PROCEEDINGS OF INTERNATIONAL SYMPOSIUM ON SOIL MANAGEMENT FOR SUSTAINABLE AGRICULTURE 2017

-PART 1-

INTERNATIONAL SYMPOSIUM ON SOIL MANAGEMENT FOR SUSTAINABLE AGRICULTURE 2017

ORGANIZER:
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-PART 2-

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International Symposium on Soil Management for Sustainable Agriculture 2017

PROGRAM
–PART 1–

DAY ONE: Monday, August 28

Time: 9:30-19:30
Venue: Main Seminar Room (6F in UGSAS Building, Gifu University)
Master of Symposium: Prof. *Kohei Nakano (Gifu Univ.)*

Time Table

9:30-10:00	Registration
10:00-10:05	Opening Remarks *Prof. Masateru SENGE (Dean of UGSAS, Gifu Univ.)*
10:05-10:10	Welcome Speech *Dr. Fumiaki SUZUKI (Executive Director and Vice President of Gifu Univ.)*
10:10-10:50	Keynote Speech 01 *Prof. Yasushi MORI (Okayama Univ.): Soil Physical Rehabilitation*
10:50-11:30	Keynote Speech 02 *Assist. Prof. Yuki KOJIMA (Gifu Univ.): Soil Water and Energy Dynamics*

Session 1 —General Issue and Solution— Session Chair: Prof. *Muhajir Utomo (Lampung Univ.)*

11:30-11:55	*01. Prof. Isril BERD (Andalas Univ.)*
11:55-12:20	*02. Dr. Komariah (Sebelas Maret Univ.)*
12:20-12:30	Photo Session
12:30-13:40	Lunch Break (Light meals served)

Session 2 —Soil Science— Session Chair: *Assistant Prof. Keigo NODA (Gifu Univ.)*

13:40-14:05	*01. Prof. Muhajir UTOMO (Lampung Univ.)*
14:05-14:30	*02. Dr. Afandi (Lampung Univ.)*
14:30-14:55	*03. Mr. Didin Wiharso, M.Sc. (Lampung Univ.)*
14:55-15:20	*04. Dr. Nuyen Thi Hang NGA (Thuy Loi Univ.)*
15:20-15:30	Coffee Break

Session 3 —Watershed Management—Session Chair: *Associate Prof. Takeo ONISHI (Gifu Univ.)*

15:30-15:55	*01. Dr. Khandra Fahmy (Andalas Univ.)*
15:55-16:20	*02. Dr. Muhammad MAKKY (Andalas Univ.)*

CONTENTS

— PART 1 — KEYNOTE SPEECHES

Changes of soil morphology and properties in *long-term* soil management under humid tropical regions of Lampung, Indonesia

○Didin Wiharso, Muhajir Utomo and Afandi
(Faculty of Agriculture, Lampung University, Indonesia)

SUMMARY

The humid tropical climate was characterized by high rainfall and solar heat for most of the year, resulting in high rates of soil weathering, soil losses, cations leaching, and oxidation of soil organic matter. The aim of this research was to observe the changes of soil morphology and soil properties due to differences in soil management for 20 years. There were three types of soil management, Intensive Tillage (IT), Minimum Tillage (MT) and No or without tillage (NT). Basically, Minimum Tillage and No Tillage are the Conservation Tillage (CT). The results showed that the lower content of organic matter in the upper layer of IT had caused the soil color become lighter, which was characterized by higher chroma. Soil structure on the top layer of IT had changed from crumbs toward to the angular blocky. The topsoil on IT was more friable than two others, while the lower layer was more dense or compact. Generally, the chemical properties of CT were better than IT, and NT was slightly better than MT.

Keywords: Intensive Tillage, Minimum Tillage, No-Tillage, Conservation Tillage

1. Introduction

Technically the major constraint for humid tropical regions in producing food is the low quality of soil due to the rapid rate of soil degradation, as a result of high temperature and rainfall. Because of the large amount and high intensity of rainfall in the humid tropics, soil erosion can potentially reach dramatic levels in this region (El-Swaify *et al.*, 1982; Lal, 1990), therefore the soil quality will decrease rapidly. Decrease in soil quality both physically and chemically occurs at a high rate due to the high rate of soil loss, soil organic matter, nutrients, as well as damage to soil structure and compaction process. The above conditions occur because in general the existing agricultural cultivation or conventional agriculture is less attention to soil conservation aspects and this is not only happening on the farmland but also occurs in plantation companies.

In order to minimize or reduce the rate of soil degradation due to high rainfall and solar heat in the humid tropics, alternative agricultural cultivation technology is needed to pay more attention to soil conservation aspects, among others by reducing soil tillage or minimum tillage (MT) and another alternative is that with no-tillage technology (NT). Both of these cultivation technologies can be referred to as a conservation tillage (CT) or conservation agriculture because they do not modify soil layers intensively, therefore it will not alter or damage the soil structure. Conservation tillage, the most important aspect of Conservation Agriculture, is thought to take care of the soil health, plant growth and the environment (Busari *et al.*, 2015).

Through conservation tillage technology, besides not too damage soil structure at the top soil, residue of the harvest that is spread over the soil surface could be function as a mulch. The presence of mulch above the soil surface is expected to reduce soil damage due to splash erosion and surface Run-Off. Plant residues from previous crop season which are used as mulch is important in CT practices. This is not only because its effectiveness in reducing soil erosion, but also in converting the substrate to microbial biomass carbon (Wright and Hons 2004; Smith and Collins 2007; Utomo *et al.* 2010). In addition, the mulch covering the soil surface is expected to restrain the effects of solar heat so that the microclimate on the surface layer will not overheat which will further reduce the rate of oxidation of soil organic matter. By using mulch, soil temperature in 5 cm depth could decrease between 5-9 °C and could increase soil moisture content (Kamara, 1986).

This study aims to determine the changes that occur in the morphology and soil properties after the difference of land management for 20 years.

2. Material and Method

This research was conducted on Reddish Brown Latosol (Udult) derived from andesitic volcanic rocks that originating from Mount Betung in the Southern part of Sumatra Island, Indonesia (Mangga et al., 1993). Soils had been managed for 20 years since 1987 with 3 types of management, the first treatment was the intensive tillage (IT), the second was the minimum tjllage (MT), and the third was no-tillage (NT). The cereal-legume-fallow rotation sequences were set each year. Plot size of this long-term experiment was four by six meters (Utomo *et al.* 1989). In the IT plot, prior to planting, the soil was plowed twice, while all weeds and previous crop residues were removed from the plots. In the MT plot, soil was plow lightly at a depth of 0-5 cm by using a hoe. In NT plots, weeds were sprayed with glyphosate at a dose of 4.8 liters per hectare. In CT plots (MT and NT), all dead weeds and previous crop residues were used for mulch covering the soil surface, while in IT plot, all weeds and previous crop residues were removed from the plots (Utomo *et al.*, 2013). Nitrogen source for the N treatment was Urea 46% N. Nitrogen fertilizer application was applied as hand banding in the row close to the crop. A week after planting, P and K fertilizers at rates of 100 kg SP-18 ha^{-1} and 100 kg KCl ha^{-1} were applied as basal fertilizers, respectively (Utomo *et al.* 2010).

Soil profile was dug in the middle of each plot, then soil profiles were described and sampled according to

Soil Survey Division Staffs (1993). Soil color was determined by Munsell Soil Color Charts (Macbeth, a Division of Kollmorgen Corporation, 1975). Disturbed soil samples were taken for analyzing soil texture by pipette method (Gee and Bauder, 1986) and soil chemical properties. Soil chemical properties include organic carbon content (Walkley and Black); total nitrogen (Kjeldahl), pH in H2O with ratio of 1:2.5 (pH meter); Exchangeable bases, soil CEC extracted by 1 N NH4OAc. at pH 7.0, and exchangeable Al & H extracted by 1 N KCl were measured by AAS. Undisturbed soil sample was taken through sample ring with a 2 inches diameter to analyze Bulk Density by the core method (Blake and Hartge, 1986). Soil strength in each soil layer was measured using a pocket penetrometer (Unconfined comp. strength ELE).

3. Result and Discussions

3. 1 Soil Morphology

3. 1. 1 Soil Horizons

From soil surface to a depth of 150 cm, there is a difference in the number of soil horizons, IT pedon has 6 soil horizons, MT pedon has 5 soil horizons and NT has 4 soil horizons. Differences are also found in the thickness of the surface horizon where the surface horizon of the IT pedon (18 cm) is thicker than that of both CT pedons (15 cm). This happens because the soil plowing reaches a depth of 18 cm on the IT pedon.

3. 1. 2 Soil Color

There is a gradual difference in soil color on the surface horizon where the soil color on the IT pedon (7.5 YR 3/4) is slightly lighter than the CT pedon (7.5 YR 3/2) which is characterized by the higher chroma. Although there is a difference in the soil color, all of the three pedons have the same class that is the dark brown color (Table 1). The soil color difference on the surface horizon is due to the difference in soil organic carbon (SOC) content, where the SOC content on the upper layer of the IT pedon (1.42 %) is less than the two CT pedons (Table 3). Between the two pedons CT, the soil C-organic content on the surface horizon on the NT pedon (1.60%) was higher than that of the MT pedon (1.53%) (Table 3).

3. 1. 3 Soil Structure

Soil structure on the surface layer of soil on the two CT pedons have the same shape of structure that is Crumb, while the IT pedon has shown a change toward to the form of angular blocky (Table 1). The change is certainly related to the reduced content of soil organic matter (SOM) (Table 3). According to Busari *et al.* (2015), implying yearly practice of no-till system over a long period of time, is beneficial to maintenance and enhancement of the structure and chemical properties of the soil, most especially the content of soil organic carbon.

3. 1. 4 Soil Consistence

The topsoil on the IT pedon has a more friable consistency than both CT pedons (Table 1), because soil plowing could dismantle the chunk of the soil, therefore soil aggregates will rupture become smaller. In the subsoil horizon, soil consistency in the IT pedon has a thicker layer of firmly soil consistence, while the NT pedon has no firmly soil consistence (Table 1). The presence of a layer of soil that has a firm consistency will inhibit the growth and development of plant roots. The very thickness of a firm layer of soil on the IT pedon will inhibit the development of plant roots.

3. 2 Soil Physical Properties

3. 2. 1 Soil Texture

All three pedons have the same texture class that is clay. The content of clay particles in the soil surface layers ranges from 55-58%, while at the bottom layer ranges between 80-88%. Differences in clay content is actually found in the second soil layer, where the content of clay on pedon NT is much higher than the other two pedons. This may occur because of the more open topsoil on the IT pedon as a result of intensive soil tillage can promote the leaching processes of clay particles running more intensive than in NT pedon, therefore the clay content in the second layer of IT pedon is the least.

In IT pedon, more open soil in the surface layer due to low BD and without mulch cause the penetration of rain water becomes higher. With such condition, it will be conducive to the leaching of clay particles. In addition, the opening of soil without mulch and higher macro pore space on the soil surface layer causes better aeration, so that the exchange of air and heat from sunlight allow to enter the deeper layers of the soil. This condition could cause the adhesiveness of granules become stronger, consequently the consistency of the soil becomes more firm (Tabel 1) and the BD value becomes higher (Table 2 and Fig 1).

3. 2. 3 Soil Strength

In line with the soil texture, BD and soil consistency, the higher the clay content cause the BD value will increase and the soil consistency will be stronger, then this will cause the soil strength is also stronger. Figure 2 shows that the soil strength in the lower layer of IT pedon stronger than pedon CT. The stronger the soil strength will further inhibit the growth and development of plant roots.

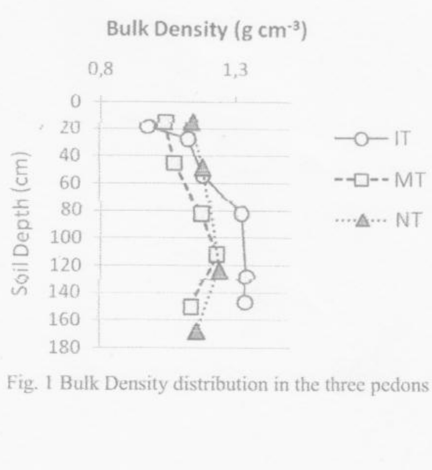

Fig. 1 Bulk Density distribution in the three pedons

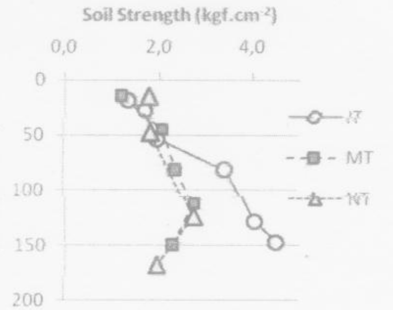

Fig. 2 Soil Strength of three pedons

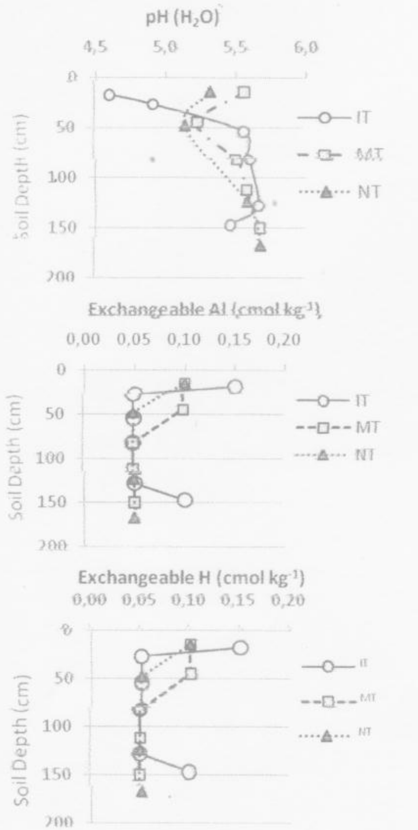

Fig. 3 Soil pH, Exchangeable Al and H of the three pedons

3. 3 Soil Chemical Properties

3. 3. 1 Soil pH and potential soil acidity

The pH of the soil surface layer on the IT pedon is lower than that of the two CT pedons, while the soil pH on the NT pedon is less than the MT pedon (Figs. 3 and 3). This is related to the exchangeable Al & H on the IT pedon

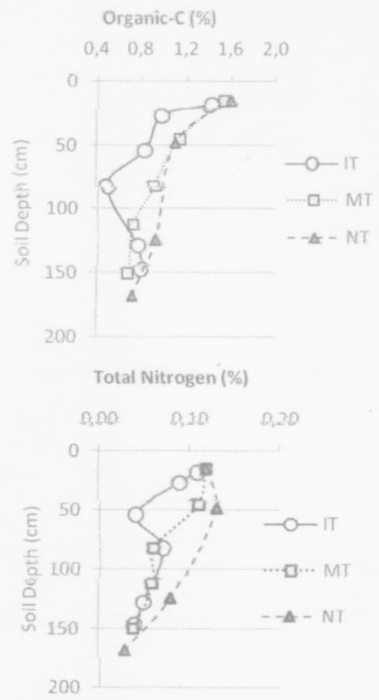

Fig. 4 Organic Carbon and Total Nitrogen of the three pedons

higher than the two CT pedons. Al cation is the soil acidity potential that is able to release H + into the soil solution consequently the soil becomes more acid.

3. 3. 2 Soil organic carbon and total nitrogen

Up to a depth of 100 cm, the soil organic-C content on the IT pedon is lower than that of both CT pedons, while the total-N content of the IT pedon is lower to 60 cm from the soil surface (Figure 4). The data of soil organic-C on the surface horizons of the three pedons indicates that the CT treatment is more capable to conserve the soil organic matter content in the soil surface layer than the IT treatment. Meanwhile, among CT treatments showed that NT treatment was more able to conserve the soil organic matter content in the soil surface layer from loss through erosion, leaching, or from the oxidation processes. Between the two pedons CT, the soil organic-C content on the surface horizon on the NT pedon (1.60%) was higher than that of the MT pedon (1.53%) (Table 3). The presence of mulch as a soil cover could preserve the loss of soil nitrogen either through evaporation,

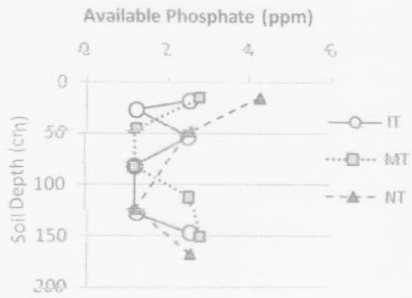

Fig.5 Available Phosphate of the three pedons

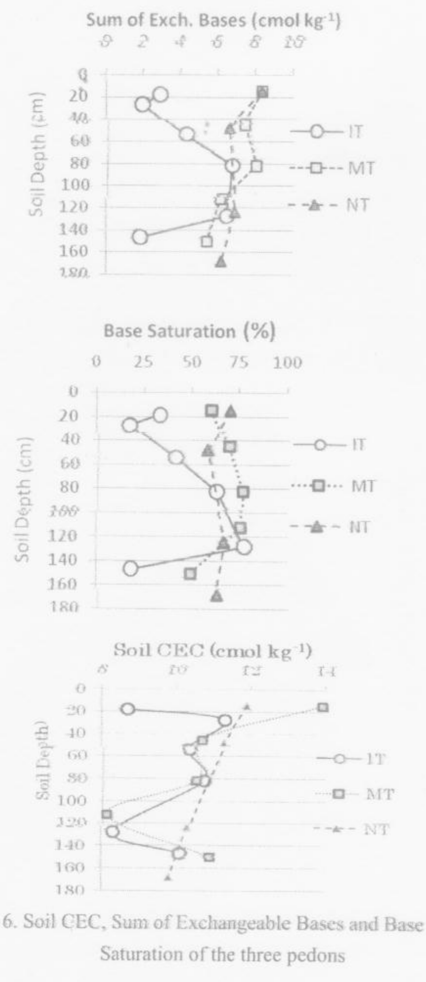

Fig 6. Soil CEC, Sum of Exchangeable Bases and Base Saturation of the three pedons

decomposition of soil organic matter, or through leaching process.

3. 3. 3 Available Phosphate

Figure 5 shows that the available Phosphate of the NT pedon higher than IT and MT pedons. As a static element in the soil body, phosphates are generally more stable and is usually loss through surface runoff and soil erosion, although water-soluble phosphates could be lost through leaching process. The absence of destructive treatment to soil surface layer causes NT system to better protect the soil from phosphate loss through surface runoff, erosion, or leaching process compared to IT or MT systems.

3. 3. 4 Soil CEC, Exch. Bases & Base Saturation

Figure 6 shows that the IT pedon has soil CEC, sum of exchangeable bases and Base Saturation less than the CT pedons. Both of the two CT pedons have the same Sum of exchangeable bases, while the soil CEC of MT pedon is higher than NT pedon, therefore the Base Saturation of NT pedon is little higher than MT pedon. Natural weeds can take nutrients from the deeper layers through the roots and brought to the canopy of the plant, then through the process of dead weed decomposition will release nutrients to the topsoil. Through the nutrient cycles, the longer it becomes, the higher the soil layer of nutrients than the lower layers. Nutrient contribution through the weed cycle then could be utilized by the main plant. Covering soil surface with natural weeds and its residues in Coffee plantation had increased organic carbon content, total nitrogen, soil pH, CEC, exchangeable calcium, as well as decreased exchangeable Al and Al saturation in soil surface horizon (Afandi et al., 2003). Therefore, in addition to the CT system can reduce the loss of soil and SOM, it can also contribute plant nutrients and simultaneously improve the soil chemical properties.

4. Conclusion

The results showed that the lower content of soil organic matter in the upper layer of IT had cause the soil color become lighter, which was characterized by higher chroma. Soil structure on the top layer of IT changed from crumbs toward to the angular blocky. The topsoil on IT was more friable than two others, while the lower layer was more dense or compact shown by the higher BD, stonger Soil Strength, and very thick firmly soil layer. Generally, the chemical properties of CT were better than IT, and NT was slightly better than MT, particularly at the soil surface layer.

5. References

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