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Land Evaluation for Oil Palm Plantation on Peat Soil in Pondok Kelapa District, Midle Bengkulu Regency of Bengkulu Province

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ABSTRACT

The development of oil palm plantations in Indonesia as a commodity crop has increased rapidly from year to year. The oil palm plant in Pondok Kelapa District, Middle Bengkulu Regency is the second-largest plantation of people after oil palm. Increasing the income and welfare of farmers can also be done through the evaluation of peatland custom in oil palm crops. This study aims to evaluate the suitability and analyze peatland limiting factors for oil palm plants in Pondok Kelapa District and provide peatland processing direction based on limiting factors to produce palm oil production in Pondok Kelapa District. This research was conducted in Pondok Kelapa Bengkulu Tengah Regency from December 2014 until January 2015 through 4 stages, namely pre-survey, field survey, data analysis, and making a map of the potential development of oil palm plantations. The results showed that each observation point has a low to moderate soil fertility rate It is characterized by low pH and N total values, as well as low P_2O_5 in providing nutrients for oil palm plants. In general, limiting factors are the dominant limiting factors, namely available nutrients (P_2O_5, N total) and nutrient retention (pH). The results of land suitability evaluation in Pondok Kelapa District showed the land suitability class is S2 and S3, actual land suitability class for oil palm plants in Pondok Kelapa District with barrier factors hampered drainage, fertility / low soil nutrients, and soil drainage is very hampered/very bad. Efforts to increase peatland potential for oil palm crops can be done by improving drainage, planting systems, and high maintenance of groundwater levels in oil palm plants.

Keywords: oil palm, peat land, Pondok Kelapa District

INTRODUCTION

Palm oil (*Elaeis quenensis* Jack) based on its history comes from West Africa, although palm oil is suitable to be developed outside its home region including in Indonesia. Oil palm has been cultivated in the form of commercial plantations in more than seven countries. Until now the largest producers of palm oil are in Malaysia, Nigeria, Indonesia, Colombia, Thailand, Papua New Guinea, and Ivory Coast (Departemen Pertanian, 2012).

Based on data from the Departemen Pertanian (2012), Indonesia's oil palm plantation area in 2012 was 9,074,621 hectares with a growth rate of 10 to 20% per year. Based on World Wild Fund (WWF) Indonesia data, in 2013 oil palm plantations in Indonesia reached 13.5 million hectares. This figure exceeds the development of palm oil in the last 5 years as of December 2012, which is 9.5 million hectares. development of oil palm by state or private companies as well as individuals is very helpful for the community economy in improving welfare. But on the other hand, oil palm development sacrifices a lot of productive land for food crops, crops, and horticulture or more extreme is to turn wetlands in the form of rice fields into oil palm land. So finally most of the productive land has been turned into plantations. Such conditions began to be felt by the government and small farmers. Therefore, the government began to direct oil palm development to sub-optimal and marginal lands by issuing regulations limiting the development of oil palm crops on productive lands (Direktorat Jenderal Perkebunan Departemen Pertanian RI, 2012).

Many opportunities can be done to optimize the plantation land owned by the community, especially the land of the people of Central Bengkulu. The area of Bengkulu Tengah regency based on BPS data of Bengkulu Tengah Regency in 2011 was 1,123.94 km^2. Land use of oil palm plantations in Central Bengkulu there is 7,363 ha with an average production of 34,731 tons $year^{-1}$ (BPS Bengkulu Tengah, 2011).

In line with the increase in population, it encourages the transfer of peatland functions into agricultural land to support food security, meet paper industry raw materials, meet the needs of plantation areas, and in the framework of bioenergy development. The most prominent peatland utilization effort today is the transfer of peatland functions for oil palm plantations (Direktorat Pengelolaan Lahan Deptan, 2008).

Land evaluation is an approach to assess the potential of land resources. The results of this evaluation will provide information on land use that may be required and ultimately the expected value of production that is likely to be obtained. Land evaluation requires physical variables of the environment of an area detailed into land qualitys, and each land quality usually consists of one or more land characteristics. Some characteristics of land generally have a relationship with each other. Land quality affects the type of use and growth of crops and other land-based commodities such as livestock, plantations, fisheries and forestry (Balai Besar Litbang Sumberdaya Lahan Pertanian, 2011).

Land suitability assessment reference used criteria for classification of good land suitability (Karim, 1996). Soil classification is a way to group soils that have soil properties (Hardjowigeno, 1993). While the purpose of soil classification is to provide systematic soil data for knowledge of soil and its relationship with plants (Rachim & Suwardi, 2002).

A land survey is one of the ways or methods to evaluate the land to get data directly from the field. Survey activities consist of field activities, making data analysis, data achievement to the objectives and is chemical, physical and biological data in the field with the purpose of public and special land use (Abdullah, 1993).

Agricultural development is an effort to improve the welfare of farmers' lives achieved through the development of the agricultural sector and increasing farmers' productivity. Therefore, based on the development of oil palm in the peat area, the evaluation of the suitability of oil palm plantation land needs to be done to increase the production of oil palm crops in Pondok Kelapa District, Bengkulu Tengah Regency.

This study aims to evaluate the suitability and analysis of peatland limiting factors for oil palm plants in Pondok Kelapa District and provide peatland processing direction based on limiting factors for oil palm production income in Pondok Kelapa District..

MATERIAL AND METHOD

This research was conducted in Pondok Kelapa Bengkulu Tengah Regency from December 2014 to January 2015. The necessary materials include secondary data, physical data obtained from field fingerprints and soil chemistry obtained from analysis at the Soil Science Laboratory of the Faculty of Agriculture, University of Bengkulu, a scale map of 1:50,000 as a base map, a map of land types, and land units, a scale of 1:250,000, a land-use map scale of 1:50,000 and a scale slope map of 1:50,000. The tools used in this study are drawing tools, rulers, erasers, pencils, thought paper. Field equipment consists of a compass, folding meter, plastic bag, airy knife, hoe, ground drill, machete, and Global Positioning System (GPS). After the preparation of materials and tools, questionnaires are made to obtain socioeconomic data covering production factors.

The general stages of this research are divided into 4 stages, namely pre-survey, field survey, land analysis, and evaluation and map-making. Data collected from the observations in the field.is marbles, the height of place, effective depth, soil color, structure, texture, and production of land units. Climate variables include annual rainfall (mm) and air temperature (°C) obtained from BMKG Class 1 Baii Island. Analysis in the laboratory includes soil pH with the electrometric method and soil CEC established by the calorimetric method.

The data obtained is then analyzed and presented descriptively to obtain the potential of oil palm plants from the aspect of land suitability.

RESULT AND DISCUSSION

Land Use in Pondok Kelapa District

Based on the use of rice fields and observations in the field, in general, the area of rice fields at the research site is 1,446 ha. For the development of food crop commodities, especially rice fields must have the requirements to grow the commodity. Therefore, it is necessary to conduct land evaluation activities to obtain potential in the framework of developing certain commodities, especially rice fields. The use of rice fields in Pondok Kelapa District has been converted to plantation crops. In the use of land found in the field a lot of lands that is intercropping with oil palm crops. This condition can reduce the yield of rice planting rice fields. For land ownership that researchers found in the field on when research in each unit of the land map (SPL) the average land ownership has its own or property rights and there is also shaking rice fields owned by others.

Based on a report from BPS Bengkulu Tengah in 2014 land use in Pondok Kelapa District is for rubber plantation plants with an area of 102.6 ha, oil palm area of 93.0 ha, coffee area of 20.5 ha, and rice fields area of 1,896 ha while based on analysis of land use imagery in Pondok Kelapa District for oil palm plants 279 ha, mixed gardens 15.19 ha, open land 151 ha, and rice fields 144 ha. This shows a very large comparison .from BPS data and image analysis. The use of rice fields in Pondok Kelapa District is currently reduced due to the transfer of land functions to plantation crops. The use of rice fields is decreasing because plantation crops are easier to maintain than rice crops, especially on land that is very difficult to get water supply. Plantation crops have a higher value than rice crops. While the area of land used to grow plantation crops tends to increase, so rice farmers begin to decrease and switch to plantation crops (BPS Bengkulu Tengah, 2014).

Characteristics of Land Observation at the Research Site

Observations in the field and data from the map of land types there are 6 SPL (land map units) which are oil palm plants in Pondok Kelapa District. SPL 1 (Af.1.2.2), SPL 2 (Af.4.1.1), SPL 3 (Au.1.1.1), SPL 4 (Bfq.1.1), SPL 5 (Bfq.1.2), SPL 6 (Tf.3.2), SPL 7 (Au.1.1.1), and SPL 8 (Au.1.1.1). SPL 1 unit of soil complex shoal beach young joints smooth and not rough, SPL 2 units of land type river terraces fine sediment, flat 100-400 (slopes < 3%) somewhat teratogen, SPL 3 units of land type alluvial plain joints are not distinguished swamp vegetation low open flat (slopes< 3%) SPL 4 units of soil type.

The physical and chemical properties of soils have a big role to play in determining whether the soil is potential or not. The physical nature of the soil is very important in its role in the median means of growing plants. The parent material can be derived from materials deposited from elsewhere as a result of the transportation process by wind and water. The parent material is the state of the ground zero time (time zero) of the soil formation process through the weathering process.

Nutrient retention is a factor of the ability of the soil to absorb nutrients or colloids in the soil that are temporary so that conditions in the soil are suitable for certain nutrients then the nutrients that are absorbed will be released and can be absorbed by plants. Nutrient retention in the soil is influenced by CEC and pH, nutrient retention to increase CEC in each SPL has a high to very high criteria value. CEC values are criteria in SPL 1,2,3,4,5,6,7 and 8. Some of the factors that cause high to very low CEC values are with a high content of organic matter and high clay content than with soils with low organic matter or sandy soils. Each SPL at each research location has mass pH criteria. While at the research site has a pH value below 7 which is 4.3 to 4.8. pH acidity levels can affect nutrient availability for plants (Table 1).

Nutrients available are nutrients that can affect the growth and physical development of plants. Nutrients available in the soil such as N, P, and K nutrient availability for plants can affect productivity in oil palm plants. The medium total N values are SPL 1,3, 5,6 and 7 with a value of 0.31 while for high criteria in SPL 2,4 and 8 with a total N value of 0.84. Macronutrients such as N, P, and K are nutrients that are needed by plants because their role can spur plant growth.

Slope class can be divided into 5 classes: class 1 with a slope of 0-8% (flat), grade 2 with a slope of > 8-15% (ramps), class 3 with a slope of > 15– 25% (slightly steep), class 4 with a slope of > 25-45% (steep) and class 5 with a slope of > 45 -65% (very steep). Slope 1-3% which is included in the criteria is very sloping or flat in Pondok Kelapa District has a height of 1 -3%. Observation of soil color in the field using standard color Munsell Soil Colour Chart in 3 units namely Hue, Value, Chroma, soil color in each SPL is generally dark ranging from Black on SPL 1,3,4 and 6, SPL 2,5,7 and 8 soil color yellowish brown Ligh (Table 1).

Rooting media is determined by drainage, effective depth, peat maturity, peat depth, and texture. Rooting media at drainage level in all SPL has a level of stagnant drainage, rice field soil shows the morphology of different profiles with the soil in peatland, soil drainage is related to the speed of water to seep into the soil (infiltration) and shows the length of saturated and stagnant soil. At effective depth levels in SPL 1, 2, 3, 4, 5 , 6,7 and 8 including depths in which it reaches > 90 cm. Effective depth at SPL 1, 3, 5, and 8 includes deep depth because the depth > 50 cm. While in SPL 2, 4, 6, and 7 enter in a depth between 25-50 cm. This depth difference is the type of the main parent material of the soil only organic and mineral materials. In the field, the level of peat maturity is determined by the method of permeation shown by looking at the results of liquids and the remaining squeeze materials by hand, SPL 4 and 6 have sapris peat maturity while peat maturity SPL 2 fibris maturity level. Sapris peat is a peat level of maturity that has advanced (ripe) while the peat fibris raw peat that has not occurred is composed. To determine the thickness of peat is done by measuring from the top layer up to the mineral soil. The thickness of different peat will affect peat fertility rate the thicker the peat the the fertility rate will be lower because the plant will be difficult to reach the layer (Table 1).

Table 1. Soil Physical and Chemical Properties

SPL	Parent material	Effective depth (cm)	Peat depth (cm)	Texture	Drainage	pH	N Total (%)	CEC (C mol)
1	Mineral	70		Clay	Flooded	4.8	0.31	30.3
2	Organic	100	100	Clay	Flooded	4.6	0.84	48.49
3	Mineral	50		Clay	Flooded	4.6	0.31	37.07
4	Organic	100	45	Clay	Flooded	4.8	0.84	30.32
5	Mineral	50		Clay	Flooded	4.5	0.31	49.94
6	Organic	100	40	Clay	Flooded	4.5	0.31	27.26
7	Mineral	70		Clay	Flooded	4.3	0.31	23.98
8	Organic	100	45	Clay	Flooded	4.8	0.84	30.32

+ Field observations and Analysis of the Soil Science Laboratory, Agriculture Faculty, University of Bengkulu and BPTP (2015) ; SPL = unit of the land map

Table 2. The actual land suitability class for oil palm trees at Pondok Kelapa District

SPL	Actual Land Suitability	Explanation
1	*S3nfr*	Land that has S3 land suitability (according to marginal) with limiting factor N (available nutrients)
2	*S3nf*	Land that has S3 land suitability (according to marginal) with limiting factor f (nutrient retention) pH and N levels
3	*S3nfr*	Land that has S3 land suitability (according to marginal) with limiting factor f (nutrient retention) pH and N levels
4	*S3nfs*	Land that has S3 land suitability (sufficiently suitable) with limiting factor N (available nutrients) level f (nutrient retention), pH and D (rooting medium)
5	*S3fn*	Land that has land suitability S2 (sufficiently suitable) with limiting factor N (available nutrients) level f (nutrient retention), pH and D (rooting medium)
6	*S3sfn*	The land with S1 land suitability is very low
7	*S3nf*	Land that has S3 land suitability (according to marginal) with limiting factor f (nutrient retention) pH and N levels
8	*S3snf*	Land that has S3 land suitability (according to marginal) with limiting factor f (nutrient retention), pH and N levels

+ S2 (quite suitable), S3 (according to marginal), N (available nutrients), F (nutrient rents), D (root media and T (climate). Results of analysis in the laboratory and direct field observations; SPL = unit of the land map

Table 3. Development potential or potential land suitability

SPL	Sample	Actual suitability class	Potential suitability class	Repair effort
1	1	S3nfr	S3nf	make improvements to the pH and P_2O_5 levels
	7	S3nf	S2nf	make improvements to the pH and P_2O_5 levels
2	2	S3nfr	S2nf	make improvements to the pH and P_2O_5 levels
	4	S3fn	S2f	make improvements to the P2O5 and pH levels. Cannot improve the effective depth of soil and peat maturity
	6	S3sfn	S2sf	make improvements to the pH and P_2O_5 levels
	8	S3nf	S2nf	make improvements to the P_2O_5 and pH levels. Cannot improve the effective depth of soil and peat maturity
3	3	S3snf	S2nf	make improvements to the pH and P_2O_5 levels
4	5	S3nfr	S2nf	make improvements to the pH and P_2O_5 levels

+ Observation Result Data (2015); S2 = (Sufficiently suitable), S3 = (Marginally appropriate), N = (Unsuitable), t = (Climate), d = (Root media) s = (Erosion hazard) f = (Nutrient retention), SPL = unit of the land map

Land Suitability Class Assessment Results

The results of the evaluation of oil palm plantations at Pondok Kelapa District were carried out by matching the characteristics of the land with the requirements for growing oil palm plants based on land suitability criteria. Having an actual land suitability class S2rc, nr is marginally suitable land with a limiting factor of root media and nutrient retention. Potential land suitability class In S2 with an inhibiting factor for root media and nutrient retention, improvements can be made so that its potential suitability becomes S1 (appropriate). Efforts that can be done are for nutrient retention by inundating oil palm plantations to increase the pH and also by fertilizing dolomite or liming. Meanwhile, for rooting media, repairs are only done by making drainage channels so that the amount of water entering and leaving can be controlled.

Based on Table 2 above, sample 1 has different actual land suitability classes at each observation point or each sampling. At SPL 1, it is marginally suitable land with limiting factors of root media and nutrient retention. Potential land suitability class. In sample 1 S3nfr with N inhibiting factor and nutrient retention can be improved so that the potential suitability becomes S2 (quite appropriate). Efforts that can be done are to increase the pH and also with dolomite fertilization. The actual land suitability class for oil palm trees at Pondok Kelapa District.

Potential Land Suitability

The development of oil palm perennial crops at Pondok Kelapa District requires a study and evaluation of land suitability to be carried out to determine the conditions and land suitability classes as a source of support for the development of food crops at Pondok Kelapa District..

Based on Table 3, the S3nfr land suitability class at SPL 1 can be upgraded to an S3 land suitability class. At SPL 1 which has a limiting factor, namely P_2O_5. The only improvements that can be made are the available nutrient levels by adding phosphate fertilizers according to the growing requirements for oil palm plants. At SPL 2 and 3 which have a limiting factor for nutrient retention at the pH level, and available nutrient P_2O_5. Improvements can be done at the pH level by flooding and liming which is adjusted to the growing conditions of the palm oil plant to become pH neutral. At the P_2O_5 level, fertilize with P fertilizer by the requirements for growing oil palm plants.

Land suitability class S2nfd has available nutrient limiting factors (P_2O_5), nutrient retention (pH), root media (peat depth and peat maturity). SPL 4 can be upgraded to land suitability class S3fn performs improvements at the P_2O_5 and pH levels. At the P_2O_5 level, fertilization is carried out by adding phosphate fertilizer and at the pH level, flooding and paving are carried out, while at the peat maturity level and the peat depth cannot be repaired.

CONCLUSION

The results of the analysis of the physical and chemical properties of the soil on oil palm plantations at each point of observation have low to moderate soil fertility. In general, the limiting factor is the dominant limiting factor, namely available nutrients (P_2O_5, total N) and nutrient retention (pH). The results of land suitability evaluation at Pondok Kelapa District show that the land suitability classes are S2 and S3. The actual land suitability class for oil palm plants in Pondok District has limiting factors for inhibited drainage, low fertility/soil nutrients, and very poor / very poor soil drainage.

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