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# Fertility Status of the Soil in the Area Where Rubber (*Hevea brasiliensis*) Plants are Being Replanted (*Elaeis guineensis* Jacq)

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**Abstract**

Rubber plants (*Hevea brasiliensis*) will experience a decrease in production as plant age and the nutrient content in the soil decreases. This study aims to find out the chemical properties of soil on plantations of rubber crops that are converted into palm and coconut crops. The research was conducted from October 2023 to January 2024 at the palm coconut plantation of PTPN III Aek Nabara North Garden in Labuhanbatu district and analyzed in the Land Laboratory of the Faculty of Agriculture of the University of Northern Sumatra. The methods used are observation methods, field sampling, and analysis in the laboratory to obtain quantitative data. Observation parameters include soil pH, C-organic, Total Nitrogen, Available P, Cation Interchange Capacity, and Base Fulness. The results of the survey showed that the level of soil fertility at the site of the research was included in the low category. The main limiting factor that causes the low fertility of the soil is the low content of organic material in the soil. In order to improve the fertility status of the ground at the research site for further planting, it is necessary to make efforts such as irrigation and fertilization, as well as the addition of organic materials, to make the availability of nutrients for plants more affordable

**Keywords:** replanting area, rubber plants, conversion, soil fertility, quantitative data

## A. Introduction

Replanting rubber plants into oil palm plants is an alternative effort to maintain the continuity of plantations, especially oil palm, however, the use of replating land for planting oil palm and new seeds has several disadvantages, including the level of land productivity and changes in soil structure due to previous rubber planting. According to (Merhan, Kesumawati and Sufardi, 2016) alluvial soil is clay-textured soil and has a neutral reaction with a pH of around 6.5, low organic C content, very low total N content, very high available K content and high P content.

The results of Faizal's research (2021) show that during the replanting period of oil palm soil in Rokan Hulu (age 26 years) the results were not good, data was obtained that the pH was classified as acidic, C-organic was classified as low, the N content was classified as low category, content in the very low category, K content in the low category and CEC in the low category. The research results of (Kiki, Aspan and Hayati, 2022), also show that the soil fertility status of the oil palm replanting land studied in Sanggau Regency, West Kalimantan is included in the low criteria. Soil reaction (pH) is very acidic, C-Organic is low, N-total is medium criteria, P-total is very low, K-total is low criteria, CEC is low criteria and base saturation is low.

Planting oil palm plants can be done in three ways, namely opening new land (new planting), planting on converted land (land used by other crops) and replanting on land used by oil palm plants (replanting). Of these three methods, the recommended planting method for existing plantations is to replant on open land (replanting).

This land use can be an effective solution for the continuity of oil palm plants because it can reduce illegal logging, forest burning and can avoid conflicts with local communities (Lubis and Siregar, 2009). Implementing replanting of oil palm plants requires land evaluation to determine the condition of the land. as well as the level of soil fertility.This is due to the possibility of changes in soil physical elements and soil chemical elements which affect soil fertility on land due to the absorption of oil palm plants during the previous planting period (Harahap, Sitompul, Rauf, Harahap, and Walida, 2019)

The main obstacle in using land for agriculture and especially plantations is the low level of soil fertility caused by a number of chemical obstacles that limit plant growth, such as acidity problems, nutrient availability and low soil organic matter content. According to Rinojati et al., (2017) this condition is further exacerbated by the limited use of organic fertilizers and the inappropriate use of inorganic fertilizers at the time, dose, type and application. So good soil management efforts are needed based on soil chemical fertility parameters, meaning that they are in accordance with the needs of the type of plant being cultivated.

For this reason, strategies are needed to be able to carry out rejuvenation well, one of which is by paying attention to the chemical properties of the soil on oil palm plantations, so what are the chemical properties of the soil on rubber plantations that are around 20 years old, Why is it necessary to test the chemical properties of the soil and how to increase the nutrient content of the land? So before replanting on the replanting land

## B. Methodology

The research was carried out on replanted rubber plantation land which will be planted with oil palm owned by PTPN III Kebun Aek Nabara Utara, Labuhanbatu Regency at a height of 32 meters above sea level in Figure 1. This research was carried out from October 2023 to January 2024 on oil palm plantations and analyzed at the Soil Laboratory, Faculty of Agriculture, University of North Sumatra.

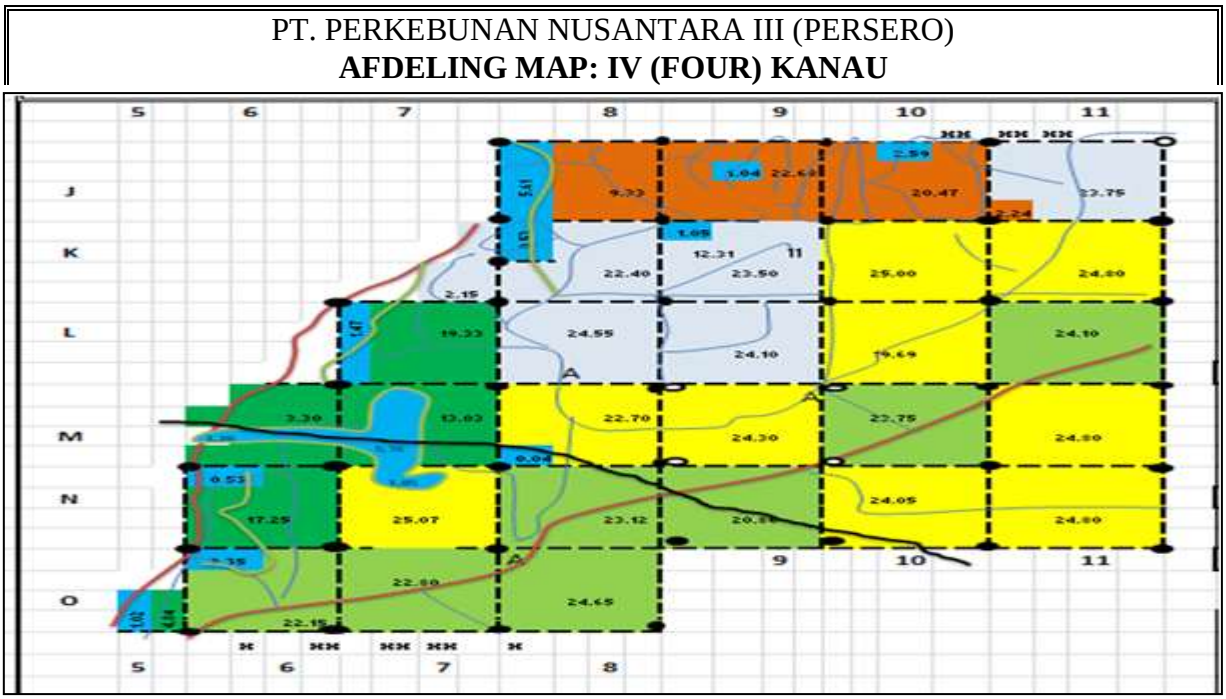


**Figure 1. Map of research locations**

The research began with pre-research by taking soil samples and the method used is the observation method, taking samples in the field and analyzing them in the laboratory to obtain quantitative data. The method used in this research is a free grid measurement method at a semi-detailed survey level (observation frequency of 1 sample per 500 meters). Take soil samples from up to 5 sampling points with a distance of 100 meters in the field using a random method, spread over a predetermined area based on the base map as shown in Figure 3 (Rauf and Harahap, 2019).

Sampling was carried out using a random sampling method at predetermined points in each block, sampling was carried out from two depths, namely from 5 samples each at the same two depths for checking chemical content. explore the properties of the soil with certain predetermined criteria. To determine the chemical properties of soil using certain criteria that have been determined based on the Technical Guidelines for Soil Fertility Evaluation (PPT, 1995) which are presented in Table 1.

| Soil Parameters | Very low | Low | Currentl y | Tall | Very high |
|---|---|---|---|---|---|
| C-organic (%) | < 1.00 | 1.00-2.00 | 2.01-3.00 | 3.01-5.00 | > 5.00 |
| Base Saturation (%) | < 20 | 20-35 | 36-50 | 51-70 | > 70 |
| P2O5 HCl 25% | < 10 | 10-20 | 21-40 | 41-60 | > 60 |
| K2O HCL 25% | < 10 | 10-20 | 21-40 | 41-60 | > 60 |
| CEC (me/100 g) | < 5 | 5-15 | 17-24 | 25-40 | > 40 |

Source: (PPT Bogor, 1995)

Soil samples are analyzed to determine the nutrient content, namelysoil pH,Nitrogen (N)Kjeldah method unit %, Pospor (P) MethodHCl 25% unit mg/100, C-Organic MethodsWalkey and Black units %,Cation exchange capacity and Base Saturation

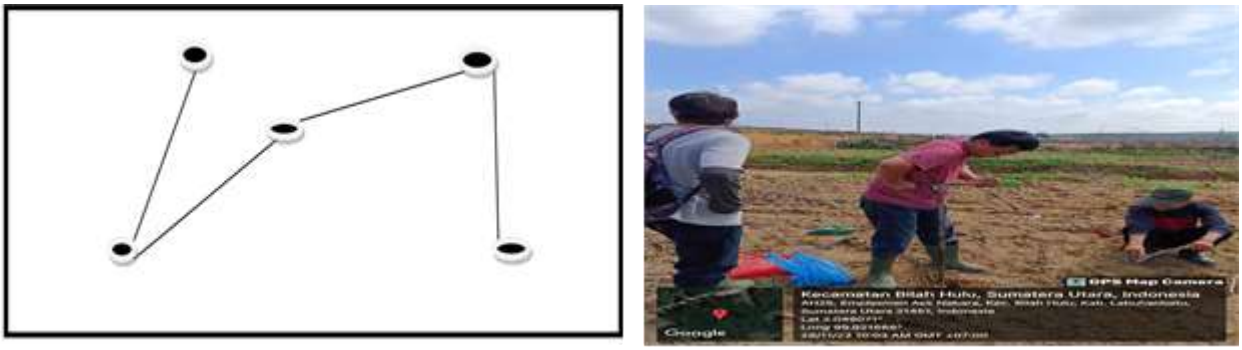

**Figure 2. Taking soil sample points in the field**

## C. Results and Discussion

Primary data (analysis data) obtained from the results of soil analysis in the laboratory were valued according to the PPT Bogor soil fertility assessment (1995). So it is known that the value of soil chemical fertility parameters including low, medium and high status can be seen in Table 1. The results of measuring soil fertility parameters and soil fertility status of land replating rubber plantations converted to oil palm are presented in Table 2.

| Parameter | Unit | Sample | | | | |
|---|---|---|---|---|---|---|
| | | I | II | III | IV | V |
| Soil pH | | 4.91 | 5.67 | 5.65 | 5.27 | 5.33 |
| N-Total | % | 0.13 | 0.19 | 0.12 | 0.18 | 0.81 |
| P2O5 | ppm | 46.50 | 32.86 | 42.88 | 26.33 | 23.43 |
| C-Organic | % | 1.72 | 1.15 | 1.34 | 1.62 | 1.55 |
| CEC | me/100 gr | 10.72 | 9.85 | 9.48 | 10.28 | 10.18 |
| KB | % | 17.91 | 10.80 | 7.54 | 20.12 | 18.17 |

The results of Table 1 show that the soil pH at the research location is included in the slightly acidic category, namely around 4.91-5.67. Soil pH is a soil reaction that indicates the acidity or

alkalinity of the soil. Soil pH plays an important role in determining whether or not nutrients are easily absorbed by plants. Nutrients can generally be absorbed well by plants at a neutral pH. Soil microorganisms and fungi can grow well at a pH above 5.5, if it is less then their activity will be hampered. Low soil pH will cause plants to be unable to utilize the N, P, K and other nutrients they need. Low pH also causes the availability of toxic elements such as aluminum which always poisons plants and also binds phosphorus so that it cannot be absorbed by plants (Hardjowigeno 2007).

Base Saturation (KB) of Soil Base saturation is the ratio between the number of base cations exchanged with the CEC of the soil expressed in percent. The soil at the research location has a low base saturation value with a value of 7.54 to 20.12%. According to Bohn et al. (2009), the CEC value of soil is usually directly proportional to the CEC of the soil, because base saturation is a reflection of the high number of cations in the soil colloid complex. Addition of fertilizer at the time of planting is one of the causes of the increase in CEC at the research location. Apart from CEC, base saturation also determines soil fertility. Base saturation is a comparison between the number of base cations exchanged and the cation exchange capacity (CEC) of the soil expressed in percent. Base saturation at the research location is included in the medium and very high categories. The CEC value of soil is usually directly proportional to the base saturation (KB) of the soil, because base saturation is a reflection of the high number of cations in the soil colloid complex (Bohnet 2009).

Soil C-organic levels The results of determining organic C levels at the research location with low criteria were between 1.34-1.72%. This is thought to be due to the fact that in oil palm cultivation at the research location organic fertilizer is rarely added, only inorganic fertilizer is given. Low organic C content indirectly results in low oil palm production, because soil organic matter is one of the parameters that determines soil and plant productivity. The results of measuring the total phosphorus content of soil from each field in the planting year were very moderate in value23.43 – 46.50 ppmThis is also in line with the low organic material content at the research location. The P elements in the soil come from organic materials (manure and plant residues) in addition to phosphate minerals in the soil (apatite) (Sukisno et al., 2011). The land at the research location rarely had organic material added to it, which ultimately further impoverished the soil fertility. Phosphorus is an essential macro element second to nitrogen which is really needed by plants which functions in cell division, albumin formation, formation of flowers, fruit and seeds, accelerates ripening and strengthens stems so they don't collapse easily. The phosphorus element in soil comes from organic materials, soil minerals and artificial fertilizers (Anggreany, Muljono, and Sadono, 2016).

Cation exchange capacity (CEC) is an indicator of soil fertility. Soil at the research location has a CEC value between 9.48-10.72me/100 with low status. Based on this fact (Sufardi, Zaitun, and TF, 2017). stated that one thing that influences the CEC value of soil is the soil humus content and the type of clay minerals. Soils dominated by Al and Fe oxide-hydrate fractions usually have a low negative charge on the colloid surface (Sposito, 2010), so the CEC value of the soil is usually low. This is in line with the generally low organic material content in research locations. Naturally, the organic matter content of soil in tropical areas rapidly decreases and the decline reaches 30-60% within 10 years (Sufardi et al., 2017).

**Evaluation of Soil Fertility Status**

Evaluation of Soil Fertility Status According to in Husni (2016) Soil fertility is the ability of a soil to provide nutrients, in certain doses and balances to support the growth of a type of plant in an environment with other growth factors in favorable conditions. Sutedjo (2002) added that fertile soil has sufficient nutrient availability for plants and there are no limiting factors in the soil for plant growth. Soil fertility status is the condition of soil fertility at a certain place and time which is assessed based on standard criteria for soil fertility parameters according to technical instructions for evaluating soil fertility.

Soil Research Center, PPT Bogor 1995 (Susila, 2013). Based on the determination of soil fertility status based on technical instructions for evaluating soil fertility, the Soil Research Center, Bogor (PPT, 1995) shows that the assessment of the overall fertility status of oil palm plantation land is low fertility status. The low fertility status at the research location is caused by limiting factors, namely low soil organic C content and soil base saturation. The C-organic content (organic matter) of the soil greatly influences the soil's ability to maintain soil fertility and productivity through the activity of soil organisms. Many soil properties, both physical, chemical and biological, are directly and indirectly influenced by organic matter.

Organic matter also plays a role in the formation of soil aggregates. Organic additions absolutely must be given because soil organic matter plays a very important role in creating soil fertility (Tolaka, Wardah, and Rahmawati, 2013). Furthermore, soil base saturation is always associated as an indication of the fertility of a soil. The ease of releasing absorbed ions for plants depends on the degree of base saturation. S oil is very fertile if the base saturation is > 80%, if the base saturation is between 50-80% the soil fertility is moderate and the soil is not fertile if the base saturation is < 50%.

## D. Conclusion

The level of soil fertility at the research location is included in the low category. The main limiting factor that causes low soil fertility is low soil organic matter content. To improve the soil fertility status at the research location for further planting, efforts are needed in the form of liming and fertilizing as well as adding organic material so that the availability of nutrient elements for plants is more adequate.

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