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## Optimalization of upja revenue (business provider services) rice cultivation using linear programming analysis in seputih raman district, central Lampung

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**Abstract.** Rejo Asri Gapoktan is a farmer group located in Seputih Raman District, Central Lampung Regency and has an Alsintan Service Provider (UPJA) Business for Rice cultivation. In carrying out its activities UPJA Gapoktan has several tools and machines related to the management of rice cultivation, including: tractors, hand tractors, transplants, plant maintenance tools (hand sprayers and power weeder) and combine harvester. The problem faced by Gapoktan is the management of tool management, especially in maximizing revenue gains from managing these tools and machines. During this time Gapoktan has not been able to obtain an ideal profit, only in the break-even stage between business income and expenditure. Constraints on the extent of claim for each tool, equipment rental time, tool working hours, number of operators, operational costs, and rejuvenation costs for each tool still cannot be harmonized, so that it has not been able to achieve maximum profit. One effort to provide a solution to the problem in this study is the use of the Simplex Method which is one of the analysis of Linear Programming which aims to maximize the benefits of UPJA. The research method used is a quantitative method using Linear Programming analysis method using QM-For Windows V helper software. 5. The results showed that Linear Function for Z max objective function =  $4.305.000X_1 + 3.255.000X_2 + 3.258.500X_3 + 16,800,000X_4$ , where  $X_1$ ,  $X_2$ ,  $X_3$ , and  $X_4$  are Tractors, Tractor Hand, Transplanters, and Combine Harvester respectively. And the equation of the constraint function P1 (Land Area) =  $60X_1 + 120X_2 + 56X_3 + 120X_4 \leq 9408$ , P2 (Rental Time) =  $240X_1 + 240X_2 + 240X_3 + 240X_4 \leq 1448$ , P3 (Tool Hours) =  $56X_1 + 120X_2 + 56X_3 + 120X_4 \leq 1448$ , P4 (Number of Operators) =  $X_1 + 2X_2 + 3X_3 + 4X_4 \leq 10$ , P5 (Operating Costs) =  $290000X_1 + 290000X_2 + 835000X_3 + 800000X_4 \leq 38545000$ , P6 (Equipment Rejuvenation Costs) =  $123000X_1 + 93000X_2 + 199500X_3 + 240000X_4 \leq 11836500$ . Conclusion, after optimization, solutions of solutions  $X_1$ ,  $X_2$ ,  $X_3$ , and  $X_4$  are 4.71, 0, 0, and 1.32, the total overall profit obtained by the Gapoktan Rejo Asri from the UPJA is Rp. 42,494,670. , - for one planting season (MT) and for the Cropping Index in Seputih Raman Sub-district, 2 is made in one year is Rp. 84,989,340, - assuming profitability is in accordance with the objective function and the same constraint function.



## 1. Introduction

### 1.1. Background

The majority of the Indonesian population consumes rice as a staple food to fulfill their daily needs, hence the need for food, especially rice, must be fulfilled and sustainable. Rice is a major buffer for national food security, and rice farming is the backbone of the rural economy. Rice production in Indonesia must be improved, in carrying out the agricultural production process it is always needed labor, tools and agricultural machinery. The use of alsintan in today's rice cultivation is very much needed. Therefore it is necessary to use alsintan in rice cultivation.

In the village of Rejo Asri, Seputih Raman sub-district, Central Lampung district, there are gapoktan which have an Alsintan service provider business (UPJA) that can support rice production in the area as white as the Raman village, specifically the Rejo Asri village. In Rejo Asri Gapoktan there are already several agricultural machinery tools (alsintan) for the needs of each activity in rice cultivation including tractors and hand tractors for tillage, transplanter for rice cultivation, and combine harvester for harvesting activities. UPJA is one of the right systems to meet the needs of farmers in terms of working for rice cultivation. However, in the UPJA system in Gapoktan Rejo Asri has not been able to maximize the benefits of the UPJA rental system.

Linear Programming is the right method for optimizing profit earnings of UPJA Gapoktan Rejo Asri, because Linear Programming using the simplex method is able to solve optimization or minimization problems with a number of variables that are more than two or many variables. To simplify the work of optimizing the benefits of UPJA, QM - For Windows software is needed to get profit.

The expectation of the outcome of optimizing the rental system for the Rejo Asri Gapoktan who is using Linear Programming is that UPJA is able to obtain optimal (maximum) profit and crop yields or the farmers are able to produce rice maximally with the use of alsintan in rice cultivation. Therefore, a study of the management of UPJA is needed at the Rejo Asri Gapoktan Seputih Raman Sub-District, Central Lampung district for rice cultivation.

### 1.2. Research Purposes

The purpose of this research is to get the optimization of business income of Alsintan Service Providers (UPJA) using linear programming methods.

## 2. Materials and Methods

The research was conducted from February to April 2018. The location of data collection was in the Rejo Asri farmer group in Seputih Raman sub-district, Central Lampung Regency. The equipment used in this study are data on farmer groups, stationery, cameras, voice recorders, laptops, QM For Windows software. While the materials used are primary and secondary data, agricultural land.

### 2.1. Research Methods

The research method used in this study consisted of two types, namely the method of qualitative data analysis and quantitative data analysis methods.

#### 2.1.1. Early Stage

This stage is the initial preparation stage of the research, which includes identifying problems and gathering initial information that is useful for research.

#### 2.1.2. Data Collection Stage

This stage is the stage of collecting various data and information that is useful for research to then be processed and analyzed in accordance with existing research methods. The data used in this study are primary data and secondary data.

### 2.1.3. Analysis Stage

This stage contains an analysis of the collected and processed data to determine the management optimization value and its maximum income. The step of the analysis phase for determining the income optimization of UPJA Gapoktan Rejo Asri using a linear programming model is shown in the step step below.

1. The first stage in this research is identifying problems by calculating total management costs, production yields, and labor costs.
2. The second stage in this study is the formulation of a linear programming model. This model is one that can be used to solve a problem with optimum goals [5]. Formulation of linear programming model consists of the formulation of decision variables, formulation of objective functions and perumusak constraint functions.
3. The third stage in this research is determining the decision variable.
4. The fourth stage in this study is to set the objective function to be achieved maximizing profits with optimal management of the WORK. The objective function is a function that will be achieved to obtain maximum or minimum values in a linear problem. The value to be optimized is stated as  $Z_{max}$ .

$$Z_{max} = X1Y1 + X2Y2 + X3Y3 + X4Y4 \quad (1)$$

With conditions:  $Y1, Y2, Y3, Y4 \geq 0$

Information :

$X$  = Max Value Output Optimization for each tool

$Y$  = Net Income for each tool

1. Tractor, 2. Hand Tractor, 3. Transplanter, 4. Combine harvester)

5. The fifth stage in this study is to determine the function of constraints / limits. The formulation of the boundary function is derived from the factors that are limiting factors. In addition, there are also technical constraints and are absolutely fulfilled, namely in the form of provisions for the results of non-negative decisions or having a value of 0 [1].

Constraint Function:

$$FK 1 (Land Area) = nX1 + nX2 + nX3 + nX4 \leq NK \quad (2)$$

$$FK 2 (Rental Time) = nX1 + nX2 + nX3 + nX4 \leq NK \quad (3)$$

$$FK 3 (Tool working hours) = nX1 + nX2 + nX3 + nX4 \leq NK \quad (4)$$

$$FK 4 (Number of Operators) = nX1 + nX2 + nX3 + nX4 \leq NK \quad (5)$$

$$FK 5 (Operating Costs) = nX1 + nX2 + nX3 + nX4 \leq NK \quad (6)$$

$$FK 6 (Tool Rejuvenation Cost) = nX1 + nX2 + nX3 + nX4 \leq N \quad (7)$$

Where:

$X1$  = Tractor,

$X2$  = Hand Tractor,

$X3$  = Transplanter,

$X4$  = Combine Harvester

$NK$  = Right Value or Maximum value available for each Constraint Function

$n$  = Coefficient value of Constraint Function

6. The sixth stage in this study is to complete the linear programming model using the Simplex Method and the POMQM software for Windows. Simplex method is one of the most widely used procedures for solving linear programming problems, even used for resolutions from computer programs. QM software for Windows is a package that is intended for quantitative methods for business and DS for Windows contains a combination of the two previous packages [2].
7. The seventh step in this study is to analyze the optimal results of production. The analysis used is a sensitivity analysis of the optimal results obtained.

## 3. Results and Discussion

### 3.1. Profile of UPJA Gapoktan Rejo Asri

Asri Gapoktan located in Rejo Asri village, Seputih Raman sub-district, Central Lampung district, is a gapoktan which has been included in the classification of developing Gapoktan. There are several agricultural machine tools that have been operated. In this study there were four tools provided for UPJA activities, including Tractors, Hand Tractors, Transplanters (rice planting machines), and Combine Harvester (rice harvesting machines). In Seputih Raman Subdistrict Planting Intensity (IP) occurs as much as 200% or 2 plantings. The area of function land or paddy fields found in the Rejo Asri farm group is 657 Ha. The area of land that is worked on by each tool is 1-2 Ha per day, in one day the tool works for 8 hours. The time for working tools in one planting season is Tractor and hand tractor for 30 days, the transplanter is 30 days, and the combine harvester is 30 days. The rental price for equipment for each Ha is a tractor of Rp. 700,000, - Hand Tractor for Rp. 600,000, - Transplanter for Rp. 1,500,000, - Combine Harvester for Rp. 1,600,000. The rental prices are gross or the rental price is dirty. From the income above the Rejo Asri Gapoktan UPJA has not been able to obtain optimum income, therefore linear programming analysis is done using the simplex method, because there are more than two variables. In this calculation, it is done for one planting season so if in one year there are 2 planting seasons, the revenue from the optimization is multiplied by 2 in one year.

### 3.2. Linear Programming Formulation

The formulation of the linear programming model in this study using the simplex method. In this case there are four variables, namely Tractor, Hand Tractor, Transplanter and Combine Harvester and some constraint functions.

#### 3.2.1. Decision variable

Decision variable is a complete description of the decisions that will be made. Where there are 4 decision variables including:

X1 = Tractor

X2 = Hand Tractor

X3 = Transplanter

X4 = Combine Harvester

#### 3.2.2. Purpose Function

Purpose Function (Zmax) is the goal to be achieved, must be realized into a linear mathematical function, including;

Tractor = IDR 4,305,000 / MT

Hand Tractor = Rp. 3,255,000 / MT

Transplanter = Rp. 3,258,500, - / MT

Combine Harvester = Rp. 16,800,000 / MT

From the advantages above, the objective function is obtained as follows.

$$\mathbf{Zmax = 4,305,000X1 + 3,255,000X2 + 3,258,500X3 + 16,800,000X4}$$

The above benefits are net or net income which has reduced operating costs and the cost of tool rejuvenation.

#### 3.2.3. Constraint Function

Constraint function or limitation function is a constrain boundary constraint that is contained in the expression of Asri Rejo and expressed mathematically in the form of a set of linear functions. The function of the constraints at the UPJA of the Rejo Asri farmer union for rice cultivation is as follows.

P1 (Land Area) =  $60X1 + 120X2 + 56X3 + 120X4 \leq 9408$

P2 (Rental Time) =  $240X1 + 240X2 + 240X3 + 240X4 \leq 1448$

P3 (Tool Working Hours) =  $56X1 + 120X2 + 56X3 + 120X4 \leq 1448$

P4 (Number of Operators) =  $X1 + 2X2 + 3X3 + 4X4 \leq 10$

P5 (Operating Costs) =  $290000X1 + 290000X2 + 835000X3 + 800000X4 \leq 38545000$

$$P6 \text{ (Tool Rejuvenation Fee)} = 123000X1 + 93000X2 + 199500X3 + 240000X4 \leq 11836500$$

### 3.3 Linear Model Simplex Method

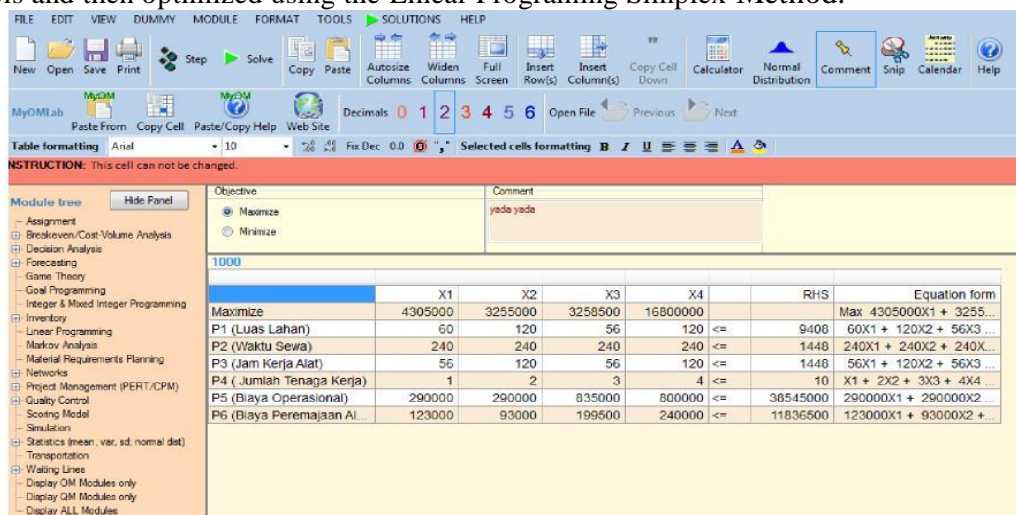
Optimization with the simplex model begins with making a mathematical model in the simplex standard equation.

**Tabel 1.** Initial Simplex Table

Basic Variable	X1	X2	X3	X4	Right Value
<b>Zmax</b>	4305000	3255000	3258500	16800000	
<b>P1</b>	60	120	56	120	9408
<b>P2</b>	240	240	240	240	1448
<b>P3</b>	56	120	56	120	1448
<b>P4</b>	1	2	3	4	10
<b>P5</b>	290000	290000	835000	800000	38545000
<b>P6</b>	123000	93000	199500	240000	11836500

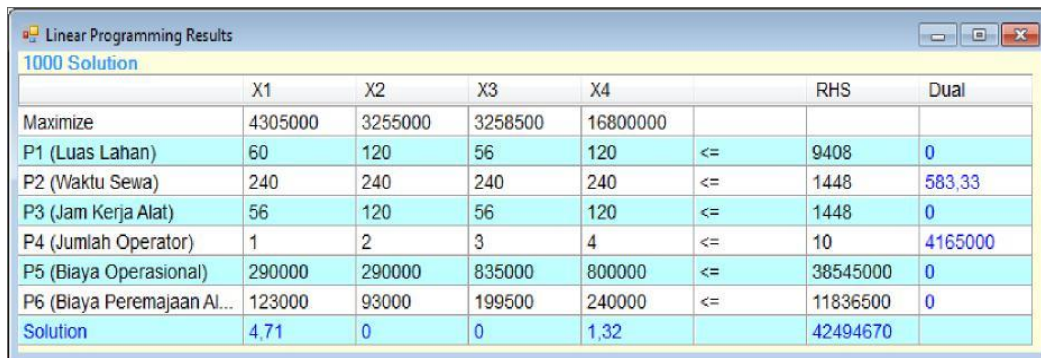
#### 3.3.1. Problem Solving UPJA Gapoktan Asri Rejo uses QM For Windows Tools

After getting the simplex table in table 1 then the data is inputted into the QM-For windows version 5.0 tools and then optimized using the Linear Programming Simplex Method.



**Figure 1.** Initial data in QM-For Windows software

After that the software in the solve and the results obtained as follows. The Linear programming result is the data analysis results from the initial data entered into the tools. Here is a display of linear programming result.



1000 Solution							
	X1	X2	X3	X4		RHS	Dual
Maximize	4305000	3255000	3258500	16800000			
P1 (Luas Lahan)	60	120	56	120	<=	9408	0
P2 (Waktu Sewa)	240	240	240	240	<=	1448	583,33
P3 (Jam Kerja Alat)	56	120	56	120	<=	1448	0
P4 (Jumlah Operator)	1	2	3	4	<=	10	4165000
P5 (Biaya Operasional)	290000	290000	835000	800000	<=	38545000	0
P6 (Biaya Peremajaan Al...)	123000	93000	199500	240000	<=	11836500	0
Solution	4,71	0	0	1,32		42494670	

**Figure 2.** Data from the results of the Linear Programming Result analysis

Based on the results of the QM For Windows Linear Programming Analysis Table, the results or profit solutions are in accordance with the objective function, namely maximizing the benefits of UPJA by multiplying each coefficient of the variable and function constraints with the solution values obtained from the results of Linear Programming Result analysis. Based on the objective function, obtained:

$$\begin{aligned}
 Z_{\max} &= 4,305,000X_1 + 3,255,000X_2 + 3,258,500X_3 + 16,800,000X_4 \\
 &= 4,305,000 (4.71) + 3,255,000 (0) + 3,258,500 (0) + 16,800,000 (1.32) \\
 &= \text{Rp } 20,276,550, - + 0 + 0 + \text{Rp. } 22,176,000, - \\
 &= \text{Rp. } 42,494,670, - / \text{MT}
 \end{aligned}$$

Whereas based on the constraint function, obtained:

$$\begin{aligned}
 P_1 &= 60 (4.71) + 120 (0) + 56 (0) + 120 (1.32) \\
 &= 282.6 \text{ Hours} + 0 + 0 + 158.4 \text{ Hours} \\
 &= (2 / A = 8 / 282.6) + 0 + 0 + (2 / A = 8 / 158.4) \\
 &= 70.65 \text{ Ha} + 0 + 0 + 39.6 \text{ Ha}
 \end{aligned}$$

Note that the function of the land area constraints must be converted back into Hectare

$$\begin{aligned}
 P_2 &= 240 (4.71) + 240 (0) + 240 (0) + 240 (1.32) \\
 &= 1130.4 \text{ Hours} + 0 + 0 + 316.8 \text{ Hours} \\
 P_3 &= 56 (4.71) + 120 (0) + 56 (0) + 120 (1.32) \\
 &= 263, 76 \text{ Hours} + 0 + 0 + 158.4 \text{ Hours} \\
 P_4 &= 1 (4.71) + 2 (0) + 3 (0) + 4 (1.32) \\
 &= 4.71 + 0 + 0 + 5.28 \\
 P_5 &= 290000 (4.71) + 290000 (0) + 835000 (0) + 800000 (1.32) \\
 &= \text{Rp. } 1,365,900 - + 0 + 0 + \text{Rp. } 1,056,000, - \\
 P_6 &= 123000 (4.71) + 93000 (0) + 199500 (0) + 240000 (1.32) \\
 &= \text{Rp. } 579,330, - + 0 + 0 + \text{Rp. } 316,800, -
 \end{aligned}$$

Based on the objective function, information is obtained as follows. For tractors, it will reach a profit of IDR 20,276,550 / MT by obtaining an area of arable land of 282.6 hours or 70.65 ha / MT for a maximum rental time of 1130.4 hours / MT, and working hours of equipment for 263, 76 hours / MT, for the number of tractor operators must also be added to 4.71 or 5 people, then for tractor operating costs of Rp. 1,365,900 / MT, and the latest cost of rejuvenating equipment is Rp. 579,330, - / MT. For X2 and X3, the solution value is equal to 0, meaning that the two devices are non-basic or both devices are not optimal solutions if operated. Whereas for X4 or Combine Harvester will reach a profit of Rp. 22,176,000 / MT by obtaining an area of 158.4 hours or 39.6 ha / MT of arable land, for a maximum rental time of 316.8 hours / MT, and working hours for 158, 4 Hours / MT, the combined harvester operator must be added to 5.28 or 5 people, then for the combine harvester operating costs of Rp. 1.056,000 / MT, and the last time the cost of rejuvenating the tool is Rp. 316,800 / MT.

### 3.4. Sensitivity Analysis

Based on the results of the optimization that has been done, the initial benefits of the Rejo Asri Gapoktan Association are Rp. 27,618,500, - / MT and after Linear Programming optimization using the simplex method using QM software - For windows version 5.0 the final profit of Rp. 42,494,670 is obtained, - / MT.

## 4. Conclusions And Suggestions

### 4.1 Conclusions

From the results of the analysis with Linear Programming, it was concluded that to maximize the income at the Rejo Asri Gapoktan Sepang, Seputih Raman Sub-District, Central Lampung Regency, with constraints Land area worked on by each tool (P1), rent time per alsintan (P2), Working Hours Tools (P3), Number of operators (P4), Operational Costs (P5), Rejuvenation Costs of Tools (P6), obtained a solution value from Tractor Variable (X1) of 4.71, Hand Tractor (X2) of 0, Transplanter (X3) of 0, Combine Harvester (X4) of 1.32. So that the optimization of P1, P2, P3, P4, P5, P6, X1 (Tractor) and X4 (Combine Harvester) get the maximum profit from UPJA activities for rice cultivation are as follows.

$$\begin{aligned} Z_{\max} &= 4,305,000X_1 + 3,255,000X_2 + 3,258,500X_3 + 16,800,000X_4 \\ &= 4,305,000 (4.71) + 3,255,000 (0) + 3,258,500 (0) + 16,800,000 (1.32) \\ &= \text{Rp } 20,276,550, - + 0 + 0 + \text{Rp. } 22,176,000, - \\ &= \text{Rp. } 42,494,670, - / \text{MT} \end{aligned}$$

So the total overall profit gained by UPJA Asri Gapoktan Seputih Raman Subdistrict, Central Lampung Regency from UPJA for rice cultivation is Rp. 42,494,670, - in one planting season and in one year or IP planted twice as much as Rp. 84,989,340, - assuming the gain in accordance with the objective function and the same constraint function.

### 4.2. Suggestion

- a. Based on the research data and linear programming analysis that has been carried out, it is recommended to the UPJA Asjo Gapoktan to add or carry out a cooperation system to increase the number of hand tractor tools so that the work area and working hours of the tool are balanced with the tractor.
- b. Collaborating with the owners of personal alsintan in the white-blooded sub-district to manage the work of Alsintan in the district as white as possible so that it is mutually beneficial.
- c. Increasing work time in other sub-districts if the working time of the tool is not enough to work on the land as white as the raman in one planting season.
- d. Further research is carried out for variations in UPJA system leases to be worked on.

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