Land Suitability Evaluation For Rubber (*Havea Brasiliensis*) Plants in Bengkulu

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ABSTRACT

Rubber (*Havea brasiliensis*) is one of the dominant commodities in the province of Bengkulu and potential for development. For optimal growth and production, it is necessary to evaluate the suitability of the land. This study was aimed to evaluate the suitability for planting rubber tree in Bengkulu. Land suitability evaluation was done by comparing the characteristics of the land with plant growth requirements. Requirements of the crops to be grown in land suitability evaluation criteria. Land characteristics data were collected through field survey and analysis of soil samples in the laboratory. The results showed that the rubber crop land suitability classes of the people of North Bengkulu is quite suitable (S2) with a temperature limiting factors, the availability of water, availability of oxygen, rooting medium and nutrient retention. Rubber crop land suitability class of the farmers' are suitable in marginal Seluma District (S3) with the limiting factor of nutrient retention. Actual land suitability classes for rubber of farmers' in of South Bengkulu is appropriate marginal (S3) by a factor limiting in nutrient retention.

Keywords: Bengkulu*, Havea brasiliensis,* land suitability.

INTRODUCTION

Dry land in Indonesia has a huge potency for agricultural development. But productivity is generally low, except for dry land farming systems with annual crops/ plantation (Syam, 2003). To obtain optimal plant growth is necessary to note the suitability of land with plants growing requirements. Djaenudin *et al*. (2003) reported that the suitability of land is an area of land suitability for particular uses. The land suitability can be assessed for the current state (present) or after improvement. Azis *et al.* (2006) adds that the suitability of land is a land suitability for particular uses, as an example of land suitable for irrigation, pond, perennial crops or agricultural farming seasonal crops.

In assessing the suitability of land there are several ways, one using the minimum law that matchs between land quality and land characteristics as a parameter to the criteria of land suitability classes which have been prepared based on the requirements of growing plants was evaluated. For example, land suitability study ever conducted in southern Sumatra area for rice crops and soybeans (Nurmegawati *et al.*, 2012). Similar research has also been done for the abaca plant in East Kutai Regency (Harijogjo and Sutrisno, 2002) and plant oil palm in Kampar regency of Riau Province (Wigena *et al*., 2009).

One of the dominant commodities in Bengkulu Province, namely rubber. The development of rubber plantations currently is quite rapidly both in large estates, private estates or in smallholdings. The rubber planting was owned by 110 465 farmers with current productivity of 1,261 kg/ha (Department of Plantation Province Bengkulu, 2010). Therefore research on rubber plant land suitability needs to be done keeping in this area has a large area and the potency for the development of plantations. With the expected land suitability class information and management practices appropriate alternatives, it is expected to increase production and the welfare of society. The aim of this study was to evaluate the land suitability for rubber plant (*Havea brasiliensis*) of farmers' in the province of Bengkulu.

MATERIALS AND METHODS

The research was conducted for 11 months. The location of research includes three districts of North Bengkulu, Bengkulu Seluma and South, which are the centers of farmers' rubber plantations. Research using primary data and secondary data including land characteristics, climate and growing requirements of the rubber.

Table 1. Land suitability criteria for rubber (*Havea brasiliensis*)

Terms of use / land characteristics	Land suitability classes			
	S1	S2	S3	N
Temperature (tc)				
The average temperature (°C)	26 – 30	30 – 34	–	> 34
		24 – 26	22 – 24	< 22
Water availability (wa)				
Rainfall (mm)	2.500 – 3.000	2.000 – 2.500	2.000 – 2.500	< 1.500
		3.000 –3.500	3.500 – 4.000	> 4.000
Number of dry months (month)	1 – 2	2 – 3	3 – 4	> 4
Oxygen availability (OA)				
Drainage	good	medium	slightly cloged	heavily clogged
Rooting condition (rc)				
Texture	fine,bit coarse	-	bit coarse	coarse
Rough material (%)	< 15 > 100	15 – 35	35 – 60	> 60
Soil depth (cm)		75 – 100	50 – 75	< 50
Peat				
Depth (cm)	< 60	60 – 140	140 – 200	> 200
Thickness (cm) of inter mineral layer (if any)	< 140	140 – 200	200 – 400	> 400
Maturity/ripeness	Sapric^{+}	saprck, hemic	hemic, fibric^{+}	Fibric
Nutrient rentention (nr)				
Clay CEC (cmol/kg)	-	-	-	-
Base saturation (%)	< 35	35 – 50	> 50	
pH H_2O	5,0 –6,0	6,0 – 6,5	> 6,5	
		4,5 – 5,0	< 4,5	
Organic C (%)	> 0,8	≤ 0.8	-	
Toxicity (xc)				
Salinity (dS/m)	< 0,5	0,5 – 1	1 –2	> 2
Sodicity (xn)				
Alcalinity/ESP (%)	-	-	-	-
Sulfidic material (xs)				
Sulphidic depth (cm	> 175	125 – 175	75 – 125	< 75
Erosion hazard (eh)				
Slope (%)	< 8	8 –16	16 – 30	> 30
			16 – 45	> 45
Erosion hazard	Very low	Medium low	Heavy	Very heavy
Flood hazard (fh)				
Inundation	F0	-	F1	> F1
Land preparation (lp)				
Surface stoniness (%)	< 5	5 – 15	15 – 40	> 40
Rock outcrops (%	< 5	5 – 15	15 – 25	> 25

Source: Djaenudin *et al.* (2003). Description; FO = without flooding, FI = mild, F2 = moderate, F3 = somewhat heavy, F4 = weight

Primary data is data obtained directly from field survey and secondary data in the form of climatic data (rainfall and humidity) obtained from the climatology station closest to the location of the research. Characteristics of land is the nature of land that can be measured or estimated, which includes rainfall, humidity, drainage, soil texture, coarse material, soil depth and slope obtained from field

surveys while, base saturation, pH H2O and organic-C obtained from analysis of soil samples in the laboratory.

Land suitability evaluation in this research comparing the characteristics of the land with the requirements of growing rubber trees that are formulated in the Technical Guidelines for the evaluation of land for Agricultural Commodities (Djaenudin *et al.*, 2003 in Subardja and Sudarsono (2005). Requirements to grow rubber trees become elative in the evaluation of suitability land (Table 1). The process of evaluating the suitability of land through: (1) preparation of land characteristics, (2) the preparation of the growing requirements of plants, (3) evaluation of the suitability of land (matching) between land characteristics and requirements grow crops in order to obtain land suitability classes. Classification of the suitability of land is determined based on the framework of FAO (1976) differentiated according to the level that the Order, Class, Subclass and Unit. At the classroom level, land belonging to the order corresponding (S) are classified into three classes, namely: land very suitable (S1), sufficient appropriate (S2), and the corresponding marginal (S3). The land belonging to the order does not match (N) is not divided into classes.

RESULTS AND DISCUSSION

Land

Seluma has an average temperature of between 21 ° C - 32 ° C with the rainfall for each year between 1500-4500 mm rainfall for each month of 221 mm, the number of rainy days between 110-230 days per year, the highest rainfall in October to December, with the wet months between September to March, the dry months between April to August (BP4K Seluma, 2012). Rainfall South Bengkulu 3,238 mm / year with 212 rainy days, temperatures between 21 ° C -31 ° C with a relative humidity of 80-88% (BP4K South Bengkulu, 2012).

Characteristics of land among the sites that include temperature, rainfall, drainage, texture, coarse material, soil depth and slope, base saturation, pH H2O and C-organic, slopes, puddles, rocks on the surface and outcrop can be seen in Table 1. Climate component data is the average temperature and precipitation in each study site is 23^0C, and 26^0C $26,5^0$C. While rainfall is very high ranging between 3000-3250 mm. Rubber good growth requires temperatures between 25-35^0C, with an average optimal temperature of 28^0C. While the annual rainfall is suitable for growing rubber trees not less than 2,000 mm. Optimal between 2500-4000 mm / yr, for areas that frequently experience rain on the morning of the production will be less. Ardika *et al*. (2010) reported that the annual rainfall ranges from l.800-2.800 mm. The conditions of considerable potentcy for the development of rubber plantations.

Table 2. Land characteristics in study sites

Land characteristic	Location		
	Northern Bengkulu	Seluma	Southern Bengkulu
Average temperature (^{o}C)	23	26.5	26
Rainfall (mm)	3250	3000	3238
Drainage	Moderate	Moderate	Moderate
Texture	Moderate	fine	Moderate
Coarse material (%)	< 15	< 15	< 15
Soil depth (cm)	> 75	> 75	> 75
Base saturation (%)	19.64	63.55	75.37
pH H_2O	4.9	4.55	4.87
Organic C (%)	3.43	3.11	1.56
Slope (%)	0-3	0-3	0-3
Inundation	FO	FO	FO
Surface stoniness (%)	< 5	< 5	< 5
Surface outcrops (%	< 5	< 5	< 5

Drainage state three study sites was moderate. Drainage affects the availability of oxygen. The relatively smooth texture class to moderate. Soil texture indicates rough or smooth a country which is a relative comparison of sand, silt and clay. Soil containing silt and clay are very difficult to be penetrated by high plant roots so that branching and stunted root development. Texture of land suitable

for rubber plant is the percentage of clay loam, sand and dust are almost the same, namely 35% clay, 30% sand and 35% of dust. Ingredients ballpark <15%. The depth of the soil / Effective included in (> 75%).

Base saturation three study sites, respectively 63.55%, 75.37%, 29.83%. Base saturation values reflect the composition of accumulated cations. The higher the value, the higher the content of alkaline soil. Including acidic soil reaction. The content of C-organic in North Bengkulu and Seluma is high while for South Bengkulu is low. Slope relatively flat so as to erosion can be suppressed. No danger of flooding with surface rock and outcrop less than 5%.

Land Suitability

Land suitability evaluation according to FAO (1976) there are two, namely: Land suitability of actual and potential land suitability. The actual land suitability or appropriateness of current land or suitability of land in its natural state, is not considered repair business and management level that can be done to overcome obstacles or factors pembatas.Faktor-limiting factors can be divided into two types, namely: (1) the limiting factor permanent and impossible or uneconomical to repair, and (2) the limiting factors that can be improved and economically still menguntuntungkan by incorporating the right technology.

Land suitability evaluation is intended for the type of land use rubber plants. Results of assessment of land suitability class is based on matching between the characteristics of the land to grow crops mangis requirements, in order to get the level of actual and potential land suitability. The actual land suitability is the land suitability classes based on survey data from the field to the area of research and effort has been no improvement while considering the suitability of potential land is land suitability achieved after the improvement efforts carried out. After the match between land characteristics (Table 1) and a rubber plant land suitability criteria (Table 2) are obtained land suitability class rubber plant in North Bengkulu people as on Table 3.

Table 3. Classes of land suitability for rubber plant of farmers' in North Bengkulu

Land charateristics	Land suitability	
	actual	Potential
Temperature	(S2)	(S2)
Average	S2	S2
Water availability	(S2)	(S2)
Rainfall (mm)	S2	S2
Oxygen availability	(S2)	(S2)
Drainage	S2	S2
Rooting condition	(S2)	(S2)
Texture	S1	S1
Coarse material (%)	S2	S2
Soil depth (cm)	S2	S2
Nutrient retention	(S2)	(S1)
Base saturation (%)	S1	S1
pH H_2O	S2*	S1
Organic C (%)	S1	S1
Erosion hazard	(S1)	(S1)
Slope (%)	S1	S1
Flood hazard	(S1)	(S1)
Inundation	S1	S1
Land preparation	(S1)	(S1)
Surface stoniness (%)	S1	S1
Surface outcrops (%	S1	S1

Description: * improvements can be made, land suitability class up one level

The actual land suitability classes for smallholder rubber plant in North Bengkulu district, namely S2 with temperature limiting factors, availability of water, availability of oxygen, rooting media and nutrient retention. Improvement can only be conducted on nutrient retention/soil fertility from S2 to S1, but the temperature, rainfall, drainage, coarse material and soil depth can not be repaired so that the land suitability classes potential S2 with the limiting factors of temperature,

availability of water, availability of oxygen and rooting medium. Factors limiting nutrient retention (soil fertility), namely pH of the soil can be improved by administering lime to raise soil pH. The limiting factor in the S2 class can usually be solved by the farmers themselves. Quite appropriate land suitability class (S2) is a land that has a limiting factor, and this factor will affect the productivity, requires additional inputs (input). The barrier can usually be solved by the farmers themselves. After the match between land characteristics (Table 1) with a rubber plant land suitability criteria (Table 2) the obtained rubber plant land suitability class people Seluma as Table 4.

Table 4. Land suitability classes for rubber in Seluma

Land Charteristic	Land suitability	
	actual	potential
Temperature	(S1)	(S1)
Average	S1	S1
Water availability	(S1)	(S1)
Rainfall (mm)	S1	S1
Oxygen availability	(S2)	(S2)
Drainage	S2	S2
Rooting condition	(S2)	(S2)
Texture	S1	S1
Coarse material (%)	S1	S1
Soil depth (cm)	S2	S2
Nutrient retention	(S3)	(S2)
Base saturation (%)	S3*	S2
pH H_2O	S2*	S1
Organic C (%)	S1	S1
Erosion hazard	(S1)	(S1)
Slope (%)	S1	S1
Flood hazard	(S1)	(S1)
Inundation	S1	S1
Land preparation	(S1)	(S1)
Surface stoniness (%)	S1	S1
Surface outcrops (%	S1	S1

Description: * improvements can be made, land suitability class up one level

The actual land suitability classes for Seluma rubber plant that is appropriate marginal (S3) by a factor limiting of nutrient retention. Repair business can only be conducted on nutrient retention / soil fertility from S3 to S2 so that the land suitability classes potential limiting factor S2 with the availability of oxygen and nutrient retention. Factors limiting nutrient retention (soil fertility) are base saturation. Suitability appropriate class marginal land is land that has a severe limiting factor and these factors will affect the productivity, require additional input more than land classified as S2. To overcome the limiting factor on S3, is required high capital so that the need for assistance or intervention (investment) by government or company.

Subardja (2007) reported that for the corresponding marginal land (S3) with a rather severe limiting factor, namely nutrient retention especially highly acidic soil reaction, extremely low base saturation and high aluminum poisoning hazard. Improved management of land necessary to improve the productivity of the soil are: (1) the addition of soil organic matter to improve soil CEC and the availability of N and P, (2) balanced fertilization, especially P and (3) provision of agricultural lime.

Land suitability classes rubber plant South Bengkulu can be seen in Table 5. The actual land suitability classes for crops of smallholder rubber South Bengkulu is appropriate marginal (S3) by a factor limiting nutrient retention. Repair business can be carried out on nutrient retention / soil fertility from S3 to S2 so that the land suitability classes potential limiting factor S2 with the availability of water, availability of oxygen, rooting media and nutrient retention. Factors limiting nutrient retention (soil fertility) are base saturation. Base saturation values reflect the composition of accumulated cations. The higher the value, the higher the content of alcaline.

Table 5. Classes of land suitability for rubber plant people of South Bengkulu

Land characteristic	Land suitability	
	actual	potential
Temperature	(S1)	(S1)
Average temperatur	S1	S1
Water availability	(S2)	(S2)
Rainfall (mm)	S2	S2
Oxygen availability	(S2)	(S2)
Drainage	S2	S2
Rooting condition	(S2)	(S2)
Texture	S1	S1
Coarse material (%)	S1	S1
Soil depth (cm)	S2	S2
Nutrient retention	(S3)	(S2)
Base saturation (%)	S3*	S2
pH H_2O	S2*	S1
Organic C (%)	S1	S1
Erosion hazard	(S1)	(S1)
Slope (%)	S1	S1
Flood hazard	(S1)	(S1)
Inundation	S1	S1
Land preparation	(S1)	(S1)
Surface stoniness (%)	S1	S1
Surface outcrops (%	S1	S1

Description: * improvements can be made, land suitability class up one level

Suitability appropriate class marginal land is land that has a severe limiting factor and these factors will affect the productivity, require additional input more than land classified as S2. To overcome the limiting factor on S3 require high capital so that the need for assistance or intervention (investment) government or company. Ritung (2011) reported that the topography of the territory was wavy to hilly and the soil fertility is low to very low (pH sour to very sour, CEC is low, NPK low to very low) the suitability of the land more suitable for annual crops (rubber and palm oil) than food plants / season.

CONCLUSION

Rubber plant land suitability class people of North Bengkulu is quite appropriate (S2) with a temperature limiting factors, availability of water, availability of oxygen, rooting media and nutrient retention. Land suitability classes of rubber plants that suit the farmers' in Seluma was marginal (S3) by a factor limiting nutrient retention. The actual land suitability class rubber plant people of South Bengkulu is appropriate marginal (S3) by a factor limiting of nutrient retention.

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