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Analysis the Potential of Malang Regency as a Center for Oil Palm Plantations in East Java

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***Abstract*— *East Java region is known for its good land potential for agriculture. One area that has a large enough agricultural land is Malang Regency. This feasibility study in the long run can become the foundation for establishing oil palm plantations and also a palm oil processing industry in the region. Thus, a feasibility study of various important aspects is carried out for the sustainability and sustainability of the development of the oil palm plantation industry in Malang. The purpose of this study is to see how land and environmental conditions suitability and to study and map the suitability of oil palm land in Malang Regency. The study was carried out in October - December 2021 in the southern Malang region and the southern Blitar location as a comparison area and industrial survey to find out data on oil quality in the southern region of Malang Regency and Blitar. Studies use survey methods to describe situations and events with the aim of solving problems in a systematic, fluctuating and accurate manner regarding the facts and characteristics of a particular population or area. Land suitability variables are in the form of geographic data, such as slopes and determination of points; macro climate data and micro climate data, such as radiation intensity, RH, temperature, flood potential and soil data including physical properties, such as soil texture, structure and depth; biological properties, such as c-organic content, litter thickness and presence of earthworms and chemical properties, such as analysis of N, P and K content, pH and base saturation and soil CEC. Based on a comparison of soil analysis data in the areas of Malang, Sumatra and Kalimantan, it can be said that the land suitability of Malang Regency is in accordance with the needs of oil palm plants based on land suitability.*

***Keywords*— Land suitability, climate type, oil palm, nutrients**

I. INTRODUCTION

One of the most important and strategic plantation commodities in Indonesia's economy is palm oil. This is because palm oil is the main ingredient for cooking oil that is widely used by the people of Indonesia, so that the supply and sustainability of raw materials must increase to meet the needs and stability of cooking oil prices. Cooking oil is the main product of palm oil and is one of the staple foods in Indonesia. Second, as one of the leading agricultural commodities for non-oil and gas exports, this commodity has good prospects as a source of foreign exchange and state taxes. Third, the process of cultivation and post-harvest production (processing) is also able to create job opportunities and improve people's welfare, especially in the oil palm plantation industry.

Land suitability is the level of suitability of a piece of land for a particular use. Even though plants seem to be able to grow in a field, each type of plant has different characteristics. According to Rayes (2007), states that land use that is in accordance with the conditions for growing plants will provide optimum results and maintain the sustainability of land use. In line with the opinion of Husna, (2015). To get maximum results from cultivation, land suitability is very important. Especially in oil palm plants, regardless of oil palm can grow in a variety of available land conditions, but each plant has a character that requires different needs. Land suitability classes are prepared by comparing (matching) the characteristics of the land/climate in each map unit with land suitability criteria (plant growth requirements). Therefore, selecting suitable land for certain crops can reduce land use impacts and increase yield potential (Everest et al., 2020; Karmakar et al., 2016). Suitability for agriculture is represented by climate, soil, water resources, and topography (Hamdani et al., 2017; Ahmed et al., 2016).

The East Java region is known for its good land potential for agriculture. One area that has a large enough agricultural land is Malang Regency. Commodities that are often found in the region are food commodities, such as corn and rice, but several plantation commodities such as sugar cane and tobacco are also found. In several areas in Malang, small-scale oil palm plantations are found. So with the initial assumption that the feasibility of cultivating oil palm in Malang can be developed. This feasibility study in the long run can become the foundation for establishing oil palm plantations and also a palm oil processing industry in the region. Thus, a feasibility study of various important aspects is carried out for the sustainability and sustainability of the development of the oil palm plantation industry in Malang. The purpose of this study is to see how land and environmental conditions suitability and to study and map the suitability of oil palm land in Malang Regency.

II. BAHAN DAN METODE

The study was carried out in October-December 2021 in the southern Malang region and the southern Blitar location as a comparison area and industrial survey to find out data on oil quality in the southern region of Kab. Malang and Blitar. Studies use survey methods to describe situations and events with the aim of solving problems in a systematic, fluctuating and accurate manner regarding the facts and characteristics of a particular population or area.

The variables observed included land suitability and agronomic data as well as agricultural socio-economic data. Land suitability variables are in the form of geographic data, such as slopes and determination of points; macro climate data and micro climate data, such as radiation intensity, RH, temperature, flood potential and soil data including physical properties, such as soil texture, structure and depth; biological properties, such as c-organic content, litter thickness and presence of earthworms and chemical properties, such as analysis of N, P and K content, pH and base saturation and soil CEC.

III. RESULTS AND DISCUSSION

Geographical suitability

In theory, the actual coordination and actual elevation in the southern Malang region, especially in the Donomulyo, Bantur and Blitar districts are in accordance with the conditions for growing oil palm. Where in coordinates, oil palm grows in the wet tropics with coordinates $112^0$17' to $112^0$57' BT and $7^0$44' LS – $8^0$26' and in elevation, oil palm grows in the lowlands with an altitude of 0-500 meters above sea level. According to (Sasongko, 2010) oil palm will develop optimally in geographical conditions 15 °N-15 °S, the ideal altitude ranges from 0-400 m above sea level, rainfall is 2,000-2,500 mm/year, the optimum temperature is 29-30 °C, the intensity of sunlight is around 5-7 hours/day with an average irradiation of 6 hours/day, the optimum humidity is around 80-90%. On the island of Sumatra, one of which is in the area of Kampar Regency, Riau Province, oil palm can be developed at 0^0 12’-0^0 20' north latitude and 101^0 14’-101^0 24' East longitude (Wigena*et al.*, 2009). The average amount of annual rainfall is 2,339 mm yr^{-1}, the average annual air temperature is 26.4^0 C and average humidity of 81.2%. These geographical conditions are very suitable for the growth and development of oil palm (Wigena*et al.*, 2009). This shows that the area of Kampar district, Riau province is geographically very suitable for developing oil palm.

Kalimantan Island, one of which is in the Marabahan sub-district, Barito Kuala Regency, South Kalimantan Province, has geographical suitability for oil palm plantationsbetween 1°21' 49″ – 4°10'14″ South Latitude and 114°19' 13″ to 116° 33' 28″ E. Average rainfall 2000-2500 mm $year^{-1}$, optimum temperature of 29 °C (Arisanty & Syarifuddin, 2018). This shows that the area of the Marabahan sub-district, Barito Kuala Regency, South Kalimantan Province, is geographically very suitable for developing oil palm commodities. When compared with Blitar Regency which is south of the Equator. Precisely located between 111°40' - 112°10' East Longitude and 7°58' - 8°9'51" South Latitude (Sasongko, 2010). Blitar Regency has its capital in Blitar, this district is bordered on the north by Kediri Regency, to the east of Malang Regency, to the south of the Indian Ocean, and Tulungagung Regency to the west. Mount Kelud (1,731 masl), one of the active volcanoes on the island of Java which is located in the northern part of this district is directly adjacent to Kediri Regency. from its geographical suitability, the Blitar district is suitable for developing oil palm commodities. An understanding of the characteristics of the soil in oil palm plantations is needed as a basis for determining the technical cultural actions to be carried out in order to ensure the continuity of land productivity (Firmansyah, 2014).

Climate Suitability

Based on the results of climate classification calculations according to Oldeman in the last 20 years in Malang Regency, the climate type for Malang Regency is C3. The results of the analysis of climate types in Malang Regency are shown in Table 1.

Table 1. Results of type analysis in Malang Regency

Year	Monthly average wet	Monthly average dry	Climate type
1999-2008	5	6	C3
2009-2018	5	5	C3

In theory, oil palm can grow well in climate types A, B, and C (Oldeman) thus the results of the analysis show that the climate type in Malang Regency is classified as C3 suitable for oil palm plantations.

Table 2. Solar radiation from field measurements at ground level in oil palm plantations

Year	Donomulyo Gardens	Banter	Kromengan
RTC (%)	35	36	40

The results of rainfall each year differ with the highest rainfall in 2016, namely 3269 mm and the lowest in 2018 with rainfall 1614. Oil palm plants have a very important function in plantation development, through this plantation sector it can create jobs that affect the public welfare. The growth and development of oil palm plants is highly dependent on environmental factors. Oil palm plantations in Indonesia are growing rapidly, in 2019 it was recorded that the land area reached 16.4 million hectares where 40.6% of the area is smallholder plantations, 55% large private plantations and 4.4% national plantations (Sardjono, 2020). One area that has the potential to develop oil palm cultivation is Sumatra, Kalimantan and Java.

Each region has different climatic conditions. The ideal rainfall for oil palm plants ranges from 2000-2500 mm per year and is evenly distributed throughout the year while the optimum temperature for oil palm plants is between 22-23^{O}C. When compared with the regions of Sumatra and Kalimantan in the previous data, the Malang district area is suitable for oil palm plantations. According to Sirgaret al., (2014) climatic elements that have a dominant influence on oil palm plantations in Indonesia are rain, solar radiation and air temperature (in the highlands). Rainfall is an important factor for flower development and oil palm bunch production. In general, during the rainy season, more female flowers are formed, while during the dry season, more male flowers are formed (Tumer, 1978). Oil palm can grow well optimally in the wet tropics (12^{O} north latitude – 12^{O} south latitude) with Af and Am (Koppen) climate types. This will directly affect the productivity of palm oil. In line with the opinion of Pahan, (2006). For its growth, oil palm requires an average annual rainfall of around 2,000 mm year-1 no dry months Groundwater stress (drought) will show a sharp decline in production due to an increase in the number of male fruit bunches. Optimum average annual air temperature range for oil palm 25^{O}C - 28^{O}C, but can still produce at an average annual temperature between 24^{O}C - 38^{O}C. The combination of rainfall and air temperature is very likely to play a role in the mechanism of opening and closing leaf stomata which leads to photosynthesis (Risza, 2008).

Information on Soil Quality Comparison of Oil Palm and Non Oil Palm Plantations

Based on the results of laboratory analysis, the percentage of water content in 3 sub-districts in South Malang was 7.11 to 8.58 percent. Oil palm requires high amounts of fresh water for effective yields (Gheewala et al., 2014; Silalertruksa et al., 2017). Therefore, even though overall soil quality may be suitable for oil palm, low groundwater regeneration can be a serious concern impacting yields.

The role of nitrogen in oil palm plants is very important, if nitrogen needs are not fulfilled plant growth will be disrupted. The results of soil analysis showed that the percentage of total N in 3 sub-districts in South Malang was 0.13% to 0.28% percent (Figure 1). This shows that the total N% content of the soil at the study site is low. The low nitrogen is thought to be because nitrogen is lost easily through washing or evaporation (Darlita et al, 2017). In line with the opinion of Rajmi et al., (2018) the low N is thought to be because N is lost easily through leaching due to rainwater or evaporation. According to low N levels, it can also be caused by microbial activity in the soil, thus affecting the absorption of nitrogen nutrients in the form of N available to plants, because plants take nitrogen in the form of NH_4^+ and NO_3. In the soil there is 99% N in organic form, only 2 – 4% of it is mineralized into inorganic N (NH_3^+) (ammonification) by various heterotrophic microbes, then some of it undergoes nitrification (Saputra et al., 2018, Hanafiah, 2005). The role of element N is very important which is an integral part of chlorophyll and is the main component of plants absorbing the light needed in the process of photosynthesis (Barker et al., 2007; Saputra et al., 2018). According to Darlita et al (2017), soil chemical properties such as N-total, CEC, and Al-dd are parameters that increase the number of bunches per tree. There are several factors that result in limited availability of N in soil, including (1) the nature of nitrogen which is very mobile, (2) leaching of N nutrients by rainwater, (3) transported during harvest, (4) bound by soil minerals, and (5) utilized by organisms (Ginting et al. 2013; Sakti et al., 2011).

Nutrient P is a macro nutrient that is needed by plants after N and more than K. The analysis results show Total P2O5 in 3 sub-districts in South Malang of 17.76me/100g up to 23.12me/100g which is classified as very high, when viewed based on the criteria for assessing soil fertility. Phosphorus (P) is an absolute element needed by plants because it plays a role in storing and transferring energy as well as a component of protein and nucleic acids. Based on this, a high supply of P nutrients is shown by the development of branching roots and faster fruiting (Pakpahan et al., 2019; Fahmi et al., 2010). According to Umaternate et al. (2014) said that the P element that can be absorbed by plants is in the form of $H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3}- in soil solution. Factors that affect the availability of P in the soil are (1) C-organic, (2) soil pH, (3) the content of Fe, Al, and Ca, and (4) the physical characteristics of the Jajang soil, (2021).

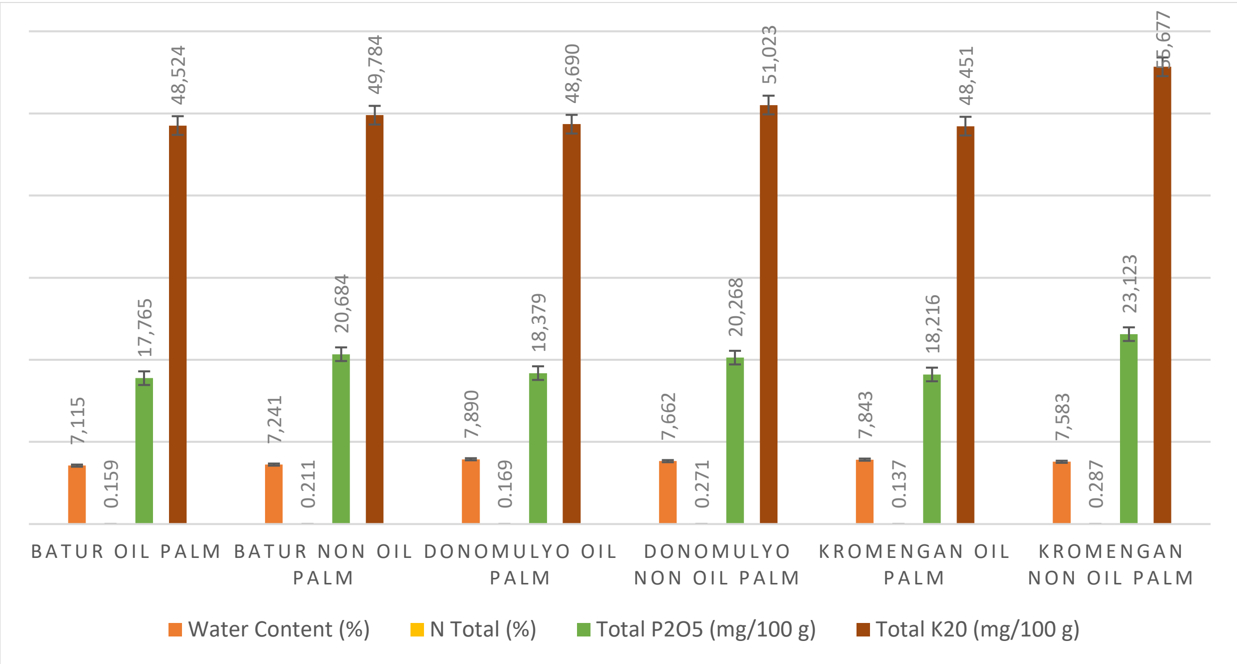

Fig.2. Comparison of Water Levels, P_2O_5, N-Total and K_2O Land of Oil Palm and Non Palm Oil Plantations in Malang Regency

Based on the results of laboratory analysis, the total K20 in 3 sub-districts in South Malang was 48.45 me/100g to 55.67 me/100g which was classified as very high. According to Ginting et al., (2013), the range of balanced nutrient ratio values for oil palm plants is 5.6-10.1 for Ca/K, 2.1-2.5 for Ca/Mg and 2.1 respectively. -4.5 for Mg/K. (Corley & Tinker, 2003) stated that the optimum soil balance for K:Ca:Mg for oil palm cultivation is 10:60:30. K elements absorbed by plants in the form of K+ ions. A positive charge will help neutralize the electric charge formed by nitrate, phosphate, Ca, Mg, and other elements (Rahma et al., 2014; Suseno et al., 2018). Element K, together with elements N and P, is one of the most important primary macronutrients for plants during their growth process. Element K is absorbed by plants from the soil in the form of K+ ions, and is abundant in ash. Young tea leaves contain 50% K2O, and young cane shoots contain between 60 and 70 percent K2O. The elemental K content in plant tissues ranges between 0.5 and 6% of their dry weight. Assimilation will stop if K is not given (Pakpahan et al., 2019).

Based on the results of the analysis, the percentage of total N in the Secanggang District, Langkat Regency, North Sumatra Province was 0.15. The percentage of P2O5 is 4.52 (ppm). The percentage of K2O is 0.81 (mg) (Nora, Manullang and Wijoyo, 2020). Based on the results of laboratory analysis, the percentage of total N in Seruyan District, Central Kalimantan was 0.13 percent. The percentage of C-org is 0.77 to 1.8 percent. Percentage P 48.14 to 88.16 (ppm). Percentage of K 10.65 to 13.73 ($mg.100g^{-1}$) (Prasetiaet al., 2017). According to Sollyet al. (2019) pH, cation logam dalam tanah, KTK (kapasitas tukar cation), dan kandungan nitrogen (metals in the soil, CEC

(Cation Exchange Capacity), and nitrogen content) (Gärdenäs et al. 2011).

Based on a comparison of soil analysis data in the areas of Malang, Sumatra and Kalimantan, it can be said that the land suitability of Malang Regency is in accordance with the needs of oil palm plantations. The value of P and K elements in Malang plantation land is quite high. Meanwhile, in poor plantation areas, the N element content is still relatively low. Thus Malang plantation land can be said to be suitable for land suitability even though there is a limiting factor for N nutrients which can be overcome by adding fertilizer to support the growth and yield of oil palm plants. Good soil chemical properties mean that the soil can provide nutrients in sufficient quantities and are available to be absorbed by plant roots. (Mawardati, 2017; Rahmah et al., 2014). Oil palm fertilization is important due to the low ability of acid mineral soils to provide nutrients, the high retention of nutrients by the soil and the genetic nature of oil palm plants that require large amounts of nutrients compared to other plants (Rahman et al., 2018; Adiwiganda, 2002).

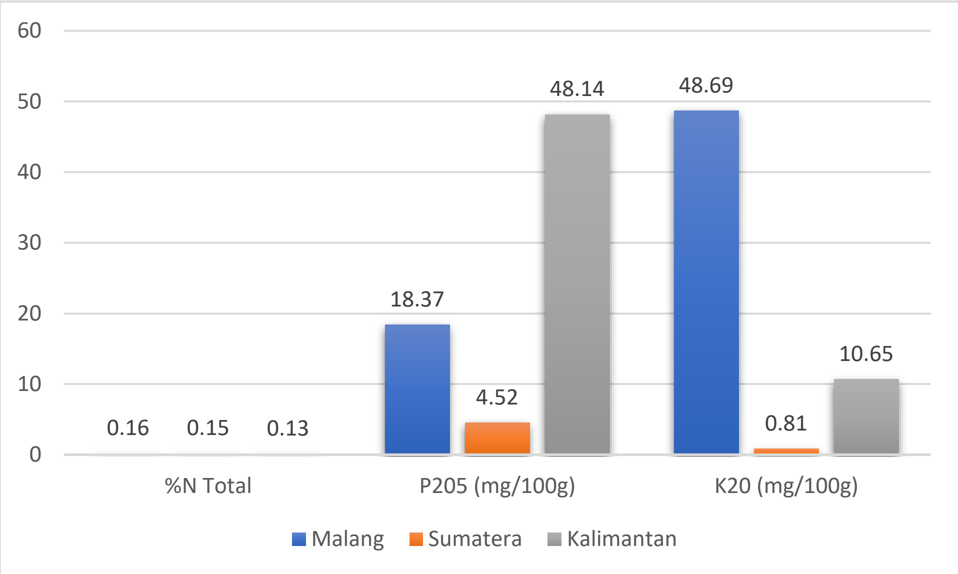

Fig.2. Comparison of the N, P and K content of oil palm plantations in Malang Regency

To increase and maintain the productivity of these soils, it is necessary to apply fertilization, especially macro-fertilizers, so that palm oil production is optimal. Therefore, in plant maintenance, the cost required for fertilizing dominates the maintenance cost which is around 60% of the total cost (Ginting et al., 2019;Koedadiri et al., 2005; Adiwiganda, 2002). The high need for nutrients in oil palm is related to the high production produced. On land with an S1 suitability level, the average FFB production is around 25.0 tons of FFB ha^{-1} $year^{-1}$. The content of nitrogen, phosphorus, potassium, calcium, magnesium and sulfur at these production levels is 74 kg N, 11 kg P, 93 kg K, 19 kg Ca, 20 kg Mg and 14 kg S respectively (Fairhust, 2002) . In line with the results of this study, it was reported that on dry, acidic land, to produce 27 tons of FFB, it was necessary to enter nutrients from outside the soil-plant system in the form of fertilizer of 190 kg N, 26 kg P, 257 kg K, 43 kg Ca, 40 kg Mg, and 60 kg S (Moody et al., 2003).

IV. CONCLUSION

1. Based on geographic analysis 112^{O}17' to 112^{O}57' East longitude and 7^{O}44' South latitude - 8^{O}26' South latitude (classified as wet tropical), climate type C3 indicates that Malang Regency is suitable and feasible for oil palm cultivation.
2. The potential of agricultural land in the district. Malang is still sufficient for the development of oil palm, it's just that sustainability aspects, especially the environment, need to be considered.

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