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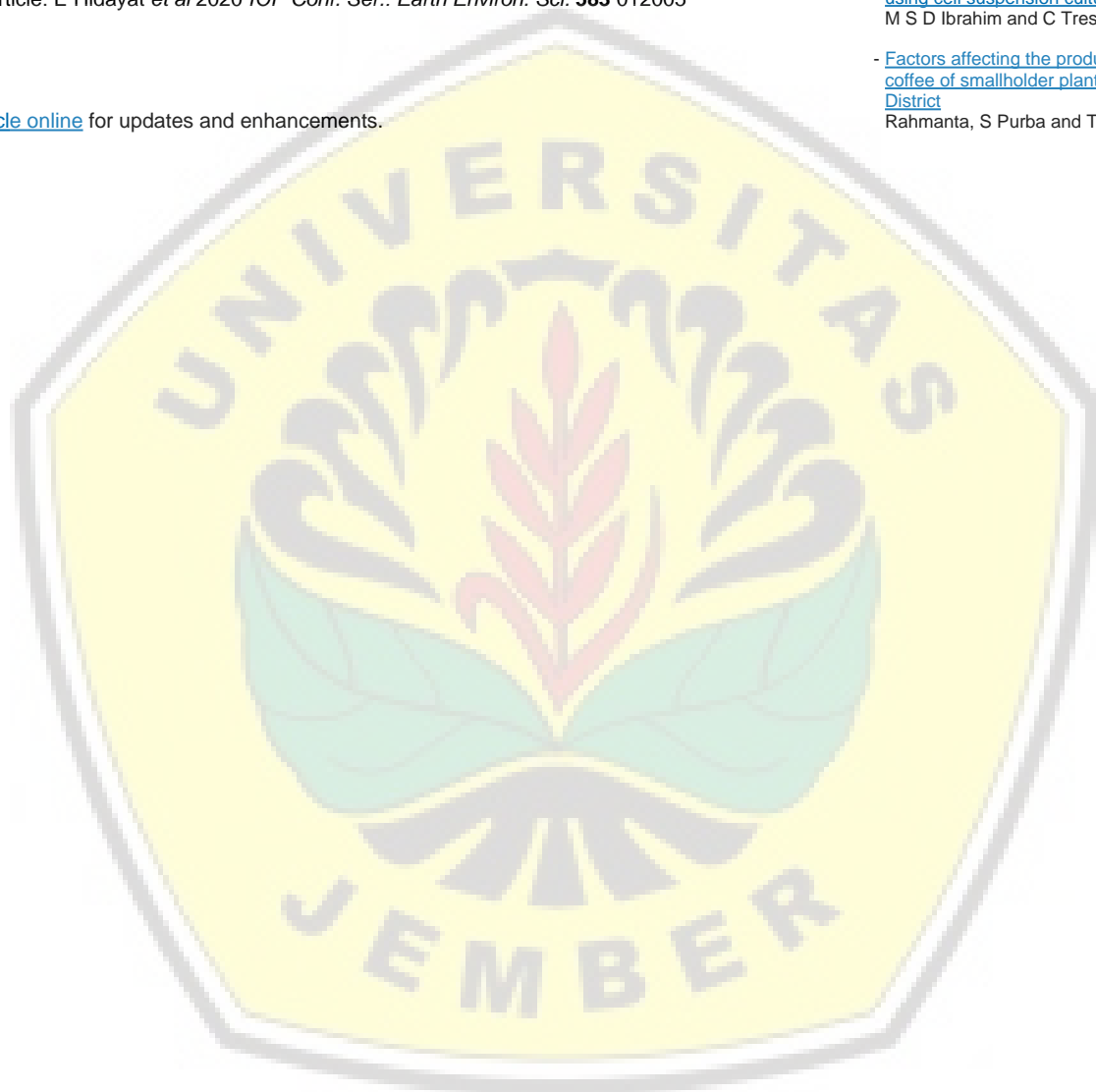
Land suitability evaluation of arabica coffee (*Coffea Arabica* L) plantation in Subdistrict Aie Dingin, Lembah Gumanti, Indonesia

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Land suitability evaluation of arabica coffee (*Coffea Arabica* L) plantation in Subdistrict Aie Dingin, Lembah Gumanti, Indonesia

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Abstract. Coffee production in Aie Dingin was relatively low (450/kg/ha/year), therefore, it is needed to know the problem of the coffee plantation there. The research was aimed to study land suitability class for arabica coffee crop and to analyze the correlation between productivity of arabica coffee plantation and land suitability evaluation in Aie Dingin, Lembah Gumanti. This study used matching method with composited sampling at 3 depths (0 – 20 cm, 20 – 40 cm, and 40 – 60 cm) for 12 sampling points from 6 out of 10 available units of land in the area. Therefore, the total samples taken were 36 soil samplings. The research was conducted in field and laboratory. Field research involved, physical analysis of land such as slope, erosion class. Laboratory analyzed consisted of: 1) cation exchange capacity 2) organic carbon, and 3) pH. The data resulted showed that coffee crop was potential to be planted in the research location, but there were difficult restrict factors especially slope level >30% and of rainfall amount. The alternative way to control land degradation in this research location is by planting protecting crops.

Keywords: land suitability evaluation, arabica coffee, plantation, Solok

1. Introduction

Indonesian is area of natural resources, so it can provide business opportunities for the development of agricultural business, and plantation crops. One of the crops cultivated by farmers is the coffee plant [1]. The most of arabica coffee is consumed much more than robusta coffee. This habit affects the share of the world coffee market especially in Indonesia that is dominated by robusta type [2]. One way for improving arabica coffee production is by expanding the planting land. The development of coffee planting land is not detached from the effort to find new land. Thus conducted the evaluation of land. The purpose is to know the potential or land value. Evaluation is not limited only to the assessment of environmental characteristics, but it can also include economic analysis, social consequences, and the impact of environment [3].

The development of arabica coffee in West Sumatera is very good, especially in Aie Dingin which



has elevation which range between of 1200 to 2300 m above sea level with temperature between from 18⁰C to 20⁰C. When compared with according to [4] that Aie dingin is suitable for cultivate of arabica coffee. Production of coffee beans in Aie Dingin only 450 kg/ha/year. As mentioned by [2], the production of coffee beans arabica coffee can reach 1.8 ton/ha/year. This is due to land use does not follow the rules of soil conservation, coffee cultivation technology was not yet optimally, the condition of the field is poorly maintained coffee and fertilizer use is not enough. It takes careful and precise planning to make land development decisions that correspond to the criteria of arabica coffee so that the results/production are optimal. This study aimed to classify and to know the potential of lands for arabica coffee crops.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Subdistrict Aie Dingin, Lembah Gumanti. The geographical coordinate of the area is between 100⁰44'0"-100⁰54'30" E and 01⁰5'31"-01⁰02'00" S (Figure 1).

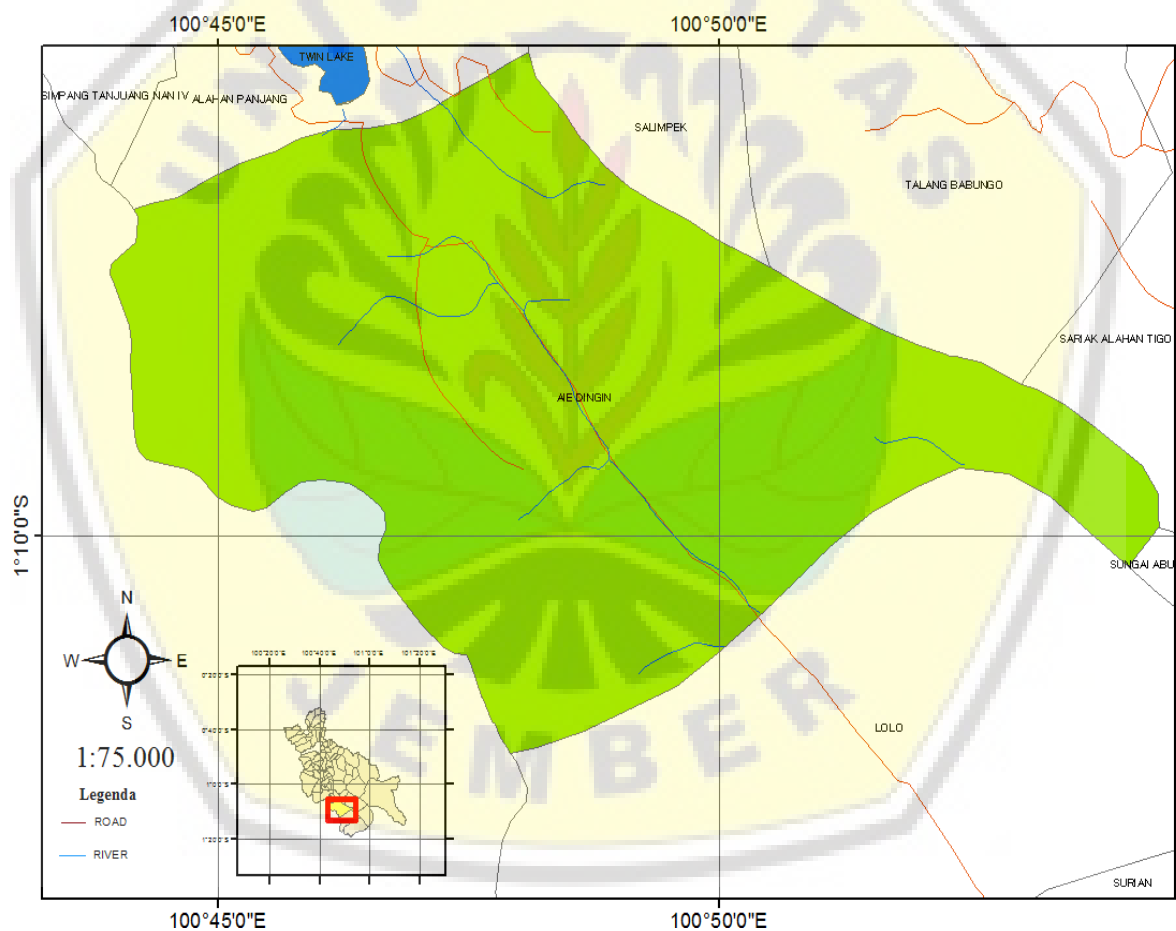


Figure 1. The location map of study area

Elevations which between range from 1.100 to 2.200 m above sea level, daily temperatures from 12 – 30⁰C and annual rainfall data 2333.70 mm/year were averaged from 2006 to 2015 [5]. If compired according to [4] that rainfall in the research area included S3 (marginal suitable). The main crops in Aie Dingin has include arabica coffee and horticultura.

2.2 Data slope and soil samples

The digital elevation model (DEM) dataset with 30 x 30 m resolution of the study area were obtained from the Geographic Information System Center of Solok Regency. Slope data were obtained from the SRTM (Shuttle Radar Topography Mission) by using ArcGIS 10.2.1. (Figure 2)

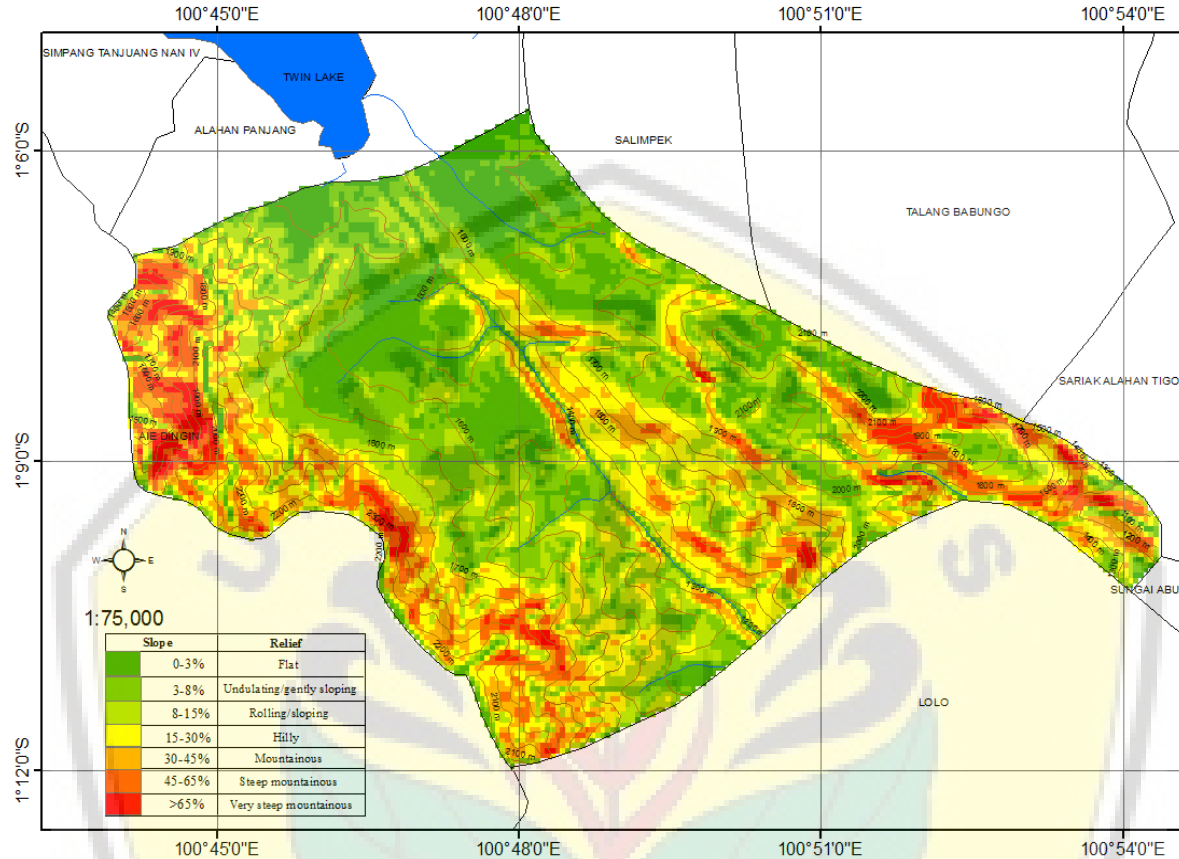


Figure 2. The location map of slope

The methods were used by composited sampling at depths 0 - 20 cm, 20 – 40 cm and 40 – 60 cm for 12 sampling points from 6 out of 10 available units of land in the area. Therefore, the total samples taken were 36 soil samplings were collected from the study area. The Overlay results on the analysis of land suitability were obtained 10 units of land. The analyzed land units are 1, 2, 3, 4, 5, and 6. While land units 7, 8, 9, and 10 didn't conducted analysis because the location on the roadside and the river does not allow to growth of arabica coffee (Figure 3). The soil samples were air dried and grounded to pass through 0.5-mm sieve before laboratory testing.

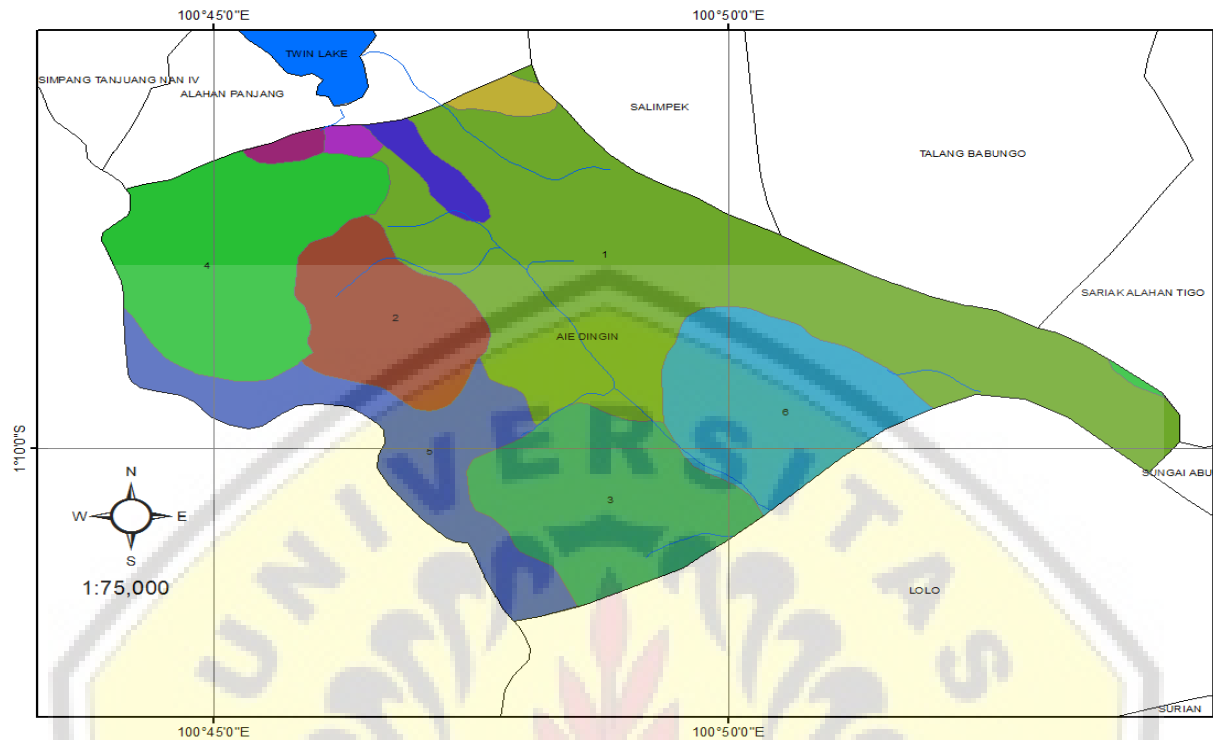


Figure 3. The location map of soil sampling

2.3 Physico-chemical properties soil samples

The physical and chemical analysis include: the pH was measured using by digital pH [7], the cation exchange capacity by methode Amonium Asetat 1 N [8], and organic matter (OM) by methode Walkley and Black [9].

2.4. Assesment and Interpretation data

The evaluation procedure was based on [4], that land will be classified into one of the suitability class i.e highly suitable (S1), moderately suitable (S2), marginally suitable (S3), and not suitable (NS).

Table 1. Land characteristic of arabica coffee

Land Characteristic	S1	S2	S3	NS
Temperature (⁰ C) (tc)	16-22	22-24	24-26	>26
Rain fall (mm) (wa)	1200	1200- 2000	2000- 3000	>3000
pH (nr1)	5.6-6.6	6.6-7.3	<5.5, >7.4	>7.4
Organic matter (%) (nr2)	>1.2	0.8-1.2	<0.8	
Slope (%) (eh)	<8	8-16	16-30	>30

The matching process is where the values of each land characteristic are compared with the requirement for each land characteristic (Table 1). If the value is within the range accepted by the land characteristic, then will be classified within the relevant suitability class.

Determining the current of suitability of each unit of land in this study were determined by using a method of matching between the quality of the land and the condition of growing plants without any improvement to the factors limiting. The potential of suitability were determined by considering the

input and management measures given to each unit of land, assuming after the efforts of repairs to the restrictions factors, then conducted of the matching with the requisite of growing agricultural crops (Figure 4).

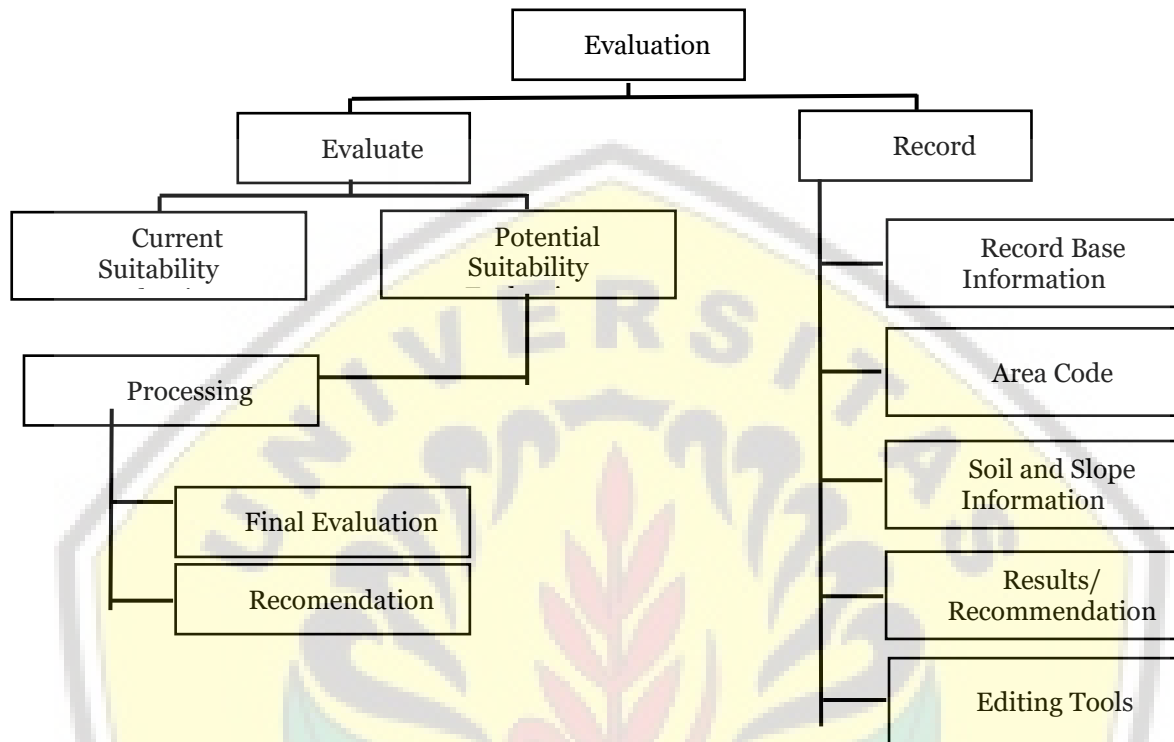


Figure 4. Evaluation process and record information in suitability evaluation from

3. Results and Discussion

3.1 Slope

The slope of the land greatly affects to the speed and volume of water runoff. The steeper a slope then the surface flow speed is greater, thereby that the less water is infiltration into the ground, consequently the volume of flow surfaces is greater. As shown in Table 2. Soil sampling is incorporated into the criteria of land suitability for arabica coffee crops according to [4]. The land of slope < 8% is included in the S1 (highly suitable), 8-16% included S2 (moderately suitable), 16-30% included S3 (marginally suitable) and >30 % included NS (not suitable).

Tabel 2. The class of land subdistrict Aie Dingin, Lembah Gumanti.

	Slope	Relief	Area (ha)
A	0-3 %	Flat	654,61
B	3-8 %	Undulating/gently sloping	1103,61
C	8-15 %	Rolling/sloping	2399,10
D	15-30 %	Hilly	2610,87
E	30-45 %	Mountainous	1788,82
F	45-65 %	Steep mountainous	1472,51
G	>65 %	Very steep mountainous	1089,33
		Total	11.118,85

3.2 Soil

Based on the map of land unit and land sheet Painan [6], soil type at the research a scale of 1:250,000 and were digitized into a scale of 1:75,000. The type of order found in the field is the *Inceptisol*. As mentioned by [10], Inceptisol order is evolved from frozen rock, sediment and metamorphic. This is because Inceptisol is a newly developed soil and usually has a variety of textures from rough to smooth depending on the weathering level of its parent materials.

3.3 Temperature

Temperature is an important climate factor in influencing the growth and development of coffee plants. Arabica coffee can produce well in the highlands that are ideal which range from 15°C to 24°C. To measure the temperature of the field was measured using by Amprobe TH-1. The temperature in Aie dingin which range from 18° to 20°C if compared with agricultural research and development (2016), that the temperature of the research area included of S1 (Highly suitable).

3.4 Land suitability of arabica coffee

The method is used by method of comparison (matching). As mentioned by [11], the matching method is comparing of the land suitability class based on the lowest of limiting factor in the evaluation of land suitability in research area. The quality of the land is arranged in order to start the best (the lowest of limiting). The lowest of limiting factor for the best class and the biggest limiting factor for the poor class.

Table 3. Characteristic land of arabica coffee

Land Characteristic	1	2	3	4	5	6
Temperature (°C) (tc)	20	20	18	20	19	19
Rain fall (mm) (wa)	2333,70	2333,70	2333,70	2333,70	2333,70	2333,70
pH (nr1)	5,03	5,05	6,34	6,77	6,19	6,65
Organic Matter (%) (nr2)	0,48	0,59	0,81	0,24	0,21	0,54
Slope (%) (eh)	16-50	>50	>50	>50	16-50	>50

Each quality of the land has a performance that affects suitability for land. The quality of land there is can be measured directly in the field, but is generally determined by land characteristics [12]. Land characteristics that can be measured or estimated. Examples such as slopes, rainfall, soil textures.

3.4.1 Land of current suitability arabica coffee

Current suitability class are determining the suitability of present condition without improvements which is resulted from the assessment of land quality [18]. The limiting factor in land evaluation can be divided into two factors i.e limiting permanent factors and limiting nonpermanent factors. Limiting permanent factor cannot be improved except using high technology. The technologies to solve the limiting factor are grouped in low, medium and high technologies. High technology is expensive and can only be applied by government, medium and large companies [11]. And limiting nonpermanent factors can be improved to give economic advantages.

From the results of the analysis conducted to assess the actual land-suitability class as shown in (table 4). 6 units include not suitable (N) and marginal suitable (S3). As shown in (table 4), land suitability 1 and 4 has limitation is the availability of water, this is indicated that the characteristics rainfall is very high, pH and organic matter were low. As mentioned by [4], that arabica coffee can be grow well which rainfall range from 1200 to 1800 mm/year. In the class of land suitability 2, 3, 5, and 6 have a very limitation factor are the danger of erosion with the slope > 50%. Arabica coffee can be

growing well at slope < 8% [4]. To improve land of current suitability to land of potential suitability needs some improvement on quality land. In each unit of land class has different levels of land quality to improvement depending on the level of land characteristics.

Table 4. Current suitability of arabica coffee

Land Characteristic	1	2	3	4	5	6
Temperature (⁰ C) (Tc)	S1	S1	S1	S1	S1	S1
Rain fall (mm) (wa)	S3	S3	S3	S3	S3	S3
pH (nr1)	S3	S3	S3	S1	S1	S2
Organic Matter (%) (nr2)	S3	S3	S3	S3	S3	S3
Slope (%) (Eh)	S3	N	N	S3	N	N
Class of Land Suitability	S3	N	N	S3	N	N
Sub-class of land suitability	S3wa.nr1.nr2 .eh	N.eh	N.eh	S3wa.nr2. eh	N.eh	N.eh

3.4.2 Land of potential suitability arabica coffee

Potential suitability class show suitability in the future after improvement application based on the limiting factors [11]. Land of potential suitability is determined by considering input and management in given to each land unit, and then comparing with requisite of growing arabica coffee. As shown in (table 5), it has been efforts to improve of land characteristics.

As shown in (table 4) there are the pH value was suitable and not suitable according to [4]. The low of pH value can be improved by lime. As mentioned by [14] that giving lime on the soil have effect of physics, chemistry, and biology. Physics effect is increasing the granulation on decomposition of organic matter and the synthesis of humus. Chemical effect, that is by adding lime will increase the pH value to suitable. Where the concentration of ion H⁺ will decrease, the concentration of ion OH⁻ will increase. The high of pH value can be added of organic matter into the soil because organic matter will be soluble in the soil and improve the value of cation exchange capacity [15]. The problem of limiting factors such as organic matter can be conducted with the addition of organic materials into the soil to increase soil carbon for improving properties of soil such as physical, chemical and biological. As mentioned by [20], that the addition of organic materials into the soil is more powerful influence towards improving the properties of the soil and gives to all the elements needed plant in a relatively balanced comparison, although the degree is very small.

Table 5. Potential suitability of arabica coffee

Land Characteristic	1	2	3	4	5	6
Temperature (⁰ C) (Tc)	S1	S1	S1	S1	S1	S1
Rain fall (mm) (Wa)	S3	S3	S3	S3	S3	S3
pH (Nr1)	S1	S1	S1	S1	S1	S1
Organic matter (%) (Nr2)	S1	S1	S1	S1	S1	S1
Slope (%) (Eh)	S1	N	N	S1	N	N
Class of land suitability	S3	S3	S3	S3	S3	S3
Sub-class of land suitability	S3wa	N.eh	N.eh	S3wa	S3wa	N.eh

As mentioned by [16] for decrease slope level can be conducted with two kinds of plant or more by random between the main of crops and protecting crops. This model can be applied to the land at slope 15-40%. Protecting crops using grass plant. Advantage of grass plant is can be use as animal feed and not causing competition on absorption nutrients between the main of crops and protecting crops [17].

Conclusion

This study aimed to classify and to know the potential of lands for arabica coffee crops. Aie dingin has a limiting factor is the availability of water, this is indicated that rainfall is very heavy, pH and organic matter is low and slope >30%. For class of land potential suitability included marginal suitable (S3) and not suitable (NS) has a limiting factor rainfall and slope. For decrease slope level can be conducted with two kinds of plant or more by random between the main of crops and protecting crops.

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