Effects of Oil Palm (*Elaeis guineensis* Jacq. L) and Conservation Method on the Chemical and Biological Properties of Soil

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**Abstract.** This study was aimed to determine the use of conservation techniques and compost fertilizer application on small holder oil palm plants with different planting years to repair and improve of chemical and biological soil character. This research was conducted in Pagarmanik Village, Silinda Sub-District, Serdang Bedagai Regency and PT. Socfin Indonesia and also Central Laboratory, Faculty of Agriculture, University of Sumatera Utara. The research was conducted in February 2018 to June 2018. The research used Split Plot Design with 2 factors and 4 replications. Factor I: year planting (Main plot) consists of 2 levels, T1: 5 years planting and T2: 20 years planting and Factor II: conservation method (sub-plot) consists of 3 levels, K1: conventional, K2: concave disk + compost and K3: individual rorak + compost. The compost used is municipal waste + cow/sheep manure + urine and cow washing water with 5: 5: 1 ratio. Soil sampling is carried out vertically with 0-60 cm depth. The parameters used are soil pH, cation exchange capacity and organic soil matter. The results showed that the use of conservation techniques in oil palm plants can maintain the pH soil content (20 years) and cation exchange capacity in the soil in 20 years old plants but have not been able to maintain the C-organik content in the soil at the age of 20 years.

1. **Introduction**

The low nutrient in the root area caused by poor organic matter results in delayed plant growth and development. The loss of nutrients from the root zone causes reduced soil fertility. These nutrients must be balanced with the provision of anorganic and organic fertilizers. This kind of damage occurs due to the overhual of organic matter and mineral weathering and the rapid washing of nutrients and loss of nutrients transported through the harvest without any effort to restore them. Soil conservation is a human effort that includes all activities to carry out maintenance and repairs that are not only limited to efforts to control erosion, soils which experience a lack of nutrient content which experience a decline in their production power with the intention that everything can be restored or increased [1].

The addition of organic matter into the soil can be through fertilizing organic fertilizers, one of which is compost in bulk (flour), granules and in other forms, can improve soil chemistry such as increasing soil nutrient availability, taking N from the air and dissolving P that has not available and the formation of substances that can spur plant growth, as well as the biological properties of soil that can increase the activity and metabolism of soil biota (microbes, meso and macrobiota) and substances that can suppress the growth of microorganisms causing plant diseases and can reduce toxic elements (anti-toxic) for plants and for soil biota. Because of its nature, it is called soil conditioner [2].
The use of conservation methods properly and correctly is expected to be able to provide good prospects for damaged land. Lack of information about proper land use and processing becomes an obstacle in the development of crop cultivation, especially in sustainable farming systems. Prolonged use of organic materials can be an effort to improve and increase land productivity so that damaged or categorized degraded land can again contribute to increasing crop production in Indonesia, especially in plantation crops. Efforts to add organic matter to the soil which has a sloping topography on oil palm plants so that mechanical soil conservation techniques are needed optimally which aim to reduce the surface flow rate caused by rain. The purpose of this study was to determine the use of conservation techniques and the application of compost fertilizer on smallholder oil palm plants with different planting years to improve and improve the chemical and biological properties of the soil.

2. Method
2.1 Location and Time of Research
This research was conducted on smallholder oil palm in Pagarmanik Village, Silinda Sub-District, Serdang Bedagai Regency, North Sumatra and soil analysis was carried out in the PT. Socfin Indonesia and at Central Laboratory, Faculty of Agriculture, University of Sumatra Utara. The study was conducted in February 2018 - June 2018.

2.2 Manufacture of Conventional Disk
Preparation of conventional disk without conservation techniques and without the addition of compost is only carried out cleaning like weeds in the disk area which is done manually and while maintaining the integrity of the existing dishes.

2.3 Making Concave Disk
Making a concave disk conservation technique is done manually by using a hoe that is, making a concave shape on the part of the soil in the center of the plant, with a depth of 0-20 cm without touching the roots of plants according to the width and amount of compost, the excavated land is placed at the edge of the excavation so as to maintain the integrity of the hole so that it can avoid holes that are washed directly by the flow of rain water, while in the uneven ground it is necessary to add burlap containing soil, arranged in a circle which is slightly elevated sunken.

Figure 1. Concave Disk
2.4 Making Individual Rorak
Making individual rorak conservation techniques is done manually by using hoe that is, making excavations (holes) on the part around the plant with a narrow distance without disturbing the circulation of roots so as not to damage the roots of plants. The size of the 0-60 cm depth corresponds to the depth of the root zone of the oil palm plantations and the width according to the amount of compost content that will be given then the excavated soil is placed at the edge of the excavation so as to maintain the integrity of the hole so that it can avoid the holes washed directly by the rainwater flow. The distance of repeating one row of plants as a separator repeats one another.

Figure 2. Rorak Individual

2.5 Garbage Compost
2.5.1 Preparation of Garbage Compost
Compost of municipal waste is obtained from Community Self-Help Groups (KSM) Pondok Miri Asri which is ready to be applied. The application of the organic material used is Compost 3+ Fertilizer, with the composition of domestic waste compost (municipal waste) + cow / sheep manure + urine and laundry cow comparison 5: 5: 5: 1 with C/N content of 9.62 and compost pH of 7.10.

2.5.2 Applied Garbage Compost
After the application site is prepared, it can apply the municipal waste compost to each conservation technique in each different planting year. The application of municipal waste compost to concave disc conservation techniques is done manually by spreading it in the center of the dish evenly according to the width and depth and according to the amount of compost to be provided (Figure 3).

2.6 Research design
The research used Split Plot Design with 2 factors and 4 replications. The first year planting factor (Main plot) consisted of 2 treatment levels, namely: T1: 5 years of planting and T2: 20 years of planting. Factor II conservation method (Sub plot) consists of 3 levels, namely: K1: Conventional, K2: Concave disk + Compost and K3: Individual Rorak + Compost. Soil sampling is carried out vertically with a depth of 0-60 cm. The extraction of soil samples analyzed was carried out 4 months after the compost application.

2.7 Data analysis
Parameters observed were soil pH (H₂O method) measured using a pH meter, cation exchange capacitor (Ammonium acetate-pH 7) and C-organik (Walkey and Black method). Data were analyzed
by analysis of variance (ANOVA) then continued with Duncan's Multiple Range Test at the level of 5%.

3. Results and Discussions
The results will be discussed in 5 subsections, they are Cation Exchange Capacity (CEC) Soil, Potensial Hidrogen Soil and C-organic Soil.

3.1 Cation Exchange Capacity (CEC) Soil (me/100g)
The results of the statistical analysis showed that the use of conservation techniques and their interactions had no significant effect, whereas in the planting year it had a significant effect on the value of the CEC land. To determine the average soil CEC at several years of planting after the use of conservation techniques are presented in Table 1.

Table 1. Value of land CEC after use of conservation techniques for several years of planting oil palm.

| Planting year | K1 (Conventional Disk) | K2 (Concave Disk + Compost) | K3 (Rorak individual + Compost) | Average    |
|---------------|------------------------|-----------------------------|-------------------------------|------------|
| T1 (5 years)  | 24,48                  | 23,25                       | 24,03                         | 23,92a     |
| T2 (20 years) | 12,09                  | 14,84                       | 20,01                         | 15,65b     |
| Average       | 18,29                  | 19,05                       | 22,02                         |            |

Description: Numbers followed by the same letters in the same column indicate that are not significant based on Duncan's multiple distance test at the level of 5%.

It’s evident that at each planting year it can improve and increase the content of cation exchange capacity in the soil while the conservation techniques and their interactions do not significantly affect the CEC content of the soil. The treatment of conventional and individual patterns of compost (T1K1) in the 5-year planting year has the highest soil CEC value of 24.48 (me/g) which can be categorized as moderate according to Pusat Penelitian Tanah/PPT (1995) which states that the CEC content of the soil can be categorized as low that is, 5-16 me/g, the medium category is 17-24 me/g and the height
reaches 25-40 me/g. This shows that the treatment of conservation techniques and their interactions with each planting year has no effect on cation exchange capacity in the soil, this is thought to be erosion and surface flow to be a factor in influencing the value of CEC land, but in each planting year shows the effect real precisely in the 5 year planting year which was influenced by the addition of large amounts of compost ranging from 450 kg/plant.

Addition of compost in soil is one factor in increasing cation exchange capacity in the soil. This is supported by previous study, which states that the provision of high organic matter can increase the value of CEC in the soil [3]. Soil weathering levels that have been occurring for years and cations in soil solutions with higher organic matter content can influence soil CEC values. In accordance, the CEC value of a soil is affected by the level of soil weathering, the content of organic matter and the number of alkaline cations in soil solutions so that the addition of organic matter will improve soil porosity, soil pH and CEC values that are needed by plants [4].

Organic matter added significantly contributes to soil CEC ranging from 20–70% with soil exchange capacity generally sourced from humus colloid (e.g. Molisol), so there is a correlation between organic matter and soil CEC [5]. Cation exchange capacity (CEC) shows the ability of the soil to hold cations and exchange these cations including plant nutrient cations which is one of the important factors in the parameters of soil fertility [6].

3.2 Potential Hidrogen (pH) Soil

The results of the analysis statistically show that the use of conservation techniques has no significant effect, so does the planting year on pH soil. Nor does it statistically indicate an interaction between the two factors. To find out the average value of soil pH in different planting years after the use of conservation techniques, can be seen in Table 2.

| Planting year | Conservation techniques | K1 (Conventional Disk) | K2 (Concave Disk + Compost) | K3 (Rorak individual + Compost) | Average |
|---------------|------------------------|------------------------|-----------------------------|--------------------------------|---------|
| T1 (5 years)  |                        | 5.43                   | 5.51                        | 5.93                           | 5.62    |
| T2 (20 years) |                        | 5.74                   | 5.72                        | 5.44                           | 5.63    |
| Average       |                        | 5.58                   | 5.62                        | 5.68                           |         |

Based on the criteria for assessing soil chemical properties in general, the neutral pH of the soil is 6.0-7.0 which can be used as an indicator in determining the level of soil hunting. The use of conservation techniques at each planting year and the interaction of both have not shown a significant effect on the pH of the soil in producing oil palm land. The application of technique rorak individual + compost (T1K3) in the 5-year planting year has the highest soil pH value of 5.93 (almost reaching 6) which can be categorized into a neutral soil pH and has met the criteria for oil palm cultivation. This is inseparable from the role of using conservation techniques accompanied by the addition of compost fertilizer.

The combination of the use of good management techniques at each planting year will show a good influence on the improvement and improvement of soil chemical properties such as at soil pH, while the role of the use of organic materials given can contribute to maintaining and increasing the soil pH content that can be said one of the determinants of soil fertility.
Organic material that is ripe and ready to be applied by adjusting the criteria in general that is good for organic materials such as compost according to the criteria of the Indonesian National Standard (SNI) is able to provide good prospects for the use of organic matter in sustainable agriculture. Soil pH can be used as an indicator of soil chemical fertility, because it can reflect nutrient availability in the soil [7]. An increase in soil pH will occur if the organic material we add has been decomposed further (ripe), because it has been mineralized and then releases the mineral as in the form of basic cations. Otherwise, the addition of organic material that is not yet ripe or still in the process of decomposition such as green manure will result in a decrease in soil pH. Organic matter or organic fertilizer such as compost during the decomposition process will release organic acids which cause a decrease in soil pH but can bind Al which will form complex compounds so that Al will be available and not hydrolyzed from the soil [7]. The addition of organic matter that has been done in the long term can improve soil pH and support the increase in macro and micro nutrients that are needed by plants [3].

3.3 C-organic Soil.

The results of the statistical analysis show that the use of conservation techniques has no significant effect, while the planting year also shows a non-significant effect C-organic on soil. Statistically it also shows no interaction between planting years after the use of conservation techniques. To find out the average C-organic soil in different planting years after the use of conservation techniques are presented in Table 3.

Table 3. C-organic Soil content after use of conservation techniques for several years planting oil palm.

| Planting year | Conservation techniques | Average |
|---------------|-------------------------|---------|
|               | K1 (Conventional Disk)  |         |
| T1 (5 years)  | 0.98                    | 0.75    |
| T2 (20 years) | 1.01                    | 1.07    |
| Average       | 0.99                    | 0.77    |

The use of techniques rorak individual + compost in plants aged 20 years (T2K3) has the highest C-organic value, at 1.13% and is still relatively low for oil palm cultivation. The C-organic content in the soil which can later be converted into organic matter in the soil can be categorized as moderate if it reaches 2.01% - 3.01% [7]. This shows that the use of rorak conservation techniques in each plant is a good conservation technique by providing proper and correct mechanical management of the soil even though erosion is still one of the main factors in its limitations.

The addition of compost fertilizer to conservation techniques and at each planting year can be one of the efforts to add soil organic matter content which was originally available, such as in the 20-year planting year which has shown higher organic matter content than in the 5-year planting period this is due to weathering in plant parts that have been occurring for years. To achieve a high increase in organic C on a land requires more effort such as adding more organic matter and high content of C-organic and based on the provision in a long period of time to be one indicator in determining the ideal soil composition. One of the factors that sees the ideal composition of soil productivity is the content of organic matter (C-organic) where ideally the soil contains C-organic around 3-5%. Maintaining and increasing organic matter in the soil requires proper management, although the main problem in the
addition of organic matter in the field is the difficulty of obtaining the unavailability of sources of organic materials such as manure and others [8]. One effort that can be done is by managing waste that was previously useless to be useful by making it as a fertilizer that has high usability and selling power. Various sources of organic material that can be developed include: green manure, crop residues, municipal waste and industrial waste. Special use of municipal waste needs to be watched out; (1) the presence of micro metals and other heavy metals that are toxic, (2) the possibility of the presence of toxic organic compounds, and (3) the possibility of the presence of disease germs (pathogens). Another role in tillage is a very important factor in regulating the recycling of nutrients which are immobilized in crop residues [9]. Piracy or hatching, not only causes buried residues, but also reverses and destroys surface so that it will increase soil porosity. This condition will accelerate decomposition of plant residues and release of nutrients to the soil [10]. This sometimes does not support loose soil which is the main factor is soil erosion and in an area with high rainfall.

4. Conclusions
The results showed that the use of conservation techniques in oil palm plants can maintain the pH soil content (20 years) and cation exchange capacity in the soil in 20 years old plants but have not been able to maintain the C-organic content in the soil at the age of 20 years on smallholder oil palm in Pagarmanik Village, SilindaSub-District, Serdang Bedagai Regency, North Sumatra.

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