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Study of Coffee Crops Development in Rantau Pulut Village, Seruyan Regency Central Kalimantan

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ABSTRACT

Coffee is one of Indonesia's most prominent agricultural commodities; various coffee plants are produced with the best results from the west to the east of Indonesia. Indonesia's climate and geographical location are suitable for cultivating the coffee plant. This study aims to determine the level of land suitability and the limiting factors for the development of coffee plants, as well as provide direction/recommendations in the development of coffee plants in Rantau Pulut Village, Seruyan Regency, Central Kalimantan. Land suitability has the potential to be increased from S2 to S1 by managing the limiting factors for the number of dry months and rainfall, SB (Saturated Base), pH, P_2O_5, and K_2O so that the potential land suitability for the study area is S2r. The method used in this study is a qualitative descriptive survey method with a matching system, namely matching land quality/land characteristics with land use requirements for agricultural commodities to be developed. The result of the actual land suitability analysis of Rantau Pulut Village for developing robusta coffee plants is S3fn.

Keywords: Coffee plant, land suitability, rantau pulut region

INTRODUCTION

Coffee is the most traded estate commodity, and in Indonesia, there are various types of the best coffee produced by various regions. Based on the Agricultural Data and Information System Center of the Ministry of Agriculture, national coffee consumption during 2016-2021 is predicted to grow by an average of 8.22 percent per year. In 2021, supply was predicted to reach 795 thousand tons, resulting in a surplus of 425 thousand tons (Nuhdijati et al. 2018). With such a high supply of coffee, Indonesia, as one of the world's largest coffee producers, exports much coffee to foreign countries. There are various types of coffee produced with the best results from the west to the east of Indonesia, and this is because Indonesia's climate and geographical location are suitable for cultivating coffee.

The Seruyan Regional Government's plan to develop coffee plants with local farmer groups needs to be appreciated because it is one of the efforts to improve the people's economy in Seruyan Regency, Rantau Pulut Village, through optimizing the function of abandoned forest lands. It is necessary to strive for efficient and sustainable forest management ecologically, socially, and economically. A more in-depth study is needed regarding the biophysical potential and land area that can be developed. Therefore, in planning, including the selection of commodities, it is better to refer to the suitability of agroecosystems, economics, and social conditions. Regarding land resource potential, the commodities developed following regional conditions are socially acceptable to the community around the forest, and from an economic point of view, they can create employment opportunities and improve the welfare of farmers.

Land resources are part of the landscape that includes the notion of the physical environment, including climate, topography or relief, hydrology, and the state of natural vegetation, all of which have the potential to affect land use (FAO 1976). Land use is a reality that describes human activities on land so that it can change the interests and needs of the community over time. Likewise, enormous pressure on land use and a lack of wisdom in land management (without paying attention to conservation principles) has led to rapid land

degradation, resulting in an increasing number of critical lands. Land management and all its rules must be understood and adhered to. Every land use must always refer to the potential capabilities and suitability of the land.

Land suitability is the conformity of a plot of land for specific uses, which in agriculture it is conformity for certain types of plants to be expanded (Pusat Penelitian dan Pengembangan Tanah dan Agroklimat 2000). The characteristics and quality of the land strongly influence the level of land suitability. Land characteristics are land traits that can be measured or estimated, such as land slope, soil texture, soil drainage, and others. Land quality is a complex land trait (a collection of land characteristics) directly affecting land use. So each land quality has a specific performance that affects its suitability for particular uses. Land qualities can be estimated or measured directly but are generally determined by understanding the characteristics of the land (Sys et al. 1993). Land quality can positively or negatively affect land use, depending on its characteristics. Land quality plays a positive role and is very beneficial for land use. On the other hand, negative land quality can act as an inhibiting factor for using the land in question. In essence, the assessment of land suitability is to match the quality of the land with the requirements of the desired land use. The level of land suitability will be determined by the limiting factor of land quality, which is the most challenging limiting factor. For example, in the land quality rating, the available nutrients are classified into class S1 (very suitable), but the quality of the root media land (adequate depth of soil with symbol r) is classified in the S3 class (marginally suitable), then the land suitability sub-class is classified as sub-class. -class S3r, which means the land in question has a suitability level that is classified as marginal to the limiting factor of the root media (shallow effective depth of soil).

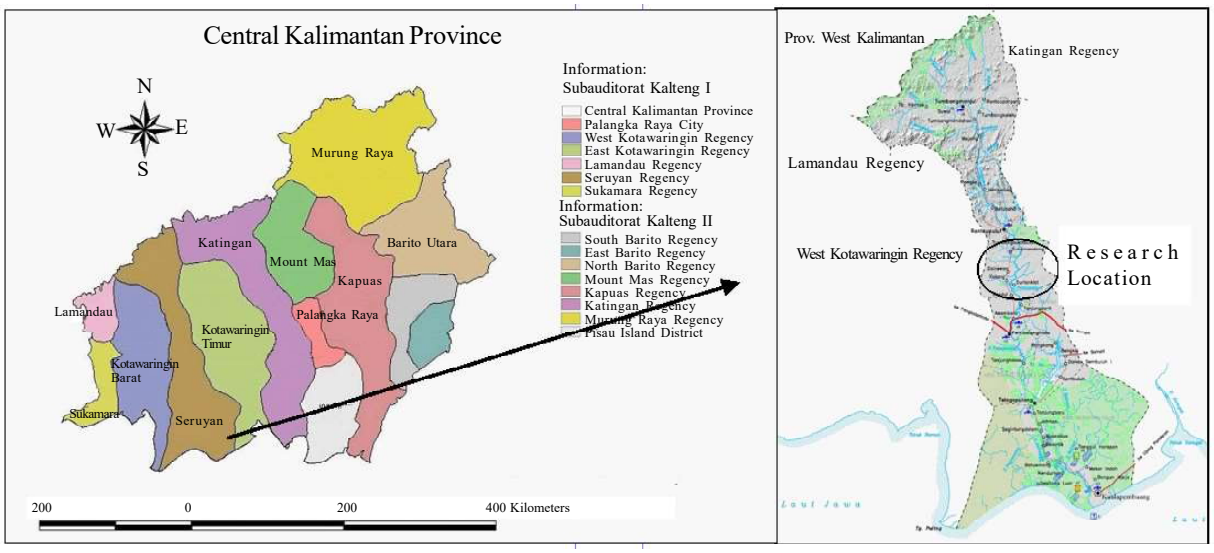
This study aims to determine the level of land suitability and the limiting factors for the development of coffee plants, as well as to provide recommendations for the development of coffee plants in the research area. The results of this study will be beneficial as a basis for reference in planning the expansion of the development of coffee plants in Seriyan Regency, especially Rantau Pulut Village.

MATERIALS AND METHODS

Assessment of land suitability using the minimum law, namely matching the land quality and land characteristics as parameters with land suitability class criteria prepared based on the terms of use or requirements for growing plants or other commodities being evaluated. This classification is based only on the physical potential of the land. This research is a survey research with a qualitative descriptive method.

The materials used for the preparation of the suitable land map are: (i) Semi Detailed Land Level Map 1:50,000 scale, (ii) Land characteristic data, which is used in land evaluation for each soil map unit, (iii) Land suitability criteria document from BBSDLP, (iv) Map of Administrative Boundaries at district/city level from the Central Statistics Agency, (v) Map of Land Use from the National Land Agency, and (vi) results of field surveys.

The sampling method used is purposive sampling based on the type of soil. Soil samples were taken at three locations with uniform land conditions based



(a) (b)

Figure 1. Research area map. (a) Central Kalimantan, (b) Seruyan Regency.

on maps of soil types and their use. The soil profile is made in a natural location (forest) and is not an area of deposition or erosion basin, so it is stated that the soil is the result of the soil formation process. Soil profile 1 (P1) was made at the closest distance to the river, which is about 500 m from the river, at coordinates S 07° 25' 37.9" E 97° 86' 0.22". Soil profile 2 (P2) was made at a distance of about 750 m from the river, at coordinates S 06° 25' 41.4" E 97° 86' 0.61". Soil profile 3 (P3) was made at a distance of about 1000 m from the river, at coordinates S 06° 25' 37.1" E 97° 86' 1.31" (Figure 1).

Observations were made on effective depth, slope, surface rock, rock outcrop, flood hazard, coarse material on the cross-section of the soil, erosion hazard, temperature, average annual rainfall,

Table 1. Suitability of robusta, arabica, and liberica coffee.

Land Characteristics	Suitability Class			N
	S1	S2	S3	
c-climate				
-Annual rainfall (mm)	1.500-2.000	1.250 2.000-2.500	1.250 2.500-3.000	< 1.000 > 3.000
- Long Dry Months (<60 mm bl^{-1})	2-3	3-4	4-5 1-2	> 5 < 1
t-Elevation (m dpl)				
- Robusta	300-500	500-600 100-300	600-700 0-100	> 700
- Arabica	1.000-1.500	850-1.000 1.500-1.750	650-850 1.750-2.000	< 650 > 2.000
- Liberica	300-500	600-800 0-300	8800-1000	> 1000
s-slope (%)	0-8	8-25	25-45	> 45
r-Soil physical properties				
- effective depth (cm)	> 150	100-150	60-100	< 60
- Texture	Sandy Loam; Loamy clay; Dusty Clay; Dusty Clay	Loamy Sand; Sandy clay; Dusty Clay	Clay	*Sandy* *Heavy clay*
- Percentage of rock on the surface (%)	-	0-3	3-15	> 15
d-Puddle	-	-	1-7 days	> 7 days
- Drainage Class	Well drained	Moderately well drained	Somewhat poorly drained Poorly drained Somewhat poorly drained	*Poorly drained* *Very poorly drained*
n-Soil chemical properties (0-30 cm)				
- pH	5.5-6	6.1-7.0 5.0-5.4	7.1-8.0 4.0-4.9	> 8.0 < 4.0
- C-Organic (%)	2-5	1-2 5-10	0.5-1 10-15	< 0.5 > 15
- CEC (me 100 g^{-1})	> 15	10-15	5-10	< 5
- BS (Base Saturation) (%)	> 35	20-35	< 20	-
- N (%)	> 0.21	0.1-0.2	< 0.1	-
- P_2O_5 available (ppm)	> 16	10-15	< 10	-
- Kdd (me %)	> 0.3	0.1-0.3	< 0.1	-
x-Tokxicity				
- Salinity (mm hos cm^{-1})	< 1	1-3	3-4	> 4
- Saturation	< 5	5-20	20-60	> 60

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length of the dry season, and current and future land management. Soil analysis includes texture, permeability, cation exchange capacity (CEC), base saturation (BS), pH-H_2O, Organic-C, Total-N, P_2O_5, K_2O, and Al saturation.

The land evaluation system used and continues to be developed at the Center for Research and Development of Agricultural Land Resources (BBSDLP) uses a matching system, namely matching land quality or land characteristics with land use requirements for agricultural commodities to be developed (Wahyunto et al. 2016). The land is classified into Highly Suitable (S1), Medium Suitable (S2), Marginally suitable (S3), and Not Suitable (N). The criteria for land suitability research for Robusta coffee plants follow the technical guidelines for land

Table 2. Land suitability assessment of Robusta coffee.

Land characteristics	value/worth	Actual Suitabaillty Class	Repair	Potential Suitability Class
Temperature (t)		S1		S1
Annual average (°C)	25-33	S1		S1
Water availability (w)		S2		S1
Dry month (<75 mm)	> 3-5 month	S2	irrigation (Medium, High)	S1
Rainfall/year (mm)	2000-3000	S2	irrigation (Medium, High)	S1
Root media (r)		S2		S2
Soil drainage	Medium	S1		S1
Texture	C, CSi, LCS, LCSi, LC	S2		S2
Effective depth(cm)	>100	S1		S1
(f)		S3		S1
Soil CEC (me/100 g)	40,52	S1		S1
Base Saturation (BS) (%)	14,23	S3	Fertilization	S1
Soil pH	4,77	S3	liming (high)	S1
C-organic (%)	1,30	S2	Giving organic material	S1
Toxicity (x)				
Saturation Al (%)	5,43	S2	Liming	S1
Nutrient available (n)		S3		S1
Total N	0,14	S2	Fertilization N	S1
P_2O_5	2,38	S3	Fertilization P (high)	S1
K_2O	3,14	S3	Fertilization K (high)	S1
Ease of processing (p)	a	S1		S1
Surface rock (%)	0	S1		S1
Rock outcrop (%)	0	S1		S1
Consistency	Quite sticky			
Erosion hazard level (e)		S1		S1
Erosion hazard	SR	S1		S1
Slope (%)	0-3	S1		S1
Flood hazard (b)	F0	S1		S1
Land suitability class		S3(fn)		S2(r)

description: S1 = highly suitable S2 = medium suitable S3 = marginally suitable

evaluation for agricultural commodities (Djaenudin et al. 2011; Supriadi et al. 2012), namely climatic, topographic, hydrological, and soil factors. The land suitability framework is determined as follows: Class S1, highly suitable: the land has no significant or significant limiting factor to sustainable use. Class S2, medium suitable: land has limiting factors that can affect its productivity and require relatively light inputs, which farmers can usually overcome. Class S3, marginally suitable: land has a weight limiting factor affecting productivity. It requires additional input that is more, requires high capital, so there needs to be government or private intervention. Class N, not suitable: the land is not suitable because it has a weighty limiting factor or is challenging to overcome. Table 1 shows the demand for Robusta, Arabica, and Liberica coffee fields.

RESULTS AND DISCUSSION

Overview of Study Area

Rantau Pulut Village, Central Seruyan District, Seruyan Regency, Central Kalimantan. This village is eight hours away from the district capital by motorbike. The livelihoods of residents are generally farmers. There are about 150 ha of critical land and 500 ha of abandoned land. Some of the lands in this village are cultivated as oil palm plantations. The research area is located along the Seruyan River as far as 7 km with a width of 1 km from the river and separated some distance from residential areas. It takes about 15 minutes by boat to reach this place. The research area used to be a coffee plantation which was then abandoned by the community, so it became an abandoned land (bush forest). The local government, in this case, the head of the Seruyan region, plans to re-pilot the area into a productive coffee plantation.

The soil morphology observations and laboratory analysis results showed that the soil in the study area was classified as a podzolic soil type. This soil is formed due to high rainfall, so alkaline washing occurs. The soil reacts acidly, and the A horizon is thin. There is an accumulation of clay in the B horizon (Bt), there is a clay film, and the base saturation is <35% and has a yellowish or reddish color. Oxidized lumps of iron and aluminum cause yellow and red colors. Silicates dominate the clay minerals found in this soil. The color of this podzolic soil indicates a relatively low soil fertility level due to leaching. Figure 2 is the actual condition of the evaluated land.

Land Suitability Study Results

Analysis of the data used is the method of comparing (Matching) the characteristics of the land with the conditions for plant growth. The results of the comparison (matching) will then be classified into highly suitable (S1), Medium Suitable (S2), marginally suitable (S3), and not suitable (N), with the lowest value as a limiting factor for land suitability evaluation. The limiting factors in question are

Figure 2. Actual condition of the study area.

temperature (tc), water availability (wa), oxygen availability (oa), root media (rc), and nutrient availability (nr) which consists of cation exchange capacity (nr-1), base saturation (nr-2), pH H_2O (nr-3), C-organic (nr-4), erosion hazard (eh) and land preparation (lp). The results of the evaluation of the land suitability of coffee plantations are presented in Table 2.

Land quality/characteristics that are limiting factors for nutrient retention (pH and KB) and available nutrients (phosphorus and potassium). The limiting factor can be increased to S2 (Medium Suitable) even to the S1 level (highly suitable) because the limiting factor can be managed to overcome with a moderate to high management level. Qualitative analysis (in the field) and quantitative (in the laboratory), as well as climate data, show that the land suitability class of the research area for developing robusta coffee is in the actual land suitability class S3(fn) (Table 2) so that this study area is a potential land suitability class after improvement to S2(r) with a limiting factor of soil texture that cannot be repaired.

Soil characteristics essential for coffee cultivation include the physical and chemical characteristics of the soil. The physical characteristic of the soil is related to the level of soil friability which is influenced by the organic matter content of the soil directly or indirectly. It will significantly affect the aeration and moisture conditions of the soil and the availability and absorption of nutrients by plant roots. At the same time, the chemical characteristic of the soil includes the soil's acidity level, cation exchange capacity, and the content of macro and micronutrients (Saidi and Suryani 2021). Efforts to improve the limiting factors of nutrient retention and nutrient availability can be carried out by periodically applying urea and TSP/SP-36, liming, and adding organic matter (ameliorant). The accuracy of the dosage of fertilizer and the time of fertilizer application to coffee plants will affect the growth of coffee plants, which causes coffee plant production to be optimal. Giving Nitrogen (Urea) in the correct dose and time will significantly affect plant growth in terms of morphology and production (Djamaan 2006).

Apart from improving soil pH, Dermawan et al. (2018) said that organic matter could also increase soil aggression and make the soil structure easy to cultivate. Besides increasing the availability of nutrients, adding organic matter can also act as a soil ameliorant (improver) that helps to overcome problems in the study area, which contains much clay, which causes hampered soil drainage, as well as soil aeration. Giving organic matter will make the soil looser so air and water circulation can occur properly. Organic matter is also a food source for soil microorganisms which play many roles in various chemical or biochemical reactions in the soil. Organic matter can also increase soil cation exchange capacity (KPK) and reduce Al activity so that the fixation of nutrients, especially P, can be reduced.

In addition to organic matter, lime also plays a vital role in increasing soil pH. According to Mariana (2012), in the results of her research that in order to increase acidic pH (4.5–5.5) to slightly acidic (5.5–6.5), 2,883.60 kg ha^{-1} of $CaCO_3$ lime is needed on soils that are finely textured. The increase in soil pH causes many microorganisms to develop appropriately, as well as the growth of coffee plants, but coffee plants are not suitable for soil pH, which has a pH > 7. In addition to inorganic fertilizers, organic fertilizers such as compost are also necessary because, in addition to providing complete nutrients, compost can also improve the soil's physical, chemical, and biological characteristics. According to (Utomo et al. 2016), the high pH of H_2O can be lowered by administering sulfur. Sulfur oxidation will produce H^+; the higher the H^+ level in the soil, the soil pH will become acidic.

Another limiting factor that is no less important needs attention in order to obtain optimal results, namely, the number of dry months, which is more than three months, and the rainfall is 2000-3000 (Seruyan 2019) because the rainfall requirements needed for Robusta and Arabica coffee are the same, namely ranges from 1,250 – 2,500 mm $year^{-1}$ (Balittri 2017). According to Kandari et al. (2013), coffee plants require a slightly dry period of 3 months to form flower primordia, flora, and pollination. So it is necessary to make an irrigation system (irrigation) that can take advantage of the flow of water from the Seruyan River. Rainfall improvements can be made with efforts to improve irrigation systems with moderate to high levels of management (Hardjowigeno and Widiatmaka 2007). In addition, according to local sources, this area has experienced flooding from the overflow of the Seruyan River, so it needs to be anticipated by making irrigation that can regulate the inflow and outflow of water when needed. In addition to doing greenery in the upstream area, this also aims to ensure that in the dry season (dry), river water is also available in sufficient quantities and helps maintain or reduce temperatures so that coffee plants can develop properly.

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