D. Bosch. 2010. *Assessment of different representations of spatial variability on SWAT model performance.* American Society of Agricultural and Biological Engineers. ISSN 2151 – 0032. Vol. 53(5), 1433-1443.

Chow, Ven Te., David, R. Maidment dan Larry, W. Mays, 1988. *Applied Hydrology*. McGraw-Hill Book Company. New York.

Kumar, D.N., K.S. Raju, dan B. Ashok, 2006. *Optimal Reservoir Operation for Irrigation of Multiple Crop Using Genetic Algoritms*. Journal of Irrigation and Drainage Engineering. ASCE. March/April: 123- 129.

Maria Carmen LLASAT, 2001. An Objective Classification of Rainfall Event On The Basis of Their Convective Features. Application to Rainfall Intensity in The North-East of Spain. International Journal of Climatologi, 21, 1385-1400.

Suprapto Rahardjo, Mamok. 2008. Modeling of Low Flow Management with Elementary Hydrological Approach. Dissertation. UGM. Yogyakarta. 253 pages.

Rossi, C.G., Srinivasan, R., Jirayoot, K., Duc, T. Le., Souvannabout, P., Binh, N., Gassman, P.W. 2009. *Hydrologic Evaluation of The Lower Mekong River Basin with The Soil and Water Assessment Tool Model.* International Agricultural Engineering Journal, 18 (1-2): 1-13.

G.13

CHARACTERISTICS OF SOIL AND SAND AS MEDIA LAYER IN GREEN ROOF VEGETATED WITH *Arachis pintoi* : THERMAL AND WATER QUALITY

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ABSTRACT

Decreasing green open space is a major problem faced in urban areas. Urban environmental problems are likely related to urban heat island and storm water. The utilization of green roof becomes one of alternative solution to mitigate urban heat island and stormwater problems. The objective of this research is to study characteristic green roof with soil and sand as medium layer as its function as temperature reduction and its runoff water quality. A green roof that contained soil and sand as the media layer was installed on roof. Compared to the concrete surface temperature, the canopy of green roof had capability to reduce 7 °C of surface temperature and lowered of 12 °C compared to the temperature of the green roof base. Based on storet methods, runoff water is classified as lightly polluted due to high TSS and TSS.

Keywords : green roof, roof temperature, runoff water, water quality.

I. INTRODUCTION

The provision of residential and industrial facilities to meet the needs is increasing as the population grows. One consequence is the change of land use from vegetated land to land for residence and industrial estate. In Jabotabek area, RTH decrease 23% in periode of 1972-1997. At the same periode, built environment increase 23% in urban area [1]. On of impact of land use change is the reduction of green open space (RTH) in urban area. Changes in the function of green open space (RTH) from soil surface to impermeable layer such as industrial and building facilities, road and parking area caused the reduction of water catchment area. Furthermore its potentially reduce the raw water resources while the need for clean water increases. Rainwater can be an alternative source for urban water supply. Rainwater is a very important water source especially in areas where there is no clean water supply system, low surface water quality and groundwater [2].

The most concerning of people for rainwater harvesting is Water quality. The water quality includes physical and chemical properties for secure and safe consumption. Due global warming, air pollution caused acid rain. Reference [3] reported that in the Cibinong-Citereup area of Bogor showed that the average rainwater acidity decreased from 5.00 in 1999 to 4.77 in 2009 which indicated the occurrence of acid rain due to pH <5.6. Another problems in rainwater harvesting is high turbidity caused by dust, debris, leaves when rain water flows through gutter and roof into rainwater collection system.

Built environment in urban area commonly covered with cement and asphalt. Both cement and asphalt are impermeable layer that not allowed raindrop infiltrated into soil and in versace evaporated into the air to reduce air temperature surround. Furthermore the impermeable layer in built environment caused urban heat island. Air temperature in Jakarta is higher than rural area (has air temperature higher of 1 ^{o}C [4]. Benefit of green roof in temperate systems have been evaluated in many countries for covering building in built environment or urban area [5,6,7,8,9]. However, there is not much study about evaluation of green roof in tropical country. Tropical country is characterized by hot and humid weather all the day. Roof surface receive solar radiation almost 12 hours per day. Thus heat load into roof surface is bigger than temperate area. Precipitation is occured heavily in short time. When heavy rain is happened, rainwater erodes growing medium and bring media particles into water body and lowering water quality of run off. To avoide the advanced problems that caused by green roof it's necessary to study the characteristics of green roof. In this study, characteristic of medium layers was studied to know the impact on reducing roof temperature and water quality of runoff water.

II. MATERIALS AND METHODS

This research was conducted on roof top of Center of Agricultural Technology Information Pusat Informasi dan Teknologi (PITP) Building, Campus IPB Darmaga. A green roof model of 1 m x 1 m was covered by *Arachis pintoi*. The thickness of 30 cm growing media consists of 3 layers, soil (0-12cm), sand (12-26 cm) and drainage layer (26-30 cm) as shown in Fig 1. An automatic weather station (AWS) was installed to collect weather data such as solar radiation, precipitation, air temperature and humidity, also wind (direct and speed). The media temperature was measured using thermocouple at each layer. The data of media temperature was recorded in a hour interval using GL-840 midi logger. Physical parameters such as temperature, total suspended solid (TSS) and total dissolved solid (TDS) were analyzed to determine water quality of rain water and runoff water from green roof model. Water quality class is determinated based on storage and retrieval method (STORET) as regulated in Kepmen LH No. 155 of 2003 about guidelines for Determination of water quality status. The threshold was referenced to PP No. 82 of 2001.

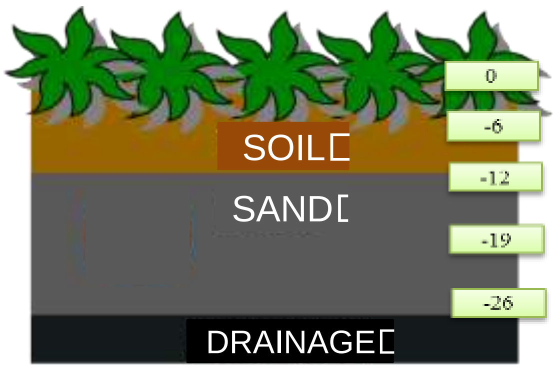

Fig. 1. Growing medium layer of green roof

III. RESULTS AND DISCUSSION

Fig 2. Shows the diurnal temperature of concrete and green roof surface. Temperature on surface both concrete and green roof followed as solar radiation, started at minimum level in the morning then rose until noon and decreased to sun set. Temperature of green roof surface is below temperature of concrete roof surface all the day. The concrete roof surface absorbed and reflected solar radiation energy and its temperature rose to 42 °C on June 1, 2017 at 12:42 WIB. The canopy of green roof lowered of 7 °C the roof temperature compared to concrete roof and lowered of 12 °C compared to temperature of green roof base. Roof surface received heat flux from solar radiation. Concrete roof absorbed energy from solar radiation and reflected to atmosphere by convection thus increasing temperature on roof surface. In green roof, leaves growth and spread covering roof surface and had function as canopy to roof and likely reduce heat gains [6]. Furthermore green roof can greatly affect the roof temperature profile—cooling surface layers and internal space on warm days [10].

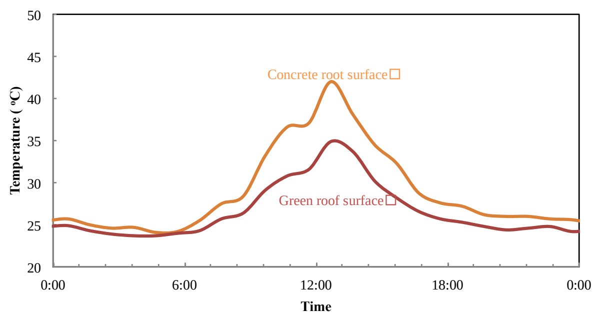

Fig. 2. Diurnal temperature on rooftop on June 1, 2017

Diurnal temperature of green roof differs from bare concrete roof. The temperature at depth of 29 mm green roof media is more stable than at surface layer. A temperature at base of green roof layers was below 30 °C while surface temperature daytime was varied and rose until 40 °C at the maximum of solar radiation. The amplitude of the temperature wave becomes smaller with increasing depth of green roof layers thus temperature decreased when it passed through green roof layers from surface to roof base (Fig. 3). Roof surface functioned as exchange surface thus surface layer of medium received radiation and reflected back to the air and heated the air above the surface and keep surface temperature warmer than deeper layers. For the soil such as growing medium in green roof layers, heat is stored in each succeeding layer so less heat is passed on to the next layer [11]. It shows green roof media layer able to protect the base roof against higher temperatures at tropical climate.

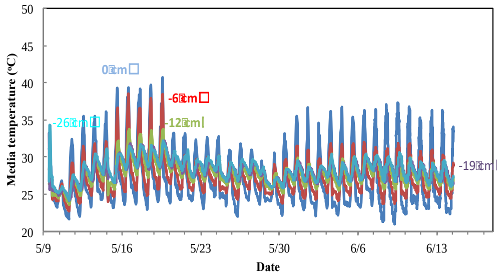

Fig. 3. Temperature on green roof media during experiment

The threshold of water quality for clean water based on PP No. 82/2001 for temperature is ±3°C from air temperature. During experiment, temperature of rainwater and green roof runoff water was complying within the threshold (Fig. 4). Both rainwater and runoff water tend to higher than air temperature because its absorbed heat. When rainfall, the raindrop had direct contact with the air, absorbed the heat and particulates in the air and carried down thus warmer the rainwater. Rain event usually occur in the afternoon when green roof media already warmer because absorbed solar radiation during daytime. Raindrop felt down to green roof and go through pores in the green roof media. During crossing media, water absorbed heat from media particle thus increasing temperature of runoff water.

TSS and TDS both of rainwater and green roof runoff water shows that it's compliy of the third class water quality level (400 mg/L) but not comply to first and second class water quality at first flush (Fig. 4). TDS in both of rainwater and green roof runoff water was comply to the threshold except at first and second flush for green roof runoff water. TDS of rainwater remain at low level while runoff water tend to decrease after first and second flush and droped below threshold. The higher of total dissolved solids in runoff water was due to the organic matter content in green roof medium.

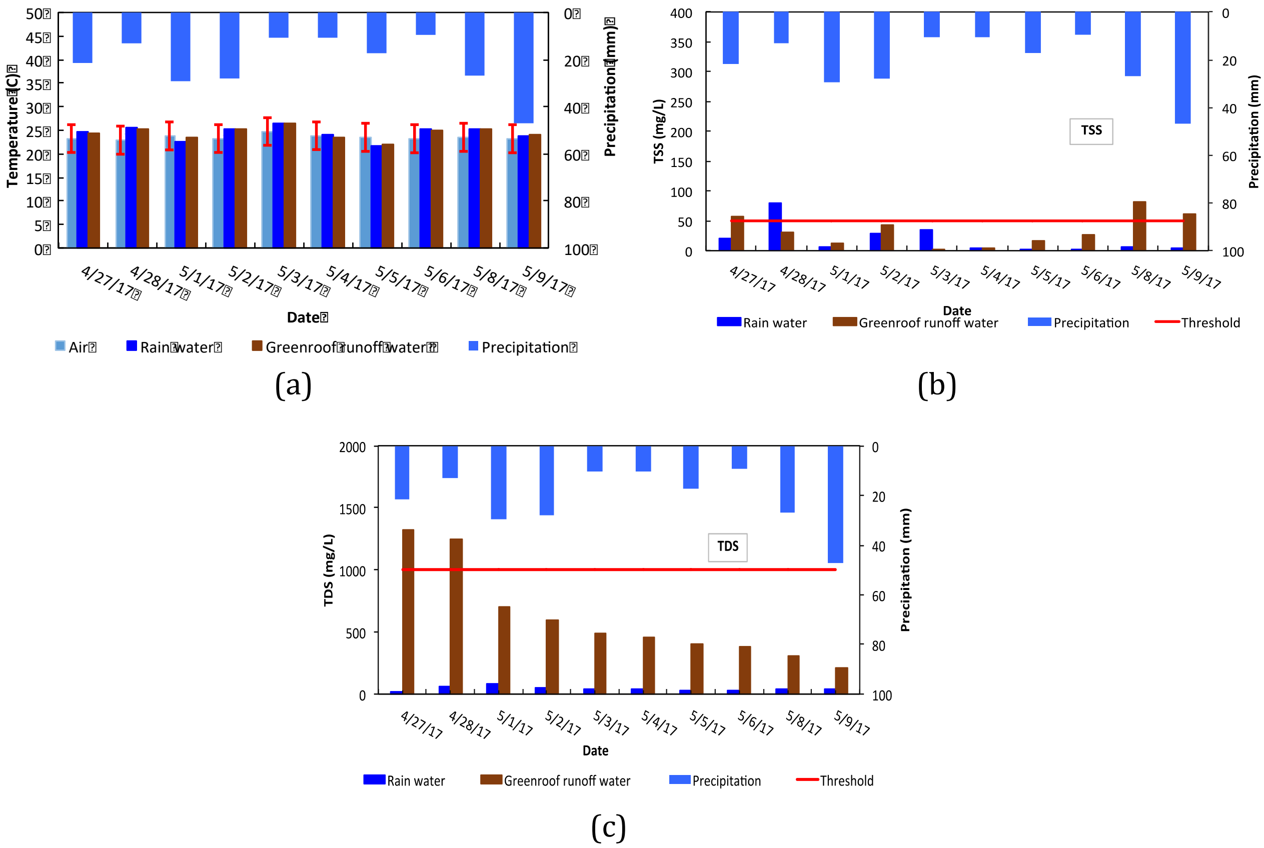

Fig. 4. Physical parameter of water quality such as (a) temperature, (b) TSS and (c) TDS

Total suspended solids can include clays, silts, fine organic debris, and other particulate matter in suspension. TDS are soluble substances in the form of chemical compounds and other material. Runoff water had higher TDS and TSS than rainwater because water washed the green roof medium and some medium particle were flushed into runoff water. Suspended solids are regulated under the clean water act for point discharges and are associated with poor water quality. TSS and TDS have positive correlation with turbidity. Reference [5], [7] show that the material used in the substrate layer has an important influence on runoff quality. Similarly, [8] found that green roofs can increase suspended solids and turbidity after installation and the turbidity levels varied significantly between media used but decrease runoff water quantity [12]. During a heavy rainstorm, the rain washed more nutrient and soil particles off the green roof. Furthermore it increased total turbidity of runoff water because of high TSS and TDS. In work of [7], the highest turbidity levels from the green roofs investigated were seen during the first flush with a steep decline in mean turbidity afterward.

Based STORET method, particularly physical properties refer to PP No 82/2001, rainwater scored -2 and runoff water has scored -4. Both of rainwater and runoff water are classified as lightly polluted due high TSS and TSS. Reffer to PP 82/2001 the green roof runoff water is classified into second class of water quality. Second class water is designated for irrigation, water pond, flushing and other designations that require the same water quality as those based on PP 82/2001

IV. CONCLUSION

Indonesia as tropical country, characterized by hot weather and higher rainfall intensity. This encourages the development of incident green roof to protect the building from weather and built better environment. This paper articulated that application of green roof is able to function as a heat insulator on the rooftop of buildings in urban area by reducing 12 ^{o}C of roof temperature with 29 cm of thickness growing media. The air temperature in the upper layer of the roof can be lowered thus reducing the heat island effect in urban areas can be expected. Runoff water is classified into second class of water quality. Second class water is designated for irrigation, water pond, flushing and other designations that require the same water quality as those based on PP 82/2001.

REFERENCES

[17] S. Effendy, A. Bey, A.F.M. Zain, I. Santosa, “Peranan ruang terbuka hijau dalam mengendalikan suhu udara dan urban heat island di wilayah jabotabek,” J. Agromet., vol. 20, pp. 20-23, 2006.

[18] F.A. Abdullah and A.W. Al-Shareef, “Roof rainwater harvesting systems for household water supply in Jordan,” *Desalination*, vol. 243, pp. 195-207, 2009

[19] Sutanto dan Iryani A, “Hujan asam dan perubahan kadar nitrat dan sulfat dalam air sumur di wilayah industri Cibinong-Citereup Bogor,” *J. Teknologi Pengelolaan Limbah*, vol. 14, pp. 1-9, 2011.

[20] J. Sitorus, E. Rustiadi, M. Ardiansyah, Analisis pola spasial perubahan penggunaan lahan dan sub-urbanisasi di kawasan jabotabek periode 1992-2000,” M.S. thesis, Bogor Agricultural University, Bogor, Indonesia, 2004

[21] Alar Teemusk and Ulo Mander, “Rainwater runoff quantity and quality performance from a greenroof: the effects of short-term events. *Ecological Engineering* vol. 30, pp. 271-277, 2007.

[22] Jeffrey Sonne, “Evaluating Green Roof Energy Performance,” *ASHRAE Journal*, vol. 48, pp. 59-61, Feb, 2006.

[23] Morgan, S.; Alyaseri, I.; Retzlaff, W. Suspended solids in and turbidity of runoff from green roofs. *International Journal of Phytoremediation*, vol. 13, pp. 179-193, 2011.

[24] Grace E. Harper, “Green roof water quality impacts and physicochemical stability,” M.Sc. thesis, Missouri University of Science and Technology, Missouri, USA, 2013.

[25] Hideki Takebayashi and Masakazu Moriyama, “Surface heat nudget on green roof and high reflection roof for mitigation of urban heat island,” *Building and Environment*, vol. 42, pp. 2971-2979, 2007.

[26] M.T. Simmons, B. Gardiner, S. Windhager, J. Tinsley, “Green roofs are not created equal: the hydrologic and thermal performance of six different extensive green roofs and reflective and non-reflective roofs in a sub-tropical climate,” *Urban Ecosyst.*, vol. 11, pp. 339-448, July 2008.

[27] Gaylon S. Campbell and J.M. Norman, *Introduction to environmental biophysics,* 2nd ed., New York, USA: Springer-Verlag, 1998.

[28] N.D. vanWoert, D.D. Rowe, J.A. Andresen, C.L. Rugh, R.T. Fernandez, L. Xiao, “Green roof stormwater: effects of roof surface, slope, and media depth,” *J. Environ. Qual.*, vol. 34, pp. 1036-1044, May 2005.

[29] N. Dunnet and N. Kingsbury, *Planting Green Roofs and Living Walls*. Portland, USA: Timber Press, 2004.

H

SYSTEM AND AGRICULTURAL MANAGEMENT

H.1

FARMERS RESPOND TO SCHOOL FIELD MANAGEMENT INTEGRATED PLANT CORN (SLPTT-JAGUNG) (CASE IN MEKAR LAKSANA FARMER GROUP, ARJASARI SUB-DISTRICT, BANDUNG DISTRICT)

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ABSTRACT

Corn is a commodity mainstay in upland plateau Arjasari Sub-district, Bandung District. Integrated Crop Management Field School (SLPTT) intended to improve performance and increase the productivity of maize farmers. The purposes of this research were (1) investigate the response of farmers to SLPTT corn and (2) determine the income of corn farmers after attending SLPTT. The study was conducted in 2015 used descriptive survey research methods. The number of respondents 25 farmers. The farmers respond were measured knowledge (cognitive), attitudes (affective), and cultivation practices (conative). Measurement of the response to a Likert scale. The results showed the corn farmer's response to high enough SLPTT 88%. The cognitive response consists of awareness and the SLPTT program is very good 92% and the farmers knowledge on SLPTT 84%. Affective responses consist of interest and confidence. The farmers 'interest on the SLPTT program is not good, only 56% and the farmers' confidence is 60%. Conative responses consist of tendencies and behaviors (actions). Farmers tend to SLPTT very good 88%, but the implementation of SLPTT only 68%.

Keywords: response, farmers, SLPTT

I. INTRODUCTION

One way to optimizing production of corn is by applying a program of *Sekolah Lapang Pengelolaan Tanaman Terpadu* (SLPTT) specialized in corn. *Sekolah Lapang Pengelolaan Tanaman Terpadu* (SLPTT) which being held since 2008 is one of The Government programs in supporting the process of corn production's acceleration by implementing The PTT Technology. Farmers' empowerment model in SLPTT is done by improving farmers' ability and capacity as human resources through acceleration of technology adoption in which hopefully will improve the farmers' ability in managing plants integrally to be able to improve their crops' production. This is also in line with The Government's efforts in achieving the main target of agricultural development policies in five years or from 2010-2014 which are: (1) Sustainable self-sufficient achievement, (2) Increase in food diversification, (3) Increase in value-added, competitiveness, and exports, also (4) Increase in farmers' welfare.

Since 2009, Arjasari Sub-district have implemented the *Sekolah Lapang Pengelolaan Tanaman Terpadu* (SLPTT) program specialized in corn with good results as seen in table 1. One of farmers group which become a participant of SLPTT corn program is Mekar Laksana Farmers Group. Hybrid fresh corn seed varieties of BISI-2 and N35 was planted in its plant season of November 2011 up to February 2013.

Table 1. Realization of Harversted Area, Productivity and Corn Production in Cimanggung Sub-district from 2008 - 2013

Realization	Before SLPTT			After SLPTT			
	2007	2008	2009	2010	2011	2012	2013
Harvested Area (ha)	1.021	1.212	1.45	1.575	1.587	1.378	1.407
Productivity (kw/ha)	25,92	36,80	42,30	56,01	54,71	54,29	51,33
Production (ton/ha)	3.047	4.460	6.134	8.821	8.682	7.154	7.222

Source : *Badan Pusat Statistik* (BPS) Bandung District, 2013

Not all farmers agree with SLPTT, eventhough it has great goals and results. Many reasons to which why farmers didn't apply SLPTT mostly due to they not knowing it or their incapability in implement it. Because of that, it is necessary to further examine farmers' response against SLPTT through their knowledge (cognitive), attitude (affective), and skills (psychomotor).

II. MATERIALS AND METHODS

The research was conducted 2015 in Mekar Laksana Farmers Group, Arjasari Subdistrict, Bandung District. The design of the research was quantitative and research's methodology was survey descriptive .The Variables which were studied consist of:

1. Farmers' characteristic: Age, Education, Land area, farming experience.
2. Application of integrated plant technology: superior varieties, high quality of seeds, cultivation technique, harvesting technique. And post-harvest.
3. Farmers' response: Cognitive response (consciousness and knowledge); Affective response (interest and conviction); conative response (tendency and behavior).

Data Source: primary and secondary. Primary data source: farmers, field counselor (PPL), *Unit Pelaksanaan Teknis Dinas* (UPTD), *Unit Pelaksana Teknis Badan Penyuluhan Pertanian Perikanan dan Kehutanan* (UPTB P3K) and leader of farmers group. Secondary data source: reports from Agricultural Service, research reports, and scientific journals. Primary data source was determined by census survey of a whole population resulted in 25 farmers who have following SLPTT.

Data collection techniques were through structured interviews and observation. Data measurement was using 1, 2, 3 Likert Scoring Scale. Likert Scale used for assessment of each questions in the questionnaire. Likert Scale used to measure attitude, opinion, and perception of a person or group of people about social phenomena (Sugiono, 2011).

Table 2. Response Value Interpretation

No	Response Value	Criteria
1	0 – 0,33	Low response
2	0,34 – 0,67	Medium response
3	0,68 – 1	High response

Source: Arikunto, 2009

III. RESULTS AND DISCUSSION

A. Farmers response to SLPTT Corn

1. Cognitive Response

Cognitive response is a statement of what was trusted and believed in the attitude of an object. Cognitive response consisted of perception, trust, and stereotype owned by individuals regarding of something. These commodities may often be synonymous as vision (opinion), especially on controversial issues and problems. Trust is came from what we see or what we know and based on what we see then formed an idea and notion on the nature and general character of an object. (Azwar, 1995).

Table 3. Farmers Awareness toward SLPTT Program

Statement	n	%
Unaware	–	–
Roughly / Doubtful	2	8
Aware	23	92

Source: Primary Data, 2015

There are two kinds of awareness, which are:

- Passive Awareness

Passive awareness is a state of whereby an individual received all the given stimulus at the moment, both internal and external stimulus.

- Active Awareness

Active awareness is a condition in which someone will emphasize to the initiative and seek and he/she can select which stimulus will be given. From 25 respondents of farmers, ninety-two percent aware of SLPTT program.

Most of human knowledge obtained through education, other's experience, mass media and environment (Notoatmodjo, 2003). From 25 respondents of farmers, 84% know about SLPTT program.

Table 4. Farmers Knowledge of SLPTT Program

Statement	n	%
Not knowing	2	8
Roughly / Doubtful	2	8
Knowing	21	84
Total	25	100

2. *Affective Response*

Response affective is a feeling of individual towards an object's attitudes and related to the emotion issues. Emotional aspects as this which usually rooted to survive the most to the influences that may change the attitude of a person. Affective components are related to the subjective emotional issues of a person to an object's attitudes and equals to the feeling that owned toward something. Emotional reaction which an affective component is much influenced by a belief (Azwar, 1995).

Table 5. Farmers Interest toward SLPTT Program

Statement	n	%
Not interested	2	8
Roughly / Doubtful	9	36
Interested	14	56
Total	25	100

Interest of a person toward an object will be more visible when the object is in line with the objective and pertaining to the wants and needs of someone concerned (Sardiman, 2010). Interest has a very large influence in achieving a feat on a job, position, or career. From 25 respondents, 56% of them interested in SLPTT program.

Table 6. Farmers Conviction toward SLPTT Program

Statement	n	%
Uncertain	2	8
Roughly / Doubtful	8	32
Certain	15	60
Total	25	100

Conviction is a certain suggestion feeling that develops within a person so he/she feels confident in doing something. From the 25 respondents, 60% of them have conviction to the SLPTT program.

3. *Conative Response*

Conative response contains a tendency to act or to react to something in a certain ways. Conative components shows how a behavioral tendency within one person pertaining to an object their facing (Azwar, 2005).

Table 7. Farmers Tendency toward SLPTT Program

Statement	n	%
Not interested	–	–
Roughly / Doubtful	3	12
Interested	22	88
Total	25	100

Respondents tended to be positively interested in following SLPTT program. This can be seen from their level of participation in questionnaire paper. From the 25 correspondents asked to fill the questionnaire, 56% are interested in SLPTT program.

Table 8. Farmers Implementation of SLPTT Program

Statement	n	%
Did not implement SLPTT	–	–
Roughly / Doubtful	8	32
Implement SLPTT	17	68
Total	25	100

Respondents tended to be positively interested by SLPTT program. This can be seen from their participation in the implementing SLPTT. From the 25 respondents, 68% were good at implemented the SLPTT program in accordance with the SOP.

B. Farmers Respond toward Pengelolaan Tanaman Terpadu (PTT)

Table 9. Farmers Respond toward Pengelolaan Tanaman Terpadu (PTT)

Pengelolaan Tanaman Terpadu (PTT) Technology of Corn	Score of Farmers Respond toward PTT		
	1	2	3
Using superior varieties	–	3	22
Amount of Seeds 15 kg/ha	3	4	18
Depth of Seeds 15 - 20 cm	2	1	22
Land per square 1 m^2	1	8	16
Ditch with wide of 30 - 40 cm and depth of 30 cm	–	8	17
Fertilizer in accordance with soil fertility level	–	7	18
Planting hole around 3 - 5 cm	–	–	25
Distance between plants 75 - 25 cm	2	7	16
Thinning according to the number of plants	–	6	19
Perform stitching	–	1	24
Weeding of plants at age of 15 days	–	8	17
Landfill soil of plants at age of 6 weeks	–	9	16
Routine irrigation to prevent plants from withered	25	–	–
Pest disease and weed control with repeal and a little use of pesticides	–	6	19
Harvesting at 86-96 days after planting	-	8	17
Harvest by whirl the cobs or break the stalk	3	8	14
Stripping when corn still attached on the stalk	23	1	1
Drying the crop for 7-8 days	1	2	22
Pluck corn seed with hand or special tools	–	3	22
Sorting while monitoring the quality	–	4	21
Total Frequency	60	94	346
Percentage	12	18.8	69.2
Response Score		0.86	

Conative component (PTT excevutor), the respondent's answers for 1 score about 12%, 2 score about 18,8% and 3 score about 69,2%. Therefore, conative response can be calculated as follows:

Score of Conative Response = (60 + 188 + 1038) : 1500 = 0,86 which is high response area (Arikunto, 2009). This means, corn farmers in Arjasari Sub-district were very responsive toward SLPTT program

IV. CONCLUSION

1. Cognitive response consists of awareness and knowledge. Farmers have a very good awareness of SLPTT at 92% and knowledge about SLPTT at 84%.
2. Affective response consist of interest and conviction. Farmers' interest to SLPTT program was not quite good just as much as 56% and their conviction at 60%.
3. Conative response consist of tendencies and beharior (execution). Farmers tendency toward SLPTT was very good around 88% while their execution of SLPTT only 68%
4. The score of farmers' response toward *Pengelolaan Tanaman Terpadu* (PTT) of Corn was 0.86 which belong to the high response criteria or very responsive.

ACKNOWLEDGEMENT

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REFERENCES

[1] Anggoro, N. 2004.. *Respon Petani Terhadap Program Konservasi Tanah di Kabupaten Klaten.* Skripsi. Fakultas Pertanian. Universitas Gadjah Mada.

[2] Arikunto, S. 2009. *Prosedur Penelitian Suatu Pendekatan Praktik*. Edisi revisi 6. Jakarta: Rineka Cipta.
[3] Azwar, S. 2005. *Sikap Manusia*. Yogyakarta: Pustaka Pelajar.
[4] Badan Litbang Pertanian. 2013. *Pedoman Sekolah Lapang Pengelolaaan Tanaman Terpadu*. Badan Litbang Indonesia.
[5] Moleong, Rexy. 2006. *Metodologi Penelitian Kualitatif*. Bandung: PT. Remaja Rosdakarya
[6] Notoadmodjo, Soekidjo. 2003. *Pendidikan Pertanian dan Perilaku Petani*. Jakarta : Rineka Cipta.
[7] Kementrian Pertanian Republik Indonesia. 2008. *Panduan Pelaksanaan Sekolah Lapang Pengelolaan Tanaman Terpadu (SLPTT) Jagung*. Jakarta.
[8] Sardiman, A.M. 2010*. Interaksi dan Motivasi Belajar Mengajar*. Jakarta : Rajawali
[9] Sobur, Alex. 2003. *Psikologi Umum*. Bandung: Pustaka Setia.
[10] Sugiyono. 2011. *Metode Penelitian Kuantitatif Kualittatif dan R&D*. Bandung : Alfabeta.
[11] UPTD Pertanian Tanaman Pangan Dan Hortilutura Desa Cimanggung. 2013. *Laporan Tahunan Realisasi SLPTT Jagung*. Dinas Pertanian Dan Tanaman Pangan Kabupaten Sumedang.

H.2

THREATS OF SOCIAL PROBLEMS IN SUSTAINABLE AGRICULTURE DEVELOPMENT IN RURAL AREAS OF WEST JAVA, INDONESIA

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ABSTRACT

The implementation of sustainable agriculture in Indonesia tend to focus heavily on economical, technological and environmental aspects, while rarely taking social perspective into account. Consequently, agricultural sector is currently facing various social problems such as aging, under value and brain drain. This study aimed to analyze the impact of the socio-agricultural problems on the implementation of sustainable agriculture development in West Java. The study mixes qualitative and quantitative methods, with more focus on positivistic paradigm. Survey was conducted on 280 agribusiness actors, which was followed by quantitative descriptive and structural analysis. The results showed that social problems affected rural economy, application of technology and environmental. The real impacts are slow adoption rate of technology, decreased productivity, stagnation of rural institutions, environmental degradation, and saturation of employment and entrepreneurs. This condition hampers the quality, competitiveness and independence of agricultural sector. Therefore, it is necessary to focus on innovation, especially those that will increase the attractiveness of agricultural sector in order to boost the regeneration rate of agricultural youth labors. Aside of that, brain gain policy has to be developed in order to enhance the rate of agricultural and rural development.

Keywords : impact, aging, under value, brain drain, sustainable agriculture development.

I. INTRODUCTION

Sustainable agriculture since two decades ago has been seen as a paradigm of agricultural development in Indonesia. Hopefully, it will create a just and sustainable agriculture in the economic, political, social and environmental aspects, so as to ensure the needs of the present without compromising the ability of future generations. Sustainable agriculture through the development of the social aspects, especially for human resource has received enough attention. Various efforts to increase revenue, capacity, independence, institutional and welfare of farmers developed through partnerships, training, internships, counselling, field schools, mentoring, empowerment and others. The problem is the implementation of human resource development applied more focused on strengthening the capacity of the actors of agriculture that exist today, that are mostly aging and saturated.

Agricultural Census 2013 [1] showed that the number of household farmers aged over 45 years to over 60 years amounted to 17,785,806 of the total 26,135,469 or household as much as 60 percent. Whereas young farmers, aged 15-34 years as many as 3,359,414 or only 11 percent of the total household farmers. The Indonesian Statistics Bureau [2] noted that employment in the agricultural sector is also increasingly dominated by older age groups (77 percent), even a majority of more than 50 years old. Department of Agriculture (2013) also reported that about 68 percent of civil servants of old age (over 50 years), and even about 49 percent of retirement. Limitations of the quantity and quality of extension workers is the main constraint extension [3]. Much earlier, research [4] in West Java revealed that the average age of farmers was 49-year-old, and approximately 80 percent over the age of 50 years [5], [6].

According to [7], [8] and [9], identical to the old age and poor-quality education characterized by intention, performance and low productivity. [2] showed that 79.5 percent of human resources working in the agricultural sector pass and do not pass the Primary School; 10.5 percent of junior high school graduates; 9.7 percent of high school graduates; and only 0.3 percent of college graduates. Old age is also identical to deterioration of physical, psychological, social, economic and health, so it can be a real threat to the existence, productivity, competitiveness and sustainability of the agricultural sector in the future. How could the agricultural sector will be superior, quality and competitiveness if the culprit is weak resources, are not qualified and not competitive.

In addition, the agricultural sector is also faced with the fact the low ratings (under value) community and youth participation. According to [2], [1] the composition of the youth group, only 23 percent of the total labour force in agriculture and 11 percent of total farm households. The figure continued to decline, from 9.5 million people (in 2007) to 8.4 million people (in 2011), down 12.11 percent. In fact, the results of the 2010 population census revealed that approximately 28,965,014 inhabitants of Indonesia's total population (237.6 million people) are rural youth. Trend, the proportion of rural youth will continue to increase along with the increasing number of young people. Indonesian Statistics Bureau [2] notes, the youth Indonesia in 1971 amounted to 29.68 million, then rose to 39.98 million (1980), 50.89 million (1990), 59.84 million (2000) and 62.34 million (2010). On the demographic bonus era (2015-2035) and the golden generation (2035-2045), the number of rural youth expected to increase two-fold. The low valuation and youth participation in agriculture has resulted in the aging of farmers age, as well as the lack of proportion in the quality of human resources in the agricultural sector and rural space as a whole.

The low appraisal and young people to the agricultural sector (under value) has increased the rate of migration of qualified young workers from rural to urban and from agriculture to non-agriculture (brain drain). Because the brain drains and uncontrolled running in the same direction, then the agriculture and rural sector becomes stagnant and difficult to develop. Faiz [10] asserts that brain drain has become a major problem for the region, the periphery and rural. Research results of Kupets [11], Adebayo [12], Johnson [13] and Faiz [10] in Asia, Africa, Europe and North America reveal, because the perpetrators of the brain drain are generally the age group of talented young, the socially-spatial has resulted empty qualified young workers in suburban and rural areas, especially in the agricultural sector. According to Kurnia [14], the brain drain is caused by the drivers of the countryside (push factors) rather than the appeal of urban (pull factor).

Furthermore, aging-agriculture, under value and brain drain baited negative feedback so that exacerbate inequality and crises that have occurred in the agricultural sector and rural space. In the end, the slower the process of regeneration and age structure of the actors in the agricultural sector is getting old. According to Faiz [10], such a phenomenon is common in countries that are growing, including in Indonesia. For the agricultural sector and rural areas, their implications not only weaken the agricultural management performance, but the performance of the institutional and overall rural activity. Systemically, three have resulted in the development process (especially agriculture), become stunted and slow. Ironically, despite the implications of these three issues are very real, but until now Indonesia has not been preparing a strategy to address them. In fact, all three are linked to sustainability. Limitations of qualified personnel has resulted not running effective industrialization of agriculture.

In the case in Indonesia, [15] and [2] asserted that the greatest population is still concentrated in rural areas (50.02 percent), but in rural areas there is a shortage of young and qualified human resources. Generation of qualified human resources instead of rural migration to the big cities (brain drain) in the process of urbanization leap frog. Rural conditions as it was clearly a disadvantage, because it will continue to create bias and the development gap between rural and urban areas. The problem is, almost thirty years of government of China, Taiwan and India let the brain drain, but during the same progress is not achieved. In fact, India lost about two billion dollars per year due to the brain drain [16]. Therefore, India, China, Taiwan, North Africa, Romania and Lithuania put a brain drain as a serious problem for the region, peripheral and rural [17], [18]. This paper aims to analyse the impact of aging agriculture, under value and brain drain towards the sustainability of agricultural development in rural West Java.

II. MATERIALS AND METHODS

The study applied mixed method by placing quantitative methods (survey) and qualitative methods (in-depth interview and observation) as complementary. The study was conducted in the highlands of West Java province (Priangan), with sample locations in Cianjur Regency (West Priangan), Bandung regency (Central Priangan) and Garut regency (East Priangan). The research was conducted from July 2014 through September 2015. Agribusiness actors engaged in farming (on-farm), on the supply of inputs (up-stream), in the handling and processing (downs-stream) as well as in the support services (supporting system) which totalled 7,728 people (out of three selected locations) defined as the study population. Of the population and then randomly drawn sample of 280 people (102 people in Cianjur, 75 people in Bandung and 103 people in Garut). For in-depth interviews were purposively selected 10 informants from each location. Primary data was collected through structured interviews with the tool questionnaire, interview and observation. While secondary data obtained from the relevant agencies through the study of literature (desk study). The data collected and tabulated, selected and analysed descriptively.

III. RESULTS AND DISCUSSION

Sustainable agricultural development is one of the specific elaboration of the concept of sustainable development [19]. According to Burger (1998), there are four principles that must be considered in sustainable development. First, the principle of resource efficiency, which emphasizes the principle that resources are not overexploited so that it becomes useless. Second, sufficiency principle, the principle that emphasizes the existence of restrictions on the use of resources in an effort to provide (protect) the needs and rights of future generations. Thirdly, the principle of consistency, the principle which emphasizes the need for compatibility between the subsystems and with a superior overall system refers to the natural ecosystems. Fourth, the precautionary principle, the principle that an emphasis on protecting the environment from degradation. The fourth principle reflects the wisdom and the ecological balance.

In fact, sustainable agriculture is still seen and applied partial, biased commodities and bias activities on-farm, while social sustainability and ecological (actor's regeneration, land, water, inputs, institutional, agro-industries, markets, infrastructure) has not been much attention, Sustainable agriculture is not holistic and equitable, both vertically (the integration from upstream to downstream activities) or horizontally (integration of capital, sector, actors and regions). In addition, it is also still a certain bias science, has not been integrated with many disciplines, such as pharmacy, medicine, art, design and so on. According to [20], [19] and [21], sustainable agriculture is still biased economic (prospects, advantages, opportunities), scientism (technology) and physical environment (ecological environment). While the social aspect (social ecology), human (mental ecology), institutional (institutional ecology) and arts and culture (including knowledge, local wisdom, beauty, harmony) still neglected. He also has not noticed the dynamics of convergence approach, such as cyber-space, genome, Nano, blue economic and biosciences.

His life of farmers, aging, under value and brain drain has become a real bottleneck in preparing actors who are competent and ready to compete in the open market era. Technically, all three have resulted in difficult and ineffective application of agricultural science and technology (such as frontier technology, such as biotech, nanotech, cleantech, InfoTech and neurotech), the application of technology convergence, the completion of the environmental crisis (including climate change) and energy crisis. Moreover, it has also hindered investment rural agribusiness industrialized, effectiveness of application innovation (frugal innovation) and innovation integrated (such as bioscience, agro-creative, agrobiotechnology, agro-cyber, agro-tourism, agro-biosciences and agro-nanotechnology). In fact, all three are not conducive to the effective management of agricultural and rural institutions, strengthening social capital, improving the quality of education, innovation added value, value cycle efficiency, the expansion of the market, application standardization and political strengthening farmers. Furthermore, all three will be a real obstacle in responding to a wave of blue economy, acceleration agropreneur, the embodiment of food sovereignty and balanced development.

Stagnation of regeneration, his old age and poor farmers younger generation assessment of the agricultural sector has resulted in a lack of proportion qualified young workers in the agricultural sector and rural areas. In fact, the availability of qualified human resources is vital in moving the agriculture-based science and technology. The lack of qualified human resources has resulted in agricultural and rural sectors are faced with a variety of problems, such as low productivity of farming and agribusiness in general, the saturation of employment and self-employment of rural, not the development of agro and rural, difficult rise of SMEs rural, unproductive cooperative, low HDI rural, low quality of service, the rapid pace of cultural erosion, increased land use, uncontrolled exploitation of resources (especially by outsider), ineffectiveness of institutional management, rising unemployment and poverty remain high. Modern agriculture, but it is not environmentally friendly (62.09%), no regenerative and competitiveness (38.05%) (Table 1).

Aging agriculture, undervalued and brain drain has a negative impact on the sustainability of agricultural development in rural West Java. First, socially trio have not resulted in the passage of the regeneration process, resulting in quality human resources crisis, leadership crisis, innovativeness crisis, the crisis of agricultural entrepreneurship and institutional crisis in the rural area. Second, all three economies have resulted in ineffective application of economic capital, capital and innovation of science and agricultural technology, so that business productivity is not significantly increased. Third, ecologically has resulted in the further degradation of the environment (land, water, air, plants and animals) as the implications of the high dependence on agriculture actors to conventional methods of full chemical inputs. Spatially, the impact is higher in all three agroecosystem zones of lowland rice and dry land based crops than in agroecosystems zone highland vegetables based.

IV. CONCLUSION

Aging agriculture, undervalued and brain drain has led to various crises in the agricultural sector and rural areas, so that the real impact on the sustainability of agricultural development. In real terms, the more modern agricultural sector (conventional), but not the quality (not ecological) and not competitive (not socially). Regeneration or succession agriculturalists as a form of social sustainability have received less attention, so the impact on the economic and ecological sustainability. Therefore, it takes an innovative approach to succession or regeneration of agricultural development actors, one of them is brain gain (flipping personnel educated, expert and skilled workers from overseas to their home areas).

Table 1. Level of Agricultural Sustainability in Rural of West Java, Indonesia

Indicator of Sustainability	Perseption	Cianjur Regency	Bandung Regency	Garut Regency	West Java Province
		%	%	%	%
1) Level of Modernity (Economically)	(1) Traditional	10,16	20,85	26,40	19,00
	(2) Convensional	32,57	36,10	33,93	34,03
	(3) Actual	42,47	29,46	33,15	35,57
	(4) Responsivness	14,79	13,59	6,51	11,40
	Amount	100,00	100,00	100,00	100,00
	Average	54,20^{c}	58,95^{b}	54,95^{a}	p-value = 0,000
	Std. Deviasion	0,393	0,454	0,360	
2) Level of Quality (Ecologically)	(1) Exploitative	16,37	31,21	41,89	29,74
	(2) Reproductive	35,44	30,33	30,76	32,35
	(3) Productive	35,65	28,10	24,80	29,63
	(4) Ecological	12,54	10,36	2,55	8,28
	Amount	100,00	100,00	100,00	100,00
	Average	61,13^{c}	54,40^{b}	47,03^{a}	p-value = 0,000
	Std. Deviasion	0,433	0,473	0,435	
3) Level of Competitiveness (Socially)	(1) Powerless	18,70	34,81	43,25	32,05
	(2) Low Power	32,38	26,27	30,08	29,90
	(3) Powerness	35,40	27,42	24,47	29,24
	(4) Competitiveness	13,51	11,50	2,20	8,81
	Amount	100,00	100,00	100,00	100,00
	Average	60,95^{c}	53,93^{b}	46,23^{a}	p-value = 0,000
	Std. Deviasion	0,451	0,470	0,394	
3) Level of Competitiveness (Socially)	(1) Powerless	18,70	34,81	43,25	32,05
	(2) Low Power	32,38	26,27	30,08	29,90
	(3) Powerness	35,40	27,42	24,47	29,24
	(4) Competitiveness	13,51	11,50	2,20	8,81
	Amount	100,00	100,00	100,00	100,00
	Average	60,95^{c}	53,93^{b}	46,23^{a}	p-value = 0,000
	Std. Deviasion	0,451	0,470	0,394	

Caption: same letter notation (a, b, c) indicates the same group

REFERENCES

[1] Indonesian Statistics Bereau. 2014. Statistics of Indonesian Agricultural: Results of Agricultural Census 2013. ISB, Jakarta.

[2] Indonesian Statistics Bereau. 2012. Analysis of Indonesian Youth Potential: Results of Population Census 2010. ISB, Jakarta.

[3] Sumardjo. 2008. Characteristics of Rural Development: The Anthology of Rural Development in the Context of Public Welfare Improvement. IPB Press, Bogor.

[4] Sumardjo. 1999. Transformation Model of Agricultural Extension Farmers Towards Independence Development: The Case of West Java Province. Dissertation. Graduate School of IPB, Bogor.

[5] Setiawan, I. 2012. Creative Agribusiness: Pillar of Entrepreneurial Future Prosperity Towards a New World Power of Green. Penebar Swadaya, Jakarta.

[6] Agussabti. 2002. Farmers Independence in Adoption Decision Making of Innovation: The Case of Vegetable Farmers in West Java Province. Dissertation. Graduate School of IPB, Bogor.

[7] Rakhmat, Jalaluddin. 1999. Communication Pshycology. Revisi Edition. PT. Remaja Rosdakarya. Bandung

[8] Soewardi, H. 2004. Logic, Sense and Achievement: Fundamentals for Progress Nation. Bhakti Mandiri, Bandung.

[9] Indonesian Statistics Bereau. 2013. Statistics of Indonesian Youth: Results of Population Census 2010. ISB, Jakarta.

[10] Faiz, P.M. 2007. Brain Drain and Human Resources in Indonesia: Study Analysis of Reversed Brain Drain in India. Faculty of Law, University of Delhi. School of Social Science, IGNOU, New Delhi.

[11] Kupets, Olga. 2011. Brain Gain Or Brain Waste? The Performance Of Return Labor Migrants In The Ukrainian Labor Market. This project was supported by the Economics Education and Research Consortium and funded by GDN.

[12] Adebayo, Akanmu. 2010. Brain Drain-Brain Gain: Leveraging the Nigerian Diaspora for the Revitalization of Nigerian Higher Education. Paper Presented at the 25th Conference of the Association of Vice Chancellors of Nigerian Universities, Osogbo, on April 19-22.

[13] Johnson, N. 2009. Analysis and Assessment of the “Brain Drain” Phenomenon and its Effects on Caribbean Countries. Florida Atlantic Comparative Studies Journal Vol. 11, 2008-2009.

[14] Kurnia, Ganjar. 2004. Farmer: Warrior are marginalized. Papers Presented in Scientific Oration Inauguration. Padjadjaran University, Bandung.

[15] Soetomo, S. 2009. Urbanization and Development Process Morphology of Civilization and Containers Physical Space: Towards a Humane Life Space. Graha Ilmu, Yogyakarta

[16] United Nations and Development Programme. 2007. Case Evidence On ‘Brain Gain’. A UNDP Capacity Development Resource. Published by: SAGE Publications. http://www. sagepublications.com

[17] Daugėlienė R dan R. Marcinkevičienė. 2009. Brain Drain Problem In Lithuania: Possible Actions for Its’ Solution Via Brain Gain. ISSN 1822-8402 European Integration Studies. 2009. No 3

[18] Beine, M, F Docquier and H Rapoport. 2010. Brain Drain and LDCs’ Growth: Winers and Losers. The Economic Journal, 118 (April), 631–652.

[19] Susanto, S. 2005. Agrotechnology as a base in the Development of Sustainable Agriculture. In Book Revitalization of Agriculture and Dialogue of Civilizations. Kompas, Jakarta

[20] Pilliang, Y.A. 2005. Donations Sciences Arts and Design in the Revitalization of Agriculture. In Book Revitalization of Agriculture and Dialogue of Civilizations (pp 583-599). Book Publishers Kompas, Jakarta

[21] Sarwono, S.W. 2005. Humans Indonesia: Pre-mentality of Agriculture in the Information Age "Cyber" in Anthology "Revitalization of Agriculture and Dialogue of Civilizations". Kompas, Jakarta.

H.3

STUDY ON FOOD SECURITY IN RICE PRODUCTION CENTER (SURVEY IN BUAHDUA DISTRICT, SUMEDANG-WEST JAVA)

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ABSTRACT

Food is a basic need of human sufficiency a top priority for the Indonesian government. BuahduaSubdistrict is a major contributor to rice production in Sumedang District. But ironically, it is also a Subdistrict with an allocation of Raskin (rice for the poor) is quite large; it means that the level of food security of farmers is low. This phenomenon is very interesting for this study because food security begins with the smallest level of the household; moreover, farmers are the producers of the food itself. This study examines: how the food security of farmers in Buahdua Sub-district, and the factors that affect food security at the farmers' household level. The research design is quantitative with survey techniques. Stratified random sampling used and selected 43 rice farmers. Using logistic regression analysis tools and descriptive techniques. Results from this study showed that 58 percent of farmers classified as food secure while 42 percent classified as less food secure. While the factors that impact significantly on the level of food security is the education level of farmers, land area and household expenditure on food.

Keywords: Food Security, Rice Farmers, Socio-Economic Factors.

I. INTRODUCTION

Food is a basic human need that sufficiency is a top priority for the Indonesian government. Buahdua district is the main contributor of rice production in Sumedang regency. Ironically, however, it is also a sub-district with a fairly large allocation of raskin (rice poor), meaning that the level of food security is low. According to Law No. 7 of 1996 on food, food security as a condition of fulfillment of food for households as reflected by the availability of adequate food in quantity and quality, safe, equitable, and affordable. Based on this definition, food security is not only at the global, national and regional levels but also at the household level. National and regional food availability does not guarantee household or individual food security because food availability and food security are determined by access to food (Lakollo,E.M. et al., 2007).

There is no guarantee that a country capable of self-sufficiency, food security is guaranteed. Many definitions explain food security. A person who has physical, social, and economic aspects of food sufficiency, is safe and nutritious for his nutritional needs according to his taste for productive and healthy living is a concept of food security (Maxwell,S, 1992). Here is a fundamental difference between self-sufficiency and food security:

Table 1. Differences in Food Self-Sufficiency with Food Security

Indicator	Food Self-Sufficiency	Food Security
Scope	National	Households and Individuals
Target	Food Commodities	Human
Strategy	Import Substitution	Increased availability, access and absorption of food
Output	Food Increase	Nutritional status (decreased hunger, malnutrition, and malnutrition)
Outcome	Food sufficiency by domestic product	Healthy and productive people (high life expectancy)

Source: Hanani, Nuhfil.2012

Buahdua is one of the sub-districts located in Sumedang Regency with potential as the main rice producer in Sumedang Regency. Based on data from the Agriculture Office of Sumedang Regency that Buahdua Sub-district

produces about 54 tons of rice and is the largest production result compared to 25 other districts in Sumedang Regency (Sumedang District Agriculture Office, 2014). According to data in 2013 Buahdua District has a food insecurity ratio of about 24% it is still fairly high compared to other sub-districts in Sumedang District. This phenomenon is very interesting to study, because the Buahdua Sub-district contributes the largest rice in Sumedang, but the vulnerable areas are also large. Whereas food security begins from the smallest level of households, plus farmers are producers of the food itself. This study examines:
1. What is food security at farmer household level in Buahdua Sub-district.
2. What socio-economic factors affect food security at the farm household level.

II. MATERIALS AND METHODS

The research design used is quantitative and qualitative design. Quantitative research is a scientific approach that views a reality that can be classified, concrete, observable and measurable, variable relationships are causal where the research data in the form of numbers and analysis using statistics. Qualitative research is a research procedure that produces descriptive data in the form of written or oral words of people and behavior that can be observed (Neuman, W. Laurence. 2006).

Techniques in this study using descriptive survey research techniques that take cases in District Buahdua, Sumedang District. According to Rusidi (2006) survey is a method of collecting data by using instruments to solicit responses of respondents about the sample consisting of interviews and questionnaires.

The sample in this study is the household of rice farmers in Buahdua Subdistrict, Sumedang Regency. The number of rice farmers in the Buahdua Subdistrict is 853 people who are farmers with private land ownership and recorded in farmer groups. Respondents were selected by stratified sampling method. Farmer groupings are based on land ownership. The basis of determining the sample is done using the Slovin formula (Sugiyono, 20013), namely:

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where:
N: Number of samples (people)
N: Population size (people)
E: The limit of errors (no more than 15%)

The number of samples of rice farmers is 48 people. The number of samples to be taken at random from each farmer group based on land area. To know the factors that have a significant influence on the level of household food resilience of rice farmers then used logistic regression analysis. Logistic regression method is a general linear model used for binomial regression. As with regression analysis in general, this regression uses some free variables (numerical or category).

In this study, we will calculate the relationship of household food security level with several socio-economic factors. In this case, the level of household food security is an independent variable (g (x)) and is influenced by several independent variables such as land area (X_1), farmer age (X_2), farmer education level (X_3), farm household income X_4), and household food expenditure of farmers (X_5). If in multiple linear regression formula can be written as follows:

$$g(x) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \varepsilon_i \quad (2)$$

III. RESULT AND DISCUSSION

A. Farmer's Characteristics

From the research results revealed that the majority of petanit farmers are farmers land owners. Farmers cultivate rice twice a year. So to know the income of farms obtained by calculating the reduction of revenue (revenue) with the amount of fixed costs (fixed cost) and variable costs (variable cost) issued by farmers in one season. For the source of family income, the majority as farmers (80%), 10% as farm labour, 4% as traders, civil servants and private (3%), craftsmen (1%) and others (1%). From the income analysis, the results obtained as the following table.

B. Farm Household Income

Table 2. Contribution of Farm Household Income According to Land Area (Average / Month)

Type of Income	Narrow land (Rp.)	Medium land (Rp.)	Extensive land (Rp.)	Total (Rp.)
Rice Farming	636.140	1.768.796	4.204.242	6.609.179
Non Rice Farming	1.505.263	566.667	45.455	2.117.384
Total	2.141.404	2.335.463	4.249.697	8.726.563

From table 2, it can be seen that the contribution of rice farming has a big effect on the amount of income for rice farmers with medium and wide land. Only about 25% of income comes from non-farming. Usually the contribution is a contribution of household members with livelihoods outside of rice farming and some of them have home-based businesses such as food processing.

In contrast to moderate and wide-ranging farmers, agricultural output from smallholder farmers has a low contribution to household incomes. Therefore, most of them (the head of the family) only consider rice farming as a side job and choose to find a job that can support daily needs such as trade, labour, or village apparatus.

Table 3. Revenue of Rice Farmer (Owner) by Land Strata (Average / month)

Income	Narrow land		Medium land		Extensive land		Total	
	Rp.000	%	Rp. 000	%	Rp.000	%	Rp.000	%
Head of household	1.348,7	63	1.994,7	85	3.958,1	93	7.301,7	84
Household member	792,6	37	340,7	15	291,5	7	1.424,8	16
Total	2.141,3	100	2.335,4	100	4.249,6	100	8.726,5	100

From table 3, the head of household income ranged from Rp 1,348,772 to Rp 3,958,120 per month and the contribution of household head to household income was 83.67%. This shows that the role of the head of the family in contributing to family income is quite large.

If viewed based on the size of land, it can be concluded that the more agricultural land owned then the contribution and the average income of the head of the family is greater. Conversely, the more land owned by the smaller family member income contribution.

C. Farm Household Expenditure

The amount of household expenditure is directly proportional to the area of land owned. Farmers with high land area have high cost of living as well. In table 4 it can be seen that the amount of non-food demand tends to be higher than food demand, this is due to the variation of non-food needs of farm households in accordance with the needs of each member of the farm household

Table 4. Contribution of Farm Household Expenditure by Land (Average per month)

Expenditure Type	Narrow land	Medium land	Extensive land	Total
Food expenditure (Rp.000)	863,7	930	1.110	2.903,7
Non-Food expenditure (Rp.000)	1.045,7	891,3	1.135	3.072,1
Total (Rp.000)	1.909,4	1.821,3	2.245	5.975,8
Food spending share (%)	45,23	51,06	49,44	48,59

In table 4 it can be seen that household food expenditure on average consumes 48.59% of total income per month. When compared to the strata of the land owned, farmers with narrow land issue an average of 45.23% of income, households with land ownership are issuing an average of 51.06% of income, and households with large land ownership - 49.44% of revenue. When compared, there is no significant link between the amount of food expenditure and the area of land owned because of the fact that households with a large area of land are issuing the highest average income compared with others.

Some villages in Buahdua sub-district can be categorized as having difficult access to food supplies although there are still a few small shops to purchase daily necessities in small quantities. In addition to the location of the market far enough, the way to travel that distance is also not easy because of the access road is damaged. This makes accommodation costs high. However, with these conditions residents realize the need to store food reserves and produce their own foodstuffs for example by planting vegetables and raising for daily meals. For the basic needs of rice all farmers get it from the land they have.

D. Food Security of Farm Households

1. Availability of Household Food of Paddy Farmers

The availability of household food is one of the benchmarks in the calculation of food security. Food availability describes the adequacy of food that can be consumed by households. Based on the National Food Resilience Agency statement that the minimum rice availability is 105 kg per year per capita. The results show that 100% off farmers have rice availability> 105 kg per capita per year. This proves that the farmers have met their rice supply well. It is also indicated because the farmers produce their own rice and prioritize the supply of rice for households rather than for sale. Based on the provisions of LIPI in 2004, households are stable if they have availability above 105 kg per year per capita with a feeding frequency ≥3 times a day, whereas families with rice availability of more than 105 kg per year per capita with twice daily feeding frequency are categorized Less stable households. Of the total farmers there are 28 people or 58.33% which is classified as stable households and there are 20 people or 41.67% of farmers with household category less stable.

Table 5. Stability of Farmers Household Food

Adequacy of Food Availability	Eating Frequency						Total	
	≥ three		twice		once			
	n	%	n	%	n	%	N	%
>105 kg rice	28	58.3	20	41.7	0	0	48	100
1-105 kg rice	0	0	0	0	0	0	0	0
No inventory	0	0	0	0	0	0	0	0
Total	28	58.3	20	41.7	0	0	48	100

From the table above can be seen that there is no correlation between farmers landed narrow, medium, or broad with food stability. Of the three strata, the group of moderate farmers is the group with the highest amount in terms of less stable food. While the other two groups tend to respond to stable food. This causes some farmers to be categorized as less stable food because they choose to sell crops in the form of grain or rice rather than storing for household consumption. The farmers chose to sell to meet other needs outside of food, in the case of Buahdua District most of the farmers tend to sell crops for their children's education and accommodation costs for their mobility. Accessibility of food or the affordability of food in food security can be measured from the way households get their food in this case especially staple food (rice). The accessibility is divided into two categories, namely, direct access where the household owns its own land and indirect access where the household has no land to obtain food. This way can also be divided into two other categories namely own production and purchase.

In this study, all farmers have direct access in obtaining their food, moreover all farmers are farmers of land owners.

Table 6. Food Accessibility on Farmer's Household

How to Get Food	Land						Total	
	Narrow land		Medium land		Extensive land			
	n	%	n	%	n	%	N	%
Own pro-duction	19	39,5	18	37,5	11	23	48	100
Buying	0	0	0	0	0	0	0	0
Total	19	39,5	18	37,5	11	23	48	100

As mentioned before, all farmers have direct access to obtain food or own wetland with private ownership, so in this case the grouping is focused on how to obtain their own food production or purchase. As illustrated in Table 6, all farmers produce their own food to meet their household needs. Inventory owned by farmers was above the minimum. Although there are some farmers who are still less stable food, but access them more easily. Food continuity can be measured with the accessibility and stability of household food. Based on these indicators if a person has direct access to stable food conditions then the availability of food is called continuous and if someone has direct access but food unstable then the availability of food is stated less continuous.

Table 7. Level of Continuity of Food Availability on Farmer's Household

Continuity level	Land						Total	
	Narrow land		Medium land		Extensive land			
	n	%	n	%	n	%	N	%
Continuos	12	25	8	16,6	8	16,7	28	58,3
Less Continuous	7	14,6	10	20,8	3	6,3	20	41,7
Not continuous	0	0	0	0	0	0	0	0

In table 7 can be seen the level of continuity of household food availability of farmers. Overall there are 58.33% of farmers stated continuous with and 41.67% stated less continuous. Of the three land tenure groups, farmers with land ownership have the highest percentage in the case of less sustainable households. Continuity means the extent to which households need their daily needs whether they are continuous or not, whether their food is guaranteed or not. Although farmers have direct access to food, it does not guarantee continuity of availability.

2. Household Consumption Subsistence of Rice Farmers

Measures of food quality are only seen from the presence or absence of foodstuffs containing animal protein and / or vegetable protein in household consumption, in this case it is not taken into account the nutritional value of the food consumed. Based on the conditions in the field, the expenditure allocated by farmers to buy / get the side dishes in the form of animal protein and vegetable protein or vegetable protein / animal only. Animal proteins that are often consumed by farmers include salted fish, eggs, and freshwater fish. This is because how to get it tend to be easy and the price is cheaper than other sources of animal protein.While the source of vegetable protein is often obtained from tofu, tempeh, and red beans. Soybean as a raw material of tempeh / tofu is widely grown in

District Buahdua itself, the culture in the sub-district is to plant soybeans as a rotation of rice planting. Therefore, many people who are also producers of tofu /"tempe".

The reason for the consumption of these proteins is more because of the household habits that have been done continuously and affordability of their purchasing power. According to LIPI's reference to measures of household food resilience of rural farmers, it can be stated that households have good food quality.

Table 8. Expenditure Value of Protein Animal and Vegetable Protein Based on Farmer Land Area (Average per month)

Expenditure Value of Protein	Land			Total
	Narrow land	Medium land	Extensive land	
Animal Protein (Rp)	215.920	326.000	444.000	309.292
Vegetable Protein (Rp)	647.760	605.000	666.000	635.750
Total (Rp)	863.680	930.000	1.110.000	945.042

From table 8 it can be seen that expenditure to buy the largest protein is issued by farmers with large area. It can also be concluded that there is a relationship between protein expenditure and the area of land owned. The more land that the farmers have, the higher the costs incurred to obtain protein for household consumption needs. The higher the expenditure allocated for the source of protein, the better the quality of the protein. Food security index is calculated by combining the four indicators of food security namely availability, stability, continuity, and food quality. As explained earlier, the adequacy of food availability and the frequency of feeding, provides an indicator of food stability. Food stability with food access provides an indicator of food continuity. While the food security index will be measured by combining food continuity with food quality.
Based on analysis, households can be grouped into three:

a. *Household food insecurity*

Household food insecurity is a household with continuous food availability and has expenditures for animal and vegetable protein or animal protein alone. Also, it can be seen that there are 58.33% of farm households classified as food resistant. There is no significant relationship between the strata of land owned and the food security. On a land basis, 25% of farmers with narrow land ownership, 16.67% of farmers with medium land ownership, and 16.67% of farmers with large landholdings are classified as food resistant.

b. *Household is less food resistant*

Less food-resistant households are households with continuous food but only have expenditure on vegetable protein alone and households with less continuous food continuity but have expenditures on vegetable and animal protein or animal protein alone. In this study found 41.67% of farm households classified as less food resistant. Indicated that it is classified as less food resistant because it has a continuity of food that is less continuous despite having expenditure for vegetable protein and animal or animal protein only. Based on the structure, there are 14.58% of farmers with narrow land ownership, 20.83% of medium-sized farmers, and 6.25% of farmers with large landholdings are classified as less food resistant. From the data it is also seen that land ownership farmers have the highest number of food insecure groups.

c. *Households are not food resistant*

Non-food-resistant households are households with four main characteristics:

- It has continuous food continuity but has no expenditure for animal or vegetable protein.
- Has a continuous continuity of food and only has expenditure for animal or vegetable protein only and / or not both.
- It has continuous food continuity although it has expenditure for animal or vegetable protein.
- It has continuous food continuity and only has expenditure for vegetable protein only or not both.

In this study, no farmers were found to be unsustainable. This is not due to the high level of living, but due to the arrangement of a good lifestyle and tailored to the needs. Not that a person with a narrow area can be indicated as not being food-resistant, a person with large ownership has that potential, although in the case of Buahdua Sub-district represented by the sample, there is no indication of food insecurity.

Thus, the level of income and the level of expenditure on the whole household strata does not guarantee the household is resistant or unstable. Because there could be other factors in the household that encourage the household to care about household food needs. Because if they can manage their income appropriately, their food stability and continuity are well met.

3. Socio-Economic Factors Affecting Household Resilience of Rice Farmers

In this study, there are several socioeconomic factors that are considered as factors influencing the resistance of one's household food and which factors have a significant influence on household food security. These factors include land ownership, age of farmers, farmer education level, household income, and household food expenditure (Herdiana, Eka. 2009). By logistic regression analysis, the results are obtained from table 10. Where independent variables are land ownership (X_1), farmer age (X_2), farmer education level (X_3), household income (X_4), and household food expenditure (X_5) That affects the dependent variable that is the resistance or not of the household food of the farmer, where 1 is food resistant and 0 is other than food resistant.

Table 9. Logistic Regression Analysis

Omnibus Tests of Model Coefficients

		Chi-square	df	Sig.
Step 1	Step	17,740	10	,060
	Block	17,740	10	,060
	Model	17,740	10	,060

H_0 from this research is there is no independent variable that influence level of household food resistance, hence is there at least one of independent variable have significant influence to household food security. It can be seen from table 10 that the significance value is 0.06, less than the predetermined degree of error of 0.15. If the value of significance is smaller then H_0 is rejected, it means there is one or more independent variables that have a significant influence on household food security of farmers.

Table 10. Logistic Regression Analysis (continue)

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	47,463[a]	,309	,416

Negalkerke R-Square has a similar interpretation as determination on linear regression. The value of Negalkerke to R-Square is 41.6% or has the meaning of all the factors tested, the factor has an influence of 41.6% in determining household food security and 58.4% influenced by other factors not taken into account in research this. To know which factors have a significant influence on household food security, it can be seen based on the partial analysis table of the following variables.

Table 11. Logistic Regression Analysis (continue)

Variables in the Equation

		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 1[a]	Land	,425	1,263	,113	2	,125	1,236
	Age	,536	1,613	,110	1	,740	1,709
	Education	,525	1,637	„150	1	,123	2,080
	Income	,700	1,223	,327	1	,156	2,013
	Food expenditure	,707	1,225	,333	1	,144	1,493
	Constant	2,883	2,140	1,815	1	,178	17,871

a.Variable(s) entered on step 1: Land, Age, Education, Income, Food expenditure

As the previous analysis, that the variable has a significance value smaller than 0.15 then the variable has a significant influence on household food security. The table above is a table of independent variable analysis partially or one by one, can be seen that has a significance value smaller than 0.15 is the level of education and food expenditure. Thus, it can be concluded that the level of education of farmers and household food expenditure has a significant influence on the level of household food security. Other variables such as age, land area, and income do not mean have no relationship or are not factors affecting food security, but these factors have influence but not significantly determine the level of household food security.

In the income variable, its significance value is close to the criteria as the significant factor. Revenue affects household expenditure, such as food expenditure and non-food expenditure. It can be seen from the regression analysis that food expenditure has significant influence over the income itself, this can be caused by the portion of income itself which is partly not intended for food purposes, hence the value is not significant because it is represented by the variable of food expenditure.

Another significant factor is the level of education, the results of analysis in accordance with the reality of the field because a farmer with a high level of education has an awareness to regulate his food. Starting from their consideration to have a supply of food within a certain time until the type that must be met for food.

Other variables such as land area and age influence the smallest to the level of food security. No significant correlation between land ownership and food security has been established, some examples of farmers with narrower land holdings are more resilient than those with large landholdings, in which case farmers with narrow land only focus on production The adequacy of family food is different from the large farmers who focus on buying and selling. However, the level of food security can be influenced by household habits itself, how the pattern of daily consumption. While the variable age is not very influential because the average farmer has a age that is not much different, ie at age 50 years and over, this is what causes the age factor has no significant effect on food security.

IV. CONCLUSION

A. Conclusion

1. Characteristics of socio-economic households of paddy farmers in Buahdua District are as follows:

a. The average characteristic of agricultural farm household area is 0,75 ha classified as medium land. The average age of the head of the family in all strata is 51 years and is a productive enterprise. The average education of the head of household is at the level of Senior High School (SMA) and classified as higher education.

b. The average family income is Rp 32,367,917 per year with a range of Rp 14,840,000 to Rp 84,000,000 per year. The contribution of head of household income was 81.15% to total household income. Family with narrow land ownership have an average income of Rp 25,696,842 per year, land-owning families have an average income of Rp 28,025,556 per year, and Families with large landholdings have an average income of Rp 50,996,364 per year.

c. Average Expenditure for household food needs per month is Rp 948,750. The contribution of expenditure on food per month is 48.48% of the total expenditure. The average household expenditure of smallholding land holdings is Rp 863,684 per month, average household expenditure on medium land ownership is Rp 930,000 per month, and the average household food expenditure has a land area of Rp 1,100,000 per month.

2. Household food security in Kecamatan Buahdua can be grouped: 58.33% belong to food and 41.67% other classified as less food resistant. Food security can be realized with a good lifestyle that can be built within a household or family scope by managing food availability, managing expenses, and a good understanding of the importance of maintaining household food.
3. Socio-economic factors that have a significant influence on household food security are the level of education of farmers, land area and the amount of household food expenditure on food.

B. Suggestion

1. For the local government, should pay more attention to household food security especially in access to obtain food. Because there are several factors that cause difficulty of food access in the research location, one of them is the access road that is difficult to pass because damaged. The government also can provide counseling to the citizens about the importance of maintaining the resilience of households, not just quantity but also the quality of food that must be met.
2. For the development of science, in the measurement of food quality indicators is a good comparison between the standardization of protein content (animal /vegetable) with calories needed by the community to get more accurate results and better results. The research processes and procedures can also be directed to findings on how to formulate a model of food security management to address the presence or absence of household vulnerability to food in the research area.

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REFERENCES

[1] Regional Food Security Agency of West Java Province. 2013. Food Security Statistics of West Java Year 2013. Available at http://perpustakaan.bappenas.go.id/. Retrieved 11 January 2016.

[2] Central Bureau of Statistics (BPS) of the Sumedang Regency. 2014. "Kabupaten Sumedang Dalam Angka 2014". Available At: https://sumedangkab.bps.go.id/index.php/publikasi/ Retrieved 12th September 2016.

[3] Food Agricultural Organization. 2002. Worl Food Summit, 13-17 November 2002. Rome, Italy: Food Agriculture Organization of the United Nation.

[4] Food Agricultural Organization. 2001. Assessment of The World Food Security Situation. Rome: Committee on World Food Security.

[5] Hanani, Nuhfil. 2012. Family Food Security Strategy. Journal of Agricultural Economics Vol. 1, No.1, p. 1-10. Available At: http://perhepi.go.id/. Retrieved 15 September 2015.

[6] Herdiana, Eka. 2009. Pathway Analysis of Factors Affecting Household Food Security (Case Study: Lebak District, Serang Banten). Essay. Bogor: Bogor Agricultural University.

[7] Kartika TWW. 2005. Analysis of Croping Strategy and Food Security of Farmer's Household in Majasih Village, Sliyeg Sub-district, Indramayu Regency. Department of Community Nutrition and Family Resources, Faculty of Agriculture, Bogor Agricultural University.

[8] Lakollo, E.M., Rusastra, I.W., Saliem H.P., Supriyati, Friyanto, S., and Budi, G.S. 2007. Rural Socio-Economic Dynamics: Comparative Analysis of Agricultural Census. Final Report of Research. ICASEPS-Agricultural Research and Development Agency Ministry of Agriculture. Jakarta. Available At: http://pse.litbang.pertanian.go.id/. Retrieved 16 September 2015.
[9] Maxwell S. 1992. Household Food Security a Conceptual Review. Unicef-IFAD.
[10] Mulyana, Andi. 2012. Strengthening Food Security to Suppress Number of Poor and Food Vulnerable People at National and Regional Level. Journal of Agricultural Economics Vol. 1, No.1, p. 11-17. Available At: http://www.perhepi.go.id/. Retrieved 15 September 2015.
[11] Neuman, W.Lawrence. 2006. *Social Research Methods: Qualitative and Quantitative Research.* USA: University of Wisconsin
[12] Purwaningsih, Yunastiti. 2008. Food Security: Situation, Problems, Policy, and Community Empowerment. Journal of Economic Development Vo. 9, No. 1, pp. 1-27. Available At: http://perpustakaan.uns.ac.id/. Retrieved 21 September 2015.
[13] Rosyadi, Imron. Didit, Purnomo. 2012. Level of Household Food Security in Disadvantaged Villages. Journal of Development Economics Vol. 13, No. 2, p. 303-315. Available At: http://journals.ums.ac.id/. Retrieved 21 September 2015.
[14] Rusidi. 2006. Quantitative Analysis Technique. Bandung: Unpad Research Institute.

H.4

SEDIMENT YIELD CALCULATION ON A RESERVOIR USING SWAT MODEL

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ABSTRACT

Sediment transport from high land to downstream cause sedimentation in reservoir, river, irrigation channel and makes new soil in the edges and delta river. This study aims at knowing the most sensitive parameter of SWAT (soil and water assessment tools) and deposition of sediment in Wadaslintang reservoir. SWAT divides a watershed into subwatersheds. Each subwatershed is connected through a stream channel and further each subwatershed is divided into Hydrologic Response Unit (HRU). HRU is a unique combination of soil, land use and slope type in a subwatershed. Sequential Uncertainty Fitting-2 (SUFI-2), in a SWAT-CUP2012 sub-module computer program, was applied to optimize the parameters of the SWAT using monthly observed sediment yield data at Wadaslintang reservoir. Fifteen hydrological years data were used for model calibration and validation. From calibration process, the most sensitive parameter is USLE_P (USLE support practice factor) on the other hand, CH_S2 (average slope of main channel) is the least sensitive parameter. The highest of sediment yield is 2349 ton/ha (13,42 cm) accours in 2010 and the lowest is 303 ton/ha (1.73 cm) in 2008. Trend sediment was decreased from 2001 to 2008, meanwhile increased in 2009 to 2010. Multi-objective function statistic of validation: coefficient of determination, R^2 (0.97), Nash–Sutcliffe efficiency, NSE (0.93), root mean square error observations standard deviation ratio (RSR) (0.265), and percent bias, PBIAS (−22.197%). With this result, the model is suitable to predict sediment yield at Wadaslintang reservoir.

Keywords: sediment yields, SWAT (soil and water assessment tools), calibration, validation.

I. INTRODUCTION

Sediment yield is the amount of sediment derived from erosion in the catchment area were measured at a certain period of time and place. Sediment transport from high land to downstream cause sedimentation in reservoir, river, irrigation channel and makes new soil in the edges and delta river (Ridwansyah *et al*, 2010) . Some effects sediment yield according Suroso *et al*, (2007) is the shrinkage in storage capacity and the effective storage capacity of the reservoir. Likewise, the age of the reservoir plan, the age of the dam plans to accelerate the reduction.

Model is a representation or formalization in the specific language of the real system. Hydrological model used to evaluate the impact of climate practices, land use, and management of the plant on the quantity and quality of land and water resources (Yesuf *et al*, 2015). Modeling is done for ease in handling and proper management in managing watersheds that tend to have a very wide area coverage.

SWAT (Soil and Water Assessment Tools) is a model which continue, semi-distributed, and based on the Watershed process (Arnold *et al*, 2012). SWAT is developed by Dr. Jeff Arnold for the Department of Agriculture and the American Research (USDA-ARS). SWAT is a model watershed scale events that continue to operate on a daily basis and is designed to predict the impact on the management of water, sediment, and agricultural chemicals in the. SWAT base on physical, streamlined computerized, and able to make a simulation for a long period of time (Neitsch *et al*, 2011).

SWAT predicts the sediment yield within each HRU using Modified Universal Soil Loss Equation (MUSEL) (Williams, 1975).

$$sed = 11.8\left(Q_{surf}.q_{peak}.area_{hru}\right)^{0.56}.K_{usle}.C_{usle}.P_{usle}.LS_{usle}.CFRG \qquad (1)$$

Where :

sed = sediment yield on a given day (metric tons)

Q_{surf} = surface runoff volume (mm ha^{-1})

q_{peak} = peak runoff rate (m^3 s^{-1})
$area_{hru}$ = area of HRU (ha)
K_{usle} = Universal Soil Loss Equation (USLE) soil erodibility factor (0.013 metric ton m^2 h (m^3 metric ton cm)$^{-1}$)
C_{usle} = USLE cover factor
P_{usle} = USLE support practice factor
LS_{usle} = USLE topographic factor
CFRG = coarse fragment factor.

This study aims at knowing the most sensitive parameter in the SWAT model of sediment in the reservoir modeling results Wadaslintang and also calculates the results of sediment in the reservoir Wadaslintang.

II. MATERIALS AND METHODS

A. Location

This research was conducted in Watershed Wadaslintang located about 7°35' of latitude and 109°50' of longitude, or precisely located in Wonosobo regency of Central Java province, as shown in Fig. 1.

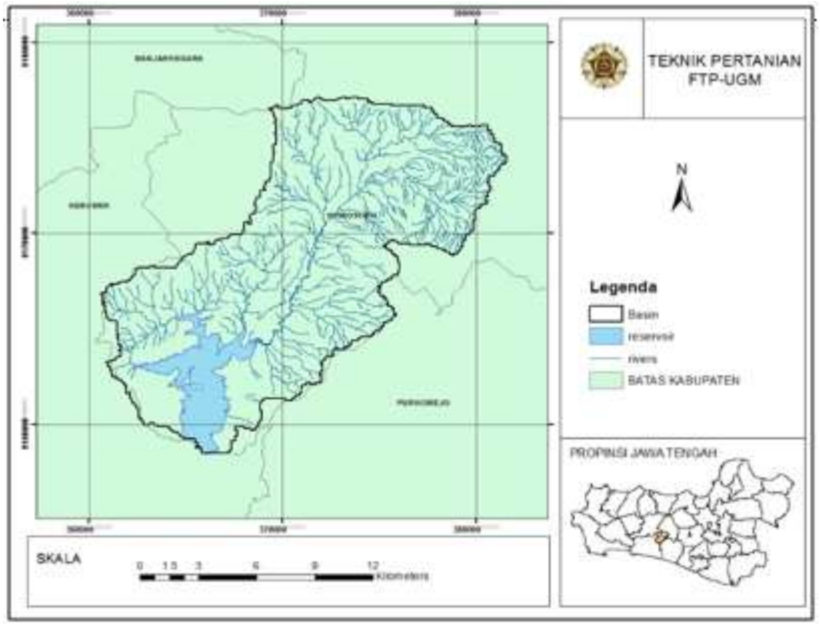

Fig. 1. Location of the study

B. Materials

The tools used in this study are: a set of computer, ArcGIS software, ArcSWAT 2012.10_2.16, SWAT - CUP 2012 software version 5.1.6. While the materials used are rainfall data of 2000-2013, the daily temperature data in 2000-2014, 2000-2014 sediment data, the humidity, wind speed data, Digital Elevation Model (DEM) from the SRTM with a resolution of 90x90 m with an extension of ASCII , soil type maps, land use maps, slope maps, and map boundaries.

The rainfall data obtained from three observation stations, namely station Kaliwiro, Limbangan and Wadaslintang. Details location and elevation are presented in Table 1. Before the rainfall data is used for modeling, previously tested data homogeneity with Rescaled Adjusted Partial Sum (RAPS), as in Equation 2 to Equation 5.

Table 1. Location of rainfall stations and elevation

No.	Name of Stasiun	Latitude	Longitude	Elevation (m)
1	Kaliwiro	-7.462	109.850	350
2	Limbangan	-7.504	109.849	414
3	Wadaslintang	-7.548	109.821	275

$$S_k^{**} = X_k = \sum_{t=1}^{k} \frac{Y_t - \bar{Y}}{S_Y}; k = 1, \dots, n \quad (2)$$

$$S_k^{**} = \frac{S_k^*}{S_y}; \quad (3)$$

$$S_k^* = \sum_{t=1}^{k} (Y_t - \bar{Y}); k = 1, \dots, n \quad (4)$$

$$S_Y^2 = \sum_{t=1}^{n} \frac{(Y_t - \bar{Y})^2}{n} \tag{5}$$

Where :
$\bar{Y}$ = sample average
S_Y = standard deviation
n = is the number of time series data . $= maks\ |S_k^{**}|$; if Q/ (√n) count less than Q/ (√n) table, then the rainfall data at the station is homogeneous.

C. Sensitivity Analysis

SUFI-2 calibration and uncertainty algorism, which is linked with SWAT-CUP2012 version 5.1.6, was used to perform sensitivity analysis of parameters. One-factor-At-a-Time (OAT) design, with a combination of Latin hypercube (LH) random sampling method was used to conduct local sensitivity analysis for eleven parameters (Table 4) governing sediment yield in ArcSWAT at the early stage of calibration. Soon after, parameter sensitivities were once again performed in SUFI-2 using global sensitivity analysis to take out more insensitive parameters from the calibration process. A t-test was used to identify a measure of sensitivity of each parameter (larger in absolute values are more sensitive), and p-values were used to determine the significance of the sensitivity (a value close to zero has more significance) (EAWAG, 2015).

D. Calibration

Calibration is the process of determining the optimum parameters. Used in the calibration process complete data (± 3 years) is in the range of observational data monthly period 2000-2002. In this study, the calibration process using SWAT-CUP with auto-calibration method. This process is considered more reduce subjectivity compared to manual calibration methods. Auto-calibration process used in this study is adopted from Arnold *et al*, (2012).

E. Validation

Validation is the process by which the output of the model was tested with data from observations in the field. In this study, the validation process used polynomial equations by plotting the relationship between flow and sediment yield in the observations. The next models evaluated using statistical methods. Four statistical methods chosen to evaluate the model**.**

1. Coefficient of determination (R^2): as a standard regression, it describes the degree of collinearity between simulated and measured sediment yield.

$$R^2 = \left\{ \frac{\sum_{i=1}^{n}(O_i - \bar{O})(P_i - \bar{P})}{\left[\sum_{i=1}^{n}(O_i - \bar{O})\right]^{0.5}\left[\sum_{i=1}^{n}(P_i - \bar{P})\right]^{0.5}} \right\}^2 \tag{6}$$

where *Oi* is the ith observed value for the sediment yield (metric tons), and Pi is the *i*th predicted value for the sediment yield (metric tons), Ō is the mean of observed sediment yield for the entire evaluation time period (metric tons), and P is the mean of model predicted sediment yield for the entire evaluation time period (metric tons), and n is the total number of observations.

2. Nash–Sutcliffe efficiency (NSE): is a normalized dimensionless statistic that determines the relative magnitude of the residual variance compared to the measured data variance. NSE indicates how well the plot of observed versus simulated data fits the 1:1 line. NSE is computed as shown:

$$NSE = 1 - \left[\frac{\left[\sum_{i=1}^{n}(O_i - P_i)\right]^2}{\left[\sum_{i=1}^{n}(O_i - \bar{O})\right]^2} \right] \tag{7}$$

3. Percent bias (PBIAS): measures the average tendency of the simulated data to be larger or smaller than their observed counterparts (Gupta *et a.,* 1999). PBIAS is calculated as shown in Eq. (7).

$$PBIAS = \left[\frac{\sum_{i=1}^{n}(O_i - P_i)}{\sum_{i=1}^{n}(O_i)} * 100 \right] \tag{8}$$

where PBIAS is the deviation of data being evaluated, expressed as a percentage.

4. RMSE-observations standard deviation ratio (RSR): RSR standardizes RMSE (root mean square error) using the observations standard deviation and it combines both an error index and includes a scaling/normalization factor. RSR is calculated as the ratio of the RMSE and standard deviation of measured data, as shown in Eq. (9):

$$RSR = \frac{RMSE}{STDEV_{obs}} = \frac{\left[\sqrt{\sum_{i=1}^{n}(O_i - P_i)^2}\right]}{\left[\sqrt{\sum_{i=1}^{n}(O_i - \bar{O})^2}\right]} \tag{9}$$

III. RESULTS AND DISCUSSION

A. Homogeneity Test of Rain

Daily rainfall data years 2000-2013 in each station first tested homogeneity by using RAPS (Rescaled Adjusted Partial Sums). RAPS test all of rainfall data in each station is homogeneous (Table 2). This indicates that the data from each observation station of rainfall can be used for modeling process.

Tabel 2. Result of homogeinity

Rain station	Q/√n max	Q/√n table	Description
Wadaslintang	1.048	1.172	homogeneous
Kaliwiro	0.793	1.172	homogeneous
Limbangan	1.013	1.172	homogeneous

The correlation between observations and sediment discharge at the Wadaslintang reservoir observation shown in Fig. 2. It appears that between discharge and sediment observation has a strong correlation. It is characterized when the rainfall intensity is high, the discharge produced high, so that the flow that carries most of the particles eroded soil and then accumulate into the sediment results are also high.

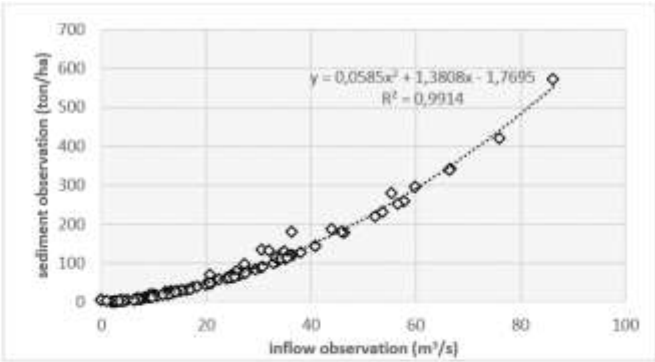

Fig. 2. Correlation between inflow observations and sediment yield observation

B. SWAT Model Analysis

Delineation point on the outlet Reservoir of Wadaslintang watershed produce catchment area covering 193.8 km² divided into 31 sub-watersheds, the delineation is presented in Fig. 3. The land use (Table 3) is used as one of the input data to create a spatial SWAT hydrologic response units (RHU) in each basin. Land use translated into a database in order to swat can be read by ArcSWAT. Land use by area and the presentation area are shown in Table 3. The area is dominated by agriculture (AGRL) with extensive 11531.45 ha (59 % of the total catchment area) area of agriculture (AGRL) is the largest area because of a combination of farm and field iside the category of AGRL.

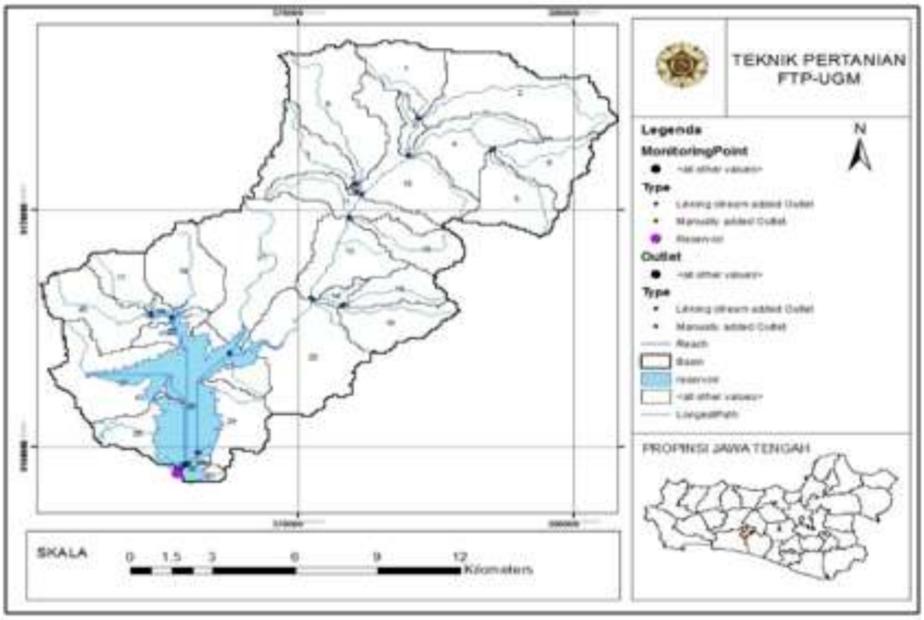

Fig. 3. Delineation results by SWAT

Table 3. Land use of Wadaslintang

No.	Land use	SWAT code	area (Ha)	Presentage (%)
1	Range Grasses	RNGE	894,22	4,64
2	Forest	FRST	629,96	3,27
3	Agriculture	AGRL	11531,45	59,9
4	Urban area	URBN	2397,64	12,45
5	Rice field	RICE	2404,49	12,49
6	Reservoir/water	WATR	1395,09	7,25
	Total		19252,85	100

C. Sensitivity Analysis

Eleven parameters chosen for the sensitivity analysis on SUFI-2. The name of the parameters, the range of uncertainty, and rank presented in Table 4. From the table it appears that the most sensitive parameter for discharge into the Wadaslintang reservoir is USLE_P (USLE support practice factor) and the least sensitive parameter is CH_S2 (average slope of play channel). The parameter value, then used in the calculation process for simulation results.

Table 4. Selection of parameters

Process	*Parameter_Name*	*Description*	*Fitted_Value*	*Min_value*	*Max_value*
sediment from landscape	1:R__USLE_P.mgt	*USLE support practice factor*	0,543333	0,1	0,8
	2:R__USLE_K(..).sol	*USLE soil erodibility factor (0.013 metric ton m2 h/(metric ton–cm))*	0,316667	0,15	0,35
	3:R__HRU_SLP.hru	*Average slope steepness (m/m)*	0,08	-0,2	0,2
	4:R__LAT_SED.hru	*Sediment concentration in lateral and groundwater flow (mg/L)*	83,333328	0	100
	5:R__SLSUBBSN.hru	*Average slope length (m)*	-0,205	-0,25	0,2
sediment from channel	6:R__SPCON.bsn	*Linear parameter for calculating the maximum amount of sediment that can be re-entrained during channel sediment routing*	0,000263	0,0001	0,005
	7:R__SPEXP.bsn	*Exponent parameter for calculating sediment re-entrained in channel sediment routing*	1,13	1	1,3
	8:R__CH_COV2.rte	*Channel cover factor (m/m)*	0,416833	0,001	0,5
	9:R__CH_N2.rte	*Manning's "n" value for the main channel*	0,03	0	0,3
	10:R__CH_K2.rte	*Effective hydraulic conductivity in main channel alluvium (mm/h)*	0,186667	-0,2	0,2
	11:R__CH_S2.rte	*Average slope of main channel*	9	0	10

D. Model Calibration

The calibration process is done by auto-calibration in SWAT - CUP uses the monthly flow data in the period 2000 to 2002. Performance SWAT models in predicting discharge inflow would be better if done at monthly intervals. According to research conducted by Ferijal *et al*, (2015) which generates NSE simulation time interval is greater compared with NSE performed at daily intervals. Observational data obtained from the sub-watershed 31 that there is a reservoir outlet as comparative data simulation results. In the calibration process, the value of R^2 can be received if greater than 0.6 and greater than 0.5 of NSE (Santhi *et al*, 2001; Arnold *et al*, 2012). Calibration results are presented in Table 5. The relationship of correspondence between observation and simulation results are presented in Fig. 3.

Table 5. Results of statistical test calibration

Method	Ojective function values			
	R^2	NSE	PBIAS	RSR
Sufi-2	0.81	0.70	-18.9	0.55

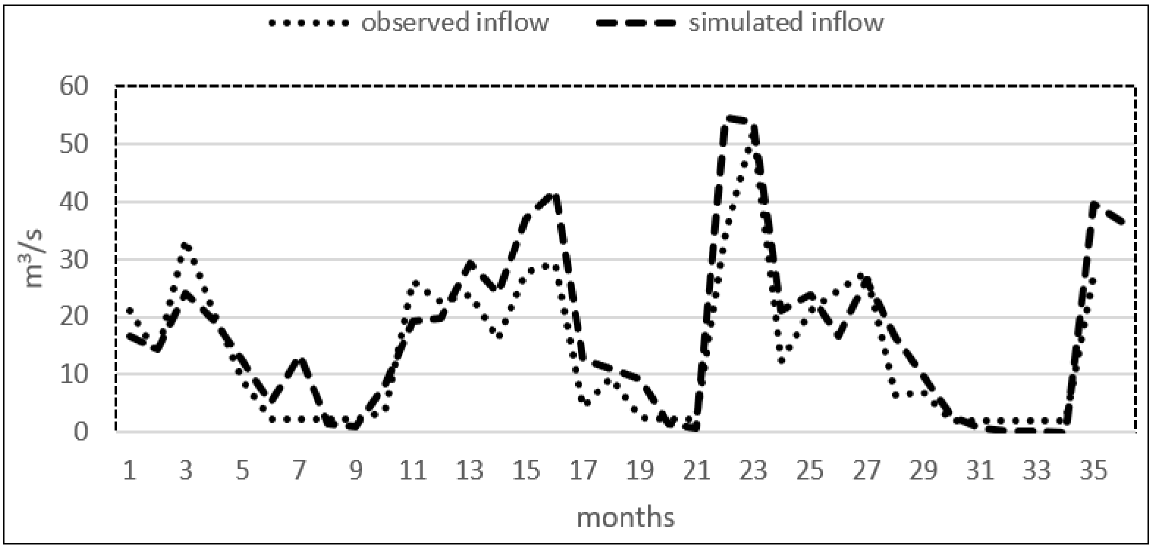

Fig. 4. Graph the results of calibration observed inflow and simulated inflow

With the value of the resulting statistical wherein R^2 is 0.81 and the NSE of 0.7, the results of model calibration was considered quite satisfactory. This outcome is the result of better calibration of research Yesuf *et al*, (2015) which only get the value of R^2 = 0.55 and NSE = 0.55. The differences in the calibration results can be caused by poor observation data or it could be due to the conceptual model built less significant. Based on the graph in Fig. 4, the fit between the observed inflow and simulated inflow results of the calibration results are quite good.

E. Model Validation

Sediment yield simulation generated from a polynomial equation between sediment inflow data observation and sediment observation (Fig. 3). While the model validation is done by comparing data from sediment simulations with data from sediment observation. Results plot generates a polynomial equation, $y = 0.0585x^2 + 1.3808x - 1.7695$. y is the result of sediment yield observation and x is an inflow observation. From this equation and then produced sediments in the simulation of Wadaslintang reservoir in monthly periods with an inflow replacing by x and y as a simulation of simulation of sediment that had previously been calibrated using SUFI-2. Statistical results of the validation test sediment simulation results presented in Table 6.

Table 6. Results of the validation test.

	R^2	NSE	PBIAS	RSR
Validation	0.97	0.93	-22.197	0.265

Coefficient of determination (R^2 as shown in Fig. 5 has a range of values between 0 and 1 ($0<R^2<1$). Where getting close to 1 then the model has a small error variation (Rathjens and Opelt, 2012). For the modeling of sediment yield, the model can be said to be satisfactory if $R^2>0.50$ (Santhi *et al,* 2001; Van Liew *et al,* 2003). The result of validation showed R^2 = 0.97 this indicates that the model is acceptable

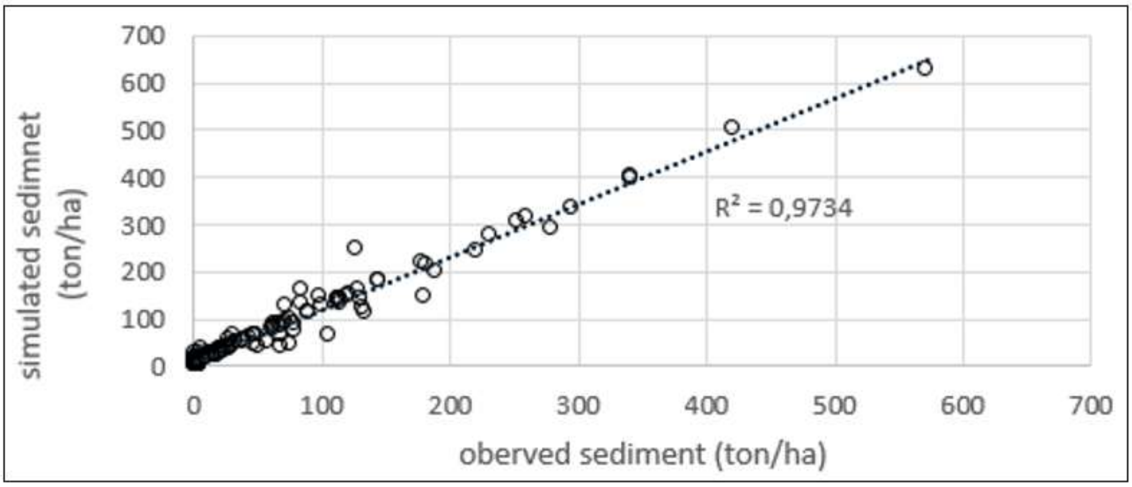

Fig. 5 The correlation between simulated sediment and observed sediment

NSE determine the magnitude of the relative value of the variation error between observation data and simulation data. NSE has a value range -∞ to 1. NSE with a value of 1, the model is said to be perfect (Moriasi et al, 2007). The tests showed NSE=0.93. This shows that the model is good enough. While the results of Yesuf *et al*, (2015) shows the NSE gained only 0.55 and it has been categorized enough.

PBIAS simulation results indicate whether the data tend to be larger or smaller than the observation in the field. PBIAS optimum = 0.0%. PBIAS positive result indicates that the model is under estimation bias, whereas a negative result indicates PBIAS bias exceeds the estimated models (Gupta *et al,* 1999). PBIAS validation value is -22.197 this means that the model of sediment in the Wadaslintang reservoir exceed estimates.

RSR has a range of values from 0 to + ∞. RSR = 0 indicates that the RMSE = 0 which means that the simulation model is very good. RSR that is positive and large indicates that the model performs poorly (Moriasi *et al,* 2007). RSR validation results sediment in reservoir simulation Wadaslintang is 0.265 where the value is close to 0, so the models are categorized either. In general the modeling results of the sediment (sediment yield) in Wadaslintang Reservoir produce a model that is satisfactory and acceptable. This is supported by the recommendations of Santhi *et al*, (2001), Van Liew et al, (2003), and Moriasi *et al*, (2007). Kesesuaiam plots between observed and simulated sediment results are shown in Fig. 6.

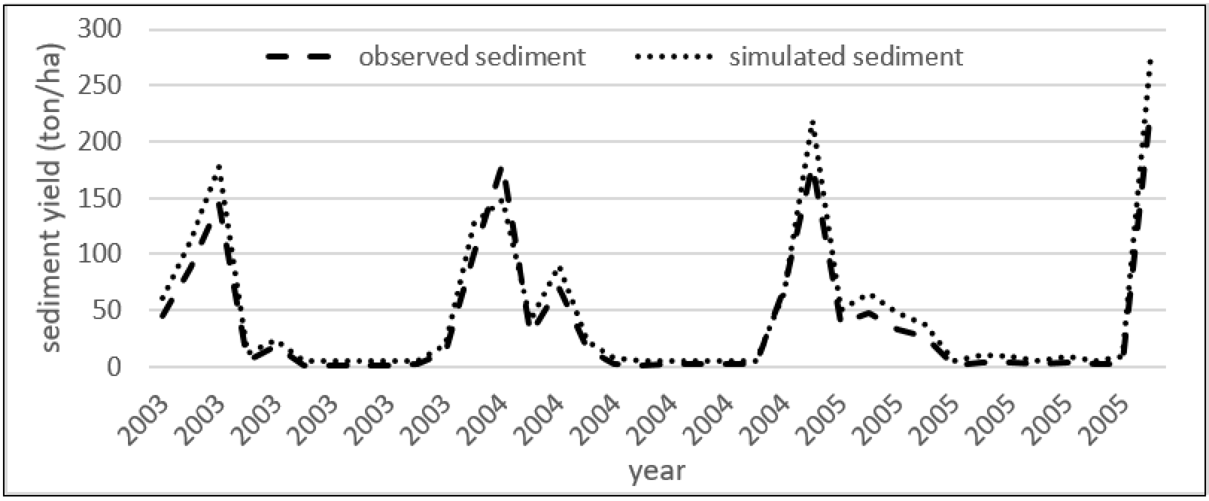

Fig. 6. Correspondence between simulation results and the results of sediment sediment observation

F. Sediment results

Distribution sediments cannot be known with certainty much less evenly distributed across the entire base of the reservoir. But in general the sedimentation is expected to be more widely available in the building transfer area and the outflow below. In this case the position Wadaslintang dead storage reservoirs located at an elevation +123 m. So that the dead storage area that contained a lot of stack sediment. The relationship between sediment and reservoir elevation Wadaslintang in shown in Fig. 7.

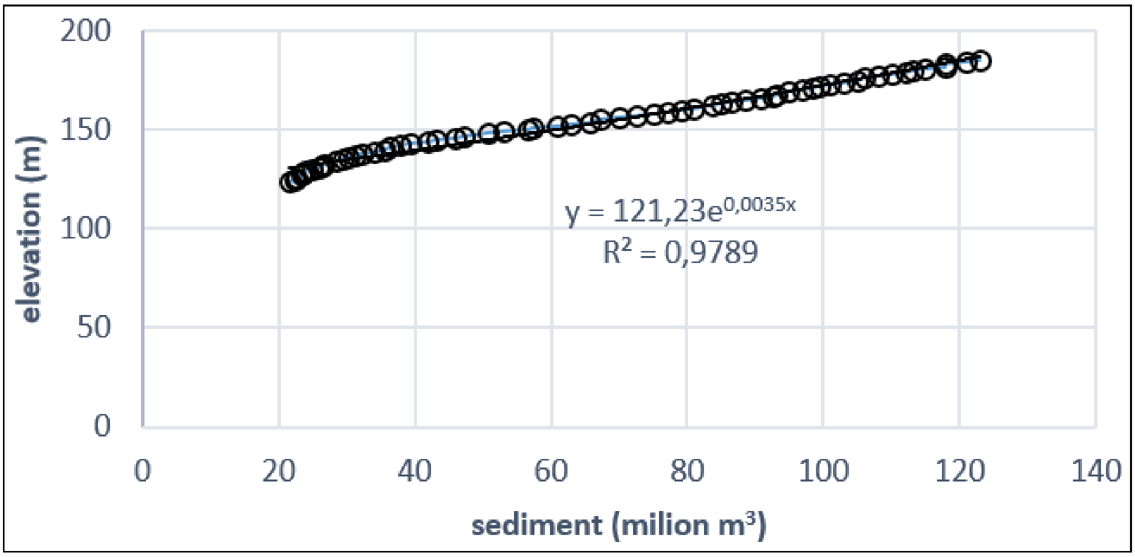

Fig. 7. The relationship between elevation and sediment

Sediment yield at Wadaslintang Reservoir from 2000 to 2014 are presented in Table 7. It is seen that the sediment yield increased from 2000 to 2001 and decreased in 2001 and 2008. This indicates that the upstream watershed land conservation is quite well done. But an increase in sediment significantly in 2009 to 2010, and tends to fluctuate up to 2014. This indicates the occurrence of significant degradation.

Sediment yield increase from erosion level which come into the reservoir. The research from Schiettecatte *et al,* (2008) in Wahyuningrum *et al*, (2014) stated that agricultural land has the highest erosion rates which exceed the actual erosion allowed (tolerable erosion) and the conversion of forest into open land erosion will increase by 12%. This is in accordance with the conditions of the Wadaslintang watershed dominated by agricultural land amounting to 11531.45 hectares. So it needs to be revisited in the management of land use and conservation efforts in the upstream of Wadaslintang watershed. Fluctuations in the Wadaslintang reservoir sediment yield show in Fig. 8.

Tabel 7. Sediment yield

years	Sediment yield (ton/ha)		Sediment yield (cm)	
	Sediment observed	sediment simulated	Sediment observed	sediment simulated
2000	382,17	345,82	2,18	1,80
2001	663,06	1044,94	3,79	5,97
2002	390,09	504,90	2,23	2,89
2003	424,52	558,22	2,43	3,19
2004	553,57	618,16	3,16	3,53
2005	398,07	531,35	2,28	3,04
2006	393,80	464,31	2,25	2,65
2007	451,15	558,52	2,58	3,19
2008	212,04	303,19	1,21	1,73
2009	987,74	1122,94	5,64	6,42
2010	1997,05	2349,09	11,41	13,42
2011	536,46	648,58	3,07	3,71
2012	1221,36	1479,16	6,98	8,45
2013	1684,31	1961,80	9,63	11,21
2014	1177,28	1387,46	6,73	7,30

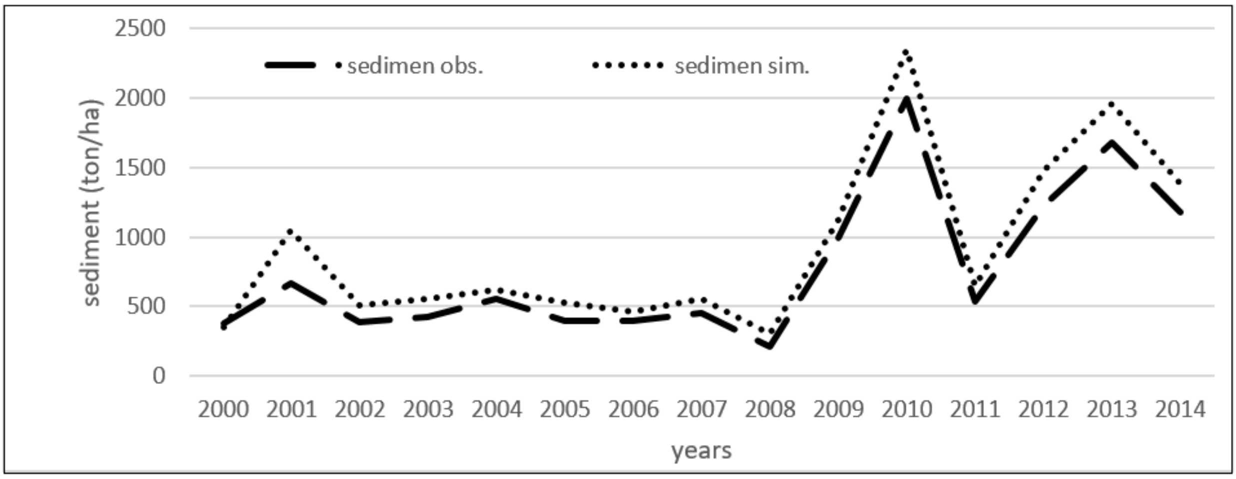

Fig. 8. Results of sediment in 2000-2014

IV. CONCLUSION

From the research that has been done in modeling sediment yield at the Wadaslintang reservoir results it can be concluded:

1. The most sensitive parameter USLE_P (USLE support practice factor) and the least sensitive parameter is CH_S2 (average slope of main channel)
2. The model validation tests give satisfactory results with R2;0.97, NSE;0.93, PBIAS;-22.197, and RSR;0.265.
3. The result is the largest simulation of sediment in 2010 amounted to 2349 tons / ha (13.42 cm) and the smallest was in 2008 amounted to 303 tons/ha (1.73 cm). While the trend of sediment decreased in 2001 to 2008 and rose in 2009 and 2010.

REFERENCES

Arnold, J.G., Moriasi, D.N., Gassman, P.W., Abbaspour, K.C., White, M.J., Srinivasan, R., Santhi, C., Harmel, R.D., van Griensven, A., Van Liew, M.W., Kannan, N., Jha, M.K. 2012. *SWAT: model use, calibration, and validation*. Trans. ASABE 55 (4), 1494–1508

Ferijal, T., Mechram, S., Jayanti, D.S., Satriyo, P. 2015. Pemodelan Daerah Tangkapan Air Waduk Keliling Dengan Model SWAT. *Jurnal AGRITECH,* Vol. 35, No. 1

Gupta, H. V., Sorooshian, S., and Yapo, P. O. 1999. Status of Automatic Calibration for Hydrologic Models: Comparison with Multilevel Expert Calibration. *Journal Hydrology*. Eng., 4, 135–143

Moriasi, D.N., Arnold, J.G., Van Liew, M.W., Binger, R.L., Harmel, R.D., Veith, T., 2007. *Model evaluation guidelines for systematic quantification of accuracy in watershed simulations*. Trans. ASABE 50 (3), 885–900.

Rathjens, H., Oppelt, N. 2012. *SWAT Model Calibration Of Grid-Based Setup*. European Geosciences Union. 32 pp 55-61

Ridwansyah, I., Yulianti, M., Daruati, D. 2010. *Pemodelan Erosi-Sedimentasi Menggunakan GIS di Hulu Waduk Kedungombo*. Prosiding Seminar Nasional Limnologi V

Santhi, C., Arnold, J.G., Williams, J.R., Dugas, W.A., Hauck, L., 2001. *Validation of the SWAT model on a large river basin with point and nonpoint sources*. J. Am. Water Resour. Assoc. 37 (5), 1169–1188.

Suroso, Anwar, M.R., Rahmanto, M.C. 2007. Studi Pengaruh Sedimentasi Kali Brantas Terhadap Kapasitas Dan Usia Rencana Waduk Sutami Malang. *Jurnal Rekayasa Sipil*. Volume 1, No.1 ISSN 1978 – 5658

Van Liew, M.W., Arnold, J.G., Garbrecht, J.D., 2003. *Hydrologic simulation on Agricultural watersheds: choosing between two models*. Trans. ASABE 46 (6), 1539–1551.

Wahyuningrum, N., Sudira, P., Supriyo, H., Sabarnurdin, S. 2014. Perhitungan Nilai Nisbah Hantaran Sedimen Dengan Menggunakan Kurva Sedimen Dan Model Erosi Tanah. *Jurnal AGRITECH,* Vol. 34, No. 2

Williams, J.R. 1975. *Sediment-yield prediction with universal equation using runoff energy factor*. PP 244-252.

Yesuf, H.M., Assen, M., Alamirew, T., Melesse, A.M.. 2015. *Modeling of sediment yield in Maybar gauged watershed using SWAT, northeast Ethiopia*. Elsevier B.V. Catena (127) 191–205.

H.5

COMPETITIVE AND SUSTAINABLE PRODUCTION OF COCOA IN TANGGAMUS, LAMPUNG PROVINCE, INDONESIA

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ABSTRACT

Lampung province is the 7th largest cocoa producers in Indonesia where 18,906 ha of them situated in Tanggamus Regency. This regency was the major producer of both coffee and cocoa. In the last 13 years, the coffee growing area decreased by 11.61% and its production decreased by 24.01%, meanwhile the cocoa growing area and its production increased by 400%. This study was aimed to explore the competitiveness and weakness factors of sustainable cocoa production in Tanggamus. The survey was taken at two sub-district of Tanggamus Regency which purposively sampled based on different land suitability. Field survey, interview, and focused group discussion were conducted in 2016-2017. Feasibility study was done in Bulok Sub-district using a total of 60 family samples.The finding showed that cocoa farming was more competitive than coffee farming for the following reasons: higher price (in 2008-2015 cocoa price was 20.12% higher than coffee price), higher farm income (Rp 12,808,551 compared to Rp 6,583,484) and higher ratio R/C (1.85 compared to 1.48). Beside coffee, cocoa land areas with moderate suitability and good market access could out compete the usage of land for other cash crops including fruits and vegetables that usually having high price. Nonetheless, the sustainability of cocoa production in Tanggamus faced some weaknesses i.e. low availability of high yielding planting materials and that resistant to pest and diseases, high incidence of pest and disease in the field, obstacles of replanting or rejuvenating old and less productive cocoa stands, variability of bean production, and low quality of unfermented bean and improperly drying.

Keywords : cocoa, coffee, competitive, production, sustainable

I. INTRODUCTION

Cocoa is important trade commodity of Indonesia, with export volume of cocoa bean in 2015 of 350,750 ton and value of 1,316 million US$. Lampung province is the 7th largest producers of cocoa in Indonesia, having 73,531 hectares of cocoa plantation, including in Tanggamus Regency with 18,906 ha. Lampung province is also the 2nd largest producers of coffee in Indonesia. Tanggamus has 17,919 ha of smallholder coffee plantation [1]. In Lampung, cocoa plantations were situated in 100-600 m above sea level [2] where coffee also planted.

There were a dynamic of land use in Tanggamus between coffee (as a traditional commodity) and cocoa. In the last 13 years, coffee area decreased by 11.61% and production decreased by 24.01%, meanwhile cocoa area and production increased 400% (Table 1). Some farmers converted coffee plantation to cocoa plantation meanwhile others remained to plant coffee

Expansion of Indonesia cocoa planted area especially smallholder plantation increased significantly since 1987. Due to scarcity of forest area to plant cocoa, cocoa plantations were superimposed or diversified with other industrial crops such as coffee, coconut, rubber, and banana [2]. Among expansive commodities such as cocoa, rubber, and oil palm, some coffee plantations were survive. Plantations dynamic based planting period of replanting and new planting showed competitiveness of cocoa encouraged by the market [5].

Along with the vast development of new cocoa areas, the recent production and productivity of cocoa in Indonesia continues to a significant decline that threaten the sustainability of cocoa production. The decline in the quality and yield were influenced by many factors, among others, the attacks of infectious diseases and pests such as cocoa fruit borer *Conophomorpha cramerella*, plant materials, post-harvest and farming systems [6]. This research aimed to study (1) competitiveness of cocoa farming compare to coffee farming and (2) factors indicating sustainable cocoa production particularly in Tanggamus, Lampung, Indonesia.

Table 1. Planted areal and production of coffee and cocoa in Tanggamus

Year	Coffee		Cocoa	
	Areal (ha)	Production (t)	Areal (ha)	Production (t)
2002	51,814	40,242	3,774	2,079
2006	54,185	45,064	14,017	7,180
2009	54,256	45,342	14,314	7,180
2010	53,706	45,310	15,194	7,195
2012	53,105	44,639	17,081	7,404
2015	45,798	30,578	18,906	10,216

Source: BPS Kabupaten Tanggamus [7]

II. MATERIALS AND METHODS

The site of this survey covered two sub-districts of Tanggamus Regency which purposively sampled representing different land suitability for cocoa and coffee and village development indices. Bulok represented a remote, mountainous, less population sub-district with low village development indices where cocoa plantation is the main farming system followed by coffee plantation. Sumberejo represented a good access, more populated sub-district with high village development indices where cocoa is only secondary crop among many others such as coffee, fruits and vegetables.

Table 2. The characteristics of study site

Characteristics	Bulok	Sumberejo
Land area (km^2)[7]	51.68	56.77
Topography	Sloping (medium gradient mountain)	Sloping (medium gradient hill)
Altitude (m above sea level)	400-500	600-700
Population density (person/km^2)	405.3	576.3
Land suitability for cocoa [8]	S3 – N	S2-S3
Land suitability for coffee	S3 – N	S2-S3
Soil classification [8]	Dystropepts, hapludults	Dystropepts, humitropepts, tropaquepts
Cocoa farming type	Smallholder plantation, cocoa is the main crop	Home-garden, cocoa is secondary crop
Cocoa land area (ha)	0.5-2.0	0.01-1.5

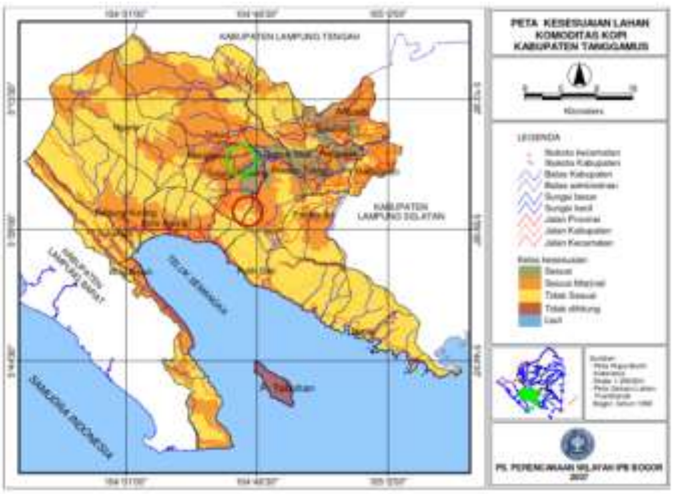

Fig. 1. Map of coffee land suitability in Bulok (red marked) and Sumberejo (green marked)[8]

Land suitability of Bulok is not suitable – marginally suitable for cocoa and coffee. Land suitability of Sumberejo is marginally suitable – moderately suitable for cocoa and coffee (Table 2, Fig. 1-2). Field survey, interview, and focused group discussion (FGD) was conducted in 2016-2017. Feasibility study was conducted in Bulok Sub-district using 60 family samples from 30 of each cocoa and coffee farmers. Data were analysed using financial feasibility analysis and SWOT analysis.

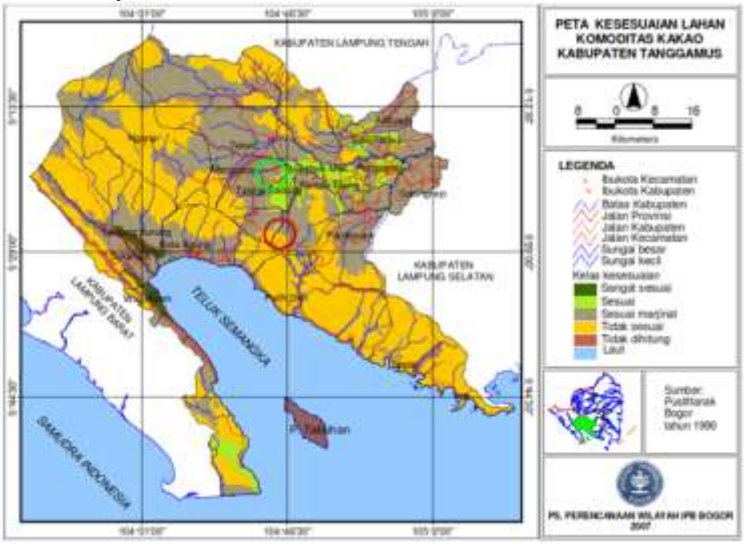

Fig. 2. Map of cocoa land suitability in Bulok (red marked) and Sumberejo (green marked)[8]

III. RESULTS AND DISCUSSION

A. Land Use Shift

Basically coffee plantation of smallholders were the main farming system in Tanggamus including in Bulok and Sumberejo Sub-district. However alternative crops were developed driven by good price and demand. In Bulok Sub-district, some coffee land uses were shifted to cocoa by full conversion (coffee cleared to plant cocoa) or inter-planting coffee with cocoa. If cocoa trees were inter-planted at close spaced (3-4 m), coffee trees were gradually died due to light and nutrient competition with cocoa. In Sumberejo more coffee land uses were shifted to banana or papaya that offer higher income. Cocoa trees were planted at home-garden and at plantation as mixed crops. Farmers prefer to plant coffee inside Sumberejo Sub-district and as well outside sub-district closed to forest area.

Table 3. Land use share in Bulok and Sumberejo

Land use	Bulok (ha)	Sumberejo (ha)
Coffee	2,252	1,647
Cocoa	2,615	148
Black pepper	733	284
Coconut	539	594
Snake fruit	35	400
Mango	286	286
Durian	1,095	823
Banana	1,132	3,880
Papaya	60	3,811
Upland field	1005	1036

B. Cocoa Price

Farmers' decision to plant cocoa were driven by high price and high productivity of cocoa plantation. In average of 2008-2015 cocoa price was 20.12% higher than coffee price (Fig. 3). However, prices were volatile. FGD results noted that in 2017 cocoa and coffee price become closer that farmers remain to plant coffee. Coffee farmers concluded that coffee farming has low risk (price, pest and disease) yet low farming expenses (Table 4). Cocoa farmers noted that beside high price, bean yield may reach 1-2 ton/ha when cocoa plantations were under proper manage (mainly fertilizing, pruning, sanitation) and pods were bearing along the year with enough rainfall. Cocoa trees were prone to long dry season that makes leaves drop followed by high incidence of black pod disease. In contrast, coffee trees were prone to long wet season that makes failure of flowering and fruiting. Coffee flowers and fruits dropped when rainfall was accessed especially at night rainfall. FGD concluded that both coffee and cocoa were prone to extreme rainfall due to climate change.

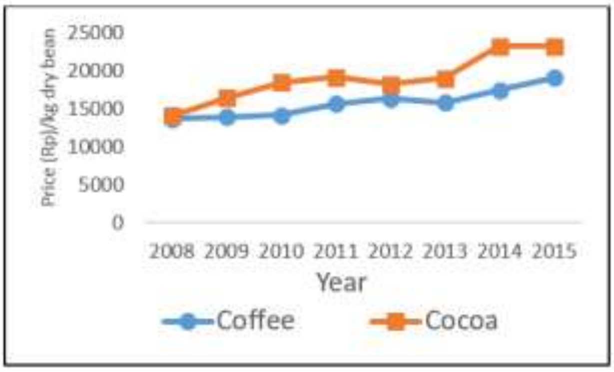

Fig. 3. Dynamic of cocoa and coffee price in 2008-2015 (Source: Directorate General of Estate Crops [1])

Table 4. Reasons of coffee change or not change to cocoa

Satisfaction Factors	Coffee not to change to cocoa (% farmers, n=30)	Coffee change to cocoa (%farmers, n=30)
Coffee farmer		
Farming risk is lower	53.33	
Farming expenses is lower	33.33	
Influence of other farmers	13.33	
Total	100	
Cocoa farmer		
Cocoa has higher price		53.33
Harvesting along the year		33.33
Farming expenses is lower		10.00
Influence of other farmers		3.33
Total		100

C. Farming Income

Structure of cost and income of coffee and cocoa farming showed on Table 5. Cocoa farmers applied more manure, fertilizers (particularly urea and NPK compound), and herbicide than coffee farmers. Fertilizers were applied 2-3 times a year, at early and end of wet season to induce growth (after dry season) and bearing (before dry season). Cocoa plants were managed more intensive in term of manure, chemical, and labour resulted in higher production cost. However, due to higher yield productivity and higher price, cocoa farming generated higher revenue and farm income. In fact cocoa farming offered higher financial feasibility. Some farmers changed their coffee plantation to cocoa plantation hopefully to get higher income.

D. Cocoa replanting

Farmers had changed their plantation to cocoa, but good agriculture practices for cocoa has not adopted yet. About 20% of cocoa trees were in age 15-19 years old that need to be rejuvenated. Moreover about 23% of cocoa trees were more than 20 years old that need to be replanted or rejuvenated. Farmers could manage old coffee tree to be cut, to be replanted or changed to another plant (Fig. 4, coffee tree data of 15-19 years old was drop due to conversion), or to be rejuvenated by clonal grafting. Coffee plantations usually had good performance of pruning and grafting. In other hand farmers let old cocoa tree to grow older and higher with minimal pruning. Not much farmers pruned their cocoa trees and cloned it by side grafting or top grafting.

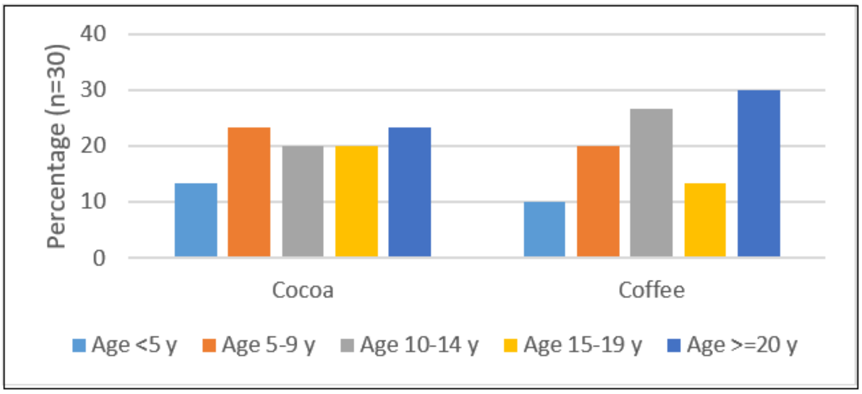

Fig. 4, Age structure of coffee and cocoa plantation

Table 5. Comparing cost and income of coffee and cocoa farming (ha^{-1})

Variables	Coffee		Cocoa	
	No.	Value (Rp)	No.	Value (Rp)
A. Farm expenses				
1. Fertilizer				
Manure (kg)	643	965,000	936	1,403,846
Urea/ZA (kg)	97	242,130	205	507.052
NPK compound (kg)	78	233,333	186	450,000
TSP/SP36 (kg)	122	330,556	103	256,410
2. Pesticide				
Herbicide (l)	5	237,197	9.6	440,346
Fungicide	0	0	0	0
3. Non family labour (cash)	75.4	3,015,604	79.8	3,192,145
4. Harvesting transport		130,119		178,887
5. Hulling		338,304		0
6. Land tax		6,578		6,000
7. Levy		0		35,000
Total (A)		5,498,821		6,469,686
B. Accounted cost				
1. Family labour	16	643,178	49	1,944,701
2. Land rent (ha-1)		2,000,000		2,000,000
3. Depreciation cost		13,825		20,938
Total (B)		2,657,003		3,965,639
C. Production cost (A+B)		8,155,824		10,435,325
D. Dry bean yield (kg)	680		903	
E. Revenue		12,082,305		19,278,237
R/C		1.481		1.847
Farm income (E-A)		6,583,484		12,808,551
Net income (E-C)		3,926,481		8,842,912

Table 6 showed cost of replanting or new planting cocoa and coffee tree per hectare of land area. Cost of planting cocoa in first year was not very much higher than of planting coffee. However cost of cocoa seedlings was more expensive and high yielding planting materials were sometime not available. For smallholders it was a big money to invest in 3-4 years before cocoa plantations generating income. Cocoa farmers land tenure were small, only less than 2 hectares. Farmers tended to delay replanting old cocoa plantation. Without rejuvenation, old cocoa trees (> 20 years old) produced low yield. Moreover, as cocoa trees become older, labour inputs for pruning, shade management, and pest and disease control begin to decline to very low levels as reported by Curry *et al.* [9].

Table 6. Replanting/new planting cost of coffee and cocoa plantation (ha^{-1})

Cost variables	Unit	Coffee		Cocoa	
		No.	Value (Rp)	No.	Value (Rp)
1. Land clearing	Man day				
Felling		25	1,250,000	20	1,000,000
Cutting and stacking		6	300,000	7	350,000
2. Tillage	Man day				
Hoeing 1		12	600,000	14	700,000
Hoeing 2		10	500,000	10	500,000
3. Seedling	polybag	2,650	2,650,000	1,165	4,660,000
4. Planting					
Manure	ton	4	1,200,000	2	600,000
Holing and planting	Man day	10	500,000	5	250,000
5. Maintenance					
Hand weeding (3x)	Man day	36	1,800,000	36	1,800,000
Herbicide(1x)	litter	3	300,000	3	300,000
Herbicide spraying	Man day	1	50,000	1	50,000
Fertilizer Urea, Phonska (3x)	kg	200	500,000	200	500,000
Fertilizer application	Man day	12	600,000	9	450,000
Total cost			6,903,350		7,463,700

E. Cocoa Multiple Cropping

Fig. 5 showed cocoa and coffee farmers land tenure. Having small scale cocoa plantation usually less than 2 hectare, 100% of sampling farmers practiced mixed planting. It was the way to manage the risk and to increase farm income. The risk of cocoa farming were including price fluctuation and yield drop due to pests, diseases, and long dry season.

Smallholder cocoa plantations were characterized by intercropping cocoa with variety of plants and shading trees. It makes smallholder cocoa plantations usually had high biodiversity [2]. When farmers wish to diversify their sources of income and maximize their land use they can intercrop their cocoa land in spite of monoculture plantation. Snoeck [10] reported that intercropping rubber-cocoa and was significantly more profitable than other associations with rubber tree until the 12th year.

We could found varieties of plant associated with cocoa trees in smallholder plantation including fruits, spices, and others. Banana, durian, and black pepper were the most commonly planted with cocoa in the area. Bananas had been planted since the establishment of cocoa plantation, functioning as shading plants and also as income generating. As cocoa trees canopy closed, banana partly eradicated and some clump were left. Banana clumps were thinned to leave a single tree and single ratoon tree.

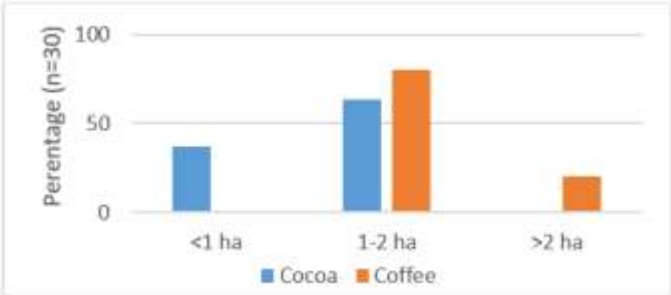

Fig. 5. Cocoa and coffee farmers land tenure

Intercropping cocoa with banana significantly increased the yield of cocoa due structure effect of cocoa – banana [11]. In a degraded cocoa plantation with a long history of intensive fertilization, inter-planting with banana and shade trees had positive effects on cocoa yield probably linked with the creation of an environment that improves cocoa crop physiology and reduces pressure of pests and diseases [12]. Shading also beneficial as an adaptation measure for cocoa plantation to climate change [13].

Table 7. Farming income from multiple cropping

Variables	Coffee multiple cropping	Cocoa multiple cropping
Intercrops (frequency, n=30)	Banana (23), Durio (16), black pepper (19), *Parkia speciosa* (14), coconut (3)	Banana (17), Durio (11), black pepper (10), *Parkia speciosa* (7), clove (3), *Lansium domesticum* (2), long pepper (1), coconut (1), mangosteen (1)
Revenue (Rp)	6,320,611	4,475,790
Farm expenses (Rp)	560,541	504,910
Farm income (Rp)	5,760,070	3,970,880
Farm income percentage to cocoa (%)	87.5	31.0

Black pepper was commonly intercropped with cocoa at the middle of the cocoa rows using Gliricidia sepium as standard. Durian trees were planted commonly at the border of the land. The multiple crops in cocoa farming generated income of 31% to income from cocoa bean. The multiple crops in coffee farming could generated higher income (Table 7), especially for coffee – black pepper multiple cropping due to high price of black pepper. Gross [14] concluded that diversification of crops is an important strategy allowing cocoa and coffee farmers to reduce their exposure to climate and other risks. This measure would not be difficult to implement, as it could be based on a return to more traditional, diverse farming methods that were common before intensification and monoculture were adopted. Jagoret *et al.* [15] reported that input-intensive system (based on the monoculture of selected hybrids) to increase cocoa production has reached its limitation including agronomic, socio-economic and environmental. In poly-culture cocoa plantation where cocoa trees were planted with others association trees, yield might reach 1,100 kg of cocoa per hectare and cocoa trees had longer lifespan.

F. Sustainable Cocoa Production

About 53% of cocoa farmer sample was above 40 years old (Fig. 6). It was better than those of coffee farmers that 100% was above 40 years old. It seemed that being a farmer of cocoa or coffee plantation was not attractive for youth. During FGD no youth really willing to be cocoa farmers. They preferred to go to city and work as factory labour. If they failed living in the city, they might back home and work as a farmer, replacing their father take care of cocoa orchard.

Table 8 showed SWOT analysis for sustainable production in the studied area. The strengths were mainly related to competitiveness of cocoa compare to coffee which is the main plantation in Tanggamus. Cocoa trees might be grown at marginal land suitability in a broad farming system including monoculture and poly-culture plantation and home garden. Cocoa productivity and price might be higher that generated higher farm income. It might drive land use shift from coffee to cocoa plantation. However, during FGD we found some weakness for sustainable cocoa production. Whenever price of other competitor commodity was rise (for example black pepper price increased in 2015-2016 and coffee price increasing in 2017), farmers would convert cocoa planted area to other crops. In India region, strengths and weakness for sustainable cocoa supply have been reported by Beg et al [16].

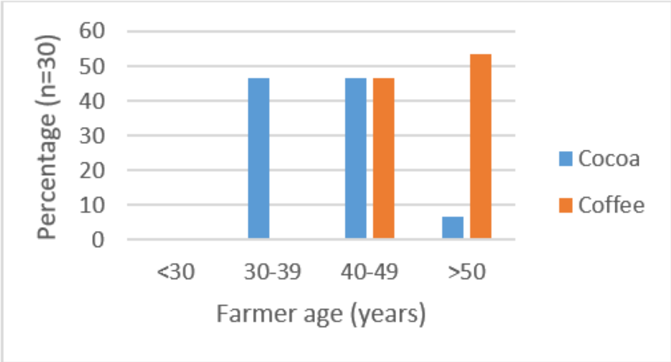

Fig. 6. Percent age distribution among cocoa and coffee farmer

High yielding cocoa planting materials were available mostly for every farmer groups. However local varieties and clones were commonly planted because its seedling price was lower. Farmers had experience that selected local variety could produce high yield. Unfortunately, unlike in coffee farming, pruning, grafting, rejuvenating, replanting were not commonly practiced yet in cocoa farming. Farmers produced unfermented cocoa bean with high water content. In rainy season, sun-drying take longer time to meet standard water content of dry bean unless cocoa bean became mouldy and black.

Table 8. SWOT for sustainable cocoa production

Production sustainability	Indicators	Factors
Strength	Agronomy & economy	Planted as home garden, plantation, or mixed cropping, adaptive to marginal suitability, fruiting along the year, simple post-harvesting, higher productivity, price, and farm income (compared to coffee)
	Environment	High trees coverage and tree biodiversity, minimum chemical applied
	Social	High farmer satisfaction of cocoa farming, easy to manage, easy to sell
Weakness	Agronomy & economy	Planting local and low yield clones, less pruning, less farm sanitation, high incidence of pests and diseases, less rejuvenation/ rehabilitation/re-planting, fluctuating yield 400-900 kg/ha, low quality cocoa bean (non-fermented, not proper sun drying), small scale smallholder plantations made less efficient handling and processing, pod peal waste was still rarely used for goat feeding.
	Environment	Commonly planted at marginal land suitability, applied intensive fertilizer and herbicide, terracing was not commonly built, farmers prefer to burn litter ground cover to prevent outbreak of black pod disease
	Social	Small land tenure, living in less developed village, age of more 40 years old, not much youth eager to be cocoa farmer
Opportunities		There are programs of sustainable cocoa initiatives, programs of society forest, adoption of new varieties and clones with high yield, pests and diseases resistance, price incentives for fermented and high quality bean, price incentive for organic cocoa, processing to other cocoa product, processing and marketing organized by cooperatives, empowering and investing in small holder cocoa farming
Threats		Fluctuating and decreasing cocoa price, climatic condition due to climate change, land use shifting to other competitive plants, long chain of marketing

IV. CONCLUSION

In Tanggamus Lampung Province cocoa farming was more competitive than coffee farming for the following reasons: (1) higher price (in 2008-2015 cocoa price was 20.12% higher than coffee price), (2) higher farm income (Rp 12,808,551 compared to Rp 6,583,484) and (3) higher ratio R/C (1.85 compared to 1.48). Beside coffee, cocoa land areas with moderate suitability and good market access could out compete the usage of land for other cash crops including fruits and vegetables that usually having high price. The sustainability of cocoa production in Tanggamus faced some weaknesses i.e: (1) low availability of high yielding planting materials and that resistant to pest and diseases, high incidence of pest and disease in the field, (2) obstacles of replanting or rejuvenating old and less productive cocoa stands, (3) variability of bean production due to climatic situation, (4) producing low quality cocoa bean including no fermentation, mouldy bean and high water content, (5) small scale smallholder plantations made less efficient handling and processing, (6) youth generation had little interested in cocoa farming.

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REFERENCES

[1] Directorate General of Estate Crops. Tree Crop Estate Statistics of Indonesia 2014-2016 Cocoa. Ministry of Agriculture. Jakarta. 2016.

[2] R. Evizal, Sumaryo, N. Sa'diyah, J. Prasetyo, F.E. Prasmatiwi, I. Nurmayasari. Farm performance and problem area of cocoa plantation in Lampung Province, Indonesia. Conference Proceeding the USR International Seminar on Food Security. p. 193-205. 2016.

[3] M. Wessel and P.M.F. Quist-Wessel. Cocoa production in West Africa, a review and analysis of recent development. NJAS-Wageningen Journal of Life Science 74-75: 1-7. 2015.

[4] E.A. Ellis, K.A. Baerenklau, R. Marcos-Martinez, E. Chavez. Land use/land cover change dynamics and drivers in a low-grade marginal coffee growing region of Veracruz, Mexico. Agroforest Syst 80:61-84. 2010.

[5] F. Ruf. Diversification of cocoa farms in Cote d'Ivore: Complementary of and competition from rubber rent. In: F. Ruf and G. Schroth (eds). Economics and Ecology of Diversification. DOI 10.1007/978-94-017-7294-5_2. 2015.

[6] Rubiyo and Siswanto. Peningkatan produksi dan pengembangan kakao (Theobroma cacao L.) di Indonesia. Buletin RISTRI 3(1): 33-48. 2012.

[7] BPS KabupatenTanggamus. Tanggamus Dalam Angka. Kota Agung. 2016.

[8] PS Perencanaan Wilayah IPB Bogor. Peta Kesesuaian Lahan Komoditas Kopi dan Kakao Kabupaten Tanggamus. Bogor. 2007.

[9] G.N. Curry, G. Koczberski, J. Lummani, R. Nailina, E. Peter, G. McNally, O. Kuaimba. A bridge too far? The influence of socio-cultural values on the adaptation responses of smallholders to a devastating pest outbreak in cocoa. Global Environmental Change 35:1-11. 2015.

[10] D. Snoeck, R. Lacote, J. Keli, A. Doumbia, T. Chapuset, P. Jagoret, E. Gohet. 2013. Association of hevea with other tree crops can be more profitable than hevea monocrop during first 12 years. Industrial Crops and Products 43: 578-586. 2013.

[11] O. Deheuvels, J. Avelino, E. Somarriba. Vegetation structure and productivity in cocoa-based agroforestry systems in Talamanca, Costa Rica. Agriculture, Ecosystems and Environment 149: 181-188. 2012.

[12] W. Vanhove, N. Vanhoudt, P. van Damme. Effect of shade tree planting and soil management on rehabilitation success of a 22-year-old degraded cocoa (*Theobroma cacao* L.) plantation. Agriculture, Ecosystems and Environment 219: 14-25. 2016.

[13] G. Schroth, P. Laderach, A.I. Martinez-Valle, C. Bunn, L. Jassogne. Vulnerability to climate change of cocoa in West Africa: Patterns, opportunities and limits to adaptation. Science of the Total Environment 556: 231-241. 2016.

[14] M. Gross. Coffee and chocolate in danger. Currant Biology 24(11): 503-506. 2014.

[15] P. Jagoret, O. Deheuvels, and P. Bastide. Sustainable cocoa production learning from agroforestry. Perspective Ecological Intensification (27): 1-4. 2014.

[16] M.S. Beg, A. Ahmad, K. Jan, K. Bashir. Status, supply chain and processing of cocoa - A review. Trends in Food Science and Technology 66: 108-116. 2017

H.6

FARMER'S UNDERSTANDING ON ECOFRIENDLY FARMING SYSTEM (CASE STUDY ON VEGETABLE'S FARMER IN SUKAMANAH VILLAGE, SUBDISTRICT OF PANGALENGAN, DISTRICT OF BANDUNG, WEST JAVA)

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ABSTRACT

The application of green revolution technologies in farming systems that rely on the use of inorganic fertilizers and synthetic pesticides intensively have resulted in severe damage to the environment. To overcome the negative impact, agricultural experts has developed a sustainable agriculture system that emphasizes the use of natural resources. The main key success of the agriculture sustainable implementation is farmer's understanding of ecofrienldy farming system comprehensively. This research was to know the farmer's understanding of ecofriendly farming that was done in two models of vegetable culture, according to the farmer perception, i.e ecofriendly farming and conventional farming (green revolution) system. Based on the case study of vegetable farmers in Sukamanah Village Subdistrict of Pengalengan, Bandung West Java, we concluded that the vegetable farmers, had still not yet understood the ecofrienldy farming comprehensively. The provent of this evident found that the implementation of vegetable production technology is relatively the same. In general, difference in the vegetable cultivation technology is applied only on the use of organic fertilizers and pesticides. In the farming system, organic fertilizers used were double compared to the conventional farming systems (4-5 tons ha^{-1}), while the use of inorganic fertilizers was not difference. Pesticides application in ecofriendly farming systems on potato was 8 times (without herbicide) compared to 12 times in conventional farming systems (with herbicide). Pesticides application on cabbage and lettuce in ecofriendly farming systems was 4 times times (without herbicide), while in conventional farming was 5 times (with herbicide).

Keywords : farmer's understanding, coventional farming, ecofriendly farming system

I. INTRODUCTION

West Java Povince is one of vegetable production center in Indonesia. One of the vegetable production centers in West Java is Pangalengan Subdistrict District of Bandung. Some commodities that farmers cultivated in Pangalengan were potato, green beans, cabbage, spinach, onion, carrot, beans, squash, turnips, and cauliflower (Dinas Pertanian Tanaman Pangan Provinsi Jawa Barat, 2014). From several types of vegetable crops, potatoes are dominant commodities in Pangalengan area (Kiloes et al., 2015).

According to data of Dinas Pertanian Tanaman Pangan Provinsi Jawa Barat (2013), the averages productivity of vegetable crops during 2009 – 2013 are potato 20.23 t/ha, cabbage 23.24 t/ha, mustard greens 20.51 tons/ha, and carrots 22.24 t/ha. Although the vegetables productivities are higher than national productivities, but if those are compared to the potential productivity of each commodity, i.e. potato 38-50 t/ha, mustard 26 tons/ha cabbage 42.5 t/ha and carrots 20-25 t/ha the level of productivity is still low.

One of causal factors thst has caused less vegetable productivity is pest and diseases attack. The pests attack on crops has impacted on yield loss that reaches 30% per annum (Ghosh et al., 2010), while pathogens give impact yield loss of about 16% - 18% per year (Oerke, 2006; Woodward, 2012). In cabbage and tomato crops, the loses due to pests and pathogens reach 50% - 80% (Tolman et al., 2004). In Pangalengan, pests and pathogens impact reach 50.88%, and the probability of crop failure in the fifth growing season increase double (Ameriana, 2008).

Significant yield loss caused by various diseases and insects is a great concern in vegetable production. Spraying pesticides is a highly common behavior of vegetable farmers.

Misuse and overuse of pesticides are harmful to the health of farmers as well as the environment. The high pesticide residue concentrations found on vegetables are harmful to consumers. Because fruits and vegetables are often traded and consumed in fresh forms, biological contamination and pesticide residue are serious issues (Patel et al., 2013).

An increase in resistance of insect pests to chemical pesticides has also been noticed. Health hazards associated with intensive modern agriculture, such as pesticides residues in food products and groundwater contamination are matter of concern. In chemical faming a specific insecticides may be applied to quickly kill off a particular insect pest but his encourages rapid natural selection of resistant insects, plants and other organisms, necessitating increased use or more powerful control measures. With increase in cost of production inputs, inorganic fertilizers became increasingly more expensive. Another issue of great concern was the sustainability of soil productivity as land began to be intensively tilled to produce higher yields under multiple and intensive cropping systems (Dubey and Shukla, 2014).

II. MATERIALS AND METHODS

Research was conducted in the Village of Sukamanah, Subdistrict of Pangalengan, Bandung Regency with altitude of place ± 1200 asl. Place used for research that consists of 2 locations that apply conventional farming systems and 2 locations that apply eco-friendly farming system. The average area of land used in this study is ± 760 m^2, the land area is in accordance with the ownership of farmers. Interviews were conducted on landowner farmers to get data specifically about farmer habits on the input used. The interviews were conducted on farmers who adopted conventional and environmentally friendly farming systems

III. RESULTS AND DISCUSSION

Conventional farming is an agricultural system that has been applied by farmers of respondents since 20 years ago. Cultivation of vegetables with conventional farming systems, is believed to keep the level of plant productivity remains high. The belief is primarily on the outside inputs used during the cultivation period. Utilization of synthetic pesticides and synthetic fertilizers, has psychologically influenced farmers' optimism in the implementation of crop cultivation. According to respondent farmers, the use of scheduled fertilizers and pesticides can keep the plants in good condition to make the production process and minimize the level of pest attack.

An alternative cultivation technology used by farmers in Pangalengan is environmentally friendly farming system. Eco-friendly farming system is an agricultural system that is considered capable of maintaining environmental stability. This farming system began to be applied to farmers of respondents about 5 years ago on vegetable crops. The reason for implementing this farming system is more based on the improvement of soil properties. The effort in improving the soil properties is to provide more organic matter and useful micro-organism applications.

In general, the implementation of conventional farming systems and eco-frienly farming systems by farmers in Sukamanah Village, have the characteristics as follows in Table 1.

Conventional farming systems implemented in Pangalengan show that, very intensive external inputs are used in vegetables. The external inputs commonly used are synthetic chemicals pestiside (especially insecticide and fungicide). In accordance with the general principle of cultivation of conventional agricultural systems described by Theocharopoulos *et al.* (2012), the use of external input is done intensively to support nutrient needs.

Based on Tabel 1, we notify that vegetable farmer's have not been yet implemented the ecofriendly farming system comprehensively. There are not reduce the of external input used among the systems. Dose of Urea and NPK used are still same between conventional farming system and ecofriendly farming system. The used of pesticide in potato convensional farming system is very high which is about 16 times/planting season and in ecofriendly farming system is high enough, 8 (eigh) time/planting season (Table 2). According to Sastrosiswojo et al. (2005), differences in methods on eco-friendly farming systems are mainly in the control of pests and diseases. Pest and disease controls are more emphasized on the utilization of natural enemies (predators and parasitoids), biological agents (antagonistic microbes), vegetable pesticides, intercropping, trap crops, overlapping and reducing pesticide used to the maximum, the farmer never used the natural enemy or biopesticide.

In an environmentally friendly farming system implemented by vegetable farmers is still not comprensive. The use of external inputs on plants tends to be high, both the use of synthetic pesticides and synthetic fertilizers. According to Beus & Bailey (1990), on eco-friendly farming systems, the use of synthetic fertilizers and pesticides should be maximally reduced. Farmers in Pangalengan newly applied the second technical are the utilization of natural resources, including the utilization of organic materials and the use of microoganism.

Over the past year, farmers have used variety of synthetic pesticides to protect their crops, about 10 pesticides, comprised of 1 herbicide and 4 insecticides and 5 fungicides used to control weeds, pests, and pathogens in potato plants, cabbage, and petsai or mustard which often attack at every season. Utilization of synthetic pesticides on other commodity (cabbage and mustard) is ranging for 3-5 kinds. Common fungicides used to control of pathogens in potato plants uses are Mancozeb 80.3%, chlorothalonil 82.5%, simoxanoyl 10%; and copper dihydroxide 10%,, in cabbage and mustard plants are Mancozeb 80,3%, propineb 77% and azoksistrobin. 25%. Insecticides commonly applied to potato plants are profenofos 50% and whereas in cabbage plants only use deltamethrin insecticide. Concentration of formulations commonly used is by mixing several types of pesticides into 200 liters of water. The application technique of pesticide choosed by farmer is spraying techniques, using semi-aoutomatic sprayer with a tank size of about 14 liters or motorized sprayer.

Among the various pesticides used, Mancozeb fungicides have the highest level used, comparing with conventional farming systems or eco-friendly farming systems. Mancozeb used farmers to control the pathogenic fungi in some plant commodities. The high use of Mancozeb in various varieties of plants, is because the fungicide is able to control some types of pathogen fungi (broad spectrum) (EFSA, 2010). The differences in the use of Mancozeb between conventional and environmentally friendly farming systems can be seen in application dose formulations and application frequency.

Tabel 1. The implementation of convensional farming system and eco-friendly farming system in Sukamanan Village Subdistrik Pangalengan

Parameters	convensional farming system	eco-frienly farming systems
Soil prepation	Weed cleaning : herbicide used The soil is eased with hoe and made bunds The bunds are covered with black-silver plastic mulch Application of manure (dirt Chicken) 8 -10 tons / ha	Weed cleangin : mechanics metods/hands weeding The soil is eased with hoe and made bunds The bunds are covered with black-silver plastic mulch Application of manure (dirt Chicken) 8 -10 tons / ha Application Effective Organism (EM4)
Plant manage	Cultivated commodities: Potatoes, cabbage, and mustard greens Planting system : Monoculture planting system ie: planting one type of plant in each growing season Spacing planting: - Potato 70 cm x 30 cm - Cabbage 60 x 40 cm, - Sawi 20 x 20 cm.	Cultivated commodities: Potatoes, cabbage, and mustard greens Palnting system : Monoculture planting system ie: planting one type of plant In each growing season Spacing planting: - Potato 70 cm x 30 cm - Cabbage 60 x 40 cm, - Sawi 20 x 20 cm.
Fertilizer	Chicken manure : 4-5 t/ha (one week before planting) Urea : 200 kg/ha NPK Phonska : 100 kg/ha Dose of apllication of Urea and NPK : First application (basic fertilizer): 70-80% Urea and 20-30% NPK Second fertilization : 20-30% Yrea and 70-80% NPK Fertilizer application techniques: Chicken manure : it's sown to planting hole (burrow) Urea and NPK : pouring of liquid (fertilizr mixwd with water) on every planting hole Application time Basic fertilizer : Before closing with black-silver plastic mulch Second fertilizer : 35-40 days after planting (dap) e : 25-30 dap ustard) : 14-20 dap	Chicken manure : 4-5 t/ha (one week before planting) Urea : 200 kg/ha NPK Phonska : 100 kg/ha Dose of apllication of Urea and NPK : First application (basic fertilizer): 70-80% Urea and 20-30% NPK Second fertilization : 20-30% Yrea and 70-80% NPK Fertilizer application techniques: Chicken manure : it's sown to planting hole (burrow) Urea and NPK : pouring of liquid (fertilizr mixwd with water) on every planting hole Application time Basic fertilizer : Before closing with black-silver plastic mulch Second fertilizer : 35-40 days after planting (dap) e : 25-30 dap Sawi (Mustard) : 14-20 dap
Pesticide	Pesticide are applied on regular time schedule (2 times/week), though no attack pest and diseases on plant	Pesticide are applied on basd monitoring result. Pesticide are applied if pest and/or diseases attack are detected on plant
Water rosourch	Source of water : embung or water well Giving method : sprinkling Sprinkling time : every days	Source of water : embung or water well Giving method : sprinkling Sprinkling time : every days

Table 2. The used of pesticide/season in conventioan and eco-friendly farming system in Sukamanah Village subdistrict of Pangalengan

Farming System	Como-dity	Pesticide: Active ingredient	Pesticide: Concentrastion of Formulation	Dose of solution volume in litre (frecuency applictation/week x dose of application): 1	2	3	4	5	6	7	8	9	10	11	12	13	Frequency of application
Conventioan farming system	Potato	Mancozeb	500 g/200 L			2 x 400	2 x 600	2 x 600	2 x 600	1 x 800	2 x 800	1 x 800	1 x 800	1 x 800	1 x 800	1 x 600	16 time
		Simoksanil	250 g/200 L														
		Chlorothalonil	250 g/200 L														
		Profenophos	250 ml/200 L														
		CuH2O2	100 g/200 L														
	Cabbage	Mancozeb	500 g/200 L			1 x 200		1 x 300		1 x 300		1 x 400		1 x 400			6 time
		Deltamethrin	250 ml/200 L	1 x 100													
		Propineb	500 g/200 L														
		Azoksistrobin	40 ml/200 L														
	Green Mustard	Mancozeb	500 g/200 L			1 x 200		1 x 300									3 time
		Deltamethrin	250 ml/200 L	1 x 100													
		Propineb	500 g/200 L														
		Azoksistrobin	40 ml/200 L														
Ecofriendly farming system	Potato	Mancozeb	500 g/200 L			1 x 400	1 x 600	1 x 600	2 x 600	1 x 800	2 x 800	1 x 800	1 x 800	1 x 600	1 x 600	1 x 600	14 time
		Simoksanil	250 g/200 L														
		Chlorothalonil	250 b/200 L														
		Profenovos	250 ml/200 L														
	Cabbage	Mancozeb	500 g/200 L			1 x 200		1 x 200		1 x 300		1 x 400		1 x 400			6 time
		Deltamethrin	250 ml/200 L	1 x 100													
		Chlorothalonil	500 g/200 L														
		Azoksistrobin	40 ml/200 L														
	Green Mustard	Mancozeb	500 g/200 L			1 x 200		1 x 200	1 x 300								4 time application

As show in Table 2, during one growing season, the frequency of mancozeb application on conventional farming systems for potato is very high, i.e. 16 times, beside on cabbage and mustard plant are 6 and 3 times application respectively. Total dosage of formulation of mancozeb in potato plants can reach 24 kg/ha/platning season, in cabbage 4 kg/ha/planting season and in mustard plants of about 1,5 kg/ha/planting season. In eco-friendly farming systems the frequency of Mancozeb applications tends to equal with conventional farming systems. The application of mancozeb in potato, cabbage and mustard were 14 times, 6 times and 3 times application respectively. Total dosage formulation in potato plants can reach 21.5 kg/ha/planting season, on cabbage plants reach 3,75 kg/ha/planting season and in mustard 1,75 kg/ha/planting season. In every application of Mancozeb and in each plant commodity, farmers use the same concentration formulation as much as 2.5 g /l Mancozeb fungicide. Total for one year, soil must accept mancozeb between 27 kg/ha in ecofriendly farming system or 29.5 kg/ha in conventional farming system.

IV. CONCLUSION

Based on the reseach results we concluded that there are no signficant differences between the implementation on conventional farming system with ecofriendly farming system which is aplied by vegetable farmers in Sukamanah Village Subdistrict of Pangalengan Distric of Bandung. There are only a little difference among them, i.e. in the use of herbicide in conventional farming system and the use of EM4 and increasing the chicken manure. The dose of chicken manure in ecofriendly farming system was 2 fold than conventional farming system.

REFERENCES

Ameriana, M. 2008. Perilaku petani sayuran dalam menggunakan pestisida kimia. J. Hort. 18 (1): 95 - 106.

Beus, C. E and Riley E. D. 1990. Conventional versus alternative agriculture: the paradigm roots of debate. Rural Sociology 55 (1): 590 - 616.

Dinas Pertanian Tanaman Pangan Provinsi Jawa Barat. 2014. Sentra Produksi Komoditas Unggulan Jawa Barat dan Unggulan Nasional.

Dubey, R. Kr. and N. Sukhla. 2014. Organic Farming: An Eco-Friendly Technology and Its Importance And Opportunities in the Sustainable Development. International Journal of Innovative Research in Science, Engineering and Technology Vol.3 , Issue 3, March2014. 10726-10734.

EFSA. 2010. Reasoned Opinion Modification Of The Existing Mrls For Mancozeb In Fresh Peas (Without Pods). EFSA Journal 2010; 8 (1): 1451

Ghosh, P. G., Sawant N. A., Patil S. N., and Aglave B. A., 2010. Microbial biodegradation of organophosphate pesticides. International Journal of Biotechnology and Biochemistry

Kiloes, A. M., Sayekti A. L., dan Anwarudin S. M. J. 2015. Evaluasi Daya Saing Komoditas Kentang di Sentra Produksi Pangalengan Kabupaten Bandung (*Potato Competitiveness Evaluation in Production Center of Pangalengan, Bandung Regency*). J. Hort. 25 (1):88-96

Oerke, E. C., 2006. Crop losses to pests. Cambridge Journal internet site and The Journal of Agricultural Science. 144 (1): 31 - 43.

Patel, Ms. N. , S. Choudhary, and V. K. Swarnakar. 2013. Study on Adoption of Eco-Friendly Management Practices by Vegetable Growers in Indore Block of Indore District (M.P.) IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) Volume 2, Issue 4 (Mar. - Apr. 2013), PP 22-25

Sastrosiswojo, S., Tinny S. U., dan Rachmat S. 2005. Penerapan teknologi PHT pada tanaman kubis. Balai penelitian tanaman sayuran. Bandung

Tolman, J. H., D. G. R. McLeod, and C. R. Harris. 2004. Cost of crop losses in processing tomato and cabbage in southwestern Ontario due to insects, weeds and/or diseases. Canadian Journal Plant Science 84 (3): 915 - 921

Tripp, B. 2006. Is low external input technology contributing to sustainable agricultural development? Natural Resource Perspectives 102. November 2006.

Woodward, J. W. 2012. 2010 Georgia plant disease loss estimates. UGA Cooperative Extension Annual Publication 102 – 3.

H.7

ENGAGING FARMERS' COMMUNITY IN CLIMATE CHANGE RESPONSE AND ADAPTATION PLANS: CASE STUDY SEDAYU, TANGGAMUS REGENCY, LAMPUNG PROVINCE, INDONESIA

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ABSTRACT

Farmers as the producers of food are one of vulnerable community related to climate change. Therefore assessing climate change impact on farmers' community is necessary not only for their living but also for our food security. However, effective responses to climate change require at least community support and, ideally, genuine community participation. Sedayu is a village (450-550 m asl) with normal rainfall about 2500 mm/year and more than 30% has land slope about 8%; Sedayu had a possible risk of flash flood. Efforts to apply climate change adaptation are needed since 76.25 % of the population is farmers with paddy, cocoa and coffee as their main products. Decreasing disaster risk effectively and planning for handling emergency situation was started with analyzing the community condition physically and socially. The community participated with giving information and data needed. Through some trainings and using tools they were able to discuss and analyze the data and eventually formed the *Local Resilience Action Plan* (LRAP) which will be part of Regency Medium Term Development Plan. This paper reported the analysis of the village condition related to the possibility of disaster risk caused by climate and the action plan as an effort to climate change adaptation.

Keywords: Climate change, farmers, adaptation, disaster, action plan.

I. INTRODUCTION

Climate Change is defined as statistically significant variation in either mean state of the climate or in its variability, persisting for an extended period, typically decades or longer [1]. Rising fossil fuel burning and land use changes have emitted, and are continuing to emit, increasing quantities of greenhouse gases into the Earth's atmosphere. These greenhouse gases include carbon dioxide (CO_2), methane (CH_4) and nitrogen dioxide (N_2O), and a rise in these gases has caused a rise in the amount of heat from the sun withheld in the Earth's atmosphere, heat that would normally be radiated back into space. This increase in heat has led to the greenhouse effect, resulting in climate change and are expected to affect many aspects of human activities including tropical cyclones (hurricanes and typhoons), floods, droughts and heavy precipitation events ([2], [3]).

Climate change could severely exacerbate the impact of natural hazards, disaster and extreme weather and will have wide-ranging effects on the environment, and on socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems and biodiversity and coastal zones. Therefore, effective responses to climate change require at least community support and, ideally, genuine community participation.

There are some concepts in qualifying communities response to climate change: risk, vulnerability, adaptation and resilliance. Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change. Adaptation is initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change [7]. In other words, adaptation is a process through which societies make themselves better able to cope with an uncertain future. Therefore, safety and resilience can be addressed most effectively by building communities' capacities to reduce their vulnerabilities to hazards, recognizing that risk is ultimately driven by the combination of the hazard environment and vulnerabilities to those hazards. Without addressing the vulnerability side of the equation, community exposure to natural hazards cannot be reduced in a sustainable way that contributes to resilience [5].

Engaging communities in dealing with climate change had been conducted in some countries. In Australia, 85% of its population lives in coastal regions; Besides common impacts of climate change, coastal communities face the additional threat of rising sea levels. Therefore, they need to plan ahead to adapt to these changes.

In North East Victoria, Australia three acitivities were conducted for activating communities involvement: workshops for the seniors in community, leadership trainings for the existing grassroot community groups and mobile outreach using fun activities for public [4]. In Batticaloa city, Eastern coast of Sri Lanka, the community was involved using participatory approach in developing coastal greenbelts, to prevent coastal erosion, and mitigate the adverse impacts of natural coastal hazards on human lives and property [7]. Over the last few years, unusual and erratic climate conditions have had a detrimental effect across global coffee producing belts leading to considerable economic losses in many countries. In Uganda, Farmers formed various type of asscociations that could support access to other service providers and networks, thereby developing vertical social capital and enhancing the adaptive capacity of smallholder farmers [6].

Sedayu is a village in mountainous area of Tanggamus District in Lampung Province. Located close to Semaka Bay and Bukit Barisan National Park makes this area vulnerable to flash flood, landslide but also drought. To prevent from potential disasters in the future.

Sedayu needs better integrated and coordinated plans. The plans would be one part of disasters resilliance which composed from identification of potential disasters, disasters risk analysis and finally, actions and activities focus programs. Sedayu residence and local communities and government were involved in all of those processes and steps. The processes and results were documented in what we callled Local Resilience Action Plan (LRAP). LRAP was a proposal in community level contained efforts deals with adaptation to climate change and disasters reduction and resilliances. The LRAP was a tool for building synergic communications among the local residences, local government, academic institutions, NGO and others. In other words, LRAP was the result of Participatory Action research (PAR).

PAR is a reflective process of progressive problem-solving led by individuals working with others to improve the way they address issues and solve problems. PAR is generally applied within social learning contexts, where multiple actors collectively construct meanings (problem definition, objectives) and work collectively toward solutions [10].

This research paper explains such methodology in composing the LRAP and the action plans following the LRAP as one example in engaging farmers community to adapt and response to possible disasters related to climate change.

The purpose of composing the LRAP were: increasing community understanding related to climate change, the impacts and how we responds to it; arranged participation action plans to cope with climate change impacts and improving community resillience, to integrate the climate change action plan with local government development program, to guide the community leaders in running programs related to climate change.

II. MATERIALS AND METHODS

A. Climate data analysis to identify climate change

Rainfall and air temperature trends were analysed in simple ways by arranging the data from 1976-2005 (30 years). By averaging the data series, normal value of the rainfall could be counted. The data series divided by 5 years period each and compared to the normal value to get descriptions of possible shifting and changing in rainfal patterns over the 30 years period. Rainfal data series was also arranged from the lowest to the highest and divided into certain ranges to calculate rainfall frequencies.

B. Composing LRAP

1. Organizing Processes

Composing LRAP document started with forming the organization, set up the community commitments and trust; formed the working group in community level including stakeholders representatives, local government agencies, and community leaders. The working groups arranged and formulated what action plans would be excecuted to get data and information related to adaptation and reducing disasters risks. They also explored all stakeholders in order to structure them in their groups.

2. *Evaluation of community vulnerability and capacity*

For completing the materilas for the LRAP data and information was collectef about Sedayu condition and characteristics. Data could be collected from secondary sources (literatures, documents) or primary sources (observations, interviews). In this steps a training was conducted to introduce supporting tools to evaluate the community vulnerabilities and capacities.

The supporting tools were: hazzard mapping, historical hazzards analysis and season calendar. Hazzard mapping was done for identifying areas that had riks like flood, landslides, sea level rising, erosion, abrasion, drought, storms and endemic diseases. Historical hazards analysis used for getting deep descriptions about hazzards in the past whether they changed in time: characteristics, intesities and behaviours that the society could aware about the trends and variations in period of time. Season calendar used for analyzing periodic changes including stress, hazards, or diseases that could be used to evaluate climate information in making plans.

3. Identification choices of actions or activities

This step was conducted based on focus group discussion of the village community; they decided what actions and activities needed for their village.

4. Formulated the action plans

After made decisions about the actions that would be taken, then the community formulated the steps and plans for the actions so that the action plans met the target and the budget.

5. Evaluation of the action plans and resilliance criterias

In this part all activities that proposed by the community were evaluated whether they were related to resilliance criterias and could improve the community strength and ability related to adaptation and resilliance to climate change.

6. Making priority in action plans in climate change

After evaluating all the actions proposals then the community set priorities for the action plans chosing the most important and gave major contributions for the community in facing climate change impacts and possible future hazards.

7. Monitoring and evaluation

During the implemention of the action plans, it is necessary to have ways in monitoring and evaluating the activities.

III. RESULTS AND DISCUSSION

A. Sedayu climate

1. Rainfall

As a village in mountaneous area Sedayu has constant high rainfall al year, more than 50mm/10 days; no clear distinction between rain and dry season. Climate analysis in the period of 1976-2010; Sedayu had 310 days with rain (rain season) and only 50 days was dry. The highest rainfall was 99,3 mm (the 2nd week of October) and the lowest was 29,1 mm (2nd week of June).

Fig. 3 showed that rainfall tended to decrease below the normal line after 1992; high rainfall in Februari should be noticed since it would be potential to cause landslides in hilly areas. Fig. 4 was rainfall distribution during the 30 years, rainfall most often fall on the range of 50 – 70 mm in 10 days.

2. Air temperature

Global data showed that air temperature tended to rise 0.0018/month with base temperaure was 26.7 °C (Fig. 5).

3. Extreme weather

Extreme weather in terms of hight intensity rainfall, high wind speed happened more often in October during the transitional season from dry to wet season even though it could also happened in any month.

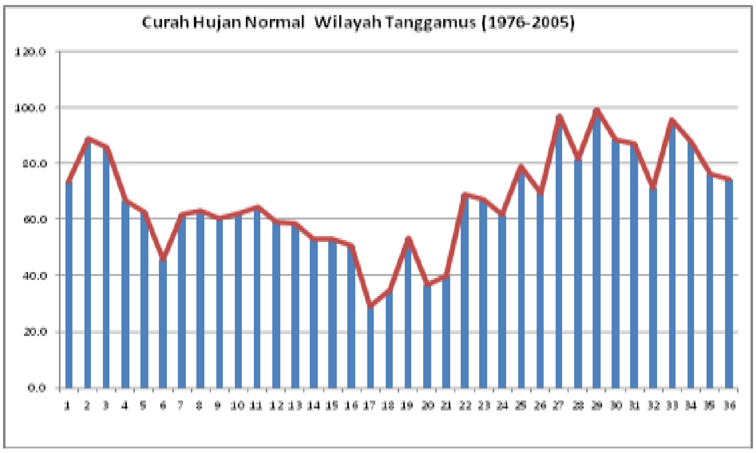


Fig. 1. Normal rainfal pattern in Tanggamus District (1976-2010)

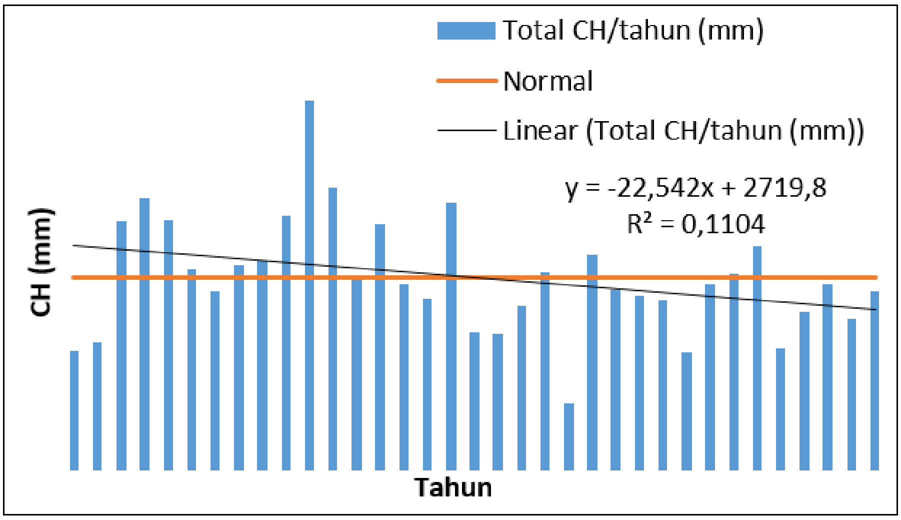


Fig. 2. Total rainfal trend (1976-2010)

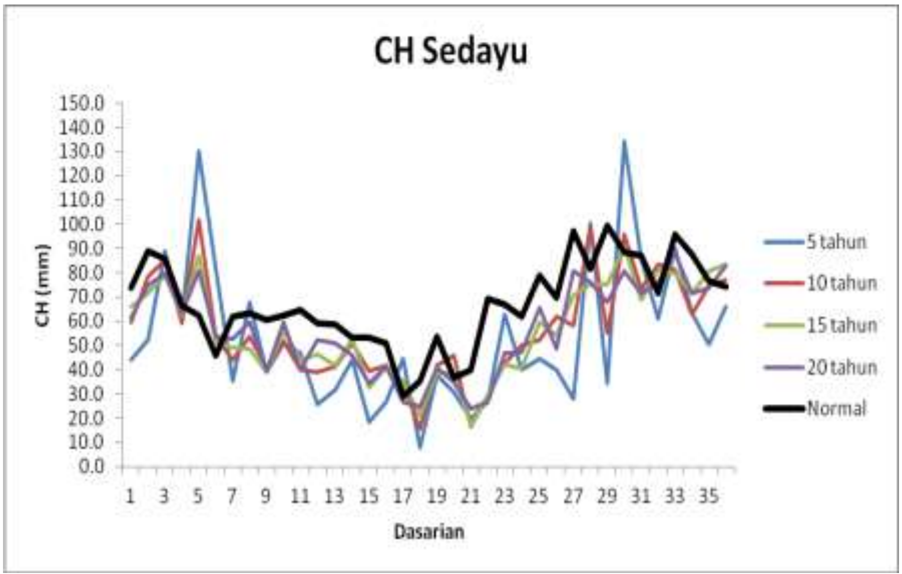


Fig. 3. Rainfall distribution (1976-2010) and the changes every 5 years

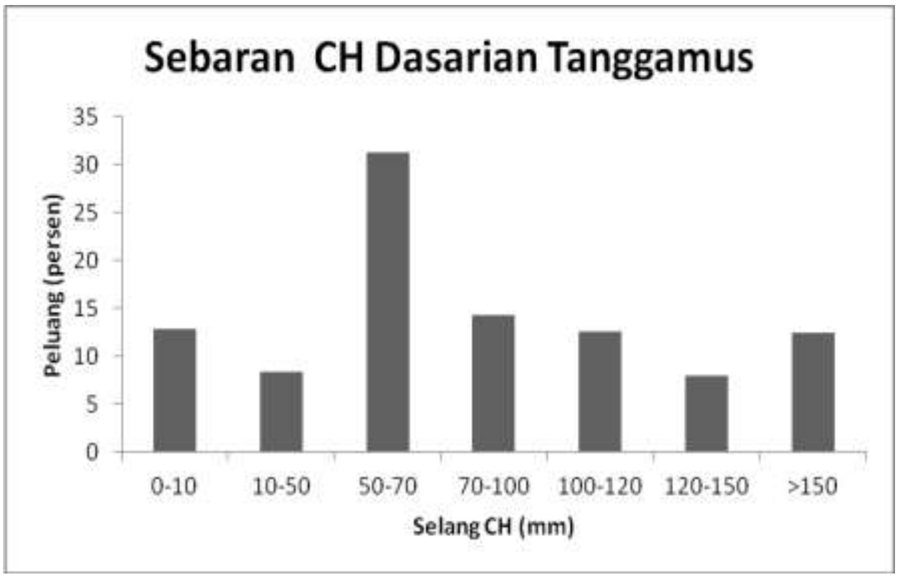


Fig. 4. Rain depth distribution of Tanggamus District

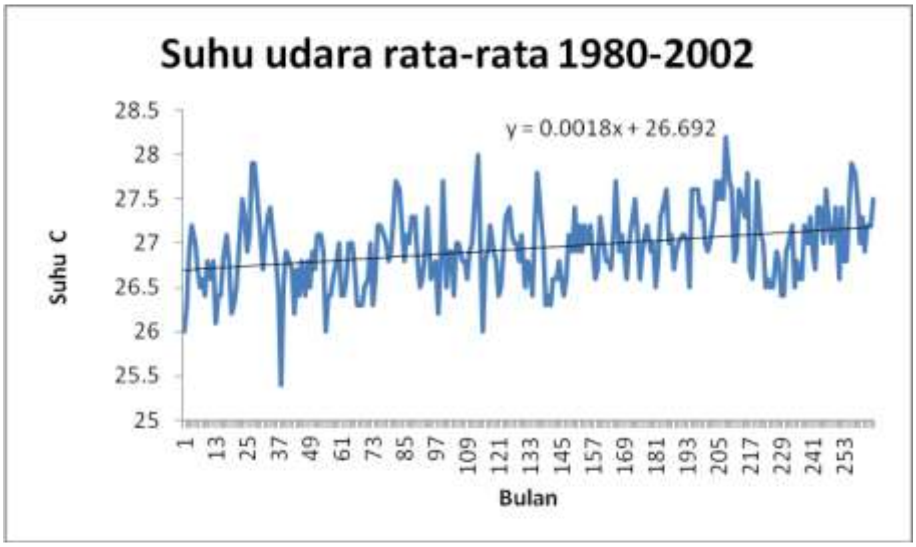


Fig. 5. Temperature rising trend (1980-2002)

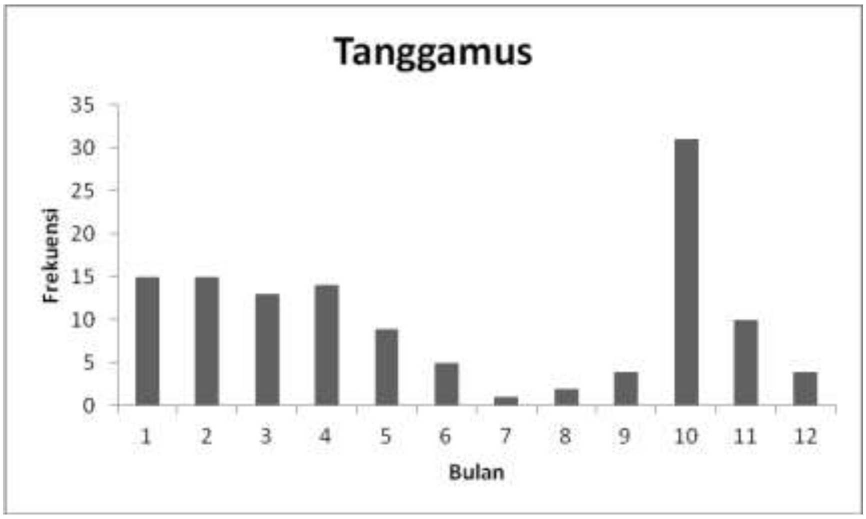


Fig. 6. Frequency of extreme weather (2009-2010)

B. Physical description of Sedayu

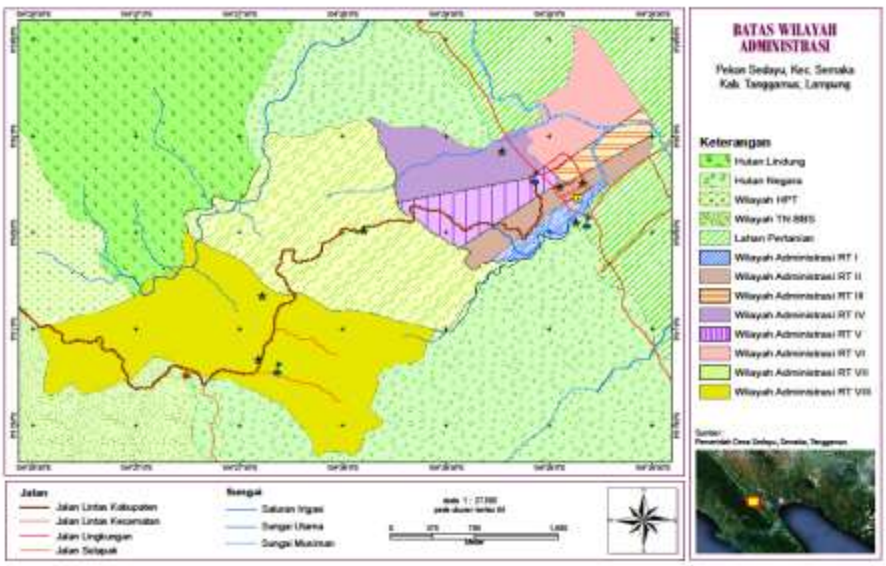


Fig. 7. Administration border of Sedayu, Tanggamus District

1. *General information*

Sedayu consists of 8 neighborhood communities; most of the residences live on low ground area but plant coffee and cocoa on the high ground or hills area. The population consisted of 52, 01 % male and 47,99 % female, in addition 13,32% was children and old age people who considered vulnerable to any disturbance. Most of them had permanent houses to live in quite good condition including the sanitarian facilities; however, the availability of clean water was limited in some area.

Education level in Sedayu was quite low, 44,79% graduated from primary and junior high school, 11,23% from high school and only 0,01% entered university level, but they had good knowledge about environment issues. Sedayu people was kind of "transition" in their way of life; they did not involve in communal works as tradition community do but they hold a belief on their ancestors protection.

Most of the Sedayu people made their living ftom agriculture activities (76,25%); small number (7,75%, 8,06%, 1,38% respectively) worked as local traders, various services and government officers. In general, they had moderate income level.

2. *Land elevation, slopes and land cover*

Sedayu had gradient elevation from low area (~ 25 m, 16.13%) up to > 500 m (41,27%). Lowland area, especially in riparian area, was proned to flood, while the highland was proned to landslides. Most of the Sedayu land was flat to a bit tilted (72,64%) and 27.36 % was steep.

Sedayu was covered by forest (42,85%, both natural and secondary forest) while 52,69% was agricultural area (paddy and other commodities field) and the rest was residential area.

C. The possible hazards caused by integrated climate factors and the physical condition of Sedayu

Rainfall distribution in Sedayu was considerate low in term of causing disasters; however, it could be a threat depends on the physical environment of the area. In lowland area especially in riparian area rainfall could potentially cause flood. As stated above 16,13% of Sedayu was lowland area, therefore, floods could be one disaster of Sedayu.

Flash flood could happen because of cumulated water in highland soil and when the soil could not hold the water, it would rush to and flood the lower area. Flash flood had a higher possibility to occur in Sedayu since it surrounding by hillyarea.

Landslides did has a potential to happen in Sedayu but the probability might low since only 27.36 % was steep land while the rest was categorized as flat, except if the rain intensity was high and for long time.

Land cover influences the soil ability in absorbing and holding water, therefore, preventing from landslides. Sedayu has a good soil surface coverage in forest area; however it still had almost 50% for residential area and agricultural area which might not good in holding water. Flood from the river, flash flood and landslides were still had possibilities to danger Sedayu.

Those analysys above were closely reflected on disasters historical records in Sedayu (Tabel 1) flash floods were the major disasters in this area. Part of the forest upland area in was converted to coffee and cocoa fields, when the rain occured with high intensity or in prolong time, flash flood and landslides are most predicted disasters.

Tabel 1. Historical Disasters Records And Management In Sedayu

Year	Type of disasters	Disasters impacts	what had been done
1979	flash flood	no major destruction since the population was low that time	
1986	flash flood	destroyed the cemetry and village bridge	government helped to rebuilt the bridge and opened the transportation access
1994	Major earthquake in West Lampung but could feel the shake	no major destruction	
1996	flash flood	sinked the cemetery area	
2009	flash flood and landslides	12 houses dissapeared, 4 person died and 2 were missed also 1 elephant found dead	government helped to rebuilt and opened the transportation access
2010	flash flood and landslides	2 houses were burried, 2 houses were carried away, 5 was badly destroyed, 1 toddler was died, and major roads weas covered by mud.	Evacuation of the victims; reconstructed the road, deepen the river and built temporary shelter for the community.

D. Community vulnerability and adaptation capacity related to social, economic and local government policies

There are various factors in evaluating community vulnerability and adaptation capacity. From the interviews and quosioners the vulnerability and adaptation capacity of Sedayu was described as follows:

1. *Climate change adaptation on social matters:*

Health facilities and access and income ussualy were indicators for adaptation capacity. Health and sanitation in Sedayu was considered good; however it still lacked of health facilities especially medical doctor; only one midwife was available in Sedayu and no community health centre.

The majority of Sedayu made their living from agriculture activities by planting coffee and cocoa. Sedayu has formed farmers organization and it runs very well. The farmers organization was independent and able to manage the members raw productions into processed and comercial products. However, they still need more knowledge in improving cultivation techniques for their coffee and cocoa.

In general, Sedayu residences had good income; they could be considered as had a good capacity in dealing with climate change impacts as along as there are some way to train them. For example, they could develop their own irrigation facilities. However, farmers did not have an easy access to bank and finacial facilities, no bank local branch offices in this area.

2. *Climate change adaptation capacity on physical environment matters*

Transportation including evacuation routes and infrastructures facilities were basic requirements in facing any disaster. Sedayu did not have permanent roads and bridges facilities; the main roads just had been constructed in 2012. Some public facilities like schools, mosques or other buildings could be used as shelter in disasters time but not adequate yet. In general, public and infrestructures facilities in Sedayu needed much improvement.

3. *Climate change adaptation capacity on human resources matters*

Sedayu residences were mostly in productive age, however their education level was quite low ; 13.32% was considered vulnerable. They needed more information and guidance to take care their environment to prevent them from disasters.

4. *Climate change adaptation capacity on local government policies*

Adaptation capacity of Sedayu local government was low since there was no plans and commitments on resiliance and climate change adaptation on its policies, no rules, mechanisms, structures and guidance for managing the village environment, no connections between policies and regulations in village development, and have no external partners in developing the Village. All activities: economics, social, environment were community spontaneous and independent movements.

E. The LRAP processes and implementation

1. Organizing Processes

The team for writing the LRAP consisted of the Sedayu village government; Farmers organisation leaders; the district level of BNPB (Badan Nasioanl Penanggulangan Bencana; National Board of Disasters Resilliance), the NGO: Mercy Corps Indonesia and the academic: Universitas Lampung.

2. *Evaluation of community vulnerability and capacity*

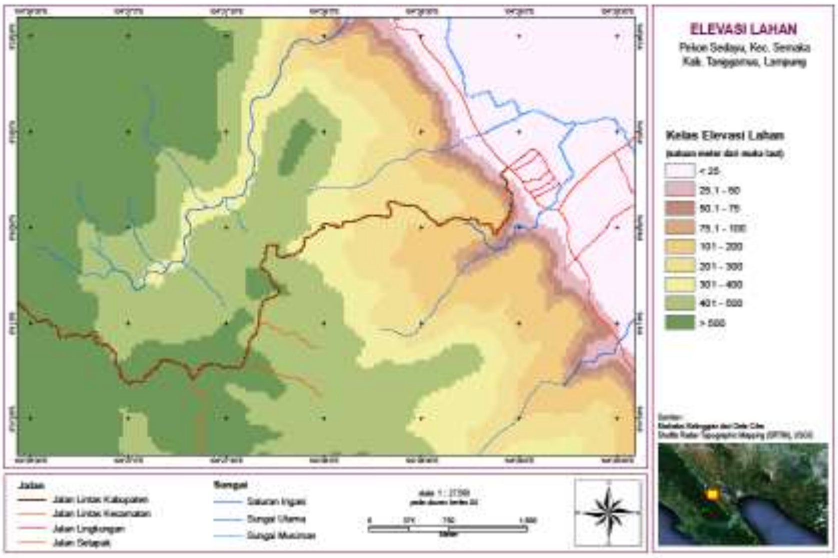
Hazard mapping has been done with results as desribed in Fig. 8 (a.b,c); while the hitorical records of past disasters was presented in Table 1.

3. *Identification choices of actions or activities:*

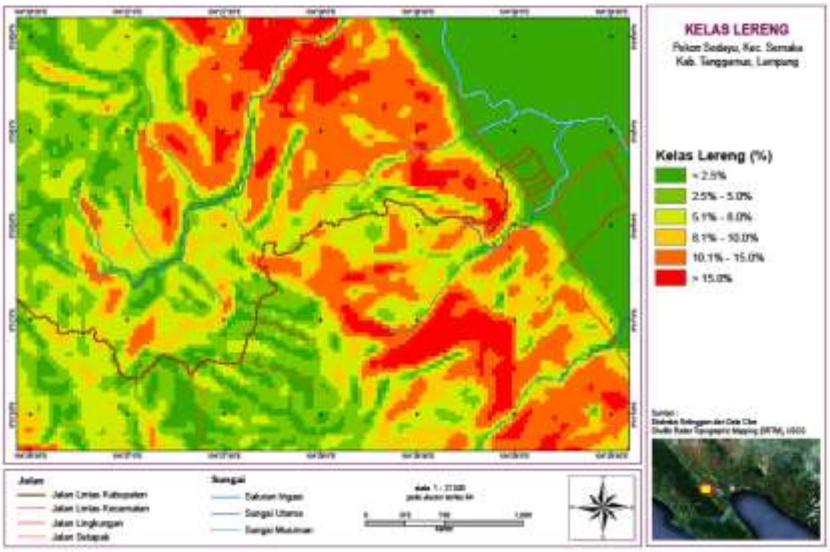
After some discussions among the stakeholders the activities that they proposed were: replanted tress on bare and open land to prevent the village from flash floods and landslides, developed and trained community organisations of disasters awareness, procurement of disasters resilliance equipments, renovation of public building dan made them as shelters during disasters, constructed walls along the river, gabion along the main road and water tunnel as landslides, flood and flash flood preventation.

4. *Making priority in action plans in climate change adaptation*

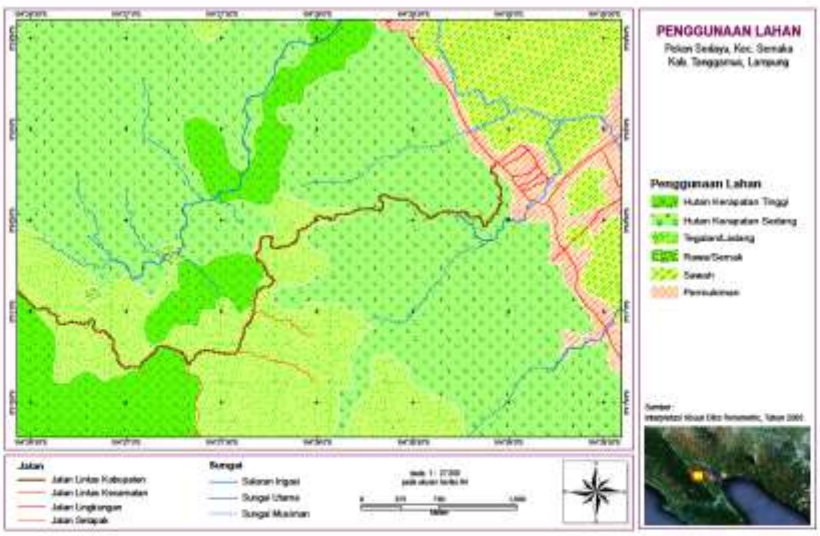
After evaluating all the actions proposals including budget source and time frame of this project, buiding a dam was set as the highest priority. All the proposed activities were presented in Table 2.



(a)



(b)



(c)

Fig. 8. Land elevation (a), slopes (b) and land cover (c) of Sedayu, as factors of possible disasters

F. Integrated LRAP on mid-term local development plans of Sedayu

Eventually the activities proposed on LRAP of Sedayu which was discussed and planned by the communuty stakeholders was integrated in local government development mid term (5 years) plans. With this method and processes, adaptation action and disaster resilliance related to climate change was adopted on local government legal documents.

The Praricipatory research methods which was conducted in Sedayu could be considered successful. The check dam construction was completed during this project; however, without guidance from external partners such as NGO it was doubt that the other plans on the LRAP would be implemented.

There are many methods in engaging local communities to some action or pregram for dissaters resillience. In highland locations in Bolivia and Ecuadorthe poorest regions of the Andes the local organisations created program called Katalysis which focused on enhancing local knowledge of climate change and creating opportunities for coping with it [8].

Table 2. List Of Activities Proposed By Sedayu Community For Adaptation Capacity To Climate Change Impacts

No	Activities	contribution to disaster ressilliances	Fund needed (IDR)
1	Building Check dam on Sedau rivery	handling drought on farmers field and water availability	98,900,000
2	Planting trees to cover steep land	reducing drought, erosion and flash flood	
3	Training for groups regarding dissaster resilliance	Improving resources to understand impact of climate change to have groups who will be standby for sudden disasters	23,375,000
4	Procure ment of disasters manage ment equipments	to improve adaptation capacity of Sedayu	36,475,000
5	Renovation of community meeting place for shelters	for evacuation in disasters for a meeting place of the disasters resilliance groups for an information centre	81,293,000
6	Built river wall	preventation from river flood and flash flood	120,500,000
7	Organic crops (paddy and cocoa) training	to improve farmers capacity in facing changing climate	32,625,000
8	Built clean water facility	to help the community during drought	-
9	Dredged the river and put gabion	to deepen the river base so that it could flow water from the upper part to prevent soil erosion along the river bank	-
		Total	393,168,000

However, Katalysis is in conflict with domi nant institutional designs since its principle was donor and development agencies must hand over more trust and responsibility to communities to design and implement their own agendas. Local people and outsiders need to be free to learn from each other, and to learn as they go along. In Solomon Islands, countries recognized by the IPCC as being among the most vulnerable to the impacts of climate change although contributing the least to GHG emissions [2].

Critics of top-down, expert-driven approaches to adaptation suggest the need for tools and methods capable of addressing the gap between scientific and local understanding of climate, therefore they formed Participatory Three-Dimensional Modelling (P3DM) for adaptation planning. The results showed that P3DM is able to bridge topdown and bottom-up approaches to adaptation by creating a space for mutual learning.Further research is necessary in order to overcome technical barriers to the integration of indigenous and scientific knowledge such as the downscaling of climate information to a scale compatible with community information as visualised on the relief model [11]. The LRAP methods applied in Sedayu was similar with urban participatory climate change adaptation appraisal (PCCAA) which was conducted in Mombasa (Kenya) and Estelí (Nicaragua). There the steps were community characteristics; severe weather; vulnerability to severe weather; asset adaptation; and institutions supporting local adaptation. It concluded that the PCCAA can become an important tool in the dialogue between communities and local authorities concerning the most appropriate interventions that will best assist them to build long-term resilience in the face of changes in weather conditions associated with climate change [12].

It is obvious that informing local communities about likely change effects, for identifying and dealing with potential risks and vulnerabilities, and also for encouraging and mobilising community activities geared to minimising these risks is important. For that purpose it needed people with a willingness to engage with others in open, unfettered and respectful multi-disciplinary discussion [9].

IV. CONCLUSION

Sedayu in general did not have severe disaster risks; as observed, the risks would be flood from the river and flash flood. Combination of education level, social life and economics of the residences showed adequate potentials in adaptation capacity. However, Sedayu was considered vulnerable because of local government weakness in regulations and commitments to secure their environment and to strengthen its resilience in terms of disasters caused by climate change.

Engaging local community together with other stakeholders in understanding and taking action for adaptation capacity and disaster resilliance related to climate change is important. From doing analysis on the local condition, the community could propose activities and programs which were met their needs. Guidances from external partners (NGO, Academic and other agencies) helped the community to force local government to adopt the LRAP into their legal documents and integrated it to their mid-term development plans.

ACKNOWLEDGEMENT

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REFERENCES

[1] IPCC. Special Report on Emissions Scenarios. Intergovernmental Panel on Climate Change Secretariat. Geneva, Switzerland. <http://www.grida.no/climate/ipcc/emission/. 2000.

[2] IPCC. Fourth Assessment Report. Intergovernmental Panel on Climate Change Secretariat. Geneva, Switzerland. http://www.ipcc.ch/. 2007.

[3] G. A. Meehl, T. F. Stocker, W. D. Collins, P . Friedlingstein, A T Gaye, J M Gregory, A Kitoh, R Knutti, J M Murphy, A Noda, S C B Raper, I G Watterson, A J Weaver and Z-C Zhao. 2007. Global Climate Projections. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Eds Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt K B, Tignor M and Miller H L]. Cambridge University Press. 2007.

[4] Riedy, Chris. Engaging Communities In Climate Change Adaptation: A Case Study From North East Victoria. Institute for Sustainable Futures, University of Technology, Sydney, NSW. http://www.coastal conference.com/2012/papers2012. 2012.

[5] IFRC. Climate Change Adaptation Strategies for Local Impact. 2009

[6] J. Frank, and P. Buckley, C. 2012. Small-scale farmers and climate change. How can farmer organisations and Fairtrade build the adaptive capacity of smallholders? IIED, London

[7] D. L. Senanayake, P. K. S. Mahanama , K. S. Barthelot . "Community Participation For Climate Change Adaptation: Participatory Approach For Planning And Design Of Coastal Green Belts In Batticaloa" *In SAITM Research Symposium on Engineering Advancements* (SAITM – RSEA, 2013). p:12-15 S. 2013.

[8] Sherwood and J. Bentley. Katalysis: helping Andean farmers adaptation to climate change. *Participatory Learning and Action* 60.Ed H. Ashley, Nicole. K, and A. Milligan. IIED. 2009.

[9] H. Ross, S. Shaw, D. Rissik, N. Cliffe, S. Chapman , V. Hounsell , J. Udy, Ng. Trong Trinh and J. Schoeman. "A participatory systems approach to understanding climate adaptation needs". *Climatic Change* Volume 28 No 1 and 2. 2014. DOI 10.1007/s10584-014-1318-6

[10] L.A. German, A. M. Tiani, A. Daoudi, T. M. Maravanyika, E.Chuma, C. Jum, N. Nemarundwe, E. Ontita and G. Yitamben. The *Application of Participatory Action Research to Climate Change Adaptation in Africa*. International Development Research Centre and Center for International Forestry Research.2012

[11] P. A, Paper. "Participatory mapping for adaptation to climate change: the case of Boe Boe, Solomon Islands". *Knowledge Management for Development Journal* 9(1): 24-36. 2013. available at http://journal.km4dev.org/

[12] C. Moser And A. Stein . Implementing Urban Participatory Climate Change Adaptation Appraisals: A Methodological Guideline Environment & Urbanization Vol 23(2): 463–485. DOI: 10.1177/0956247811418739.

H.8

FARMER GROUP: AN ACCELERATOR TO DEVELOP UNPAD CHILLI SEED (PERSPECTIVE OF SUSTAINABLE DIFFUSION OF INNOVATION)

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ABSTRACT

Capitalization in agriculture has lead to a shift in farming orientation, which encourages change in patterns of relationship between farmers and farmer group. Agricultural development is still putting farmers group to it's ideal function. The research question was how the ideal function of farmer group provides acceleration to the development of Unpad chilli seeds. The purpose of this study was to describe the performance of farmer group in providing facilities of Padjadjaran chilli seed development at farm level. This study was carried out in 2016. The research method was qualitative descriptive, used case study at the Kisingasari farmers group, District of Kawali, Regency of Ciamis, and Mekarsari farmers group, District of Taraju, Regency of Tasikmalaya. The results showed that farmers group based on its capacity, provided acceleration in the development of Padjadjaran chilli seed, through learning function of group, dissemination of information and develop networking with agribusiness stakeholders. The acceleration was indicated by farmer group performance in developing Unpad chilli that reaches 70%.

Keywords: farmer group, accelerator, Padjadjaran chilli seed

I. INTRODUCTION

Human consumption on vegetables is increasing, including chilli (*capsicum annuum L*). In 2016, chilli consumption in Indonesia has reached 914.825 tons (Kementan, 2017). High price fluctuation of big red chilli indicated that demand was not matched with supply. Moreover, climate variability has also resulted in production decrease in several production centres, in addition to seed scarcity at farm level. Unpad's breakthrough developed four Open Pollinated (OP) red chilli varieties in order to answer increasing chilli seed needs and farmer dependency to use non-reproducible seed (Rostini et al, 2015), namely:

1. Unpad CB 1 variety, which has high productivity and high capsaicin, to be used for increasing big red chilli production.
2. Unpad CB 2 variety, breeding product that has high productivity and high number of chilli fruit, with several characters expected to be useful in field.
3. Unpad CK 3 variety, which has high productivity and has specific characteristic (hairy on stem, particularly on vegetative time)
4. Unpad CK 5, which has high productivity, characterized by frequently (more than 80% of plant), chilli fruit enlaced two times.

Prudent process is needed to disseminate the seeds for farmers. As an impact of agriculture capitalization, all farmer decisions will always calculate profitability, or at least reward must be more than cost. Therefore, precautionary dissemination to all users, from producers (farmers) to end users (home industries, household consumers or restaurants) need to be conducted in order to gain responses and input for increasing the seed quality.

Group approach for dissemination is very relevant in innovation diffusion. Hitherto, government approach in empowerment process always conducted with group approach. Until 2013, 318.396 farmer groups have developed nationally. 28.801 of them are in West Java province. Furthermore, farmer group always become reference group and/or "generalized other" for farmer to act (Berry, 1986).

Despite rural community was formerly a law entity, self-sufficient groups were only in informal forms, such as "liliuran", "gugur gunung", "perelek" (Vollenhoven, 1925 in Soewardi, 1980). Moreover, Geerzt (1959) even did not find voluntary association in Java. He went on to state that Javanese community was structure less and normless.

Red chilli farmers pattern of behaviour is definitely capital intensive, with very high level of capital accumulation. Profit is the main objective and market oriented is the mean. This indicates agriculture capitalization is the main belief. Consequently, farmer relations and acts tend to be transactional.

These phenomena fostered the need for farmer group development to improve collectivism among farmers, from production to marketing. On the other hand, agriculture capitalization has developed high competitiveness among farmers, so that the possibility of farmer group to be accelerator in Unpad chilli seed development is interesting to discuss.

II. MATERIALS AND METHODS

This research implemented descriptive qualitative design, used case studies in two farmer groups, namely Kisingasari farmer group in District of Kawali, Regency of Ciamis and Mekarsari farmer group in District of Taraju, Regency of Tasikmalaya. Qualitative method is frequently an interpretative method, because the result data usually resulted from field data interpretation (Sugiyono, 2012), while case study is a descriptive technique that the object is now, only one case (community, family, or individual) and deep explorative in nature (Rusidi, 1993).

Primary and secondary data were used in this research. Primary data were obtained by interview with group members and informants and through observations. Purposive sampling to group patrons, management and members was implemented. Secondary data were obtained from report documentations, journals, books, and related government institutions.

Data collection technique was direct observation on these two farmer organizations. Interviews were conducted with farmer organization management and members and representatives from related government institutions. Collected data includes farm business development and interaction among members and management in terms of business development.

Descriptive analysis data was used; refer to identification of characteristics of human groups, things or events. In short, qualitative descriptive involves conceptualization process and results in formation of classification schemes (Silalahi, 2012).

III. RESULTS AND DISCUSSION

Farmer group grows because farmers have a lot of needs that cannot be self-fulfilled. Historically, farmer groups could be developed autonomously or as social order of the government related to government programs. However, groups that were resulted from collaborations between government and farmer needs were actually more dominant than the previous two. Farmers aware of the need for cooperation among them, but have no ideas to realize. On the other hand, government needs committed people group to cooperate for organizing programs related to technical, social and economic capacity strengthening.

Farmer groups resulted from collaboration process are functioned as learning entity, cooperation entity, information dissemination entity and develop institutional cooperation, including marketing. These functions are accelerators for chilli farmers to strengthen their capacity.

A. Farmer Group as Learning Entity

Berry (1986) stated that group is a member reference to act and behave. Because group trains and supports its members, Cartwright and Zander (1968) pointed out six group task functions: (1) satisfaction, (2) information, (3) coordination, (4) initiation, (5) dissemination, (6) clarification, while Rusidi (1978) stated that farmer groups truly work for information dissemination through learning process and training for farmers. Table 1 shows group contribution on access received by farmers in this research.

Table 1. Group Contribution on Access

No.	Group Activities	Farmer Group	
		Kisingasari	Mekarsari
1	Training and arrangement of testing farm (demonstration plot) plan	v	v
2	Provide land for testing	v	v
3	Provide workforce for testing	v	v
4	Provide finance for testing	x	x
5	Operate testing farm (demonstration plot)	v	v
6	Conduct monitoring and evaluation	v	v
7	Coordinate with other groups	x	x
8	Coordinate with extension workers	x	x
9	Relation with (local) trader	v	v
10	Gather and deliver inputs to Unpad team	v	v

Note: v) involve; x) not involve

From 10 expected indicators on group contribution on access related to Unpad chilli development, in two farmer groups only 70% of group performance indicators can be delivered. Kisingasari dan Mekarsari farmer group businesses are in horticulture. They are personally very transactional and also very rational, particularly in capacity and knowledge development. Information on Unpad chilli seed, which is potential to help farmers on adaptive and economical seed provision/relative advantage (Roger and Shoemaker, 1971), were responded positively by farmer group.

Each of demonstration plot area of these two farmer groups is 2.000 m^2 and involve farmer group member in Unpad chilli seed development. Prior to operate demonstration plot, farmers learned Unpad seed characteristics, cultivation techniques, and seed production process. Member and management attending actually were not high, only 35% of 20 active members in Kisingasari and 40% of 25 active members in Mekarsari. However, they were commonly consistent to participate in the development process from beginning to end.

In the demonstration plot, farmer involvement was very high and they were very enthusiastic. Hence, production of this demonstration was also high, namely 6-8 ounces/tree in Kisingasari farmer group, and 6 ounces/tree in Mekarsari farmer group.

Table 2. Group Contribution on Access

No.	Activities	Number of Attended Members (%)	
		Kisingasari	Mekarsari
1	Production planning	35	40
2	Production process	35	40
3	Monitoring and Evaluation	30	35
4	Product use	35	40

As a learning entity, both farmer groups have given satisfaction for their members to gain knowledge, as well as gave access (accelerator) in Unpad chilli seed development. Technically in planning, issues were emphasized on efforts to produce good propagated seed, started from seedling to cultivation techniques according to farmer capacity. In production process, land tilling and planting area as well as planting time and planting distance were determined by farmers. Furthermore, farmers also monitored plant growth and evaluate plant growth characteristics in location. Selected products were become propagated seed distributed to members.

This information shows that both farmer groups have given services on farmer capacity improvement and distribute to other members, as well as gave access to Unpad chilli seed development in terms of dissemination and innovation improvement. Unpad technological collaboration with local wisdom management shows high commitment of farmer groups as learning entities to give access in chilli seed development, which is adaptive to farmers' environment.

B. Farmer Group as Cooperation Entity

Farmer group was developed because affiliated individual has own objective. Individual objectives constructed group objective. Therefore, group is a medium to fulfil member needs. The successful of group is very dependent on "surrender" process of the members to participate in group activity. Group was actually formed by interaction. Hence, group cooperation is much related to exchange between reward and cost (Kelly, 1950 in Johnson, 1986), value similarity or equality/balance (Newcomb, 1961 in Johnson, 1986), house/living place distance (Luthans, 1981 in Johnson, 1986).

Both farmer groups were formed due to living place/house similarity and similar activity, namely horticulture farmers chasing for income increase, as stated by one respondent in Mekarsari:

.....abdimah pa, ngahaja damel sasarengan ngawangun kelompok teh supados ringan biaya ....oge tiasa ngabagi pangalaman.... (...cooperate to develop group in order to decrease cost and share knowledge...)

This information shows that cooperation has developed because of the existence of maximal expectation through low cost (efficiency). In these farmer groups, farmers work together to improve their knowledge and skills, both technical ability and marketing skills.

Information on Unpad chilli seed advantages has become stimulations to increase farmer income (R>C) in these two farmer groups. Positive responses have been followed by cooperation to develop demonstration plot. Collaboration of Unpad technology with local management model resulted in good production yields. Production has reached 6-8 ounces/tree. Economic orientation as an impact of capitalization has become a strong point to develop cooperation in order to increase production and income, in addition to living place closeness and similar values.

Cooperation developed by farmers is not only limited to production increase but ultimately to obtain income increase. Therefore, farmer groups cooperate with traders (before they have ability to develop by themselves) to entry the markets. Several criteria stated by traders as information for researchers to have good quality products, among others: 1. long of chilli fruit is not more than 15 cm, because it will easily broke and rotten, 2. Colour must not be shine (for "curly" chilli), and must be shine (for big chilli).

IV. FARMER GROUP AS INFORMATION DISSEMINATION ENTITY

In information dissemination, both farmer groups play an important part as service providers connecting innovation sources with farmers. In these farmer groups, farmer learns and be trained on chilli seed development method. Through these farmer groups, farmer aware on Unpad red chilli technology advantages compare to hybrid chilli. Through farmer groups, the breeders disseminate their technology. Although farmer group member attendance still low, between 25% and 35%, but they consistently adopted Unpad chilli technology as an alternative of seed need fulfilment in their farms.

V. CONCLUSION

From the previous explanation and discussion, several conclusions can be stated as follows:

1. Kisingasari farmer group, District of Kawali, Regency of Ciamis and Mekarsari farmer group, District of Taraju, Regency of Tasikmalaya in their function as learning entity, has given access to breeder (technology producers) meet with farmers in innovation dissemination.
2. Both farmer groups in their function as cooperation entity, has given access to breeder and farmers to participatory cooperate through demonstration plot development.
3. Through demonstration plot facilitated by both farmer groups, farmers have been convinced to continually use and developed Unpad red chili seed as their choice.

REFERENCES

[1] Kementan. 2017. *Rencana Strategi Kementrian Pertanian 2014 – 2019*. Ministry of Agriculture Republic of Indonesia.

[2] Rostini, Neni, Sumadi, Ade Ismail, Farida Damayanti. 2015. *Produksi Benih Pokok Empat Genotif Cabe Merah Unpad dan Peluncuran Benih Varietas Baru di Ciamis Jawa Barat*. Laporan Penelitian Unpad.

[3] Berry, David. 1986. *Sosiologi*. Gramedia. Jakarta

[4] Soewardi, Herman, 1980. *Kebangkitan Kelompok Tani*. Laboratorium Sosiologi dan Penyuluhan Fakultas Pertanian Universitas Padjadjaran.

[5] Geertz C. 1963. *Agriculture Involution. The Process Ecological Change in Indonesia*. University of CaliforniaPress.Berkeley.

[6] Sugiyono, 2012 *Metode Penelitian Kualitatif dan Kuantitatif dan R&D*. Alfabeta Bandung.

[7] Rusidi, 1983. *Metode Ilmiah*. Laboratorium Sosiologi Penyuluhan Fakultas Pertanian Unpad.

[8] Silalahi, Ulber. 2012. *Metode Penelitian Sosial*. PT Rafika Aditama. Bandung

[9] Cartwright and Zander. 1968.*" Group Dynamics" Resarch and Theory.* (3d Ed). New York,Harper and Row

[10] Rogers and Shoemake. 1987. *Memasyarakatkan Ide-ide Baru*. DiIndonesiakan oleh Abdillah Hanafi. Usaha nasional. Surabaya.

[11] Johnson, Doyle Paul. 1986. *Sosiologi Theory Klasik dan Modern* Jilid 2. DiIndonesiakan oleh MZ Lawang, Gramedia Jakarta.

H.9

READINESS OF ORGANIC VEGETABLES FARMER GROUPS IN DEALING MEA

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ABSTRACT

MEA (ASEAN Economic Community) is a very crucial momentum for farmers. In this era of goods or commodities can move freely into our territory from other countries. This can be a threat as well as an opportunity for our farmers to compete in it. Farmer groups should respond carefully through qualified preparations so as to benefit from this competition. This study tries to examine how preparedness of organic farming group MekarTani Jaya in Cibodas Villages, Lembangsubdistric, West Bandung Regency in facing MEA market. This research is a quantitative descriptive research, with respondents 30 members of Farmers Group Mekar Tani Jaya. The results showed that MekarTani Jaya Farmer Group is still not ready to face MEA, seen from indicator Farmer knowledge level related to MEA information is still low, farmer's motivation to compete in free trade is still low, Uncertified product and Use of Information and Communication Technology still low. The main obstacles faced by farmers in facing this free trade include the limited space for farmers to access to exporters, uncertified products, weak networks owned by the institutions, and not yet able to utilize and use ICT. Institutions are only limited to form without clear coaching.

Keywords : Readiness, Farmer Group, Organic Vegetables, MEA.

I. INTRODUCTION

The MEA market is a foreign trade system where every ASEAN country trades without any state obstacle. The MEA Agreement explains there are five things that can not be restricted: the flow of goods, services, capital, investment and the flow of trained labor. This impact on goods and services that can be freely in and out without any obstacles anymore. This condition is certainly not easy, especially for farmers farmers in Indonesia, which technically they are still not fully prepared with this situation that could be both opportunities and threats (Basyid, 2006).

Horticulture is a potential commodity that can compete in the free market. The data show that the level of overseas consumer demand for horticultural commodities is still the top ranking of the largest foreign exchange earners in Indonesia. Of the many horties in Indonesia, organic vegetables today become one of the potential primadonas to enter the free market MEA (Nazir, 2005).

Actually Indonesia as an agricultural country, has great potential to develop organic farming. Indonesia has 17 million hectares of vacant land and still the extent of traditional agriculture managed without the use of sisthetis, became one of the important capital in developing organic agriculture. Government Based on static data of organic farming in Indonesia 2012, total area of Indonesian organic agriculture in 2012 is 213.023,55ha. Indonesia supports the trend of organic agriculture by issuing a government policy called Go Organic 2010. Currently in Indonesia alone, the trend of organic product consumption has increased significantly between 20-25 percent per year.

Organic farming is one of the farming system that will be able to lead farmers to care more about the environment and to pay attention to environmental factors in every farming activity that is run (Mulyandari, 2005). One component that can be suppressed by farmers if he apply organic farming is the cost of pest control and fertilization. So far the cost of eradicating pests with chemicals as well as chemical fertilization is a cost component that suck large money for farmers. If production costs can be reduced, the price of products produced will be more competitive, so farmers will have better competition with other similar products (charina, 2017).

Unfortunately the conditions faced by farmers Organic Vegetables in Farmer group Mekar Tani Jaya Village Cibodas Lembang Distric is not easy. One of the root causes of this problem is the weak capacity and capability of the farmers themselves in managing organic vegetable farming, thus impacting on the results obtained (Deliana, 2011). To overcome these problems, it is necessary to institute agriculture that is able to give strength to farmers (high bargaining position). Institutional agriculture in this case is able to provide answers to the above problems.

Strengthening the bargaining position of farmers through the institution in this case Farmers Group is a very urgent and necessary necessity by farmers, so they can compete in carrying out farming activities and can improve the welfare of his life (Charina, 2016).To achieve high competitiveness especially in the face of free trade, for example MEA, the role of Farmer Group as an institution will be very vital. It takes the readiness of farmer groups in terms of producing export-quality products, readiness to build networks to the free market, readiness to strengthen access to capital and preparedness to prepare Information Communication Technology (ICT) in supporting the internationalization of agribusiness Organic Vegetables. This is not easy considering the condition of the Organic Vegetable Farmer group is still limited.

In general, the objectives of this research are: (1) To analyze the institutional preparedness of Organic Vegetable Farmer groups in facing MEA free trade and (2) to analyze obstacles experienced by farmer group in facing MEA

II. MATERIALS AND METHODS

Objects and Places of Research: The research was conducted at Organic Vegetable Farmer Group of Mekar Tani Jaya in Cibodas Village, Lembang Subdistrict, West Bandung Regency, which is one of the biggest rganic vegetables center in West Bandung

Research design: This research is a quantitative descriptive research conducted with census technique. Where all members of farmer group made as respondents in this research that is a number of 30 people.

Data Types and Data Sources: The type of data collected consists of primary data and secondary data. Data collection techniques are: (1). Direct observation (observation), ie direct observation made to see the location of the object of research and perform secondary data collection (2). Interview (interview), namely direct verbal communication by exploring problems and knowledge of farmers related to free trade MEA. In addition, there will be an indepth study to key persons, stakeholders and related institutions (3) Focal Group discussions (FGDs) to see and hear firsthand what is feared and expected with the MEA. (4.) library study of the latest journals of developed countries.

Data analysis: In this study used descriptive analysis to analyze the readiness of farmers in the face of free trade MEA. Descriptive analysis is a method in researching a group of people, an object, condition, system of thought, or a class of events in the present. The purpose of this descriptive analysis is to make systematic, factual descriptions of facts, traits, and relationships between the phenomena Nazir investigated (2005).

III. RESULTS AND DISCUSSION

A. *Characteristics of Respondents*

Respondents in this research are organic vegetable farmers who are members of Mekar Tani Jaya Farmer Group, Cibodas Village, Lembang Sub District, as many as 30 people. With age distribution as follows:

Table 1. Characteristics of respondents by age group

Age	Number of respondents (persons)	Percentage
30 – 40 th	10	33%
41 – 50 th	12	40%
51 – 60 th	5	17%
60 – 64 th	3	10%
Total	30	100%

Distribution of farmers by age group looks evenly. Generally farmers are in the productive age category, but here it is evident that the younger group farmers under 50 years of the number more than old farmers over 50th. Physical ability is still good to be one of the business capital of farmers to conduct farming activities more productive. Generally young age also has a strong motivation to move forward and responsive to change (Ambar, 2004),. The majority of organic vegetable farmers are male.

Characteristics of farmers based on marital status. 98% organic vegetable farmers are married, while farmer characteristics are based on education level. Judging from the last level of education pursued, the majority of organic farmers to pursue education only to elementary and junior high. But the low educational background does not become a barrier to farmers in running actifity (Sanjaya, 2015). While Sumarwan (2003) in Sanjaya (2015) said that the level of education determines a person in receiving knowledge and information. A person who has a good education will be more responsive to information, which will ultimately affect a person's decision making (Ambar, 2004).

Characteristics of organic farmers by income level. In this study analyzed is the amount of family income, which means the total income of family members. Most organic farmers (65.2%) have an average monthly income of 2 million up to 3 millions. When compared with UMR West bandung their income is slightly above the UMR. Farmers who are in the research area in Cibodas Village generally have experience of vegetable farming long enough. Some of them continue the farming of their parents, but some are pioneered by their own. Like the distribution in the following table. Only for the organic system has not been too long cultivated. The organic system began to enter Ds.Cibodas since 2012. So 100% of new respondents tried to farm with an organic system less than 10 years.

Table 2. Characteristics of espondents based on level of organic vegetable farming

Length of trying Farmer Organic Vegetables	Number of Respondents (Persons)	Percentage (%)
< 10 th	30	100%
10 - 20 th	-	-
> 20 th	-	-
Total	30	100

B. Readiness of Farmer Group in Facing MEA

Organic Vegetable Production in Cibodas Village is the highest category in West Java area. Lembang included into one of organic vegetables center. Types of vegetables are widely cultivated organically in Cibodas such as spinach, kale, cabbage, tomatoes, pakcoy, carrots and others. So far the farmers supplied their crops to the Mekar Tani Jaya farmer group. From Farmer Group Mekar Tani Jaya marketed to modern markets such as, Transmart Carefour and Griya Riau Junction in Bandung City (Mulyandari, 2015).

Organic vegetables from Mekar Tani Jaya Farmer Group unfortunately have not been certified. To be able to compete in the free market one of the requirements that are fully met by organic farmers is already certified. So far the cost is still a major obstacle farmer group not certified organic. As we know the cost for organic certification is quite high. Though the demand for organic vegetables, especially carrots, kale, spinach, beans and pakchoy high enough.

Similarly, for the export market demand for organic vegetables is quite a lot (Deliana, 2017).Besides the above exposure, the following points indicate the existing condition of preparedness of Organic Vegetable Farmer Group in facing MEA free trade.

1. Level of Knowledge of Organic Farmers About MEA Information

Farmers' knowledge of the MEA is very diverse. Farmer group officials as active farmers associated with Agriculture and Horti Farmers who often attend training or exhibition already know the information about MEA. Because in the exhibition is usually echoed the importance of the readiness of Organic Vegetable producers to produce good products in order to compete with products from other countries. Farmer group careers a number of 5 people have a high level of knowledge about the MEA.

As for other non-managing farmers, their knowledge level associated with MEA varies, 50% of them have sufficient knowledge which means they know about MEA but do not offer. 33.3% of them do not know what is MEA.

Though ideally farmer groups should make preparations to plunge in it. The farmer group must have at least a good understanding of what products can pass to the MEA (have labels, quality standards etc), prepare profitable cooperative procedures and build networks with direct exporters and have ICT (Information and Communication Technology) management capabilities, Is the digital era, online marketing can be a solution to attract as many foreign consumers as possible (Charina, 2017).

Here is the distribution of knowledge level of farmers of respondents related to free trade.

Table 3. Farmers knowledge of organic vegetables related to MEA information

Level of Knowledge	Number of Respondents (Persons)	Percentage (%)
High	5	16.6%
Medium	15	50%
Low	10	33.3%
Total	30	100%

The thing that must be considered for organic products to enter the MEA is to be certified. Because with the certification of organic vegetables, then automatic food security has been guaranteed. Due to the certification, the farmers have applied all the SOPs specified for organic vegetable processing, for example from SNI.

The second as described above, should each chairman of the group able to build its members to understand with the online business world. This is one of the methods of making as much market share as possible more efficiently. Of course here the role of the relevant Office should be able to facilitate Gapoktan by providing online-based marketing counseling. Farmers as market participants should not be blind to the internet, because a variety of information is there.At the level of Gapoktan or even Farmer group ideally have a special website for product promotion and sales service. Indeed this is not easy, but if designed from scratch properly will be able to create benefits from trading this cyber era.

2. Farmer's Motivation in Facing MEA Market

According to the book The Secret of Mindset, it is explained that "motivation" greatly influences one's behavior and attitude, which ultimately determines the level of success of his life (fate). Given this definition then that fate is determined by attitude in acting and behaving. This is also reflected in the activities of farmers in the field. Especially in old farmers, generally their motivation in dealing with MEA chests in the low category. Here shows that age is directly proportional to one's motivation. Old farmers do not have the spirit to compete in MEA, this is related to the preconditions of the MEA that they feel is quite heavy. For example in the case of a product must be certified. To achieve the certification of product is not easy, for example in the case of land must be converted for 2 years to be completely free residue, the land must be separated as far as at least 3 kilometers from other non-organic farming land.

These things are considered very burdensome old farmers, they are already familiar with current agricultural activities and are reluctant to change. They think MEA is not important to them.As with farmer group officials and jga young farmers, they have a high level of motivation to follow the MEA. Moreover, some of them there who have known the socialization of benefits that can be obtained from the MEA that makes them enthusiastic to learn that they can exist in the MEA. Results of field analysis related to motivation are reflected in the following table:

Table 4. Farmers motivation level in facing free trade

Level of Farmer's Motivation	Number of Respondents (Persons)	Percentage (%)
High	5	16.6%
Medium	10	33.3%
Low	15	50%
Total	30	100%

3. Problems of Organic Certification in Farmer group

If we look at the capacity and capability of farmer groups in the field, the conditions faced by the farmers are still varied (Sanjaya, 2015). The ability of farmers in the technical cultivation of Organic Vegetables has no doubt, because they have been in business for tens of years. However, if we look closely at the application techniques of organic vegetable farming applied they still can not apply organic farming SOP from SNI. For items such as land must be converted 2 years, water must be free of chemicals etc. for some cases not yet in accordance with SOP. Things like this is the inhibition of certification in farmer group, in addition to the cost factor of certification is large and burdensome farmer group.

Table 5. Compliance level of farming implementation with SOP

Level of Conformity with SOP	Number of Respondents (Persons)	Percentage (%)
High	3	10%
Medium	10	33,3%
Low	17	56,7%
Total	30	100%

4. Utilization of ICT in Farmer group

ICT (Information and Communication Technology) is one important component that must be prepared by farmer group to be competitive in MEA (Kim, 1999). Due to the maximum utilization of ICT will help farmer group expand the market, expand the network, facilitate access etc (Charina, 2017). Unfortunately the utilization of ICT in farmer group is still minimal. This is spurred by the individual's own ability to utilize ICTs as well as the high cost of using ICT itself.

Table 6. Level of ICT use ability

Level of ICT Use Ability	Number of Respondents (Persons)	Percentage (%)
High	5	16.6%
Medium	10	33.3%
Low	15	50%
Total	30	100%

IV. CONCLUSION

1. Farmer group still not ready to face MEA, seen from indicator Farmer knowledge level related to MEA information is still low, Farmer's motivation level to compete in free trade still less, Uncertified product and Use of Information and Communication Technology still low.

2. The main obstacles faced by farmers in facing this free trade include the limited movement of farmers to access to exporters, uncertified products, weak networks owned by the institutions, and not yet able to utilize and use ICT. Institutions are only limited to form without clear coaching.

REFERENCES

[1] Ambar Teguh Sulistyani. 2004. Kemitraan dan Model-model Pemberdayaan. Jakarta: Gava Media.
[2] Badan Litbang Pertanian. 2010. Revitalisasi Radio Pertanian Ciawi (RPC) Sebagai Pusat Informasi Pembangunan Pertanian. Melalui http://www.litbang.pertanian.go.id/warta-ip/pdf-file/5.retno_vol19-1-10.pdf. 6 Juli 2016
[3] Basyid, Abdul. 2006. Pemberdayaan Masyarakat Pertanian Melalui Penguatan Modal Usaha Kelompok Petani. Jakarta: Departemen Pertanian.
[4] Charina, Andriani, Hermita, Deliana. 2017. Penerapan Teknologi Informasi dan Komunikasi pada Sayuran Organik.
[5] Charina, Andriani, Supyandi. 2016. Daya saing Kelompok Tani Mangga Gedong Gincu dalam Menghadapi Perdagangan Bebas
[6] Deliana Y. 2011. Analysis of Consumer Behavior on the Selection of Apple, Cytrus, Imported and Local Mango, in the Bandung City, West Java. Journal Lucrari Stiintifice . Seria Agronomie. Vol 54,NR 2 p. 32-37
[7] Gelb E., Wagner P., Rosskopf K., Parker C. & Schiefer G., 2004. ICT adoption – A summary of the EFITA questionnaires. Proceedings AFITA/WCCA Congress, Bangkok, Thailand
[8] Kim, Daniel H. 1999. Introduction of System Thinking. Pegasus Com
[9] Mulyandari, RSH. 2005. Alternatif Model Diseminasi Informasi Teknologi Pertanian Mendukung Pengembangan Pertanian Lahan Marginal.
[10] Mulyandari, R.S.H. dan E.E. Ananto. 2015. Teknik implementasi pengembangan sumber informasi pertanian nasional dan lokal P4MI. Informatika Pertanian, 14: 802-817.
[11] Nazir, Tiago, Ian Baker, and Ronnie Natawidjaja. 2005. Indonesia Agrubusiness Development Opportunities- Analysis of Mango Value Chain. AusAID- IPD Rural.
[12] Sanjaya, Rudi. 2015. Faktor Yang mempengaruhi Adopsi Inovasi Petani.

H.10

IDENTIFICATION OF AGRICULTURAL BUSINESS INNOVATION PROCESS FOR STRATEGIC EXPORT COMMODITY IN PT MALABAR KOPI INDONESIA THROUGH HISTORICAL ANALYSIS

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ABSTRACT

Business sector is a dynamic and changing sector. The change is triggered by tight competition that occurs due to growing competitors, increasing market demand, and technological advances. The development of agricultural business in Indonesia is inseparable from the changing process in it. Changes occurring in a system can be categorized into innovation process when it is able to produce ways, methods, behaviors, technologies, products, or patterns of management and organizational forms that can produce added value.

This study aims to identify the innovation process in PT Malabar Kopi Indonesia as the source of benchmarking for similar agricultural business processing units. This study was conducted through field observation and deep interview. The data sets were analyzed through historical analysis. All details in innovation process conducted by PT Malabar Kopi will be explained.

The results showed that the innovation process conducted by PT Malabar was divided into 4 terms, namely product innovation, process innovation, technological innovation, and organizational innovation. Product changes occurred due to the company's desire to meet the market demand and increase value-added of products. The diffusion and adoption process occurred in association with the market demand trends and the experimental process conducted independently by the company. Process changes were closely related to the type of product produced. The innovation process took place within the method resulted by the independent observation and diffusion of the existing method from outside the company. Technological changes were related to the innovation process of generating the quality and quantity of products. The innovation process occurred in discovering and designing the technology used by independent observation and adoption of existing technology. Business Organization Changes conducted by the company took market opportunities and business network expansion into account. Organizational change also occurred in the management of supporting resources organizations, i.e. farmer groups, starting from Paguyuban Forest management community into Forest Farmer Group and Cooperative Business Unit. Changes in the form of supporting organizations were conducted by considering and maintaining relationships with supplier farmers and expanding opportunities for farmers' members to access various supporting facilities of coffee cultivation activity.

Keywords: Agricultural Business, Business Innovation.

I. INTRODUCTION

A. Background

In Indonesia, agriculture sector still plays important roles in domestic economy since its role as the supplier of food for the population, raw materials for the agricultural industry, the income source for millions of farmers throughout Indonesia, and the source of foreign exchange earners after oil and gas sector. In broad terms, agricultural context includes several sub-sectors such as plantation, forestry, livestock, and fishery. One of the subsectors gaining more attention from the government was plantation sector (Ministry of Republic Indonesia, 2009).

Coffee is one of plantation commodities included in the category of Strategic Commodities in Indonesia. As the third largest coffee producing country in the world, Indonesia is able to produce at least 748 thousand tons or 6.6% of world coffee production in 2012. Moreover, the growth of consumption of processed coffee products in this country increases by an average of 7.5% per year. This increase of coffee demand in terms of both domestic and international markets has become an opportunity for coffee business in the future.

The development of coffee business in Indonesia arises within the last 15 years, indicated by the increase of coffee production, the amount of coffee exports, and the value of investments. In 2010, the production of coffee reached 554,574.00 tons, export volume 340,887 tons / year with investment value 326.256 million USD while in 2014, the production reached 685,089 tons, volume exports 534,023 Ton / year with investment 1,252,523 million USD. Thus, it shows that since the past 15 years, the production, export volume, and investment value have been considerably potential. In addition, the increase in investment value is very high because the coffee price is considered increasing relatively high as well. Based on data released by Indonesian coffee association, it is noted that the price of Indonesian coffee market in the world is classified at high rate with Arabica coffee selling value 134.3 USD per kilogram and Robusta coffee 1922.4 USD per kilogram in 2017. Therefore, it can be said that Indonesia is considerably potential to obtain financial benefits from coffee agro-industry.

The development of coffee business is inseparable from main actors within each sub-sector of coffee agro-industry, i.e. farmers, farmer groups, and coffee processing business actors. Accordingly, the number of small and medium scale coffee business actors is increasing from year to year, indicated by the increase of land area, production, and export volume. In this case, partiesalso considered important in the chain of coffee industry are farmers and coffee farmer groups (FG). It has been recorded that the presence of farmers groups in Indonesia in 2017 reached 553,289 throughout Indonesia. Of the 553,289 farmer groups, about 50,966 farmer groups of plantation commodities were recorded, including groups of coffee farmers.

Furthermore, 100% of cherry bean production is produced in rural areas. The majority of coffee processing businesses are also located in rural areas. Therefore, these strategic commodities should have a positive impact on the socio-economic conditions of rural areas' people. Pangalengan sub-district is a sub-district producing large quantities of coffee. The area of coffee planted threre is 780.3 Ha. With a total of coffee produced reaches 7,431,345 Ton / Year. Every village in Pangalengan has The Association of coffee Farmer groups under sub-district farmer group authorization. In Pangalengan, there are also many coffee processing businesses, three of which are known to carry out export activities routinely every year. This complete subsystem of coffee agro-industry from upstream to downstream in this region makes Pangalengana coffee-producing area and the largest coffee exporter in West Java.

PT Malabar Kopi Indonesia, is the largest coffee processing business unit in West Java. Established in 2005. Initially, this coffee business was categorized to household-scale coffee processing business (Small enterprise scale), Today, the company has become a coffee processing business unit that exports coffee to various countries. The development of this business is categorizedas the limited liability company (in Bahasa: *Perseroan Terbatas*), to be eligible to identify the innovation processes occured. According to Mason, Bishop and Robinson (2009), innovations have a strong correlation with business progress. The results of his research show that the more companies create innovations, the faster the companies grow. This research is intended to identify the innovation process in PT Malabar Kopi Indonesia which has progressed through a growing number of business indicators.

B. Research purposes

The purpose of this research is to identify the business innovation process conducted by PT Malabar. The process of innovation observed is innovation in products, processes, technologies, and organizations. The benefit of this study is expected to be a reference for more innovation process that may be done by similar businesses with similar system characteristics, especially in agro processing business unit in rural areas. Furthermore, the advantage of this study results is as a reference for the determination of the appropriate process approach in developing coffee processing business in the rural areas.

II. MATERIALS AND METHODS

This research is included in explorative category, since researchers observe the object directly in the field and conduct a deep interview to the related stakeholder. The data are presented through historical analysis approach. The historical analysis will describe the sequences of the process clearly, particularly, in presenting the innovation processes as the basis for process, technology and organizational changes that occur in business unit.

III. RESULTS AND DISCUSSION

The innovation process in PT Malabar Kopi Indonesia can be identified by several processes, as follows:

A. Product Changes

The main key of PT Malabar Kopi Indonesia to run its business isby adhering the principle "to meet the needs of market demand". The market has diverse in preferences. Market demand will continue to grow as technology advances.

The table below shows that the produced product is constantly changing. The product change is the resut of the market demands and readiness of production facilities and infrastructure in company. In 2014, the ompany started exporting coffee in the form of green beans to several countries. The export process is supported by the quality and quantity of coffee produced by PT Malabar. The Efforts made by the company to obtain a good quality of coffee is to maintain the quality of raw materials in the form of Chery bean for the consumer. The process of maintaining quality becomes a big challenge, since the raw material comes from coffee farmers. The process of knowledge transfer should be done by the company to coffee farmers becoming its partners as the effort to guarantee the coffee produced by themhas a good quality.

Time	2005	2009	2010	2014
Product	Chery bean	Green bean	Roasted bean	coffe instant
	Arabica			
		(Luwak)		
Alasan perubahan	increase the added value	Market expansion Product diversification		Product diversification
Dampak perubahan	scale-up business	Export activity		

Fig. 1. Historical Figure changing in product innovation

The process of product innovation occurs due to the company has a target to meet the market demand and increase the added value of its products. The process of diffusion and adoption occurs in realtion to the market demand trends and the experiment process conducted independently by the company. The process of product innovation will also affect the production process. In a coffee industry, the type of product will be produced from different types of processes. Furthermore, The Changes in process will affect the changes in technology used. Finally, product changes will affect other sub systems in coffee production system.

B. Process Change

Process Changes are related to the innovation in the production process. This process will have a direct impact on the type of coffee product produced. Within 12 years, the company has experienced various innovations. Hereby, the historical process of innovation in the production process:

Time	2009	2014	2017
Product	***Wet Process***	***Wet process 10% Dry Process 70% Honey process 10% Natural Process 10%***	***Wet process 10% Dry Process 10% Honey process 10% Natural Process 70%***
Alasan perubahan	***increase the added value Market expansion Product diversification***	***Market demand***	
Dampak perubahan	***scale-up business Export***	***Domestic market expansion***	

Fig. 2. Historical process in Process Change

Changes in the production process are related to company's decision in determining the focus of products produced based on the consideration of opportunities and market demand. At the beginning of 2009, when Malabar Indonesia coffee processing unit started processing from cherry bean to green bean, the coffee product is produced in wet process. It is based on the preferences of domestic market that tend to the wet coffee type. The company had focused on domestic market in 2009.In 2014, the Company started producing various types of coffee, i.e. about 10% of wet process , 70% of dry process, 10% of Honey process, and 10% of natural process. Dry process percentage is greater than other types of coffee. It is indicated by the export activity.The company began to export coffee to several countries. International market demand of coffee type by dry process was very high. Another 30% of coffee is produced for domestic market. Although the percentage of the amount of coffee produced for domestic market has decreased if compared to 2009, the amount is not reduced. This is due to the quantity of coffee production as a whole has increased significantly in 2014. The changes of production process can be illustrated in the following diagram :

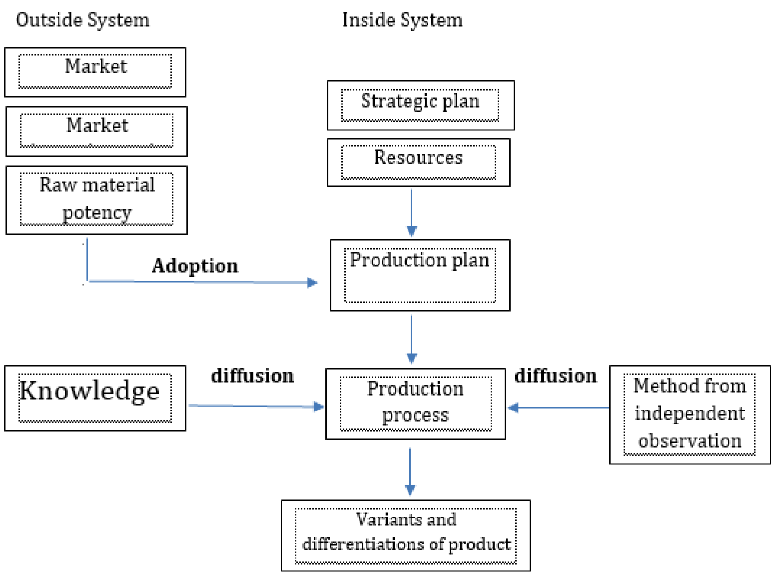

Fig. 3. Innovation in process changes

The Process change diagram above shows that the initial consideration in the innovation is market opportunity, market demand, and the potential of raw materials that can be processed. Those three external factors are adopted by the company as the consideration for product planning activity. The products planned to be produced will have an impact on the process that will be performed. In term of conducting the production process, the company performs the process of diffusion from both the outside and inside. From the outside, the new method or knowledge is associated with the production process while from the inside, the system is related to the results of independent trials conducted. The method applied always refers to the condition of resources owned by the company.

C. Technological changes

The process of technological change was following the changes in processes and products produced. The historical changes that occur are as follows:

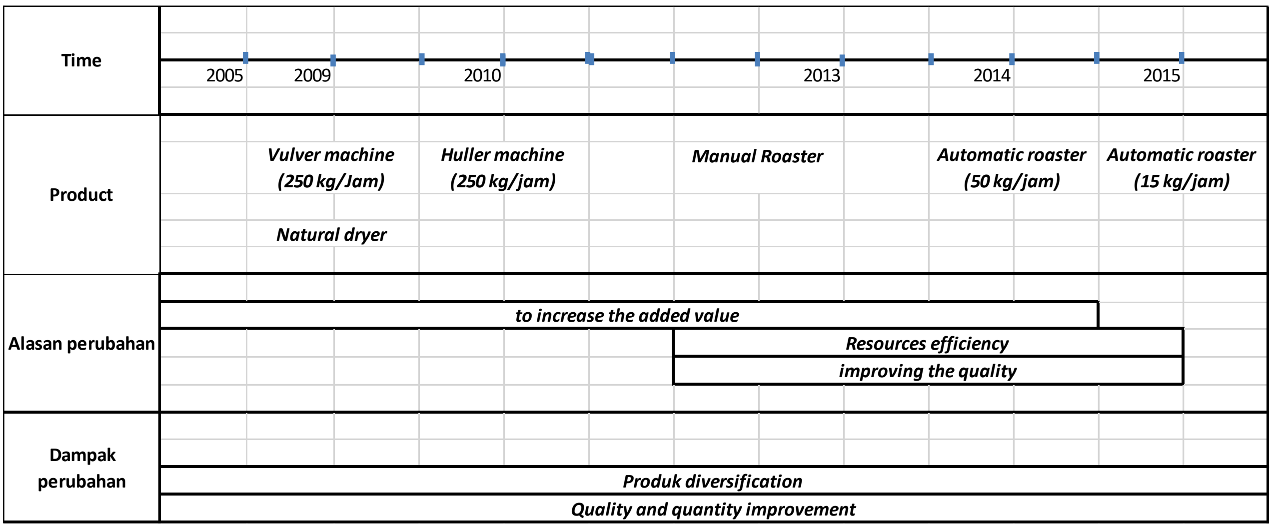

Fig. 4. Historical changes of Technology Change

Technological changes related to the innovation process for generating the quality and quantity of products. In PT Malabar Kopi Inodensia, Technological change is done gradually. It is also depend on the company's ability to provide the necessary advice and infrastructure. In 2014, the Company export products for the first time. A fundamental change is evident from the use of technology by increasing the production capacity of the equipment used. Technology adoption causes the company's ability to provide market demand.

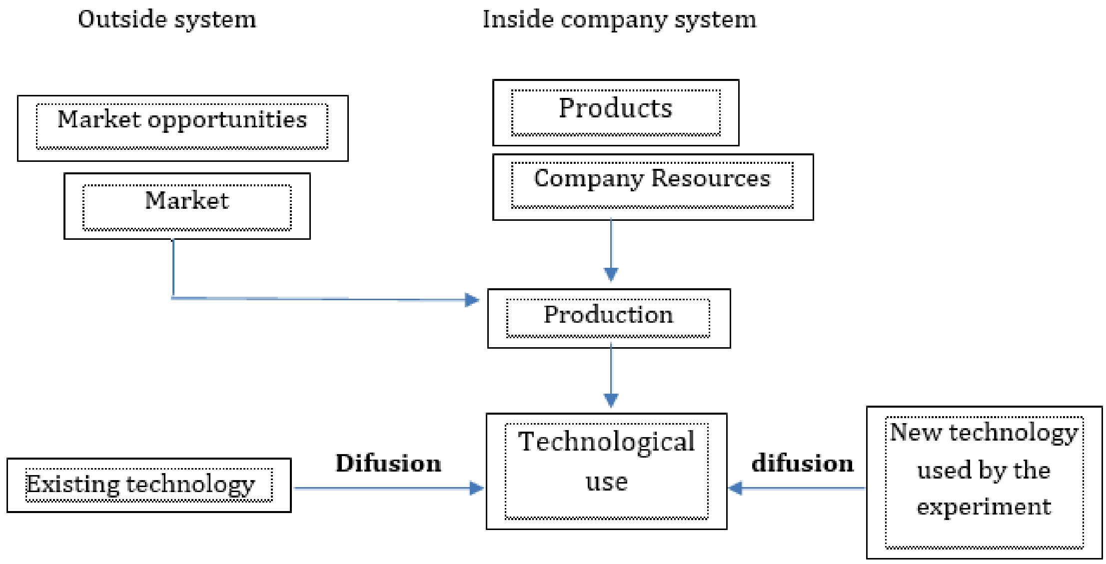

Fig. 5. Innovation in Technology Changes

D. Organization Changes

PT Malabar also experienced a change in the form of corporate organization in its business process. When it was established in 2005, PT Malabar is a coffee business unit with small scale business. As The demand is increased by the time, and raw material opportunities can be processed also developed, the business unit morphed into CV. This is done in order to be able to expand the partnership network. A successful partnership is established with the coffee exporter. In 2014 in line with the company's desire to conduct the export process independently without an intermediary buyer, then the company metamorphosed into a limited liability company (PT). The changes that occur have an impact on the networking opportunity and develop a broader business. Here is the historical change of business form.

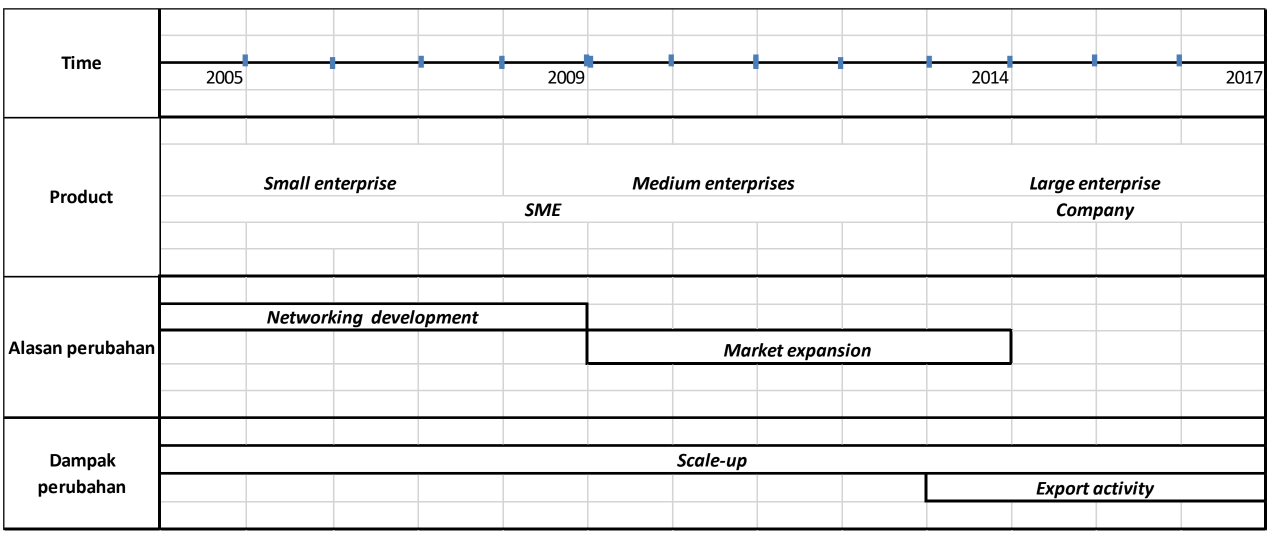

Fig. 5. Hystorical process of Organization Changes

The innovation process on Organization Changes as follows :

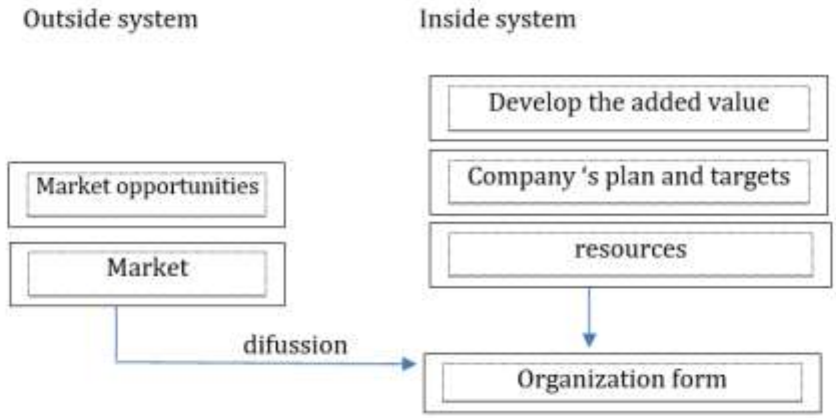

Fig. 6. The innovation process on Organization Changes

IV. CONCLUSION

1. The results shows that the innovation process conducted by PT Malabar is divided into 4 terms, namely product innovation, process innovation, technological innovation, and organizational innovation.
2. Product changes occurred due to the company's desire to meet the market demand and increasing the value-added of products. The diffusion and adoption process occurs in association with the market demand trends and the experimental process conducted independently by the company.
3. Process changes were closely related to the type of product to be produced. The innovation process takes place within the method resulted by the independent observation and diffusion of the existing method from the outside company.
4. Technological changes related to the innovation process for generating the quality and quantity of products. The innovation process occurs in discovering and designing the technology used by independent observation and adoption of existing technology.
5. Organization Changes, conducted by considering market opportunities and business network expansion. Organizational change is also accured in the management of supporting resources organizations, ie farmer groups. Starting from Pagyuban forest management community into Forest Farmer Group and Cooperative Business Unit. Changes in the form of supporting organizations are conducted by consideration of maintaining relationships with supplier farmers and expanding opportunities for farmers' members to access the various supporting facilities of the coffe cultivation activity.

REFERENCES

Mason, D., Bishop, K., & Robinson, C. 2009. *Business Growth and Innovation.* NESTA. Research report. UK.
Ministry of Agriculture RI. 2014.*Data Komoditas Perkebunan.*

H.11

FORMULATING POLICIES IN FORESTRY AND AGRICULTURAL LAND USE MANAGEMENT TO MEET FOOD SECURITY PROGRAMS AND EMISSION REDUCTION TARGET IN INDONESIA

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ABSTRACT

Food security is an essential program in Indonesia, ensuring food availability for the people across the country in the future. However, in implementing the program, the government plans to expand the agricultural areas by converting significant forest areas, which potentially results in carbon emission. Currently, Indonesia is among the countries with the highest carbon emissions in the world a result of forest land use changes. Meanwhile, Indonesia is committed to decrease its carbon emission by 29% from business as usual (BAU) by 2030. This study aims to provide insights in formulating land use policies in Indonesia to meet the emission reduction target as well as food security programs in this country. In this study, a stock difference approach from different land use types is employed to estimate the country's carbon emission based on the existing national policies on agricultural and forestry. It is also combined with gain loss approach to estimate carbon emission in peat swamp forests. To predict the carbon emission in Indonesia in the future, two scenarios are developed in this study, BAU and Conservation Scenario (CS). The study found that in the BAU scenario, a 9-million-ha rice fields expansion is estimated to results in emission 356,7 Mt CO_2-e per year by 2030, while in the CS scenario that expansion is estimated to generate emission 18,7 Mt CO_2-e. The CS scenario is mainly based on an assumption that the agricultural area expansion is accommodated from the degraded forests. This would lead to a significant reduction of carbon emission by 95% compared to BAU scenario. However, the country's land mapping need to be reconfigured because of unclear land ownership and forest boundaries. From this study, agricultural areas expansion to meet the food security program can be applied without compromising the emission reduction target in Indonesia

Keywords : food security, carbon emission, agricultural area expansion, land use change.

I. INTRODUCTION

Food security is one of the most important programs initiated by the Indonesian government to ensure food availability for all the people across country as well as anticipating increasing population in this country since 1945. To show the government's serious commitment on the programs, some national regulations have been enacted to give the legal foundations such as; Government Act No 18/ 2012 about food (Undang-undang No 18 tahun 2012 tentang Pangan); Government Regulation No. 17/ 2015 about Food Security and Nutrition (Peraturan Pemerintah No 17 tahun 2015 tentang Ketahanan Pangan dan Gizi). In addition, several institutions have been established by the government to execute programs specialized on food security. From the early of independence 1945 to 2009, there are about 405 national and local institutions established to secure food across the country [1]. Therefore, food security and its related program has always been a top priority issue in this country.

Meanwhile, Ministry of Agriculture, which is one of the institutions responsible for the food security programs in this country, plans to expand the rice field by converting 9 Mha of forest areas by 2019 [2]. The rice field expansion aims to increase food production to anticipate the country's population growth. However, the forest conversion to facilitate the rice field expansion might generate significant carbon emission to the atmosphere. This is because forests in Indonesia store significant amount of carbon in form of tree biomass and soil carbon. So, if the forests are cleared for rice field expansion, significant amount of carbon can be released to the atmosphere, resulting in greenhouse gases effect. On the other hand, as stated in the COP 21st (*Conference of Parties*) in Paris, the Indonesian government is also committed to decrease the national carbon emission by 29% from Business as Usual (BAU) scenario by 2030 as a part of the international efforts to combat climate change [3]. Therefore, the government's food security program by expanding the rice fields might contradict to the national climate change programs committed by the government because it can miss the country's emission reduction target in the future.

Indonesia is one of the largest carbon emitter countries in the world, ranked 6th in 2011 [4]. A report published by the National Council of Climate Change (*Dewan Nasional Perubahan Iklim*), DNPI and McKinsey [5] estimates that the total country's carbon emission increases from 2.1 Giga Ton (Gt) CO_2-e in 2005 to 3.3 Gt CO_2-e in 2030, with the main sources of emission are from forest land-use changes and forest fires. In this country, deforestation, which is a form of forest land-use changes, is one of major problems in the forestry sector, accounting for 6,02 Mha in the period of 2000-2012 [6]. Meanwhile, forest fires, which have been occurred since 1980s, are escalating and frequently occur due to climate change [7], [8], [9]. As a result, the Indonesian government needs to consider some policies, regulating forest land use changes as well as ensuring the country's emission reduction target for mitigating climate change. In this case, coherent policies in forest and agricultural land uses need to be formulated to prevent higher emission from agricultural expansion.

This study aims to provide insights in formulating land use policies in Indonesia to meet the emission reduction target as well as rice field expansion for food security programs in this country. This research also explores how the rice field expansion can result in significant amount of carbon emission if the expansion is conducted by clearing the forests. With this study, I would argue that degraded forest areas can be used to accommodate the rice field expansion without compromising the country's emission reduction target, so that the degraded forest area utilization become the main consideration in the policy making process in the forest land-uses in this country.

II. MATERIALS AND METHODS

A. *Estimating Carbon Emission from Forest Conversion*

The research methodology in this study is adapted from the study conducted by Nugroho [10]. Instead of 2017, We decided to start the future emission prediction in Indonesia from 2012 to 2030 because the datasets used in this study mostly discuss the forest area changes from 2000 to 2012.

Table 1. Datasets used in this research

Datasets	Descriptions	References
Total forest area changes from 2000 to 2012 in Indonesia	Research articles	[11], [6]
Land use changes in designated forest areas	Ministry of Environment and Forestry Statistics 2014	[12]
Agricultural land use changes	Ministry of Agriculture Statistics	[13], [14], [15]
Policies related to the forestry land-uses	These policies are described in the MoF Strategic Plan 2015-2019	[16]
Policies related to the agricultural land-uses	These policies are described in the MoA Strategic Plan 2015-2019	[2]
Policies related to Climate change	The Intended Nationally Determined Contribution (INDC)	[17]

In this research, there are 2 different approaches used to estimate the country's carbon emission from land use changes; stock different approach and gain loss approach. Stock difference approach is applied to estimate the total country's carbon emission as a result land use changes, particularly in primary and mangrove forests. In this approach, the amount of carbon per hectare of each type of forest is determined (table 1) then the results are multiplied with the total area changes at national scale. In this study, we use an assumption that forest conversion to the other land uses would lead to a rapid 100% decomposition of the plant biomass in the forest, which results in considerable amount of C emission to the atmosphere. This assumption is also used in a study conducted by Agus *et.al.*, [18] in which also relevant based on the IPCC guidelines. A formula to convert C biomass to the CO_2 emission is that:

$$\text{Emission} = C * 3.67 \qquad (1)$$

where

C : carbon stock in the biomass of the previous land use (Mg C/ha)

3.67 : the conversion factor from C to CO based on atomic weights of C and O of 12 and 16 g, respectively.

Basically, carbon stock in a forest ecosystem is stored in above ground (plants and litter) and below ground biomass (soil carbon). IPCC (2006) has confirmed that the default carbon storage in the plant biomass in Asian humid forests is estimated 138 Mg C/ha [27] but in this research, 300 Mg C/ha is used for primary forest carbon stock based on a study conducted by Palm and Group [20]. This is due to the wide range variation in the total carbon stock estimation in the primary forest in Indonesia. According to Agus *et.al.*, [18], the total carbon stock in primary forests in this country is ranged from 207 to 405 Mg C/ha.

Table 2. The Amount of C stock in the several land-use systems used in this study (Mg C/ha)

Land-Use Types	Min (Mg C/ha)	Max (Mg C/ha)	Source
Intact Upland	160	300	[19], [20]
Secondary upland	86	132	[21], [22]
Intact peat swamp	191	248	[23]
Secondary peat swamp	75	131	[23]
Intact mangrove	863	1,073	[24]
Secondary mangrove	690	858	[24]
Degraded forest	2	15	[18]
Agricultural areas	23.6	60	[18]
Rice fields	2.3	4.8	[25], [26]

B. Additional carbon loss in determining carbon emission from peat swamp forests conversion

Stock difference approach needs to be combined with gain loss approach to improve the accuracy in estimating carbon emission in peat swamp forests' land use changes [28]. The IPCC guidelines employs only a stock-difference approach to estimate carbon emission in the peat, which is less accurate because there is an additional carbon emission peat conversion apart from biomass loss. However, in this study, the additional carbon loss from peat conversion is only available for the conversion of peat to palm oil plantation, in which based on the research conducted by Hergoualc'h [23] it would give an additional 10.8 Mg C/ha/year from peat loss. Therefore, changes in peat swamp forest in this study are assumed to be converted to palm oil plantation due to lack of data.

C. Scenarios and assumptions used in this study to estimate future emission in Indonesia

To predict the carbon emission in Indonesia in the future, two scenarios are developed in this study; Business as Usual (BAU) scenario and Conservation Scenario (CS). In the BAU scenario, it is assumed that the rate of deforestation in the 2012 to 2030 period would be similar to that rate of deforestation in 2000s, which is 0.67 million ha/ year as reported by Wijaya [11]. Therefore, the estimation of forest loss in the 2012 to 2030 period would be 12.1 Mha. Meanwhile, it is also assumed in this study that the proportion of the deforested area in each type of forests is similar to that proportion of deforested area in the 2000-2012 period. For instance, roughly 30% of the total deforestation between 2000 and 2012 period was occurred in the peat swamp forest, therefore the same proportion of deforestation is estimated to be occurred in the type of forest in the period of 2012 to 2030.

In addition, in the BAU scenario the agricultural area expansion in the period of 2012 to 2030 is estimated at a rate of 0.616 Mha/year, which is similar to that rate of 2000 to 2012 [14,15]. This number is derived from the development of palm oil, rubber, coconut, cocoa and coffee plantation, which has grown by 7.4 Mha, instead of rice fields, which only grew by 0.6 Mha in the period of 12 years. Therefore, we estimate that the agricultural areas would expand by about 11 Mha by 2030 in this scenario.

Furthermore, it is also assumed that the deforested areas are directly converted to the agricultural areas in this study. Although a research conducted by Margono [6] has reported that forest conversion is mainly occurred in the degraded forest areas rather than in the primary forests, in the period of 2000 to 2012, when 8.04 Mha of forest are loss [11], there is an increase in agricultural areas by 7,4 Mha in the same period [14,15]. Meanwhile in the CS scenario, agricultural area expansion is accommodated from degraded forests, as a consequence, there will be no carbon emission from this activity. In addition, it is also assumed that the deforestation rate in this scenario is zero because the government is assumed to be able to solve problems related to the forest deforestation.

Table 3. Scenarios and assumptions used in this study

	Business as usual		Conservation scenario	
	Assumptions	Affected areas (ha)	Assumptions	Affected areas (ha)
Rice field expansion	Converting forest areas and degraded forests	9.000.000	Converting degraded areas	9.000.000
Agricultural area development	Expanding at a rate of 0.616 Mha/year	11.000.000	Converting degraded areas	11.000.000
Deforestation rate	Similar rate to that 2000-2012 period, 0.67 Mha/year	12.100.000	No deforestation	

III. RESULTS

A. *Business as Usual Scenario*

The results of this study are presented in the table IV to V. In the BAU scenario, a 9-million-ha rice fields expansion in Indonesia is estimated to results in a significant carbon emission rate, 356,7 Mt CO_2-e per year by 2030 (table IV). This expansion is accommodated from the conversion of intact upland and degraded forests. The highest carbon emission is resulted from the conversion of 5,8 Mha intact upland (primary forest) to rice fields, emitting carbon 350,1 Mt CO_2-e per year by 2030. The conversion of primary forest to rice field results in high carbon emission because the carbon stock per hectare stored in primary forests is significant, estimated from 160 to 300 Mg C/ha, while carbon stock of rice field is estimated from 2,3 to 4,8 Mg C/ha. Therefore, about 157.7 to 295.2 Mg C/ha is estimated to be loss as a result of the conversion of primary forest to rice field. It is assumed that in this scenario, about 50% of estimated primary forests are converted to the rice fields expansion while the other 50% of that primary forests are converted to accommodate agricultural area expansion. On the other hand, about 3,2 Mha degraded forests are converted to accommodate the rice field expansion, resulting in carbon emission 6,6 Mt CO_2-e per year by 2030. The carbon stock of degraded forests is 2 to 15 Mg C/ha, which is higher than that carbon stock stored in the rice fields. As a result, the conversion of degraded forest to rice fields also results in carbon emission to the atmosphere.

In this scenario, agricultural areas are estimated to increase by 11,08 Mha by (table 4). The increase of agricultural areas is facilitated by the conversion of intact upland, intact peat swamp secondary peat swamp, intact mangrove and secondary mangrove, which results in estimated carbon emission 538,2 Mt CO_2-e per year by 2030 in this country (table 5). The highest carbon emission is generated from the conversion of primary forest to agricultural areas, estimated at 313,3 Mt CO_2-e per year by 2030. However, the estimated carbon emission as a result of agricultural area expansion is based on an assumption that all the expanded agricultural areas are palm oil plantation. In reality, the expansion of the agricultural areas might be influenced by the global market. For example, in the period of 2000 to 2012 the palm oil plantations have expanded by almost 6 Mha [14], the highest number among the other agricultural areas. Meanwhile, cocoa plantations have only expanded by almost 1 Mha at the same period [29], which is the second highest of agricultural area expansion in this country.

In this study, forest land use changes for forest plantation and community forestry are not discussed. In addition, the allocation of 4.8 Mha of primary forests for logging concession is also not discussed, which is estimated resulting in carbon emission 164.4 Mt CO_2-e per year by 2030. The plan for allocating 4,8 Mha for logging concession is stated by in the National Forestry Planning [30]. Nevertheless, the agricultural and rice fields expansion is projected to generate significant carbon emission 1,1 Gt CO_2-e per year by 2030.

This scenario is mainly based on an assumption that the agricultural area expansion is accommodated from the degraded forests. In this scenario, the projected 9-Mha rice field expansion is estimated to generate carbon emission 18,7 Mt CO_2-e per year by 2030 (table VII). On the other hand, the 11 Mha-agricultural area expansion is estimated to sequester the carbon emission by 36,6 Mt CO_2-e per year by 2030 (table VII). As a result, the development of agricultural areas and rice fields would contribute to sequester carbon 19,9 Mt CO_2-e per year by 2030 in Indonesia. It is also important to note that the other land use changes such as; logging concessions; plantation forests; community forestry; settlement and mining; are not discussed in this study, although they might potentially produce significant carbon emission. In addition, the amount of carbon sequestered by the conversion of degraded forest to accommodate the agricultural area expansion depends on the species of plant planted in the agricultural areas. In this scenario, it is assumed that the agricultural area expansion is dominated by palm oil plantations, considering previous national trend in the period of 2000-2012.

IV. DISCUSSION

A. *How much emission reduction we can get?*

Estimated in this study, the allocation of degraded forests for accommodating rice fields and agricultural area expansion would significantly reduce the carbon emission from forestry sector in Indonesia by 2030. This can be seen in the conservation scenario, in which the 9-Mha expansion of rice fields generates carbon emission 18 Mt CO_2-e by 2030, whereas, in the BAU scenario, that field expansions are estimated to generate 0,36 Gt CO_2-e. This scenario would result in 95 % carbon emission reduction compared to BAU scenario. If the trend in the agricultural area expansion in 2012-2030 is similar to that trend of 2000- 2012 and the government accommodates this expansion by allocating the degraded forests, then the potential emission reduction increases significantly and it becomes net sink of 19,9 Mt CO_2-e. Therefore, the implementation of conservation scenario for rice field expansion in the food security program offers positive advantages in reducing the greenhouse gases in this country.

The total country's carbon emission stated in the INDC (Intended Nationally Determined Contribution) in 2030 is 2,8 Gt CO_2-e in the BAU, with 37% or 1,04 Gt CO_2-e of the total emission is from AFOLU (Agriculture, Forestry and Other Land Uses) sector [31]. Meanwhile, according to DNPI and McKinsey [5] under the BAU scenario, the total national carbon emission is estimated at 3,2 Gt CO_2-e in 2030, including emission from peat and land use change and forestry (LULUCF) 1,6 Gt CO_2-e. The DNPI and McKinsey [5] emission prediction assumes about 21-28 Mha forests are loss by 2030 to accommodate pulpwood plantation (6-8 Mha), palm oil plantation (5-7 Mha), and

Croplands (10-13 Mha), with the total carbon emission from these forest losses is 670 Mt CO_2-e. The amount of carbon emission as a result of 21-28 Mha forests loss is relatively low, however, the estimates from DNPI and Mc Kinsey is calculating emission from peat separately, estimated 972 Mt CO_2-e by 2030. In addition, in this report, the BAU scenario estimation for cropland development (10-13 Mha) is larger than that rice field expansion estimation in this study (9 Mha) but the report includes potential absorption from forest plantation development and reforestation, which are not included in this study.

B. Optimizing forest degraded area to accommodate rice fields and agricultural area expansion in Indonesia

One of the main strategies to significantly reduce carbon emission in Indonesia is optimizing the existing degraded land for facilitating rice field and agricultural expansion in the future followed by halting deforestation and forest degradation for the remaining forests in this country. However, there are inconsistencies in mapping the degraded areas as a result of discrepancies in defining the degraded areas. Data from the Forestry Statistics 2015 published by the Ministry of Environment and Forestry [32], reveals that there are 19,5 Mha critical forest areas and 4,7 Mha very critical forest areas in 2015, whereas, the same report also reveals that about 32,6 Mha of designated forest areas are un-forested or uncovered by vegetation. Meanwhile, data from the previous edition, Forestry Statistics 2012 [33], shows that the degraded forest areas in 2012 were about 27,3 Mha, while the un-forested forest area accounted for 41,2 Mha. On the other hand, forest rehabilitation programs in the period of 2011-2015 accounts for total of about 4,6 Mha, including 2,01 Mha rehabilitation program conducted in the community forestry [32]. Nevertheless, the degraded forest areas in this country are still significant, offering for low carbon development after re-mapping and re-allocation programs.

The main reasons why the existing degraded forest areas are used to accommodate rice fields and agricultural area expansion is that it results in low carbon emission as well as supporting food security programs in Indonesia. These areas expansion is also essential for supporting the country's economic development. However, there are several constraints to allocating the degraded forests for accommodating the rice fields and agricultural area expansion; land tenure; and time inefficiency in formulating policy and regulations. Land tenure is one of the most complex problems in this country. This problem causes unclear land ownerships and forest boundaries in Indonesia [34]. This is due to overlapping authority of institutions that manage land ownership in Indonesia; National Land Agency (BPN/ Badan Pertanahan Nasional), Ministry of Forestry, and Ministry of Agriculture. Each of the institutions has produced maps, which are not coherent. Nevertheless, the government has started the "One Map Policy Program" to create a single map to overcome land use and ownerships problems in this country. When the program is accomplished, Indonesia would have accurate maps that helps the land use management in this country, including re-allocation degraded forests.

The other problem in allocating the degraded forests for accommodating the rice fields and agricultural area expansion is time inefficiency in formulating policy and regulations. Since re-allocating the degraded forest for the other land-use needs some policy formulations for the legal foundation between Ministry of Forestry and the National Land Agency, policy making process is essential in supporting the program. This means that when the time for formulating policies is too long then the reallocation can be delayed, which in turn the emission reduction target is unachievable. For example, Samadhi [35] reported that the estimated time to re-allocating forest land uses is 6 years, not to involve time spent for discussion and making agreement with the house of representatives (DPR/ Dewan Perwakilan Rakyat). Based on information in the Forestry Statistics report published by the Ministry of Environment and Forestry [32], there are about 6,7 Mha primary and secondary forest in the Convertible forests, a type of forest area dedicated for conversion to other land-uses such as; settlement, agriculture etc. The report also reveals that there are about 7,6 Mha primary and secondary forest in the APL (Areas for other land-uses), areas managed by BPN. As a consequence, some policies need to be formulated to prevent forest conversion in these types of areas.

V. CONCLUSION

In conclusion, clearing the forests for accommodating the rice field expansion is potentially result in significant amount of carbon emission. However, Indonesia can still meet the 29% emission reduction target by 2030 from the BAU scenario, as well as ensuring the food security program by 9 Mha rice field expansion. The main policy to achieve this is to utilize the degraded forest areas for accommodation the rice field expansion and also the agricultural area expansion as well. As shown in the conservation scenario, the use of degraded forest areas for the rice field and agricultural area expansion can potentially reduce 95 % carbon emission reduction compared to BAU scenario in this study. However, there are some potential problems need to be addressed to achieve this; land tenure; and time inefficiency in formulating policy and regulations.

Table 4. Transition matrix of forest conversion to rice fields and agricultural areas in Indonesia by 2030 in the business as usual scenario

Types of forest	Intact Upland (x 1000 ha)	Secondary upland (x 1000 ha)	Intact peat swamp (x 1000 ha)	Secondary peat swamp (x 1000 ha)	Intact mangrove (x 1000 ha)	Secondary mangrove (x 1000 ha)	Degraded forests (x 1000 ha)	Rice fields (x 1000 ha)	Agricultural areas (x 1000 ha)	Forest area in 2012 (x 1000 ha)
Intact Upland	26.33355	1.430,5						5.816,9	5.736,1	39.318
Secondary upland		37.972								37.972
Intact peat swamp			4.397,2						986,8	5,384
Secondary peat swamp				2.841,7					3.831,3	6.673
Intact mangrove					1.183				354,9	1.538
Secondary mangrove						1.234			172,9	1.407
Degraded forest							37.982,7	3.183,1		41.165,7
Total forest area in 2030	26.333,5	39.402,5	4.397,2	2.841,7	1.183	1.234	37.982.7	9.000	11.082,1	

Table 5. Transition matrix of carbon emission per year estimated from forest conversion to rice fields and agricultural areas in Indonesia by 2030 in the business as usual scenario

Types of forest	Intact Upland (Mt CO_2-e)	Secondary upland (Mt CO_2-e)	Intact peat swamp (Mt CO_2-e)	Secondary peat swamp (Mt CO_2-e)	Intact mangrove (Mt CO_2-e)	Secondary mangrove (Mt CO_2-e)	Degraded forests (Mt CO_2-e)	Rice fields (Mt CO_2-e)	Agricultural areas (Mt CO_2-e)	Total emission (Mt CO_2-e)
Intact Upland		-49,0						-350,1	-313,3	-583,3
Secondary upland										
Intact peat swamp									-43,5	-45,2
Secondary peat swamp									-76,9	-76,9
Intact mangrove									- 75,3	-76,6
Secondary mangrove									- 29,1	-29,8
Degraded forest								-6,6		
Total		-49,0						-356,7	-538,2	-943,9
Peat loss emission										-171,5
Total country's emission										-1115.4

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REFERENCES

[1] Badan Ketahanan Pangan. Sejarah Badan Ketahanan Pangan Jakarta: Badan Ketahanan Pangan 2013 [Available from: http://bkp.pertanian.go.id/statis-11-sejarah.html.

[2] Ministry of Agriculture. Rencana Strategis Kementerian Pertanian tahun 2015-2019 (Strategic Planning of Ministry of Agriculture 2015-2019) Jakarta: Ministry of Agriculture; 2015

[3] UNFCCC. Paris Climate Change Conference - November 2015 Bonn, Germany: United Nations Framework Convention on Climate Change; 2014 [Available from: http://unfccc.int/meetings/paris_nov_2015/meeting/8926.php.

[4] Ge M, Friedrich J, Damassa T. 6 Graphs Explain the World's Top 10 Emitters Washington DC, USA: World Resource Institute (WRI); 2014 [Available from: http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters.

[5] DNPI, McKinsey. Indonesia's Greenhouse Gas Abatement Cost Curve. Jakarta, Indonesia: Dewan Nasional Perubahan Iklim (National Council on Climate Change), 2010.

[6] Margono BA, Potapov PV, Turubanova S, Stolle F, Hansen MC. Primary forest cover loss in Indonesia over 2000-2012. Nature Climate Change. 2014;4(8):730-5.

[7] Malingreau JP, Stephens G, Fellows L. Remote Sensing of Forest Fires: Kalimantan and North Borneo in 1982-83. Ambio. 1985;14(6):314-21.

[8] Harrison ME, Page SE, Limin SH. The global impact of Indonesian forest fires. Biologist. 2009;56(3):156-63.

[9] Harris N, Minnemeyer S, Stolle F, Payne AO. Indonesia's Fire Outbreaks Producing More Daily Emission than Entire US Economy Washington, USA: World Resource Institue; 2015 [Available from: http://www.wri.org/blog/2015/10/indonesia%E2%80%99s-fire-outbreaks-producing-more-daily-emissions-entire-us-economy.

[10] Nugroho A. Policy options for meeting climate change mitigation, forest conservation and economic development in Indonesia [Environmental Research Project]. Melbourne, Australia: University of Melbourne; 2016.

[11] Wijaya A, Budiharto RS, Tosiani A, Murdiyarso D, Verchot L. Assessment of Large Scale Land Cover Change Classifications and Drivers of Deforestation in Indonesia. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences. 2015;40(7):557.

[12] Statistik Kementerian Lingkungan Hidup dan Kehutanan Tahun 2014 (Statistics of Ministry of Environment and Forestry 2014) [Internet]. Ministry of Environment and Forestry. 2015. [cited 15 February]. Available from: http: // www.menlhk.go.id/downlot. php?file =STATISTIK_2014.pdf.

[13] Ministry of Agriculture of Indonesia. Statistik Lahan Pertanian Tahun 2009-2013 (Statistics of Agricultural Land 2009-2013) Jakarta, Indonesia: Pusat Data dan Sistem Informasi Pertanian Sekretariat Jenderaal Kementerian Pertanian (Center for Agriculture Data and Information System - Secretariat General Ministry of Agriculture). 2014 [Available from: http://www.pertanian.go.id/file/Statistik_Lahan_2014.pdf.

[14] Directorate General of Estate Crop. Statistik Perkebunan Indonesia: Kelapa Sawit 2013-2015 (Indonesia Tree Crop Estate Statistics: Palm Oil 201-2015) In: Ministry of Agriculture, editor. Jakarta, Indonesia: Ministry of Agriculture. 2014.

[15] Directorate General of Estate Crop. Statistik Perkebunan Indonesia: Karet 2013-2015 (Indonesia Tree Crop Estate Statistics: Rubber 2013-2015). In: Ministry of Agriculture, editor. Jakarta, Indonesia: Directorate General of Estate Crop. 2014.

[16] Ministry of Environment and Forestry. Rencana Strategis Tahun 2015-2019 Kementerian Lingkungan Hidup dan Kehutanan (Ministry of Environment and Forestry Strategic Plan 2015-2019). In: Agriculture Mo, editor. Jakarta, Indonesia: Ministry of Forestry; 2015.

[17] UNFCCC. Report on Sources of Support for the Preparation of Intended Nationally Determined Contributions (INDCs) Bonn: UNFCCC; 2014 [Available from: http://unfccc.int/files/focus/mitigation/application/pdf/support_for_indcs.pdf.

[18] Agus F, Runtunuwu E, June T, Susanti E, Komara H, Syahbuddin H, et al. Carbon dioxide emission in land use transitions to plantation. Jurnal Litbang Pertanian. 2009;28(4):119-26.

[19] Baccini A, Goetz S, Walker W, Laporte N, Sun M, Sulla-Menashe D, et al. Estimated carbon dioxide emissions from tropical deforestation improved by carbon-density maps. Nature Climate Change. 2012;2(3):182-5.

[20] Palm CA, Group ACCW. Carbon sequestration and trace gas emissions in slash-and-burn and alternative land-uses in the humid tropics: ASB Coordination Office, ICRAF Nairobi, Kenya; 1999.

[21] Roshetko JM, Delaney M, Hairiah K, Purnomosidhi P. Carbon stocks in Indonesian homegarden systems: Can smallholder systems be targeted for increased carbon storage? American Journal of Alternative Agriculture. 2002;17(03):138-48.

[22] Brearley FQ, Prajadinata S, Kidd PS, Proctor J. Structure and floristics of an old secondary rain forest in Central Kalimantan, Indonesia, and a comparison with adjacent primary forest. Forest Ecology and Management. 2004;195(3):385-97.

[23] Hergoualc'h K, Verchot LV. Stocks and fluxes of carbon associated with land use change in Southeast Asian tropical peatlands: A review. Global Biogeochemical Cycles. 2011;25(2).

[24] Murdiyarso D, Donato D, Kauffman JB, Kurnianto S, Stidham M, Kanninen M. Carbon storage in mangrove and peatland ecosystems: a preliminary account from plots in Indonesia. 2009.

[25] Noor'an RF, Jaya INS, Puspaningsih N. PENDUGAAN PERUBAHAN STOK KARBON DI TAMAN NASIONAL BROMO TENGGER SEMERU. Media Konservasi. 2016;20(2).

[26] Rakhmawati M. Pemanfaatan Citra Landsat untuk Estimasi Biomassa Atas Permukaan dari Berbagai Penutupan Lahan dengan Pendekatan Indeks Vegetasi (Studi Kasus Kabupaten Mamuju Utara, Sulawesi Barat). Bogor: Institut Pertanian Bogor; 2012.
[27] Lasco RD. Forest carbon budgets in Southeast Asia following harvesting and land cover change. SCIENCE IN CHINA SERIES C LIFE SCIENCES-ENGLISH EDITION-. 2002;45(SUPP):55-64.
[28] Murdiyarso D, Hergoualc'h K, Verchot L. Opportunities for reducing greenhouse gas emissions in tropical peatlands. Proceedings of the National Academy of Sciences. 2010;107(46):19655-60.
[29] Directorate General of Estate Crop. Statistik Perkebunan Indonesia Kakao 2013-2015. Jakarta, Indonesia: Ministry of Agriculture, 2014.
[30] Ministry of Forestry. Rencana Kerja Kehutanan Tingkat Nasional Tahun 2011-2030 (Forestry National Work Plan 2011-2030). In: Forestry Mo, editor. Jakarta, Indonesia: Ministry of Forestry; 2011.
[31] Tumiwa F, Imelda H. A Brief Analysis of Indonesia's Intended Nationally Determined Contribution (INDC). Indonesia: Institute for Essential Services Reform (IESR), 2015.
[32] Ministry of Environment and Forestry. Statistics of Ministry of Environment and Forestry 2015. In: Pusat Data dan Informasi, editor. Indonesia: Ministry of Environment anf Forestry; 2016.
[33] Ministry of Forestry. Statistik Kehutanan Indonesia 2012 (Forestry Statistic Indonesia). In: Forestry Mo, editor. Jakarta, Indonesia: Ministry of Forestry; 2013.
[34] Wibowo A, Giessen L. Absolute and relative power gains among state agencies in forest-related land use politics: The Ministry of Forestry and its competitors in the REDD+ Programme and the One Map Policy in Indonesia. Land Use Policy. 2015;49:131-41.
[35] Samadhi N. Tata Ruang Indonesia untuk Pembangunan Rendah Karbon (Spatial Governance for Low Carbon Development in Indonesia) Indonesia: World Resource Institute Indonesia; 2016 [Available from: http://www.wri-indonesia.org/id/node/41065.

H.12

URBAN FARMING: A POLITICAL PERSPECTIVE (A CASE STUDY IN BANDUNG CITY)

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ABSTRACT

Urban farming has been known widely as a trending alternative solution to tackle urban food insecurity issues around the world. In Bandung City, Indonesia, the city government has been projecting urban farming program called "Kampung Berkebun" since 2014, which involves volunteers to educate citizens, cooperating with civil organizations, and growing resident-based urban farming communities. However, the sustainability of these practices is being questioned. This paper aims to provide socio economic analysis in order to show the other side of perspective, constructive critics so that the government can perform better in promoting urban farming. The study was a qualitative study, departing from constructivism paradigm. Quantitative and qualitative data were collected through interviews with key informants (govt. officers, farmers, academicians, private sectors), and literature study. In recent development, the result shows good signs. Many people are become aware to provide their own healthy food sources as well as restoring environmental quality around their residence. Despite those positive impacts, we found that most of urban farmer exercise hydroponics method, which is still less efficient because of its high cost and limited production capacity. However, there would be a glimpse prospect to make urban farming project more feasible if the city government and communities make it integral with the urban economy system.

Keywords : urban farming, food security, city environment, urban movement, Bandung.

I. INTRODUCTION

According to the United Nations Habitat [1], 54% of the world's population were living in urban areas in 2016, and is predicted to rise by 12% by 2050. This means that the food demand in the cities is not going to be declining in the future. While in rural areas, where food is mostly produced, agriculture sector is faced with hindrances and complexities, restricting and/or even threatening its future. Agricultural modernization keeps giving hopes on tackling these threats, however, so far, we have seen many failures in its implementation. As stressed by Nugraha [2], "agricultural modernization has always been seen as the solution to the problems in agriculture, which are mostly caused by external 'squeeze', which ironically emerged as part of the modernization itself.

This article would like to highlights current approach in tackling food security issues by dragging the production to consumption areas, namely 'urban farming'. This effort is projected to become an alternative movement to improve low class population welfare in the urban areas, especially in third-world country cities such as: Accra, Nairobi, Lima, Bangalore, Zimbabwe, Ghana, Bukrina Faso, and many others. The citizen of those cities relies on urban farming activities in order to fulfil their needs and increase their income [3], [4], [5], [6], [7].

Urban farming activities sure have great potentials, ranging from increasing incomes and food security, to improving cities environment. Naturally, urban farming activities integrate economical aspects to ecological system of urban areas [8]. Urban farming is mainly supported by community based agriculture. Smith & Bailkey [9] stated that community based urban farming activity is a place that is potential to develop grassroot community, which is able to provide transparency, dignity, and achievements that would be difficult to attain otherwise. Furthermore, the community provides access to agricultural inputs, so that it is easier to get, and acts as net of knowledge, thus, reducing production costs by applying technologies [10].

In Indonesia, this activity also becoming more and more popular in recent years. Bandung is one of the largest cities in Indonesia, which is located in West Java highlands. Thus, making it geographically feasible to farm vegetables, which are considered to have higher value than food crops in urban areas. Making it to seem even more viable to achieve the goals of increasing low class urban population's welfare.

Urban farming in Bandung as in many other cities in the world, started as grassroot, community based activities. In its journey, the government started to notice its potentials and put some efforts and investment in order to develop urban farming. The development was based on International Centre for Sustainable Cities (ICSC) model, which integrates multi sectoral involvement in the approach. This approach mixes top down style, which were conducted by government-private sector collaboration; and bottom up style, which emerged from communities in the grassroot level. Moreover, there are side communities who provide cutting edge knowledge, ideas and technologies in order to continuously develop the efficiency of urban farming activities. When this process is able to be maintained to reach its success point, ideally, the program has to be upscaled to other areas, locally, nationally, or even internationally [11]. As a result, those collaboration initiated a large scale urban farming program in Bandung city area called '*Kampung Berkebun*', which is literally translated to Farming Village. This program has been running for more than 3 years in Bandung, aiming to promote urban farming as a way to increase the city's food supply and raise its environmental condition.

The question is, is the program on the right track in reaching its goals? Or is it just temporary hobby that bloomed in the society, which has no future unless different efforts were to be made? Those are no easy questions that can be answered in a single small study. Thus, this paper aims to contribute by providing political standpoints (critiques) towards urban farming program in Bandung, especially from the social economic feasibility perspectives of the actors.

II. MATERIALS AND METHODS

The study was a case study, this was done due to the limited information about the size population of sample that meets the requirements. Aside of that, case study allows the study to gain deeper information regarding the issues, allowing various data to be gathered.

This paper heavily utilises actors' perspectives in providing descriptive analysis of the situation. As for complementary quantitative data, this paper uses value creation analysis to address economic related matters. This value creation analysis however, is a simplified form of value chain analysis. The tools were adapted to the needs of this study.

In depth and semi structured interviews were conducted to key informants ranging from farmers, community leaders, government representatives, middlemen, and academicians in order to grasp wholistic data. Value chain mapping was then done to get representatives of actors ranging from farmers, to middlemen, to retail/food sellers. This was done in order to gather the value creation process in the chain, which is important in understanding various inputs and services, that have role in growing, changing, or procuring new values of products. Aside of that, value chain information can be used as references in making improvements of services in business environment [12].

III. RESULTS AND DISCUSSION

A. Social Perspective

To define urban farming practitioners in the city of Bandung requires its own construction because there are several groups of actors who are equally often called or call themselves as community. Based on the results of field studies, there are three types of grouping or community of urban farming in Bandung. First, the grouping consisting of urban residents conducting gardening activities based on the domestic environment. The groups of citizens are doing urban farming activities collectively driven by programs related to urban farming. Members of this group usually consist of mothers in the neighbourhood and make gardening or cultivation as an activity to support the local government's program, self-supporting food environment, and group economic empowerment. Urban farming groups that are tied to the domestic environment are distributed by administrative territory. Almost every RW in Bandung City has urban farming group.

The government supported communities indirectly fosters territorial sensitive communities. Urban farming implementing groups are not only doing cultivation activities, but they are also concerned with the preservation of the surrounding environment. By making the spaces around the residences residents as urban farming area. They try to make the environment look beautiful with various plants.

The community was founded based on the same interests, namely developing urban farming for food self-sufficiency and improving people's welfare. They are more suitable to be called volunteer communities. Most of the perpetrators come from the young, i.e. students, university alumni, and workers aged under 40 years. They are formed from interactions in cyberspace. Social media networks, such as Facebook and Twitter are the mediums where they meet, interact, and spread the notion of urban farming. The members of this community consist of various backgrounds and territorial origin. There are from outside the city of Bandung, students' immigrants, and citizens of Bandung itself. They are not tied to an area, but more united by a particular vision and orientation in urban farming. The existence of these groups is independent, relatively freer from urban government program intervention. Therefore, some of them are often critical of urban farming program initiated by Bandung City Government. However, they are also cooperative with any party, including with the government. They are often invited to work together by the Department of Agriculture and Food Security Bandung City in implementing programs such as Bandung Gardening. The targets of their activities are broader than the domestic community. They aim to build an independent community in the provision of food, able to provide cheap food, and realize the importance of food health aspects. Therefore, the target of this community is not only the people in Bandung, but also the people around Bandung (hinterlands). Some communities involved in this category include *Bandung Gardening, Agritektur, Bandung Green Education, and Thousand Gardens*.

There are also interest-based communities who have entrepreneurial motivation. These communities are managed by business actors whose fields are related to urban farming. They usually start from a hobby, then move on to business level. Some do business as a side income and some do so as the main livelihood. Social relationships that apply in this community not only share the knowledge of urban farming, but also contains commercial elements. Members who are just studying urban farming will be advised to purchase equipment, seeds, seeds, fertilizers and other equipment from the community management. The purpose of the entrepreneurial community, in addition to providing education about urban farming to the citizens of the city, also develop their business both individual and group. Some communities that are categorized as entrepreneurship include *Learning Hydroponics, SiS Bandung, Aspartan, Rengganis, Kebon Bibit, and Usaha Tani Mandiri*.

Certain categorizations above have shaded and interrelated. Some similarities of the communities above, among others, first, that they are formed and developed based on the social activism of its members. They have the awareness to act collectively in order to make changes for the better Bandung. Second, they use their knowledge capacity to achieve that goal. Members of the urban farming community float their knowledge through the Internet and Computers, conduct their own experiments, and such knowledge to others. The high educational background, the average college graduate, makes it easier for them to digest and develop knowledge about farming spread over the Internet. The participants act as amateurs in gardening. Those who deepen agricultural knowledge can act like professionals.

B. Economic Perspective

While urban farmers are commonly subsistent farmers, using their product only for their own family consumption, there are also farmers who have entrepreneurial characteristics, selling their products to markets. Several market chains were identified in Bandung urban farming activities during fieldwork: a) Farmers – Middle man – Retailers – Consumers, this chain is very similar to normal market chain in any agribusiness model, and is the most practiced in the society; b) Farmers – Horeca (Hotel, Restaurant, Catering, etc.), only very few farmers who have direct access to sell their products to end sellers that are on this chain; and c) Farmers – Retailers – Consumers, also very few were identified in the field, but they are mostly community based retailers who are also part of the farming community, albeit, they procure some margins from the chain. Based on the fieldwork, urban farmers in Bandung mostly grow leaf based vegetables, decorative plants, and fruits i.e. water spinach, lettuce, rose, orchid, and melon. This was due growth environment requirements of those plants that are relatively feasible to be cultivated in Bandung area, with small-scaled hydroponics farming. Unfortunately, these commodities require more capital to grow than its selling price, which is determined by the market. For example, the average production cost for decorative plants for one season (avg. 2 months) is Rp.17,995,000, covering pre-planting preparation, maintenance, cultivation, harvesting, post-harvest, and transportation costs. In one season, the productivity is limited to 800 plants, with assumed depreciation of 10%, leading to total production of 720 plants. The calculation shows that in order to make one full grown decorative plant, it needs Rp.24,993, albeit, the plants were sold at Rp.6,000 per item, which means that the farmers are unconsciously suffering a loss. However, since most of them didn't count the investment and fixed costs, they did not realize it.

Table 1. Financial analysis for decorative plants farm

Appearance (in Time New Roman or Times)		
Variable	Per Season (Rp. /Season)	Annually (Rp. /Year)
Investment	1,726,667	10,360,000
Fixed Cost	11,141,667	66,850,000
Production Cost	5,126,667	30,760,000
Total	17,995,000	107,970,000
Selling	4,320,000	25,920,000
Margin	-13,675,000	-82,050,000

As seen on Table 1., the margin for decorative plants, which is considered to have highest value over others, still suffered heavy loss. The average loss reached Rp.13.6 million per season, which if accumulated in one year, it reached a staggering Rp.82 million. However, most of the farmers are not able to see this loss, as the cost of investment and production came from the program. This is not to say that it is fine to let it like what it is, but they have to realize it as soon as possible. Our calculation shown that the investment of buildings and tools will degenerate and have to be renewed in 10 years. That said, if they want to sustain their farm for a long term, they actually have to save some of the money generated by their farm to be put for the next investment. Unfortunately, these thoughts never came to them, as most of them took the program for granted.

The calculation above is of course hard to understand from economic perspective. Compared to rural agriculture, urban farming costs way more, but at the same time, has to follow the rule of market to where its selling the products. Different markets also did not have much impact on the margins received by producers. This is due to the overly high production costs.

This shows that the urban farmers in Bandung city have non-monetary motivation. The sense of community, hobbies, and environmental responsibilities are most likely to be some of main motivations. However, this fact can't be seen in a one-sided perspective, since for them, those motivations have more value than monetary gains. Furthermore, this is to say that with the presence of such communities who care about their city, there are still hopes in the future of city planning and development.

IV. CONCLUSION

Urban farming in its roots are intended for subsistent style of farming, due to its small-scale characteristic. However, in its process of development, a shift of subsistent farming to a monetarily oriented farming, which also initiated not only from grassroots level but also from government and other actors, had been somewhat contradictory. Ploeg [13] stated that one of entrepreneurial farming characteristics is the effect of scale to efficiency in order to generate more profit. That said, the larger the scale, the easier it is to maintain efficiency (e.g. mechanization, bulk input procurement, high production, etc.). This is of course contradictive to the limited scale of urban farming. In our cases, high technology application requires high amount of investment, albeit, the production is limited by its scale. This can be seen in the value analysis of one of the products produced by urban farmers in Bandung, which shows that the business is far from healthy with continuous negative margin in every season throughout a year. Thus, this fact supports the claim that monetary gains is not the main motive of Bandung urban farmers. They do it more as hobby, or as a media to enhance the sense of communal, increasing social cohesion within the community. Some remarks that we would like to suggest are that urban farming development and promotion concepts have to be rethought by the government and/or any other non-governmental organizations in order to make it more economically feasible, so it will become accessible by the first targeted beneficiaries (low-income population).

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REFERENCES

[1] UN Habitat, 2016. World Cities Report 2016: "Urbanization and development, emerging future". United Nations Human Settlements Programme. http://wcr.unhabitat.org/main-report.

[2] Nugraha, Adi. 2015. "Bhinéka: An Ethnography Study of Farming Style in Gianyar, Bali, Indonesia." Master Thesis, Wageningen University.

[3] Prain, G., & Dubbeling, M. (2011). Urban Agriculture: A Sustainable Solution to Alleviating Urban Poverty, Addressing the Food Crisis, and Adapting to Climate Change (Synthesis Report). Leusden: RUAF Foundation.

[4] Djurfeldt, A. A. (2014). "African Urbanization Trends and Implications for Urban Agriculture," Urban and Peri-urban Agriculture for Food Security in Low-income Countries – Challenges and Knowledges Gaps (Editor: Ulf Magnusson & Kristin Follis Bregman). SLU-Global Report 2014 (4).

[5] Pedzisai, E., Kowe, P., Matarira, C. H., Katanha, A., & Rutsvara, R. (2014). "Enhancing Food Security and Economic Welfare through Urban Agriculture in Zimbabwe," Journal of Food Security, Vol. 2 (3), pp. 79-86.

[6] Bellwood-Howard, I., Haring, V., Karg, H., Roessler, R., Schlesinger, J., & Shakya, M. (2015). Characteristic of Urban and Peri-urban Agriculture in West Africa: Result of an Exploratory Survey Conducted in Tamale (Ghana) and Ouagadougou (Bukrina Faso). Colombo, Sri Lanka: International Water Management Institute (IMWI Working Paper 163)

[7] Lagerkvist, C. J. (2014). "Economic Drivers for Urban and Peri-urban Agriculture," Urban and Peri-urban Agriculture for Food Security in Low-income Countries – Challenges and Knowledges Gaps (Editor: Ulf Magnusson & Kristin Follis Bregman). SLU-Global Report 2014 (4)

[8] Mougeot, L. J. (2000). "Urban agriculture: definition, presence, potentials and risks," Growing cities, growing food: Urban agriculture on the policy agenda, pp. 1-42.

[9] Smith, J., & Bailey, M. (2006). "Urban Agriculture and the Building of Communities," Cities Farming for the Future: Urban Agriculture for Green and Productive Cities (Edited by Rene van Veenhuizen). Philippines: ETC – Urban Agriculture.

[10] Peter, D., & Olde, E, d. (2014). "Urban Landscape Transitions: Analyzing Urban Agriculture Initiatives in Four European Cities," Council of Educators in Landscape Architecture, March 2014 (Conference Paper).

[11] Seymoar, N-K., Ballantyne, E., & Pearson, C. J. (2010). "Empowering Residents and Improving Governance in Low Income Communities Through Urban Greening," International Journal of Agricultural Sustainability, 8 (1&2), p. 26-39.

[12] Webber, CM. & Labaste, P. 2010. "Building Competitiveness in Africa's Agriculture: a guide to value chain concepts and applications". The World Bank, Washington, DC.

[13] Ploeg, JD Van der. 2012. "The Genesis and Further Unfolding of Farming Styles Research." Pp. 427–39.

H.13

THE POTENTIAL OF SUSTAINABLE URBAN FARMING DEVELOPMENT

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ABSTRACT

Urban farming is a practice of plant cultivation within or around urban area by applying skill, competence, and innovation through the utilization and recycle of resources as well as municipal solid waste (urban waste) in an agricultural activity. Urban farming is a solution to meet the need for food, to produce oxygen, and to improve environmental quality and aesthetics in the urban area. An increase in population growth results in decreased urban land area. Conversion of agricultural land into settlement area generally occurs in the urban area due to the pressure of development. Land resources, space and human resources in urban areas function as potential to develop modern farming. Development of urban farming is done by utilizing the potential of available land including the land of settlement area, yard, roofs of building, side of public roads and river banks. Urban farming is an effort to meet the need of urban communities for food while improving their welfare and creating sustainable and environmental urban development. This paper aimed to describe the management of environmental and sustainable urban farming.

Keywords: Agriculture, Urban, Land, Sustainable.

I. INTRODUCTION

The number of population living in urban area continues to increase; therefore, as the needs for food of the community also increase, urban area is unable to supply the need for food of urban communities, resulting in dependence of urban area on other regions, particularly rural area. Acceleration of urbanization and urban development such as in the Special Capital Region of Jakarta will certainly create various problems. Significant increase in urban population which is not supported and compensated by enough supply of food, employment, housing, facilities and infrastructure, law enforcement officer, etc. becomes problems to be properly solved (Cahya L.D 2014). Hence, communities have desire to meet the need for food independently through the development of urban farming by utilizing the potential of available land, both in the form of residential land, yard, roofs, public roadside and riverside.

Urban farming is a result of interaction between factors of the width of yard, the development of commodity and environmentally friendly agricultural technology, agricultural extension and institution, the width of farm area, cooperation between stakeholders, and provision of incentive/compensation. The condition of urban area is already an agroecosystem which is significantly different from agriculture in rural area (Sampeliling*et al* 2012). Urban life which is often considered as the reason of declining environmental quality may due to the fact that urban area tends to have a harmful effect on environment such as high amount of household waste produced. However, it is also possible for urban area to provide environmental sustainability compared to rural area since urban area has capital in great quantity mainly as a result of environmental payment services of company and human resource to create sustainable environmental improvement. Agriculture in Indonesia is indicated as a situation in which farm land continues to be in critical condition due to excessive and rapid conversion of agricultural land to non-agricultural land. Uncontrolled land conversion is caused by unequal development which does not take the aspect of environment into consideration.

High population growth rate is already the main determinant of agricultural land conversion (Putra N.R 2015). Intensive land conversion in urban area becomes a particular challenge for the development of sustainable urban farming. However, it does not mean that urban area has no potential to develop agriculture. Urban area has quite good potential to be developed as sustainable urban farming area; thus it is able to meet the needs of its society independently as urban area with the concept of environment and sustainability. This paper is aimed to explain the management of environmental and sustainable urban farming.

II. RESULTS AND DISCUSSION

A. *The potential of Yard for the Development of Urban Farming*

Yard in urban area has the potential to achieve food security and household consumption. This will increase the household income through yard utilization. The potential of this urban area utilization can be achieved by growing commodities which have commercial value. According to Kusmiati and Sholikhah (2015), types of plants cultivated are common plants which have high economic value, short lifespan, or seasonal plants especially vegetables (celery, *caisim* or Chinese cabbage, lettuce, and *kailan* or Chinese broccoli). Therefore, utilization of yard in urban area particularly to meet the daily needs for foods is necessary. Utilization of sustainable yard farming does not mean to perform farming in the yard only once or due to activity conducted by the rural government, yet this type of farming is continuously and sustainably done.Pangerang (2013) mentioned that the sustainable farming will provide benefit and convenience to the family because this farming will continuously support the necessity of life. In principle, human needs foods along his life, and this farming is intended to meet the daily needs. Khomah (2016) said that the utilization of yard in urban area, if managed intensively and in accordance with the yard potential, may increase household income besides meeting the need for foods of household consumption. Based on Rahayu (2005), it is not impossible for well managed yard to increase family income as yard indirectly plays a role to affect household economics.

The development of urban farming is done by utilizing the potential of available land including residential land, yard, roofs, public roadside and riverside. By considering the condition of limited area of yard in urban area, the implementation can be optimized by applying pot planting technology and verticulture technics through cultivation which is done vertically thus planting can be applied on multi-story structure. According to Sampeliling*et al* (2012), the key factors that determine the sustainability of urban farming development are: (1) the width of yard; (2) the development of commodities and environmentally friendly agricultural technology; (3) agricultural extension and institution; (4) extensification of farm land; (5) cooperation between stakeholders; and (6) provision of agricultural incentive/compensation. Type of farming and distribution of available land and space is important to know for appropriate and sustainable development of agriculture (Hikmatullah*et al* 2001).

B. *Urban Farming Creates Sustainable Environment and Urban Aesthetics*

International institution (FAO, 2003) positioned urban farming as: (a) one of the sources of food system supply and option for food security of urban household; (b) one of productive activities to utilize open space and urban waste; and (c) one of income sources and job opportunities for urban population. Therefore, urban farming has good opportunity and prospect for the development of agribusiness based environmental farming. According to Sampeliling*et al* (2012), the development of commodities and environmentally friendly agricultural technology that is to increase the yield of land/space or yard and garden, policy of selective planting according to the condition of land/environment is specifically required. Thus, through the implementation of productive planting activity improvement, public is hoped to increase the number of plant population or tree propagation through the application of technology in ornamental plant commodities, annual productive plants such as rambutan, mango, guava, sapodilla, starfruit and melinjo.

Utilization of yard can be modified through the implementation of environmentally friendly technology that is organic farming, verticulture system, potinization, and hydroponic in commodities of fruits, vegetables, and ornamental plants around the house of residents or the yard of house, office, and other facilities. Implementation of the model of sustainable food house area (kawasanrumahpanganlestari) in urban area is done by optimizing the utilization and yield of yard with agricultural commodity of food through environmental technology thus resulting environmental and sustainable urban area. The existence of urban farming land/space plays an essential role in agricultural production system and maintains the quality of environment since it is the main determinant of the width of Open Green Space and the yield of farming in urban area. Maintaining the existence of land/space is not only for the sustainability of agricultural production system but also to maintain the quality of environment. In this case, urban farming provides employment and becomes the additional source of income for the society and also becomes a buffer of economic stability in a critical condition and directly related to the effort of property alleviation and sustainable environment. As applied in the Special Capital Region of Jakarta, the direction and policy, implementation strategy, and control of sustainable urban farming development are presented in Table 1.

The urban aesthetic is the main objective in professional activity of 'urban architecture. Certain part of the city or urban area is proposed in a proposal form to the city government with the goal to increase the aesthetic value of certain urban area. The main focus in the effort to increase the aesthetic value of a city it to look for, explore, and utilize the architectural potential of an area to realize architectural physical appearance. Efforts mentioned above are conducted along with the activity of urban planning and design done. Moreover, approach performed in the activity of 'city architecture' is comprehensive approach which involves related multidisciplinary science (Pawitro, 2015).

One of multidisciplinary sciences in increasing aesthetic values of urban area is agricultural science through the utilization of available land, both in the form of yard, roofs, riverside and roadside to develop modern agriculture. In addition to its extremely strategic location, area of city center also has high socio-economic value. Hence, the development in city center area also requires structuring, arrangement, and increase in visual-aesthetic value of area besides involving socio-economic aspects. Effort to increase visual-aesthetic value of area through the activity of city architecture in city center area is also necessary (UdjiantoPawitro, 2013). Lim Lan Yuan (1999), expert of urban and real estate from the National University of Singapore (NUS) mentioned that in entering 21st century, there are increases in demand for better (higher) life quality from urban society, which not only related to the level of convenience but also involving aspect of sufficient carrying capacity of city infrastructure and visual-aesthetic aspect of physical environment of urban area. Considering the aspect of planology, the activity of urban area development, besides it is intended to achieve security and convenience for the users, it also cannot be separated from the aesthetic aspect of urban area.

Table 1 Direction of policy, implementation strategy, and control of sustainable urban farming development in Jakarta Area

No	Policy Direction	Policy Strategy	Implementation and Control
1	Development of land and space of farming; yard and specific garden	Yard width area: Maintain the existence of yard. Extend the space through vertical system Saving of land utilization for non-agricultural purpose through multi-story house system	Optimization of yard utilization and apply disincentive for those who neglect (idle land) the yard.
2	Development of commodities and environmentally friendly technology	Specific land and garden: Maintain rice field and garden specific to available commodity • Developer provides productive RTH (Open Green Space) • Development of commodities which have high economic value and productive in residential area • Development of organic input farming and environmentally friendly technology	Optimization of rice field utilization and yield through incentive and compensation system. Sets condition for developer to provide 30% of total land for OGS. Implementation of the model of sustainable food house area (model kawasanrumahpanganlestari, M-KRPL) is the utilization of yield which is realized in an area (housing, RT, etc.) though the implementation of agricultural land and space intensification around houses. Increase the number of Technical mentor and agricultural extension facility. Provide incentive for infrastructure for rice production and tax exemption for land or agricultural land.
3	Social and development of agricultural institution	• Strengthen agricultural institution • Community empowerment in farming partnership pattern and agricultural incentive and compensation • Increase coordination, partnership, and integrated cooperation between stakeholders	Establish cooperation through partnership pattern between stakeholders.

Source: Sampeliling, 2012

III. CONCLUSION

Urban farming is a result of interaction between factors of yard width, the development of commodity and environmentally friendly agricultural technology, agricultural extension and institution, the width of farm land/space, cooperation between stakeholders, and provision of incentive/compensation. Urban area has quite good potential to be developed as sustainable urban farming thus it is able to meet the needs of its society independently.

One of multidisciplinary sciences in increasing aesthetic values of urban area is agricultural science. Development of urban farming is done by utilizing the potential of available land, both in the form of yard, roofs, roadside, and riverside in order to develop modern agriculture.

REFERENCES

Cahya L.D. 2014. Kajian Peran Pertanian Perkotaan dalam Pembangunan Perkotaan Berkelanjutan (Studi Kasus: Pertanian Tanaman Obat Keluarga di Kelurahan Slipi, Jakarta Barat). *Forum Ilmiah* (11) 3: 324-325.

FAO. 2003. Trade Reform and Food Security – Conceptualizing the Linkages. Food and Agriculture Organisation. Rome.

Hikmatullah et al. 2001. Petunjuk Teknis Metodologi Penyuluhan Peta Perwilayahan Komoditas Pertanian skala 1 : 50.000 Melalui Analisis Terrain. Puslitbang Tanah dan Agroklimat Bogor.

Khomah. 2016. Potensi dan Prospek Pemanfaatan Lahan Pekarangan Terhadap Pendapatan Rumah Tangga. Proceeding Seminar Nasional Peningkatan Kapabilitas UMKM dalam Mewujudkan UMKM Naik Kelas. Surakarta 17 Mei 2016.

Kusmiati, A. danSholikhah, U. 2015. Peningkatan Pendapatan Keluarga melalui Pemanfaatan Pekarangan Rumah dengan Menggunakan Teknik Vertikultur. *Jurnal Inovasi dan Kewirausahaan Volume 4 Nomor 2, Mei 2015, Hal. 94-101*.

Pangerang. 2013. *Optimalisasi Pemanfaatan Lahan Pekarangan*. Diakses pada hari Selasa tanggal 5 April 2016. http://budidayaagronomispertanian.blogspot.

Putra N.R. 2015. Implementasi Kebijakan Pengendalian Alih Fungsi Lahan Pertanian Di Kota Batu Sebagai Kawasan Agropolitan. *J Kebijakan dan Manajemen Publik* (3)2: 74-75.

Rahayu M, *dkk.* 2005. Keanekaragaman Tanaman Pekarangan dan Pemanfaatannya di Desa Lampeapi Pulau Wawoni Sulawesi Tenggara. *Jurnal Teknologi Lingkungan P3TLBPPT 6 (2):362-364*

Sampeliling *et al.* 2012. Kebijakan Pengembangan Pertanian Kota Berkelanjutan: Studi Kasus di DKI Jakarta. J Analisis Kebijakan Pertanian (10)3: 257-267.

Udjianto Pawitro, 2013. Peran Desain Arsitektur Dalam Pembentukan Kawasan Kota Yang Aman, Nyaman dan Estetis, Majalah Tri-Dharma Kopertis Wilayah IV - Jabar & Banten, Bandung, Nomor : 11 / Tahun XXV / Juni 2013.

Pawitro, 2015. Peningkatan Aspek Keindahan Kota *(The Urban Esthetic)* di Kawasan Pusat (Kota: Studi Kasus : Kawasan Pusat Kota Bandung-Jawa Barat). Media Matrasain (12)2 : 3-7.

Yuan, Lim Land, *et al*. 1999. Urban Quality of Life: Critical Issues and Options, School Of Building and Real Estate – National University of Singapore (NUS), Publishing Co., Singapore.

H.14

EVALUATION ON RSPO STANDARD APPLICATION OF OIL PALM KKPA SMALLHOLDERS TOWARDS CERTIFICATION IN KAMPAR KIRI TENGAH SUB-DISTRICT, KAMPAR DISTRICT: APPLICATION OF RAPFISH APPROACH

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ABSTRACT

Oil palm smallholders face various barriers in certification process, such as access to market, inputs, financial, information and technology. These constraints affect agribusiness management, yields, productivity, and farmers' welfare. Based on these issues, this study was aimed to (1) evaluate application of RSPO standard at oil palm KKPA smallholders towards certification, (2) analyse leverage attribute which determine farmers' choice and decision on certification. This research used survey method. Population in this research is oil palm smallholders of KKPA and the sample size is 80 farmers. Data was analysed using Multi Dimensional Scaling (MDS) approach and Monte Carlo analysis which integrated in modified Rapfish Software. The result showed that sustainability index is 45.48% for all RSPO principles and criteria which categorized inadequate. Attribute that crucial in determining sustainable management of oil palm plantation are Principle 2, 3, and 6. Sustainable index could be improved by enhancing leverage factors (sensitive indicators).

Keywords: RSPO, evaluation, oil palm

I. INTRODUCTION

Riau province is the largest oil palm producers in Indonesia which account for 24% of national production. Oil palm has significant contribution to the economy of local and national level. It contribution includes economic growth, job creation, poverty alleviation, foreign exchange earnings, and rural development.

The oil palm sector in the future is prospective. Development of down stream industry and complying with sustainable standard from importers countries need to be directed seriously by government, actors and stakeholders in the oil palm supply chains. Ador (2016) revealed that there was an increasing awareness on sustainable production of palm oil without negative impacts on environment particularly related to increasing production through expansion. In order to establish worthier estate crops with better productivity, efficiency and become a leading sector in national development, this sectors must be supported through development of high productivity and efficiency of industry.

The objectives of estate crops development includes increasing yields, productivity, quality, value added, competitiveness, people welfare, foreign earnings, and rural development. Oil palm development in Riau was established through processing industry cluster and its derivative products. The Government of Indonesia has facilitated continuous improvement of palm oil production, productivity, quality of estate crops by providing high quality of plant material, production equipment and develop partnership amongst actors in palm oil supply chains for sustainable production. However, these efforts have not work fluently particularly in Kampar Kiri Subdistrict, Riau Province. Value added could be improved at oil palm processing industry (CPO) through cluster. By cluster approach, linkage among CPO based downstream industry in the value chains and the upstream plantation could enhance value-added.

Technology is also a main barrier in product diversification and improving value added. Downstream palm oil industries cannot developed properly because of low access to technology. Additionally, development of palm oil industry has been claimed to create negative impacts on environment and social conflicts. The negative impacts occured due to distortion on management and implementation of regulations.

Charles (2001) dan Kasryno (1998) mentioned that sustainable development consists of: 1) maintaining sustainable production, 2) sustainability on socio-economy by focusing on the welfare of actors in the supply chains and maintaining community welfare, 3) institutional sustainability: maintaining transparency, equity and sustainability on best management practices through institutional effectivity and efficiency.

This research is aimed to (1) evaluate application of RSPO standard at KKPA oil palm smallholders level towards certification, (2) analyse leverage attribute in determining farmers' choice and decision on certification.

II. THE MATERIALS AND METHODS

A. *Place and Time Research*

The site of this study is Kampar Kiri Tengah Subdistrict, Kampar District, Riau Province. The study was conducted four months.

B. *Sampling and Data Method*

The method used in this research is survey method and direct research in the field by interviewing respondents. The study population are 486 farmers and the size of sample are 80 which were selected randomly from the population.

Data used in this research include primary and secondary data. Primary data were collected using structural questionnaires through in-depth interview with the respondent. Secondary data were collected from government agencies and other documents related to this research.

C. *Data Analysis*

The study used RAPFISH approach to analyse the data based on ordination technique (placing data in assessed attribute order) using Multi Dimensional Scaling (MDS) (Kavanagh dan Pitvher 2001; Fauzi dan Anna, 2002) and integrated Monte Carlo analysis using modified Rapfish Software. Rapfish analysis was started with reviewing and defined attributes, then, scoring the attributes based on Rapfish standard. MDS was conducted to determine relative position from the attributes. Monte Carlo and Leverage analysis were conducted to determine uncertainty and anomaly on attributes.

Table 1. Category of sustainability statues

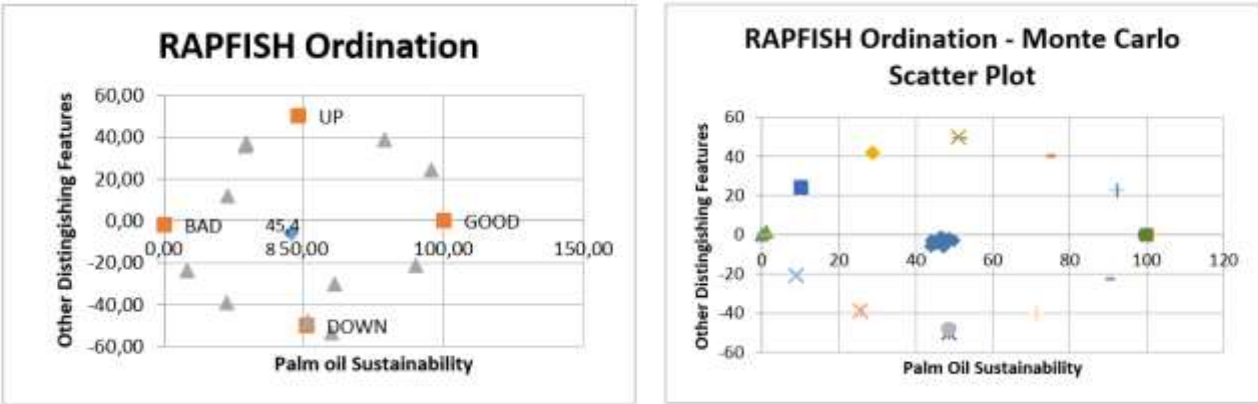
Index	Category	Description
00,00 – 25,00	Bad	Not sustainable
25,01 – 50,00	Inadequate	Inadequate sustainability
51,01- 75,00	Good	Adequate sustainability
75,01 – 100,00	Excellent	Very sustainable

III. RESULTS AND DISCUSSION

Evaluation and assessment on RSPO standards practices by KKPA oil palm smallholders at Kampar Kiri Tengah Subdistrict was based on the RSPO principles: 1) Commitment on transparency, 2) Compliance with applicable laws and regulations, 3) Commitment to long-term economic and financial viability, 4) use of appropriate best practices, 5) Environmental responsibility and conservation of natural resources and biodiversity, 6) Responsible consideration of employees, individuals, and communities, 7) Responsible development of new planting, and 8) Commitment to continuous improvement. Each principle was analysed based on attributes, i.e., sustainable indicators. The results on RAPFISH analyses on all principles were validated with values 45.48 < 51, showed that plantation management on KKPA oil palm smallholders was inadequate in sustainability criteria. Comparing RAPFISH analyses with values of Monte Carlo analysis shows relatively small different value, i.e. 0.398 < 5%.

Kavanagh dan Pitcher (2004) mentioned that Monte Carlo values can be used as validated value of error impacts. Fauzi and Anna (2002) also stated that Monte Carlo analysis can be an indicator of error caused by multidimension scoring and different opinion. RAPFISH validity can be seen from the value of squared correlation (R^2) of 84.30 which close to 1. This indicates that the mapping of the data wasprecise. The value showed that 80% of the model can be explained accurately while the rest 15.70% are explicated by other factors or attributes.

Kavanagh (2001) stated that the value of squared correlationmore than 80% shows that the model index on sustainability is accurate and adequate to be used. Test on inaccuracy or stress value of 0.1405 which is close to zero means that the output from analysis is close to the actual condition. Furthermore, Kavanagh (2001) stated that stress values can be tolerated if less than 20%. This condition also can be shown from partial analysis in the value of each sustainability principle. The values show that management practices of KKPA oil palm smallholders are in high pressure on all principles. Trade off amongst the sustainability of the RSPO principles is illustrated in Kite Diagram on Fig. 3.



(a) (b)

Fig. 1. (a) RAPFISH Ordination and (b) RAPFISH Ordination – Monte Carlo Scatter Plot

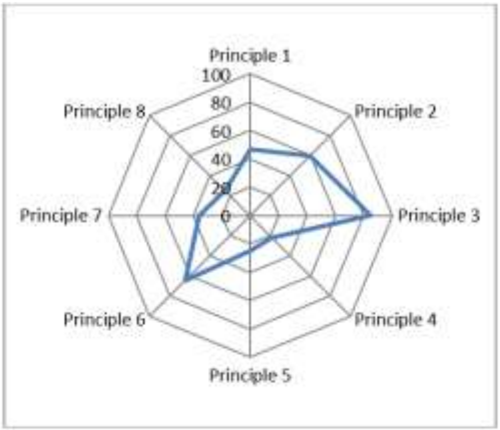


Fig. 3. *Kite Diagram* of Sustainability of KKPA Smallholders

Kite diagram shows trade-off amongs the principle where the dominant management practice is Principle 3. Principles 1, 4, 5, 7 and 8 relatively less dominant on sustainability. There are 39 criteria which are the leverage attributes or attribute that influence pressure on oil palm sustainability. All attributes were assessed to show influence amongs attributes, directly or indirectly.

Application of Principles 2 and 6 show adequate sustainable status (Table 2). Principle 3 is the only dimension that achieve very good value of sustainability. Principles 1, 4, 5, 7 and 8 show inadequate sustainability or not sustainable. In Principle 1, farmers did not carry out records and provide information on oil palm plantation activities such as legality aspect, agricultural practices aspect, environmental aspect, and social aspects. Oil palm growers and millers must provide adequate information to other stakeholders regarding environmental, social and legal issues related to the company. This act will help to counter the problem of companies not adhering to the rules and regulations especially in environmental issues. Transparency will also help to understand more about the management and operation of a palm oil company (Tan, 2009; Christin,2014).

Table 2. The value of index, stress, coefficient of determination and monte carlo

No	Dimension	Indeks	Stress	R^2	Monte Carlo %
1.	Principle 1	47	0,16	0,84	47,16
2.	Principle 2	60	0,15	0,84	60,15
3.	Principle 3	85	0,14	0,85	85,14
4.	Principle 4	22	0,14	0,83	22,14
5.	Principle 5	24,5	0,14	0,85	24,64
6.	Principle 6	64,34	0,12	0,85	64,46
7.	Principle 7	36	0,15	0,85	36,15
8.	Principle 8	25	0,14	0,85	25,14
		45,48			

Farmers did not fully apply Principle 4 related to plantation maintenance, fertilizer application, pest and disease management, and harvest. Advancement in the technology of oil palm cultivation is directed at increasing yield and reducing costs (Basiron, 2007; Christin, 2014). Application of Principle 5 was not sustainable. Farmers did not apply environmental management such as statement of environmental monitoring and management (SPPL), environmental impact assessment, records/documentation on rare, threatened or endangered species and HCV habitat. Farmers also did not fully apply Criteria 5.3 (waste management) and Criteria 5.4 related to use of fire in plantation activities due to inadequate knowledge and resources. Criteria 5.4 (efficient use of energy) and Criteria 5.6 (Pollution and emissions) were not included on RSPO standard for smallholders. Application of Principle 7 was mostly not applied for new plantation. Farmers did not conducted independent environmental impact assessment (SPPL), use soil survey and topographic information, replace primary forest or HCV areas, planting on steep terrain, marginal and fragile soils. Farmers did not have records and document on FPIC process on new planting on local people's land and compensation land acquisitions agreed. It can be seen that majority of the criteria on Principle 7 were not applied due to farmers' capability and limited resources. Principle 8 regarding commitment to continue improvement was also not applied by farmer due to lack of capacity and knowledge to get new technology for enhancing production sustainably. Seitz (2014) the RSPO depends on the goodwill of companies on the ground, and local government authorities, to ensure that these principles and criteria are abided to.

IV. CONCULSION

A. Conclusion

1. KKPA oil palm smallholders at Kampar Kiri Tengah Subdistrict are inadequately sustainable with sustainable index value of 45.48%. Sustainable attributes for plantation management includes RSPO Principles 1, 2, 3, 4, 5, 6, 7, and 8.
2. In general, leverage factor in each dimension or principle affect sustainability of KKPA oil palm smallholders directly or indirectly.The main attributes that influence the sustainability of plantation management are Principles 2, 3 and 6.

B. Recommendation

Improvement on farmers' institutions, empowerment of farmers in farmers group or association to enhance their capability and bargaining position is crucial and may be a relevant solution for sustainable production, particular when many of plantations have entered their end cycle and need replacement on their plantation.

REFERENCES

[1] A, Fauzi, S, Anna, "Evaluation of Fisheries Development Sustainability Status: Rapfish Approach Application (Case Study in the Coastal Water of DKI Jakarta)". *J. Coastal and Marine Resource*. Vol. 4(3).2002

[2] A.K,Voge and F. H, Adam, Sustainable palm oil:aspiration or reality.The potential and limitation of the Roundtable on Sustainable Palm Oil (RSPO). Berlin, Germany: Published by Bread for the world-Protestant Development Service. 2014.

[3] A.T, Charles, *Sustainable Fishery System*, Oxford: Blackwell Science Ltd. 2001.

[4] F, Kasryno, "Pemikiran Peningkatan daya saing komoditas pertanian melalui pemanfaatan mekanisasi pertanian yang ramah lingkungan," prosiding Perspektif pemanfaatan mekanisasi pertanian dalam peningkatan daya saing komoditas. Bogor: Pusat Studi Ekonomi-Badan Litbang Pertanian, Departemen Pertanian.1998.

[5] K.T,Tan, K.T, Lee , A.R, Mohamed, S, Bhatila, "Palm oil: addressing issues and towards sustainable development". *Renewable & Sustainable Energy Reviews*.Vol. 13, pp 420-427. 2009.

[6] P, Kavanagh, *RAPFISH software description (for Microsoft Excel)*. Rapid Appraisal for Fisheries (RAPFISH Project). Fisheries Center University of British Columbia. Vancouver, p 36 . 2001.

[7] P, Kavanagh and T.J, Pitcher, *Implementing microsoft exel software for Rapfish: a technique for the rapid appraisal of fisheries status*. University of British Columbia. Fisheries Center Research Report 12 (2). Canada. P 75 . 2004.

[8] S, Christin, "Keragaan usaha perkebunan kelapa sawit pola KKPA dalam menghadapi sertifikasi di Desa Bina Baru Kecamatan Kampar Kiri Tengah Kabupaten Kampar." Skripsi, Jurusan Agribisnis Faperta UR.2014.

[9] S.F, Ador, C, Siwar, R,Ghazali," A review of palm oil impact on sustainability dimension: SPOC initiative for independent smallholders". *International Journal of Agriculture, Forestry and Plantation*, Vol.2, pp 104-110. 2016

[10] Y, Basiron, "Palm oil production through sustainable plantations". *Eur. J. Lipid. Sci. Technol,*Vol.109, pp 289-295. 2016.

H.15

THE COMMUNITY ABILITY IN SUPPORTING THE LOCAL RESOURCE-BASED PRODUCTIVE EFFORT IN FOOD SELF-SUFFICIENT VILLAGES OF LAMPUNG PROVINCE

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ABSTRACT

This research aimed to identify the increase of community's ability in developing productive enterprises based on local resources as a result of the food self-sufficient villages (Demapan) program in Lampung Province. Demapan in Lampung Province becoming the object of research consisted of 16 villages/ urban villages in 12 districts/cities. The objects of research were selected with the following criteria: (a) the coverage of all districts/ cities in Lampung Province, (b) the difference of year in starting Demapan Program, and (c) the number of villages implementing Demapan program in each distrincts/cities. Data collection was conducted in each village from 15 Affinity Group members (KA) respondents, 15 non KA member respondents using a questionnaire, and 10 FGD respondents. The sampling technique (respondent) used was an accidental sampling. Data was analyzed using Excel and SPSS program. This study was conducted from August—September 2015. The results showed that the program Demapan done exerted the following effects: (a) improving the institution, particularly Affinity (KA) and financial village institutions (LKD), but still lacking for food village team (TPD), (b) slightly increasing the productive effort but the business sustainability still needs improvement. The large potency of area has been utilized less optimally to support the food self-sufficiency due to limited water resources. As the productive effort conducted by KA members had not developed yet, this research recommended the improvement of its sustainability.

Keywords : Community Ability, Productive Effort

I. INTRODUCTION

Indonesia is one of country highly committed to the development of food security as a strategic component in development. The foundation of food security and food self-sufficiency realization is contained in articles 3 and 4 of Law No. 18 of 2012 about food, stating that "the implementation of food is conducted to meet basic human needs providing benefits equitably, and sustainably based on Food Sovereignty, Food Self-Sufficiency, and Food Resilience (article 3). One objective of food organization is to facilitate or improve the access of community to food, especially those vulnerable to food and nutrition.

To create the food self-sufficiency, the government through the Food Security Agency of the Ministry of Agriculture has launched the Food Self-Sufficient Village Program (*Demapan*) since 2006. Demapan is defined as a village / *kelurahan* whose people have ability of creating food and nutrition resilience through development of availability, distribution, and consumption subsystems by utilizing local resources in a sustainable way. The purpose of *Demapan* activities is to improve the empowerment of rural communities by optimally utilizing the resources they have or control to achieve food self-sufficiency of household and community . The Activity targets are poor households in food insecurity villages to achieve community self-sufficiency.

Demapan activities are carried out for four years in four stages: preparation, growth, development, and empowerment by empowering the poor in food insecurity through double track strategy, including: (1) establishing an agriculture-based economy and Rural areas to provide employment and income, and (2) fullfilling food for poor communities in food-insecure areas through empowerment and direct assistance (Ministry of Agriculture, 2011). The realization of community's food and nutrition resilience is conducted gradually through community empowerment process to recognize its potency and capability, to seek alternative problem solving opportunities, and to make decisions in managing and utilizing natural resources effectively, efficiently and sustainably.

Demapan activities in Lampung Province began simultaneously with the launch of the program nationally in 2006. Up to 2012 Demapan activities in Lampung Province have been implemented in districts / cities spreading over 73 villages, 24 villages of which have entered into independent stage according to programming target. At independence stage in the 4th year, it is expected that changes will occur in: rural institutions (Affinity / KA, Village Financial Institutions / LKD and Village Food Teams / TPDs) as social service and economic service institutions, characterized by productive economic business that has been able to increase purchasing powerand capital, production accessibility, and agricultural marketing. This condition can encourage and even ensure the empowerment of the community in meeting the adequacy and availability of food. Considering the description above, this research aims: 1) to find out the strengthening of institutions in the community, and 2) to identify the improvement of community capacity in developing productive enterprises based on local resources as the impact of the Village Self-Sufficiency Program (Demapan) in Lampung Province.

II. MATERIALS AND METHODS

The research was conducted at *Demapan*in Lampung Province. The 16 villages of Demapan in Lampung Province, which are the object of this research, spread in 12 districts/cities. The selection of districts and villages for the research was conducted by considering: (a) the coverage for all districts / cities in Lampung Province, (b) the differences of year starting the Demapan Program, and (c) the number of villages implementing *Demapan* program in each districts/cities. Similarly, almost all districts/cities in Lampung Province were accommodated as research sites. Furthermore, by considering the implementing village of Demapan Program, more than one (two) sample villages were selected from the districts having the larger number of implementing villages.

In each village, Data was collected from 15 respondents of Affinity Group members (KA), 15 respondents of non-KA members using a questionnaire, and 10 FGD respondents. The sampling technique used for selecting the respondents was accidental sampling. Data collection was conducted by interviewing face-to-face respondents and through Focus Group Discussions (FGD). Both the interviews and the FGDs were conducted based on a prepared questionnaire (ROP, 2015), consisting of three questionnaires: A poor household questionnaire for KA members, non-KA member questionnaire, and C questionnaire for FGD. The Data were analyzed statistically descriptively, using excel program and SPSS. The Data collection was conducted from August to September 2015.

III. RESULTS AND DISCUSSION

A. *Household characteristics*

The characteristics of households in this study consist of: age of head of household, sex, education level of head of household, number of household member, status in group, and main occupation.

The average age of household heads of KA members or non-KA members is considered to be productive age. Of the 240 selected respondents, majorities were male, either for KA members or not KA members. Viewed from the education level of KA member household heads, it can be found that most of them (125 people or 52%) were educated in elementary level, and only 3 people were in college level. Overall, the education level for non KA members is relatively higher than KA members. Considering the distribution of household member number by age, it can be seen that the age of KA and non-KA member household is relatively equal in number and proportion, dominated by productive age of 15-55 years, followed by school age <15 years, and only a few are aged> 55 years. The status of respondents for KA member is mostly (65%) as a member, and the rest as commitee of organization.

The main occupation of both KA and non-KA members are not much different, most of which are farmers - 103 people or 42% and 107 people or 44%, respectively. The second rank of dominant occupation at research area is farmer worker (for example; respondents in Fajar Sari Mesuji Village working as workers at PT. Barat Selatan Makmur Investido (BSMI), and in Ringin Sari Tulang Bawang Village as workers at PT Bangun Nusa Indah Lampung (BNIL), while other small number respondents working in non-Agriculture business, such as trading business (shop for household needs), as well as mobile stores and pulses (Counter).

B. *Household Asset Ownership*

The land ownership of KA member households consists of 0.24 Ha / household of dry field, 0.7 ha / household of garden, the average large of yard is less than 0.1 Ha / household. Comparing with the beginning of the program in 2009 until 2015 there is a tendency to increase slightly, but none of the respondents have a pond from the beginning of program until 2015. Therefore, it can be concluded that Demapan program has an impact on the control of land assets of program participants, although a little. Land assets of non KA household is averagely less than KA member, this is because some non-KA households have no land, and only work as agricultural laborers or laborers in the company around the residence.

Regarding the ownership of animals, it is obtained that averagely the households have animals such as chickens, ducks and goats (in the beginning of program in 2009 – 2015). None of the KA and non-KA members have pig and horse animals, whereas the buffalo is owned only by non KA member in very small number. For KA members, in 2015 there was a slight increase in the average number of cows, goats, and ducks. This indicates that Demapan Program has a small positive impact on the ownership of animal /livestock assets by the program participants. For non-KA respondents, the average animal ownership has almost similar type of distribution with the number smaller than the KA members'.

C. *Institutional Reinforcement in community*

Institutional reinforcement in community in this research can be seen from the society perception's on Demapan institution such as Affinity Group (KA), Village Food Team (TPD), and Village Financial Institution (LKD). Institutional Reinforcement in community is viewed from the existence and the impact of Demapan institutional at the village level, as shown in Table 1. Generally people have positive perceptions on Affinity Group (KA). This can be understood from the great and prominent positive impact of KA, especially in group life and cooperation and regular meetings. Another positive influence is on the adoption of cultivation technology and plantation technology. Although less great impact of the existence of KA also positively affect the livestock business, trade, utilization of yard and others. The area that has not been touched by the impact of the KA's existence is entirely fishery business, whereas some villages have the potential to develop the fishery business. Apparently for the area, it is necessary to find a companion who has the competence of the field of fisheries.

The perception of the existence of the Financial Institution Village (LKD) is also very large and affects positively the village household financial system as indicated with the decreased percentage of households borrowing money from moneylenders and the increased number of borrowing money from LKD. However, the positive impact of LKD as a capital service institution and encouraging households to save money is not optimal yet. It takes great effort for the LKD to perform its functions optimally. The existence of other institutions' effect (TPD) on the community is rather low and affects positively in helping run the program in the village.

Table 1. The existence and impact of Demapan institution at the independent status Demapan Level in Lampung Province, 2015 (%)

No	The performance of Demapan Institution	2015
Affinity Group (KA)		
1	Perceptions on the existence of KA influence on rural communities	93.80
2	Perception of positive impact of KA toward	
	Live in groups and mutual cooperation	81.20
	Adopting cultivation technology	37.50
	Food processing business	18.80
	Plantation business	37.50
	Livestock business	12.50
	Fishing business	0
	Trading business	18.80
	Utilizing the yard	12.50
	Nutritional food	18.80
	Activity for pregnant and lactating mother	12.50
	Regular meeting	62.50
Financial institution village (LKD)		
1	Perceptions on the existence of LKD influence on rural communities	93.80
2	Perceptions on positive impact of LKD toward ;	
	More people saving money	31.20
	More people lending money	68.80
	Less people lending money from the moneylender	75.00
	LKD become institution of community capital service	37.50
Village Food Team (TPD)		
1	Perception on the existence of TPD influence on rural communities	62.50
2	Perception on positive impact of TPD toward ;	
	Assisting to make a plan of village development	25.00
	Assisting to run the program that entered to the village	56.20
	Assisting to describe village's program outside the village	12.50

D. *The Community Capacity in Supporting Local Resource-Based Productive Enterprises in Demapan*

The abilities can be interpreted as an individual's capacity to perform tasks in specific jobs (Robbins, 2006), and according to Mc Shane and Glinow in Buyung (2007) "ability of natural aptitudes and learned capabilities required to complete a task successfully". Intelligence is a natural aptitude helping the employees learn certain tasks faster and do them better.

The community's ability of supporting local resource-based productive enterprises in Food Self-Sufficient Village (*Desa Mandiri Pangan*) in this study is viewed from the affinity households' ability in the save and loan activities and in utilizing funds for productive activities based on local resources during the program period and

2015. It can also be seen from the participation of KA households in group activities during the program period and 2015 including: the existence of group dues (payment time participation, payment size, and frequency of payment); the existence of regular meetings / meetings of group members; and attending the training.

Affinity Group households in save and loan activities during the program period were 49.3 percent, and it decreased in 2015. This happens because some of the loan repayments were not performing well do to such reasons as crop failure or death of pets (such as goats), and less strict supervision or sanctioning systems for those not repaying. Save and loan activity is performed in the form of money saving and borrowing. The Demapan program has not been well disseminated to the village community in general. This value is not far from the result of evaluation on Demapan in Lampung Province in 2012 (Nawansih et al., 2012).

In general, every household can borrow on average IDR 1,000,000.00 per year, as much as 1-2 times a year with a interest rate of 1% -2% per month. This loan is used for agricultural cultivation, especially to buy production vehicles (*saprodi*), and non-agricultural micro enterprise, but some others are used for consumption, as well as for other purposes such as opening counter, treatment, education for children, and repaying loan. This is certainly incompatible to the purpose of grant provision intended to improve business. In this case, suggestions for future programs, aid in the form of money should be considered and prepared more maturely whether in planning, implementation or supervision in order to run better. For groups whose savings and loan activities are still running until 2015, the prevailing rules are relatively fixed. In Table 2 it can also seen that the Demapan program contributes to lowering the money borrowing to moneylenders (usurer).

Table 2. Household Affinity Group's participation in savings and lending activities at the Demapan Program in Lampung Province, 2015

No	The performance of saving and lending activities	Period of Program	2015
1.	The existence of saving and lending activities (%)	49.3	31,7
2.	Household in the activity of saving and lending (%)	66.1	39.0
3.	The average of loan value (IDR/Year)	996,263	1,614,107
4.	The frequency of lending activity per year (%)		
	1 time	60.5	30.3
	2 times	8.4	8.0
	3 times	0.0	0.0
	4 times	0.0	0.0
	> 4 times	0,0	0.0
5.	Loan interest(/month)	1	2
6.	The main utilization of loan (%)		
	Agricultural Cultivation	38.5	26.1
	Agricultural processing	2.1	0.3
	Non agriculture micro business	7.0	2.8
	Consumption	11.9	5,2
	Transportation Service (ojek)	0.3	0,3
	Others	13.6	5,2
7.	Lending to moneylenders (%)	3.1	2.1

The participation of KA households in group activities during the program period and 2015 includes: the existence of group tuition (payment time participation, payment size, and frequency of payments); the existence of regular meetings of group members; and attending training, as shown in Table 3.

The household's ability to pay group dues during the program period is 36.1% with an average contribution of IDR 25,956.00 and more payments are made monthly, and in accordance with the agreement of 30.4 per cent in the program period, but it decreased in 2015.

The participation of KA households in the regular meeting / group meeting activities amounted to 72.4% in the period or beginning of the program and slightly decreased to 56.3% by 2015; this is because at the beginning of the program run, the KA members held meeting more vigorously and routinely to discuss regulations in KA such as regulating / establishing group venture capital, borrowing conditions, sanctions, loan repayment patterns and timing, and determining mandatory/voluntary contributions.

The ability of households in training during the program period reached 43.0%, mainly related to agricultural cultivation 26.2%, administration 19.9%, microfinance 10.8%, processing yield 10.5%, and craft 5.2%. By 2015 the training participation has declined; this is because some of the activities undertaken at the beginning of the program were not routinely conducted anymore, interviews and observations in some villages indicate that some poor households already have other jobs besides joining the program, such as working in the company (PT) around the residence, and as a motorcycle taxi driver, but they are still eager for continuous coaching / training, because there are still potential resources that can not be developed yet that will improve their welfare. One example is the potential of fishery business in Sukorahayu Village, Labuhan Maringgai District, East Lampung.

Table 3. The Household Participation in KA Demapan Activities in Lampung Province, During the Program Period and 2015

No	Group Activities	Period of Program	2015
1.	The existence of group dues (%)	36.1	14.8
2.	The average of contribution (due) size (Rp.)	25,956	13,784
3.	The participation of contribution payment time (%)		
	Per month	19.9	9.1
	After harvesting	4.7	3.8
	Per year	15.6	7.3
4.	The payment for contribution (due) (%)	27.6	16.4
5.	The frequency of contribution payment (%)		
	According to agreement	30.4	19.9
	Occasionally	0.3	0.3
6.	The existence of regular meetings / meetings of group members (%)	72.4	56.3
7.	The frequency of regular meeting (time/month)	0.3	0.3
8.	The activeness of regular meeting (%)		
	Always	47.2	36.4
	Occasionally	31.8	17.0
	Never	4.9	1.0
9.	The activeness in training (%)	43.0	31.7
10.	In training time according to material of training (%)		
	a. Administration	19.9	13.3
	b. Cultivation	26.2	18.2
	c. Handicraft	5.2	1.0
	d. Processing product	10.5	7.7
	e. Micro finance	10.8	10.1
	f. Marketing	0.6	3.5
	g. Others	4.5	1.7

IV. CONCLUSION

The results show that: 1) the *Demapan* program carried out results in the following impacts: (a) slight improvement of the productive business, despite the need for improvement in sustainability; therefore the assistant personnel needs to carry out the assistance more intensively, (2) improving the institution, particularly Affinity (KA) and financial village institutions (LKD), but still lacking for food village team (TPD); therefore the TPD performance still needs to be optimized by increasing the frequency of group meeting; 3)The large potency of area has been utilized less optimally to support the food self-sufficiency due to limited water resources; therefore the support of water supply technology is needed in the food insecure villages.

REFERENCES

Anonym. 2012. Guidelines on the Implementation of Village Self-Sufficiency Activities. Food Security Agency of the Ministry of Agriculture. Jakarta.

Food Security Agency of the Ministry of Agriculture. 2008. Operational Guideline of Asi Desa Mandiri Pangan Program. Agriculture department. Jakarta

Buyung. 2007. Organizational Behavior in the Workplace of Graduate Program of Bina Darma University of Palembang. Palembang

Nawansih, O., R. Adawiyah, W.D. Sayekti, A. Azis, and A. Mansyur. 2012. Assessment of Impact of Food Self-sufficiency Program on Food Security and Poverty in Lampung Province

Robbins, S.P. 2006. The principles of Organizational Behaviour. Tenth Edition. Jakarta: PT Macananjaya Cemerlang.

ROP. 2015. Guidelines and Questionnaires related to the Demapan Study Program provided by the Food Security Agency of the Ministry of Agriculture, Ministry of Agriculture. Jakarta.

H.16

MODEL AND STRATEGY OF DEVELOPMENT PLANNING OF FOOD SECURITY IN METRO BASED ON EMERGENCY STATUS

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ABSTRACT

Planning is an important activity in the process of building food security. Success at the national level is strongly influenced by the success with food security conditions at the provincial / district level. Metro is one of the districts in Lampung Province that has good potential to realize ideal food security conditions. However, the reality of this condition can not be realized properly as expected. This study tries to find out what components of the food security system in Metro are still weak to make it easy in preparing its development strategy. Therefore, the use of a series of indicators of dimensions of the food synthesis system is used to assess the food security condition using the Food Security Quotient (FSQ) analysis method. The process of planning and preparation of food security development strategy is done by using SWOT method.The results of the study indicate that food security conditions in Metro City are still vulnerable in the availability and access components of food. While access to utilization and institutional and food regulation is safe.

Keywords : Food security indicators, FSQ, Strategy, Planning

I. INTRODUCTION

A. Background

Food Law No 18/2012 defines food security as the condition of the fulfillment of food for the state up to the individual, which is reflected in the availability of adequate amount and quality of food, safe, diverse, nutritious, equitable and affordable and not contrary to the religion, beliefs and culture of society , to be able to live healthy, active and productive in a sustainable manner. The World Food Summit (FAO, 1996) defines "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food." This shows that food security encompasses four dimensions, namely: availability, affordability / access, food utilization and stability.

Food security is a complex and multi-dimensional condition with various components involved in it resulting in the development of various understandings about food security itself. The various indicators currently employed for food security analysis have varied according to analyst preferences by adopting the methods adopted by the country's large-scale institutional review of the problem (FAO, WFP). However, for regional food security assessments that have different region-specific conditions, there is still no consensus uniform of data collection instruments and size indicators of food security dimensions (Carletto, Zezza and Banerjee, 2013). The variety of data attribute indicators that need to be considered in value as well as the amount of information that must be managed in handling food security programs sometimes make it difficult in the calculation process that leads to increased error rate.

The breadth of problems in handling food security and the various uses of indicators to analyze, should be able to be anticipated by policy makers in making decisions to fit the needs. Input data of appropriate food security conditions, supported by the opinions of experts in this field (experience, assessment and intuition) into a form of strategic decision model, will be a good information about the condition of food security itself.

The enhancement of this information quality can strengthen its utilization as a decision-making base capable of providing a range of alternative solutions along with its potential influence (Kusrini, 2007). Designing and evaluating policies, programs and improving the accountability of the policy process is an appropriate step to track progress in implementing food security development. The selection of appropriate indicators as the basic criteria for providing information in the assessment of multidimensional food security conditions will support the creation of such accountability (Aurino, 2014).

Metro City is one of the areas in Lampung Province which is quite densely populated. The increasing availability of agricultural land and the increasing population and small areas make this city facing problems in implementing its food security development, just like the problems faced by other districts in Lampung Province.

The availability of staple foods that must pursue the rate of population growth related to cross-sectoral policy from upstream to downstream, the distribution system is still not good, there are still residents who experience chronic food insecurity due to poverty, slow food diversification to balanced nutrition, still low public knowledge about nutrition , increasing the problem of land conversion and conservation of land and water, the development of rural infrastructure (drinking water, electricity, irrigation, farm road) resulting in high costs of food production, widespread use of formalin, borak and other preservatives and the lack of institutional aspects food security, is a problem that is still faced in the development of food security in Lampung Province (Report of BKP Lampung, 2014, Renstra BKP Lampung Province, 2015- 2019). Integration, adjustment and implementation of programs in each SKPD and inaccurate and coordinated policy determination simultaneously are other issues that also affect the process of building food security in the province (Lampung Vice Governor, 2015).

The extent to which the problem of food security development that is still faced in Metro Municipality, as well as on which resilience subsystems still need to be improved, is a fundamental need to be understood in determining the status of vulnerability of food security. The vulnerability in question is the vulnerability that occurs in each of the food security subsystems, namely: subsystem of availability, access and utilization of food.

This difference in vulnerability status must be considered in planning future food security development so that the development of food security in Lampung Province can be implemented properly and continuously. The number of data and information that must be managed and the ability to provide various information display related to the condition of food security of a region quickly and atraktf is a demand that must be available. In this regard, the redesign of a food security development plan needs to be done, one of which uses a decision support system approach (SPK) as the basis for decision making.

B. Problem Formulation

Based on the above background the formulation of the problem in research is how to design the model and planning strategy in the development of food security in the municipality of Metro by using Decision Support System.

II. MATERIALS AND METHODS

The method used in this study is a mixed methods / Mixed method of research that combines qualitative-quantitative method using descriptive and analytical approach and design. The design here is to design a decision support system to assist in determining decision making development of food security. While descriptive method is used to explain how the system designed to meet user needs and link research objectives and information generated.

Research data is obtained by collecting quantitative (secondary) and qualitative (primary) data from various sources. The principal quantitative data source is BPS data from 2010-2015, and is supplemented by interview data on several agencies related to food security system, Metro municipality. Data analysis was done using Food Security Quotient (FSQ) analysis technique, with equation:

$$FSQ_t = \frac{Xr/_{RVr}}{Xn/_{RVn}} \text{atau } \frac{Xr/_{Xn}}{RVr/_{RVn}} \tag{1}$$

where :
Xr = Value of variables in the municipality
Xn = Value of variable in Province
RVr = Total variable value in Municipal
RVn = Total variable value in province

Preparation of strategy and policy of development planning of food security will be analyzed using SWOT analysis method (Strength, Weakness, Opportunity and Threat)

III. RESULTS AND DISCUSSION

A. System Development and Indicators

In this study the food developed system adopted the food castering system of Kastaman (2012) as shown in Fig. 1.

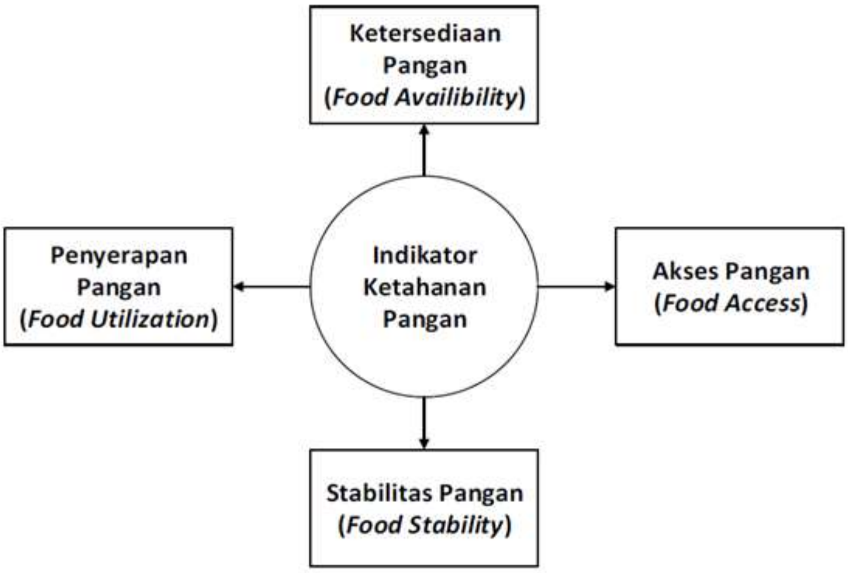

Fig. 1. The Food Security System Developed (Kastaman, 2012)

The institutional aspect becomes the differentiator from food security aspect indicator according to FAO (2006), Hanani (2009) and Suryana (2014). According to Kastaman (2012), an indicator of the institutional dimension in an assessment of food security system is more appropriate for the situation and condition in Indonesia, given the existence of food safety related institutions to guarantee the implementation of food security conditions in a region with its role to plan, monitor and support the implementation and evaluation.

The description of indicators of the four components of food security resulting from FGD activities with managers, actors and policy makers of food security programs in the research area as shown in appendix 1.

B. Analysis of Food Security Condition with FSQ Method

Based on the result of calculation using Food Security Quotien (FSQ) condition of Metro City food security will be expressed in 3 (three) form of weighted FSQ value (FSQt), namely: FSQt> 1, FSQt = 1 and FSQt <1. For FSQt value> 1 means that the condition of food security of regency / municipality is not vulnerable, FSQt = 1 means the condition of food security of regency / municipality must be aware, meanwhile for FSQt <1 value means the condition of food security of districts / municipalities is assessed to be vulnerable (unsafe). To get the FSQt value from each regency / city then weighted for FSQ value on each indicator / criterion based on the importance degree preference. In this study the preferences of degree of importance are divided into 5 (five) levels, namely: 1 = very unimportant; 2 = not important; 3 = important enough; 4 = important and 5 = very important. From the calculation result using FSQt method of food security condition in Metro municipality as shown in table 2.

Table 2. FSQt Value of Food Security Subsystem in District

Kota	Ketersediaan	Akses	Pemanfaatan	Regulasi
Metro	0,888	0,968	1,012	1,009
	not Safe		*Safe*	

From the table above shows that the food availability subsystem and Food Access FSQ value <1 and the subsystem utilization and regulation value FSQ> 1 This indicates that in the city of Metro is currently the condition of food security is still vulnerable to the subsystem of availability and access of food .. To vulnerability which occurs in the food availability subsystem in this study referred to as food insecurity, for vulnerability occurring in the food access subsystem referred to as prone to purchasing power, for vulnerability occurring in food utilization subsystem referred to as nutritional prone and for vulnerabilities that occur in the institutional subsystem and regulation referred to as prone to governance. That is, in the city of Metro still occur food insecurity and prone to purchasing power.

C. Food Security Condition Based on SPK Generator

In this research a SPK generated in the form of Generator (generator) is able to calculate and simulate quickly and precisely the conditions of food security of the three districts. The determination of the general description of food security conditions in each district / city in Lampung Province is shown in the form of a Specific Decision Support System using Excel Generator. Based on this system food security conditions in Lampung Province can be drawn as in step below.

1. Display Main Menu

The start menu view contains the title of the review performed, the information displayed as well as the identity of the user. In the main menu of information displayed in the form of Food Security Data Management and Analysis Model of Food Security Data. Data Management contains data from measurement indicators of Food Availability, Food Access, Food Utilization and Quality as well as Food Institutional Data as shown in Fig. 2 and 3.

Fig. 2. Display Main Menu

Fig. 3. Food Security Management Data

While the Food Safety Analysis Model contains Food Availability Analysis Model, Food Access Analysis Model, Analysis of Food Utilization and Quality Model, Institutional Model of Food Analysis and Food Security Analysis Model, as shown in Fig. 4.

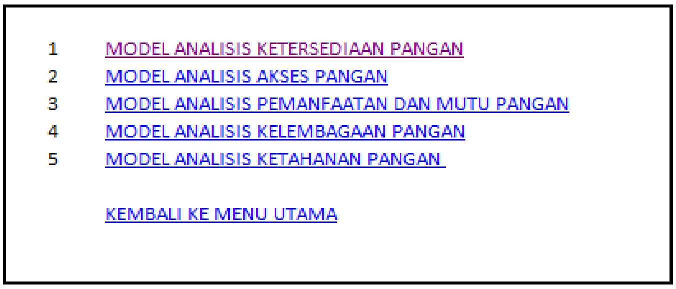

Fig. 4. Display Menu Data Analysis Food Security

2. Food Security Data Management

Food security data management contains the data of food availability, access of food, food and the quality and food institutions subsystem.

a. Food Availability Data

Food availability data contains data indicator of food aspect / subsystem indicator indicator which amounted to 34 indicators. This indicator data to assess condition of food availability subsystem in food system of regency / city in Lampung Province with intervention using FSQ technique (Food Security Quotient), so as able to give expected information.

b. Food Access Data

Food access data contains data on subsystem measurement indicators / aspects of food access in food security systems.

c. Data on Food Utilization and Quality

The data of food utilization and quality contains data of indicators of measurement of food utilization and quality aspects in food security system.

d. Data of Food Institution

The food institutional data contains data on indicators of institutional aspects of food within the food security system.

3. Data Analysis Model of Food Security

The data analysis model of food security contains Food Availability Analysis Model, Food Access Analysis Model, Analysis of Food Utilization and Quality Model. For the model analysis model of food security data is exemplified from the model of food availability analysis (for other aspects almost the same).

The food availability analysis model contains the weighted value-weighting commands and the weighted importance of each measuring indicator as well as the command to see the results of the regional food availability analysis, the order returns back to data management or returns to the main menu as shown in Fig. 5-13.

I MODEL KETERSEDIAAN PANGAN

ISIAN DATA BOBOT KEPENTINGAN VARIABEL

1	***LIHAT BARIS TERBAWAH UNTUK ISI BOBOT KEPENTINGAN***	**BOBOT KEPENTINGAN**	**PERSEN BOBOT KEPENTINGAN**
2	Produksi padi rata-rata/tahun	5	0,0368
3	Produksi jagung rata-rata/tahun	5	0,0368
4	Produksi ubi kayu rata-rata/tahun	5	0,0368
5	Produksi ubi jalar rata-rata/tahun	5	0,0368
6	Produksi padi/kapita	5	0,0368
7	Produksi jagung/kapita	5	0,0368
8	Produksi ubi kayu/kapita	5	0,0368
9	Produksi ubi jalar/kapita	5	0,0368
10	Ketersediaan Pangan beras rata-rata	4	0,0294
11	Cadangan Pangan Lumbung Pangan Masyarakat	3	0,0221
12	Pasar Tradisional	3	0,0221
13	Pasar Modern	3	0,0221
14	Luas lahan untuk komoditas padi rata-rata/thn	5	0,0368
15	Luas tanam komoditas padi, rata-rata/thn	4	0,0294
16	Luas panen komoditas pangan rata-rata/thn	5	0,0368
17	Luas lahan cadangan pangan	4	0,0294
18	Produktivitas padi/ha	5	0,0368
19	Kepadatan Penduduk Lampung/ Kab/ Kota per Km	4	0,0294
20	Persentase Rumah Tangga yang berusaha dibidang Pertanian	3	0,0221
21	Jumlah Penduduk Lampung/ Kab/ Kota	4	0,0294
22	Rata-rata kecukupan energ/kapita	4	0,0294
23	Rata-rata kecukupan protein/kapita	4	0,0294
24	Ketersediaan Benih padi rata-rata/tahun	4	0,0294
25	Ketersediaan/Penyaluran Pupuk rata-rata	4	0,0294
26	Luas Lahan yang mendapatkan Air Irigasi	4	0,0294
27	Panjang saluran irigasi	3	0,0221
28	Ketersediaan Lahan Pertanian Pangan Berkelanjutan	4	0,0294
29	Ketersediaan fasilitas utk penyimpanan pangan	4	0,0294
30	Curah Hujan Rata-rata/Tahun	3	0,0221
31	Luas Serangan Hama & Penyakit Pada Tanaman Pangan rata-rata/tahun (Padi, Jagung, Ubi Kayu)	3	0,0221
32	Luas daerah pertanian padi yang bebas Banjir dan Puso rata-rata/Tahun	4	0,0294
33	Panjang Jalan (Negara, Provinsi, Kabupaten)	4	0,0294
34	Panjang jalan kondisi Teraspal baik (Negara, Prov,Kab)	4	0,0294

Keterangan Nilai Bobot :

1 Tidak Penting
2 Kurang Penting
3 Cukup Penting
4 Penting
5 Sangat Penting

UNTUK LIHAT HASIL ANALISIS KETERSEDIAAN PANGAN DAERAH KLIK DISINI

KEMBALI KE MANAJEMEN DATA KLIK DISINI

KEMBALI KE MENU UTAMA KLIK DISINI

Fig. 5. Display Data Weight Data Interests Variables from of Food Availability Aspect

KONDISI KETERSEDIAAN PANGAN

KABUPATEN / KOTA	FSQ TERBOBOT	KONDISI
METRO	0,8893	RAWAN
KEMBALI KE PEMBOBOTAN	KLIK DISINI	
KEMBALI KE MANAJEMEN DATA	KLIK DISINI	
KEMBALI KE MENU UTAMA	KLIK DISINI	

Fig. 6. Views of Food Availability Analysis

ISIAN DATA BOBOT KEPENTINGAN VARIABEL

1	*LIHAT BARIS TERBAWAH UNTUK ISI BOBOT KEPENTINGAN*	BOBOT KEPENTINGAN	PERSEN BOBOT KEPENTINGAN
2	Pendapatan/kapita/thn	5	0,1000
3	Pengeluaran rata-rata perkapita untuk pangan	4	0,0800
4	Prosentase penduduk TIDAK miskin	4	0,0800
5	Persentase rumah tangga yang memiliki lahan ≤, Ha	3	0,0600
6	Persentase desa yang memiliki akses penghubung yang memadai	4	0,0800
7	Persentase Rumah dengan akses listrik	4	0,0800
8	Persentase Rumah Tangga dengan akses air bersih	4	0,0800
9	Prosentase Penduduk Yang Produktif	4	0,0800
10	Persentase Jumlah yang tidak pengangguran	4	0,0800
11	Pertumbuhan Ekonomi	4	0,0800
12	Harga pangan (HPP komoditas beras) dilihat dari laju inflasi	5	0,1000
13	Persentase daerah yangg tidak terisolasi	1	0,0200
14	Rata-rata lama sekolah masyarakat	4	0,0800

Keterangan Nilai Bobot :

1 Tidak Penting
2 Kurang Penting
3 Cukup Penting
4 Penting
5 Sangat Penting

UNTUK MELIHAT HASIL ANALISIS KONDISI AKSES PANGAN KLIK DISINI

UNTUK KEMBALI KE MANAJEMEN DATA KLIK DISINI

UNTUK KEMBALI KE MENU UTAMA KLIK DISINI

Fig. 7. Display Field Data Weight Interests Variable From Food Access Aspect

KONDISI AKSES PANGAN

KABUPATEN / KOTA	FSQ TERBOBOT	KONDISI
METRO	0,9672	RAWAN
KEMBALI KE PEMBOBOTAN	KLIK DISINI	
KEMBALI KE MANAJEMEN DATA	KLIK DISINI	
KEMBALI KE MENU UTAMA	KLIK DISINI	

Fig. 8. Views of Food Access Analysis

1	***LIHAT BARIS TERBAWAH UNTUK ISI BOBOT KEPENTINGAN***	**BOBOT KEPEN-TINGAN**	**PERSEN BOBOT KEPENTINGAN**
2	Angka PPH rata-rata	4	0,0645
3	Intensitas kegiatan Pemantauan dan Pengawasan ttg mutu dan keamanan pangan	3	0,0484
4	Variasi menu makanan dalam satu minggu/rumah tangga (rata-rata)	3	0,0484
5	Prevalensi status gizi tidak buruk balita terhadap tinngi badan / Stunting	4	0,0645
6	Prevelensi status gizi tidak buruk balita terhadap Berat badan /Underweight	4	0,0645
7	Prevelensi status gizi tidak buruk balita terhadap Berat bdan menurut Tinggi Badan/Wasting	4	0,0645
8	Fasilitas Kesehatan / Jumlah Puskesmas	4	0,0645
9	Rasio pelayanan kesehatan (puskesmas) per 0000 penduduk	4	0,0645
10	Anak Balita yang terlayani fasilitas Kesehatan	4	0,0645
11	0Persentase Anak SD yang terlayani fasilitas Kesehatan	4	0,0645
12	Persentase Kecukupan Vitamin A pada bayi	4	0,0645
13	Persentase Kelayakan Sanitasi Masyarakat	4	0,0645
14	Angka Harapan Hidup	4	0,0645
15	Persentase Jumlah Wanita Tidak Buta Huruf	4	0,0645
16	Indeks IPM	4	0,0645
17	Persentase RT dgn Pola Hidup Berbasis Sehat/PHBS	4	0,0645

Keterangan Nilai Bobot :

1 Tidak Penting
2 Kurang Penting
3 Cukup Penting
4 Penting
5 Sangat Penting

UNTUK MELIHAT HASIL ANALISIS KONDISI PEMANFAATAN DAN MUTU PANGAN KLIK DISINI

UNTUK KEMBALI KE MANAJEMEN DATA KLIK DISINI

UNTUK KEMBALI KE MENU UTAMA KLIK DISINI

Fig. 9. Display Data Field weight Interests Variable Food Utilization and Quality Aspects.

KONDISI MUTU PANGAN

KABUPATEN / KOTA	FSQ TERBOBOT	KONDISI
METRO	1,0119	AMAN
KEMBALI KE PEMBOBOTAN	KLIK DISINI	
KEMBALI KE MANAJEMEN DATA	KLIK DISINI	
KEMBALI KE MENU UTAMA	KLIK DISINI	

Fig. 10. Display Result of Analysis of Utilization and Quality Food

ISIAN DATA KELEMBAGAAN PANGAN

1	***LIHAT BARIS TERBAWAH UNTUK ISI BOBOT KEPENTINGAN***	**BOBOT KEPENTINGAN**	**PERSEN BOBOT KEPENTINGAN**
2	Adanya Kelembagaan Pangan Daerah	5	0,0379
3	Keberadaan dan kinerja kelembagaan pangan di masyarakat	5	0,0379
4	Daya dukung kegiatan penyuluhan terhadap proses pembangunan ketahanan pangan	4	0,0303
5	Pemberdayaan bagi tenaga pelaksanan teknis ditingkat SKPD terkait dengan pembangunan KP	4	0,0303
6	Berjalan Atau Tidaknya Peran Stabilisator Pangan (BULOG)	4	0,0303
7	Ada Tidaknya Regulasi Pangan terkait dimensi ketahanan pangan	4	0,0303
8	Koordinasi & Implementasi Kinerja Antar SKPD Dalam Mendukung pelaksanaan program Ketahanan Pgn	5	0,0379
9	Pendataan dan Pemutakhiran Data Terkait Ketahanan Pangan Sesuai Tupoksi SKPD	5	0,0379
10	Responsibility Terhadap Upaya Perlindungan Lahan Pertanian Pangan Berkelanjutan	4	0,0303
11	Implementasi Regulasi & Kebijakan Pangan	5	0,0379
12	Kelembagaan pangan ditingkat masyarakat	4	0,0303
13	Monitoring keberlanjutan pelaksanaan program ketahanan pangan	4	0,0303
14	Evaluasi keberlanjutan pelaksanaan program ketahanan pangan	4	0,0303
15	Kaji tindak terhadap keberlanjutan pelaksanaan program ketahanan pangan	4	0,0303
16	Pemberdayaan masyarakat terkait pelaksanaan program kegiatan pembangunan Ketahanan Pangan	5	0,0379
17	Partisipasi dan peran serta Masyarakat terhadap pelaksanaan program pembangunan ketahanan pangan	5	0,0379
18	Ketergantungan pada bantuan pangan kronis	3	0,0227
19	Ketersediaan anggaran kajian penelitian & pengembangan pertanian	4	0,0303
20	Komisi pengawas pupuk dan pestisida	4	0,0303
21	Antisipasi perubahan iklim	4	0,0303
22	Antisipasi terjadinya bencana	3	0,0227
23	Tindakan adanya bencanadalam waktu tahun	4	0,0303
24	Ketersediaan informasi pasar	4	0,0303
25	Pemantauan dan pengawasan gizi	4	0,0303
26	Kegiatan jejaringkeamanan pangan	4	0,0303
27	Subsidi harga pangan	4	0,0303
28	Penerapan teknologi pertanian	4	0,0303
29	Informasi & Monitoring jumlah keluar masuk trukpengangkutproduk pangan dari/keluar Lampung rata perhari	5	0,0379
30	Infrastruktur dakegiatan pelabuhan	5	0,0379
31	Akses terhadap fasilitas dan layanan kesehatan	5	0,0379
32	Preferensi masyarakat terhadap jenis pangan beras	4	0,0303i

Keterangan Nilai Bobot :

1 Tidak Penting
2 Kurang Penting
3 Cukup Penting
4 Penting
5 Sangat Penting

UNTUK MELIHAT HASIL ANALISIS KONDISI KELEMBAGAAN PANGAN KLIK DISINI
UNTUK KEMBALI KE MANAJEMEN DATA KLIK DISINI
UNTUK KEMBALI KE MENU UTAMA KLIK DISINI

Fig. 11. Display Data Weight Interests Variable From Institutional Aspect of Food

KONDISI KELEMBAGAAN PANGAN		
KABUPATEN / KOTA	FSQ TERBOBOT	KONDISI
METRO	1,0154	AMAN
KEMBALI KE PEMBOBOTAN	KLIK DISINI	
KEMBALI KE MANAJEMEN DATA	KLIK DISINI	
KEMBALI KE MENU UTAMA	KLIK DISINI	

Fig. 12. Views of Institutional Analysis of Food Results

No	**KAB / KOTA**	**KETERSEDIAAN**	**AKSES**	**PEMANFAATAN**	**LEMBAGA**
1	METRO	0,8893	0,9672	1,0119	1,0154
		RAWAN	**RAWAN**	**AMAN**	**AMAN**
	KE MENU UTAMA	KLIK DISINI			

Fig. 13. Resume of Food Security Metro City Based on DSS Generator

4. *Map Condition of Food Security*

From the calculation of FSQt value on the food security subsystem in Metro City as shown in Table 2 can be obtained composite value from the subsystems of food security. Each composite value of the food security subsystem is then used to describe (map) the condition of Metro's food security as in Fig. 14.

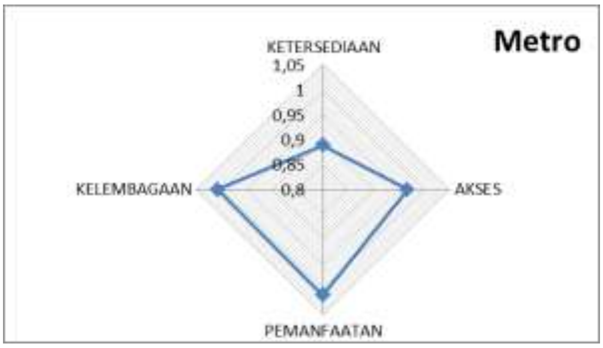

Fig. 14. Map of City Food Security Condition of Metro

5. *Strategy and Policy of Food Security Development*

From result of SWOT analysis resulted map of condition of strength, kelamahan, opportunity and threat to Metro city as shown in Fig. 15 below.

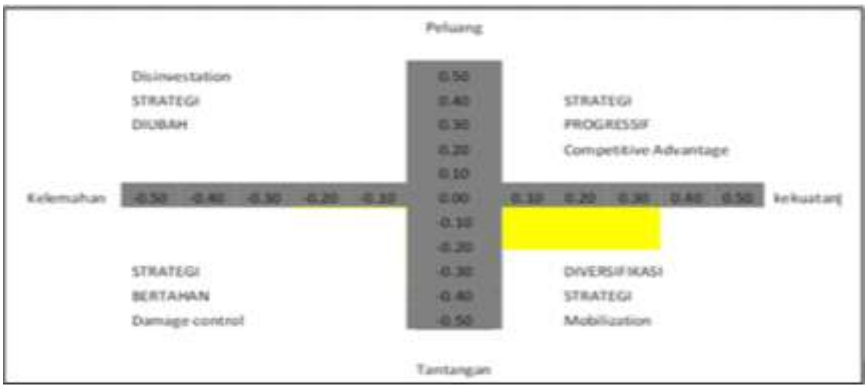

Fig. 15. Map of SWOT Results of Food Security Conditions Metro City.

So that from SWOT map above can be developed strategy for development of Metro city food security which result as shown in Table 3.

Table 3. Metro Food Security Development Strategy

no	strategy	codes	value	policy
1	improvement and strengthening the quality of life of the community to reduce the occurrence of malnutrition through improvement of public health services.	k12, k13, k14,k15, k16, k22	4.84	health sector regulations related to health services and incentive systems for health workers in serving the community due to natural conditions
2	Increasing people's purchasing power to get quality and nutritious food as an effort to reduce the occurrence of malnutrition.	k4, k5, k6, k7, k11	3.39	regulations related to food distribution and food price protection for the community
3	development of food reserves / community food barns to reduce food insecurity and anticipate the occurrence of climate change phenomenon and land use change.	k1, k2, k3, a4,	2.51	regulation that requires each village, kecama tan to build a food barn to anticipate the occurrence of food insecurity.
4	improving governance of food security through empowerment of each tbsp in terms of food security.	k17, k18, k19	2.48	Optimalization perda / perwal / sk related coordination across the SKPD using an integrated information system (one roof) to facilitate the planning, implementation, monitoring and evaluation of the implementation of programs and activities.
5	improvement and strengthening the quality of life of the community to reduce the occurrence of malnutrition through improving environmental health.	k8, k9, k10,	1.92	regulation on the associated food stabilizer agency area
6	Increased diversification of rice substitute food by way of variation of the weekly meal menu.	k1, k23	0.98	regulations on efforts to reduce rice consumption and utilization of non-rice commodities as alternative food.

From the above strategy can be arranged SKPD sequence that will be involved in the implementation of development of food security city Metro as shown in Table 4.

Table 4. SKPD Involved in Development Metro City Food Security

No.	SKPD that Involved	the number of activities related strategies
1	Bappeda	6
2	Badan Ketahanan Pangan (BKP)	6
3	Dinas Pertanian – TPH	6
4	Dinas Komunikasi dan Informasi	6
5	Badan Pusat Statistik (BPS)	4
6	Dinas Perindustrian dan Perdagangan	3
7	Dinas Kesehatan	6
8	Dinas Kependudukan dan Catatan Sipil	3
9	Dinas Pendidikan	2
10	Badan Urusan Logistik (BULOG)	3
11	Badan Meteorologi Klimatologi dan Geofisika (BMKG)	2
12	Dinas Pekerjaan Umum dan Pengairan	3
13	Dinas Perhubungan	2
14	Badan Pengedalian Lingkungan Hidup (BPLH)	3
15	Dinas Tenaga Kerja	1
16	Badan Penanggulangan Bencana Daerah (BPBD)	1
17	Badan Pertanahan Nasional (BPN)	1

6. *Recommendation*

Based on the results of the above analysis, in order to carry out development planning of food security Metro City, some recommendations that can be submitted are:

a. Model criteria, indicators for the performance of food security in Metro City can be applied to strategic planning process, policy formulation, program, activity and involvement of SKPD or Agency / institution related to development of food security in Metro City for the next 5 years.

b. Disable some real action steps to realize this food development planning model, among others :
   - Improve and strengthen the quality of life of the community to reduce the occurrence of malnutrition through the improvement of public health services.
   - Increasing people's food purchasing power to get quality and nutritious food as an effort to reduce the occurrence of malnutrition.
   - Development of food reserves / community food barns to reduce food insecurity and anticipate the occurrence of climate change phenomenon and land use change.
   - Improved governance of food security management through empowerment of human resources in each SKPD related to food security.
   - Improving and strengthening the quality of life of the community to reduce the occurrence of malnutrition through improving environmental health.
   - Increased diversification of rice substitute food by variation of weekly meal menu.

IV. CONCLUSION

A. *Conclusion*

1. Generated a series of measuring indicators that are able to describe the condition of city food security Metro for the next 5 years. 34 iindicators of food availability components, 13 indicators of food access components, 16 indicators of food utilization and quality components and 31 indicators of institutional components and food regulation.
2. Generated a Model of decision-making in the form of Decision Support System Specific that is operational and anticipatory to the vulnerability of food metro-city conditions Metro in the form of Excel Generator.
3. Metro City is currently experiencing food insecurity and prone to purchasing power.
4. Generated Model of strategy and policy formulation for development planning of Metro City food security.

B. *Suggestion*

1. Specific Decision Support System using Generator Excell generated, fore need to be developed into a form of more permanent and complete SPK so that easiness in decision making process can be improved.
2. Related to the implications for food security development policy in all three regencies in Lampung Province, the model of decision making in the form Specific SPK can be used in monitoring, evaluating and planning future food security development.

REFERENCES

Aurino. E. 2014. Selecting A Core Set Of Indicators For Monitoring Global Food Security. Working Paper Series. FAO Statistics Division. FAO of The United Nation. Rome.

Awasthi, Maya Kant and Singh, Samiksha. 2010. System Analysis of Food Security Situation in India. Center for Food and Agribusiness Mangement, Indian Institute of Management, Lucknow, India.

Azami S and Imai K., (2009), "Vulnerability and Poverty in Bangladesh Economics ", School of Social Sciences University of Manchester, United Kingdom.

Regional Food Security Agency of Lampung Province. 2013. Technical Report Application and Acceleration Standards Minimum Service (SPM) Lampung Province Food Sustainability Fiscal Year 2013. Bandar Lampung.

Regional Food Security Agency of Lampung Province. 2014. Basic Food Distribution in Lampung Province. Material In Council Meeting of Food Security December 2014. Bandar Lampung.

Central Bureau of Statistics and Regional Development Planning Agency. 2010. Lampung In Figures. BPS Lampung

Central Bureau of Statistics and Regional Development Planning Board. 2011. Lampung In Figures. BPS Lampung Province.

Central Bureau of Statistics and Regional Development Planning Board. 2012. Lampung In Figures. BPS Lampung Province.

Central Bureau of Statistics and Regional Development Planning Board. 2013. Lampung In Figures. BPS Lampung Province.

Central Bureau of Statistics and Regional Development Planning Board. 2014. Lampung In Figures. BPS Lampung Province.
Central Bureau of Statistics and Regional Development Planning Board. 2015. Lampung In Figures. BPS Lampung Province.
Carletto. C, Zezza. A. Banerjee. R. 2013. Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. Journal Global Food Security 2 (2013) 30 - 40 Elsevier.
Chia C.H, Brian A.S, 2007. The Delphi Technique Making Sense Of Consensus, e-Journal Practical Assessment Research and Evaluation Vol 12 No. 10. Ohio State University. Worthington.
FAO. 2006. Integrated Food Security and Humanitarian Phase Classification (IPC) Framework, ESA Policy Brief, 06 - 01.
FAO. (2008c). Climate change: Implications for food safety. Rome, Italy.
Kastaman, Roni. 2012. Final Report: Food Security Master Plan Bandung. Bandung Regional Development Planning Agency, Institute for Research and Community Service, Padjadjaran University.
Kusrini. 2007. Concept and Application of Decision Support System. ANDI Publisher. Yogyakarta.
Renstra BKP Lampung Province Year 2010-2014. 2009. Provincial Government of Lampung Province.
WFP (World Food Program). 2009. Emergency Food Security Assessment Handbook.