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Land suitability evaluation for oil palm plantations (*Elaeisguenensis jacq*) on Sitellu Tali Urang Julu, Pakpak Bharat District

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Abstract. The Non-Forest Area is an outside of forest area which can be used for other reconstruction sector activities, one of them is for agricultural land area sector. At Sitellu Tali Urang Julu, Pakpak Bharat district, the potential utilized land for agricultural cultivation activities is largest and expecting will improve the welfare of local farmers. This research aimed was to determine the land suitability in Sitellu Tali Urang Julu, Pakpak Bharat district for oil palm plantation (*ElaeisguenensisJacq*). The research method was survey in Sitellu Tali Urang Julu, Pakpak Bharat. This research conducted by taking soil samples in field then analyzed in laboratory. The survey activities consist of 5 stages; there were pra-survey, main survey, soil analysis in Laboratorium and also processing data. The survey results showed that retention and nutrients availability were the most limiting factor on Non-forest area Sitellu Tali Urang Julu for developing oil palm plantation, moreover the regional air temperature should be considering. Actual land conditions that cultivated in Sitellu Tali Urang Julu Subdistrict is oil palm is 939.11 ha. Than potential area land that cultured in Sitellu Tali Urang Julu is: Oil Palm around 939.11 hectares, cannot be understood.

1. Introduction

The cultivation of crop plants by farmers recently had some problems, such as, over-function of agricultural land becomes non-agricultural planted with oil palm. The productivity of crops is not only affected by superior seeds and good cultivation techniques. Climate and soil also affect by characteristics of land. For example, [5] showed the productivity of oil palm affected by the crop ages, the soil type, and slope class. Land characteristic can be measured or estimated. Land characteristics can be the factor of limiting in development of a commodity.

Land evaluation is the effort to assess a land for a particular utilization. Land suitability is suitable of level lands for particular utilization. Land suitability can be assessed by presents and future after being



repaired. Land evaluation is a potential assessment process of a particular utilization land use [4]. Land evaluation is a useful development basis on agricultural sector, especially for Non-forest utilization (APL). Non-forest area is the area outside the forest that can be used for all reconstruction sector activities, that is agricultural sector [2].

Pakpak Bharat District administratively have (eight) Subdistrict, one of them is Sitellu Tali Urang Julu, blown up from Salak. Based on the law number 08 in 2006. Based on natural and topographic conditions in Pakpak Bharat District, agricultural sector is the biggest potential that supports the people's economy. The District area is 1,218.30 km² (121,830 ha). From that area, amounting to 25,640.99 hectares is Non-forest area (APL) or an area outside the forest that can be used for reconstruction facilities such as agricultural cultivation, settlement, offices, and the other that supporting facilities [1]. Sitellu Tali Urang Julu Subdistrict has 3,303.42 hectares, or 12,86% from total of non-forest 25,640.99 hectares in Pakpak Bharat District [1].

With a quite large area in Pakpak Bharat District have a big potential utilized land for agricultural cultivation activities and this productivity expectation can improve the welfare of local people who work as farmer. The land suitability needs to be considered for cultivating crops to get an optimal growth. The land suitability is compatibility level of a land for the certain uses. Even though crops can grow on a land; however every type of crop has different characteristics.

The assessment result is class and subclass from suitable land from crops which assess determined by heaviest limiting factors. Limiting factors consist of one or more depends on the land characteristics [12]. The land suitability needs to be considered for cultivating crops to get an optimal growth. Especially for oil palm, even though oil palm can be growing in different land condition, but every crop has different character so they need different treatment [6]. The criterion of oil palm refers to two types of land according to [16] [3] the land is mineral soil and peat.

In 2000 Indonesia and Malaysia produced amounts 16.9 million tons than another production in the world it only 3.3 million tons [14]. Oil palm plantation is the one of flora plantation that occupies important positions in general, and particularly agriculture sectors. This thing because number of plant producing oil or grease, oil palm producing the biggest economic values per hectare in the world [15]. Suitability land and climate/weather factors hard related by spread of location, particularly on low compete oil palm regions than the other alternative commodities, until there are need mapping potential land for oil palm plantation. Mapping oil palm land, expected to farmer and entrepreneur beneficial oil palm in Pakpak Bharat district, good to planning activity, development and cultivation for oil palm farmer.

Information about land suitability can give feedback and information to managing accurate for development continuously and welfare the society, so that necessary researching to evaluate suitability land level of oil palm commodity that does the convenient regions to plantations and what kind of improvement effort to the cultivation, because of that it's important to evaluating suitability land on Non-forest area in Salak, Pakpak Bharat district to evaluating potential lands. The objective of this study is to evaluate land characteristics and classify suitability land classes that can be improve the productivity of oil palm crops in Sitellu Tali Urang Julu, Pakpak Bharat District.

2. Materials and Methods

Administratively in Sitellu Tali Urang Julu is apart of Pakpak Bharat regency, the District neighbouring with some Districts and Regencies with borders as follows: North Side: Siempat Rube Regency, East Side: Samosir Regency, South Side: Humbang Hasundutan Regency, West Side (Figure 1). District Sitellu Tali Urang Julu. Have a wide territory 53.02 km², on high 900-1800 m with slope gradient 7-25%, have a precipitation average 2920 mm/year, temperature average annually 19,64 °C and humidity 83.28% [1].

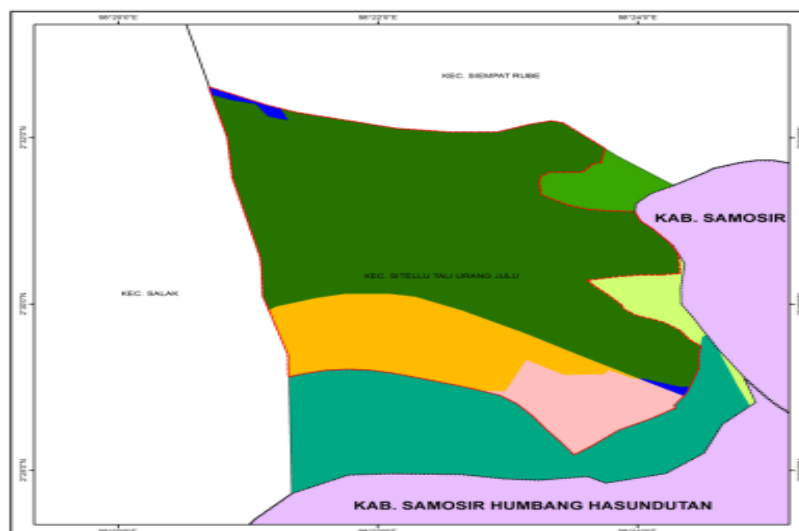


Figure 1. Map location research

There are 6 points sample have been composited (Figure 2). Determination land characteristics values for sampling soil used drill ground in depth 0-60 cm. determination chemistry land characteristics by analyzing land in laboratory research and Faculty of Agriculture Technologies in USU Medan.

This research used survey method from five steps are prepare, pre-survey, main survey, analyzing land in laboratory and processing data. taking soil sample by fracking an area land. Where an are land choose based on unit of utilization map land.

The data research deserved from interpreted criteria on fertility land's level on suitability class according to [13] [16]. Land Evaluation process specified by matching way between land characteristics with growing oil palm plantation qualified, that formulate in technical directive land evaluation for agricultural commodities [4] [11]. *Onmatching* process for minimum Leibig law to determine border factors that influence class and suitability the sub-class land. Suitability results land of plantation commodity represented into suitable formed table actual land and used potential GIS software and suitable actual mapped land and their potential.

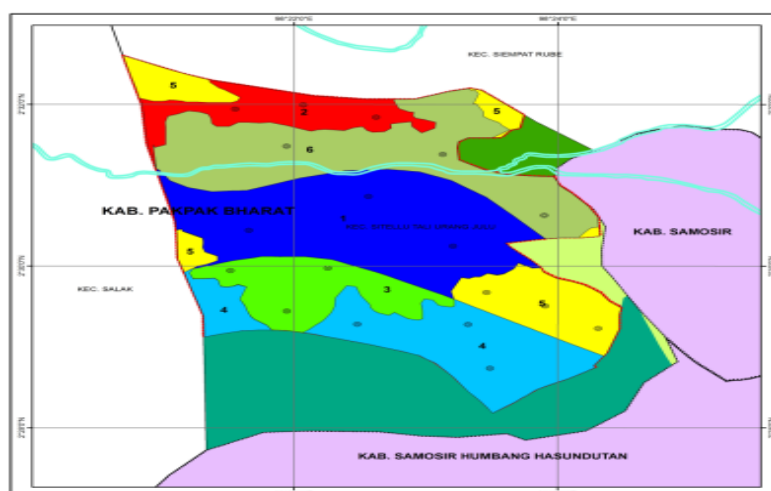


Figure 2. Soil sample drilling point

3. Result and Discussions

3.1. The land characteristics in non-forest area in Sitellu Tali Urang Julu Subdistrict

The land characteristics in non-forest area (APL) in Sitellu Tali Urang Julu, Pakpak Bharat district, is various forest species and agriculture land territory, the widest in the area is dry agriculture land and any of them, such a secondary dry land, shrubs, production forest, and paddy field. The field survey results and the example analyzing land in laboratory acknowledgeable, is the location and soil sample location grouped into 6 (six) *land unit*, by land characteristics in depth 0-30 cm and 0-60 cm each of present on Table 1 and Table 2.

Soil types that have APL land dominated by *Andisol* and *inseptisol*. *Andisol* with great group *Hapludands* dominant on dry agriculture land. *Hapludands* is formed soil from main volcanic ash. Based on [9] this territory includes into the climate zone D1 that have wet 3-4 months characteristics and dry < 2 months consecutive. Agroecosystem Zone dominated dry agriculture land and forest territory by hilly formed, that have gradient slopes 7-25 %. Physical soil characteristics influence to the plantation roots such as texture, drainage and depth roots is good enough is good soil drainage, sandy clay texture, sandy clay gristly, gristly clay, and effectively depth till > 100 cm.

Value of pH soil in Non-forest area land/APL variative from 5.4 (slightly sour) until 6.50 (netral), N-total land value in Non-forest area/APL field variative from low to high, P_2O_5 value specified very low to low, then K_2O soil on the field that specified high.

C-Organic in this APL land highest classified, most of unit land do not need addition organic material. Organic land materials contain all nutrients include humus it's very necessary for growth plantation. Organic materials role to available nutrients in soil with mineralization process, that is the last step from recast organic material. Organic material has chemistry role to served N, P, and K for plantation.

KTK value Non-forest area/APL specified high. With KTK high value the soil could have absorbed and represented more nutrients, from soil by lowest KTK. KTK value one of soil impacted by characteristic and number of clay fraction and organic material beside pH solution extractions.

3.2. The suitability land for oil palm crops (*Elaeisguinensis* Jacq.)

Recapitulation Land Suitability for Oil Palm plant in the district of Tali Urang Sitellu Julu Pakpak Bharat (Table 3). Characteristics of nutrient retention in base saturation and soil nutrient retention P_2O_5 on other land uses in the district SitelluUrangTaliJulu, to plant oil palm (*Elaeisguinensis*Jacq.) Is low. The limiting factor retention and nutrient availability is not a major limiting factor in assessing the suitability of the land, because they can do the management with the addition of nutrients to the soil. While the major limiting factor in the assessment of land suitability classes for palm oil, on the other land uses in the district SitelluUrangTaliJulu is temperature. This is consistent with the statement [8] which states limiting factors of land consists of two types, namely (1) the permanent limiting factor in a sense very difficult to repair if it will be opened for agriculture, the limiting factors, such as temperature, soil texture, elevation (altitude), and (2) the limiting factors that can be corrected, such as soil fertility, toxic elements Al, soil acidity.

In addition to temperature, the main limiting factor is also the rooting medium such as soil texture, soil texture due will not change in a short time, for example, the texture of the sand is difficult to change into a clay or hard clay texture changed into sand.

This is supported by [10] which states that the land evaluation by a factor of rooting medium such as textures do not attempt repairs, From the results of the analysis are obtained can be seen in Table recapitulation of votes following fields.

Table 1. Land characteristics for land units 1-6 at 0-30 cm depth in other use areas in Sitellu Tali Urang Julu District Pakpak Bharat District for agricultural land suitability evaluation

Land characteristics	Land unit					
	1	2	3	4	5	6
Average Temperature ($^{\circ}\text{C}$)	20.09	19.62	19.88	18.83	19.32	20.09
Place height (mdpl)	1,035	1,114	1,070	1,246	1,164	1,036
Rainfall (mm)	2,920	2,920	2,920	2,920	2,920	2,920
Dry Moon Length	1	1	1	1	1	1
Humidity (%)	83.28	83.28	83.28	83.28	83.28	83.28
Availability of oxygen	Good	Good	Good	Good	Good	Good
Rooting media	Sandy clay	Sandy pise clay	Sandy clay	Sandstone	Sandstone	Clay sandy
Texture	6.17 (S)	7.08 (S)	8.86 (S)	6.42 (S)	11.34 (S)	7.85 (S)
Coarse Materials (%)	>100	>100	>100	>100	>100	>100
Nutrient retention	25.20(T)	17.64(S)	33.48(T)	25.80(T)	31.68(T)	48.60(T)
KTK clay (cmol)	14.87 (SR)	27.16 (R)	19.93 (SR)	23.69 (R)	15.62 (R)	12.72 (R)
Alkaline saturation (%)	5.44 (AM)	5.66 (AM)	5.61 (AM)	6.50 (N)	5.73 (AM)	6.50 (N)
pH H_2O	7.60 (ST)	1.61 (R)	3.72 (T)	2.76 (S)	7.61 (ST)	7.61 (ST)
Nutrient availability	0.56 (T)	0.15 (R)	0.37 (S)	0.24 (S)	0.44 (S)	0.46 (S)
N-total (%)	11.05 (R)	6.40 (SR)	9.77 (SR)	6.16 (SR)	13.60 (R)	6.63 (SR)
P2O5 Bray II (ppm)	0.54 (S)	0.87 (T)	1.20 (ST)	0.88 (T)	1.54 (ST)	1.20 (ST)
Sodisitas /xn	1.25 (SR)	2.68 (R)	1.77 (SR)	2.04 (R)	1.62 (SR)	0.93 (SR)
Danger of erosion	6.2	18.4	7.6	15.5	8.1	5.1
Slope (%)	SR	S	SR	S	SR	SR
Danger of flooding	F0	F0	F0	F0	F0	F0
Land preparation	0	0	0	0	0	0
Rocks on the surface	0	0	0	0	0	0

Table 2. Land characteristics for land units 1-6 at 30-60 cm depth in other use areas in Sitellu Tali Urang Julu district Pakpak Bharat District for agricultural land suitability evaluation

Land characteristics	Land unit					
	1	2	3	4	5	6
Average Temperature ($^{\circ}\text{C}$)	20.09	19.62	19.88	18.83	19.32	20.09
Place height (mdpl)	1,035	1,114	1,070	1,246	1,164	1,036
Rainfall (mm)	2,920	2,920	2,920	2,920	2,920	2,920
Dry Moon Length	1	1	1	1	1	1
Humidity (%)	83.28	83.28	83.28	83.28	83.28	83.28
Availability of oxygen	Good	Good	Good	Good	Good	Good
Rooting media	Sandy clay	Sandy pipe clay	Sandy clay	Sandstone	Sandstone	Clay sandy
Texture	8.28 (S)	6.02 (S)	8.73 (S)	7.77 (S)	7.05 (S)	10.05 (S)
Coarse Materials (%)	>100	>100	>100	>100	>100	>100
Nutrient retention	26.10 (T)	13.62 (R)	29.64 (T)	20.28 (S)	31.32 (T)	34.20 (T)
KTK clay (cmol)	13.60 (SR)	35.47 (R)	18.44 (SR)	27.25 (R)	17.55 (SR)	18.92 (SR)
Alkaline saturation (%)	5.66 (AM)	5.74 (AM)	5.77 (AM)	6.56 (N)	5.96 (AM)	6.47 (N)
pH H_2O	5.57 (ST)	1.52 (R)	3.35 (T)	2.24 (S)	8.57 (ST)	6.59 (ST)
Nutrient availability	0.46 (T)	0.15 (R)	0.33 (S)	0.46 (S)	0.35 (S)	0.46 (S)
N-total (%)	9.54 (SR)	6.05 (SR)	7.62 (SR)	5.58 (SR)	9.07 (SR)	849 (SR)
P2O5 Bray II (ppm)	0.52 (S)	0.74 (T)	1.03 (ST)	0.84 (T)	1.62 (ST)	1.33 (ST)
Sodisitas /xn	1.28 (SR)	3.17 (R)	1.99 (SR)	2.51 (R)	1.38 (SR)	1.90 (SR)
Danger of erosion	6.2	18.4	7.6	15.5	8.1	5.1
Slope (%)	SR	S	SR	S	SR	SR
Danger of flooding	F0	F0	F0	F0	F0	F0
Land preparation	0	0	0	0	0	0
Rocks on the surface	0	0	0	0	0	0

From the results of GIS analysis, obtained extensive actual and potential land suitability in other uses SitelluTaliUrangJulu, to plant palm oil (Table 4)

Table 3. Land suitability recapitulation for oil palm plants in Sitellu Tali Urang Julu District Pakpak Bharat District

Land Unit	KLA	Perkiraan Usaha Perbaikan	KLP
Land 1	S ₃ -tc, rc, na	Drainage makers Liming 1.75 tons CaCO ₃ /ha Fertilization 10.10 kg P ₂ O ₅ /ha or 28.02 kg SP36/ha	S ₃ -tc, rc
Land 2	N-tc	Drainage makers Liming 1.02ton CaCO ₃ /ha Fertilization 1.29ton N/ha or 2.81ton Urea/ha Fertilization 219 kg P ₂ O ₅ /ha or 59.70 kg SP36/ha Planting parallel contours	N-tc
Land 3	N-tc, rc	Drainage makers Liming 476 kg CaCO ₃ /ha Fertilization 16.42 kg P ₂ O ₅ /ha or 45.62 kg SP36/ha	N-tc, rc
Land 4	N-tc, rc	Drainage makers Fertilization 15.00 kg P ₂ O ₅ /ha or 41.68 kg SP36/ha	N-tc, rc
Land 5	N-tc, rc	Drainage makers Liming 552.83 kg CaCO ₃ /ha Fertilization 9.02 kg P ₂ O ₅ /ha or 25.04 kg SP36/ha	N-tc, rc
Land 6	N-tc	Drainage makers Liming 1.17ton CaCO ₃ /ha Fertilization 12.92 kg P ₂ O ₅ /ha or 35.88 kg SP36/ha	N-tc

Table 4. Extent of land suitability for oil palm plants in Sitellu Tali Urang Julu District, Pakpak Bharat District.

Land unit	Actual land suitability	Potential land suitability	Land area (Ha)	Percentage (%)
1	S ₃ -tc, rc, na	S ₃ -tc, rc	939.11	28.4
2	N-tc	N-tc	258.38	7.8
3	N-tc, rc	N-tc, rc	327.84	9.9
4	N-tc, rc	N-tc, rc	567.80	17.2
5	N-tc, rc	N-tc, rc	423.17	12.8
6	N-tc	N-tc	787.11	23.8
Total			Total	3,303.42

Source: Results of GIS Analysis

4. Conclusions

The limiting factor of land in the district Sitellu Tali Urang Julu for growing oil palm (*Elaeis guineensis* Jacq.) plantation is retention and nutrient availability. The primary limiting factor in the assessment of classroom suitability of land for oil palm on other land uses in the district Sitellu Tali Urang Julu is temperature. Actual appropriate conditions cultivated land in the district is Sitellu Tali Urang Julu, oil palm area of 939.11 ha, while potentially appropriate conditions cultivated land in the district is Sitellu Tali Urang Julu: oil palm area of 939.11 ha,

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