



## **Evaluation of Land Suitability for Liberika Coffee-Based Agroforestry Development in Kedabu Rapat Village, Meranti Islands Regency**

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### **ABSTRACT**

The land evaluation compares soil, vegetation, and climate data with certain usage requirements. This study aims to identify land characteristics, evaluate the level of land suitability, and develop an appropriate Liberika coffee-based agroforestry combination pattern for improving the community's economy in Kedabu Rapat Village. The study used a survey method and soil sampling by transect with 1-kilometer intervals proportionally. Data analysis is conducted by scoring and matching land characteristics and quality data with plant growth requirements using ArcGIS 10.2 software. The results showed that the average annual rainfall is 1,200-2,400 mm/year, the temperature is between 25°C - 32°C, the topography is flat with a slope classification (<3%), the soil types are Organosol and Gleihumus, the flood hazard from none to moderate and the level of landslides and erosion danger is very light or not prone. The level of land suitability for Liberika coffee-based agroforestry with shade in the form of Coconut, Areca nut, and Gerunggung plants is very suitable (S1), covering an area of ± 848.64 ha (34.78%), suitable category (S2) covering an area of ± 584.54 ha (23, 96%), marginally suitable category (S3) covering ± 521.78 ha (21.38%), and unsuitable category (N) covering ± 380.42 ha (15.59%) while the residential area of ± 104.61 ha (4.29%). The combination pattern of Liberika coffee-based agroforestry plants with coconut, Pinang, and Geronggang shade plants in Kedabu Rapat Village is a combination pattern 1 (border tree planting/trees along the border) and a combination pattern 2 (alley cropping) where Liberika Coffee plants are planted at a distance of 2.5 x 2.5 m, Coconut spacing 10 x 10 m, Areca spacing 2.5 x 2.5 m and Geronggang spacing 5 x 5 m.

**Keywords:** *Land evaluation, land characteristic, agroforestry, Liberica Coffee, Kedabu Village*

## 1. INTRODUCTION

In Riau Province, the plantation sector continues to grow every year, and the plantation sector development has an important meaning in agricultural development, both on a regional and national scale. Currently, one of the plantation commodities that is being intensively developed in Riau Province, especially in Kedabu Rapat Village, Meranti Islands Regency, is Liberika Coffee.

Based on the initial information received from Kedabu Rapat Village, farmers are the ones who utilize peatlands with a simple agroforestry system. The opportunities to develop the Liberika coffee plantation are still very wide open, parallel to the rise of the national coffee industry.

Al Amin, the Secretary of the Community Organization for Liberika Rangsang Meranti Coffee (MPKLRM), said that the sales of Liberika Rangsang Meranti Coffee had penetrated the Malaysian market since 1980, and the Malaysian market accommodated as much as 90 percent of Liberika Meranti coffee. Only 10 percent penetrated the local market. In 2018, the export of Meranti's Liberika coffee to Malaysia reached 71 tons in the form of green beans, equivalent to 800 tons of fresh fruit. However, the current crop yields are declining, so in 2019 sales were only 45 tons. Currently, the Liberika Coffee plantation area is only  $\pm$  775 hectares (Sutrisno, 2015), so it is necessary to develop coffee plantations to meet market demand from abroad.

Land evaluation is an approach or way to assess the land resources' potential. The land evaluation results will provide the necessary land usage information and direction. Eventually, the expected value is the production that is likely to be obtained. Land suitability evaluation estimates land suitability classes for certain uses, both for agriculture and non-agriculture (Hartono et al. 2018). The land suitability class of an area for agricultural development is basically determined by the match between the environment's physical properties, including climate, soil, terrain including slopes, topography, relief, rocks on the surface, and in the cross-section of the

soil and rock outcrops, hydrology, and land use requirements or requirements for plant growth (Djaenudin et al., 2011).

Agroforestry is a forest plant management system (perennial) combined with agriculture, also known as an agroforestry system (Hairiah et al., 2013). In addition to the economic function as one of the main objectives, agroforestry also plays a role in maintaining hydrological functions through the process of rainwater interception, reducing the impact of rainwater, water infiltration, and water absorption and landscape drainage (Mawardhi et al., 2019). Kedabu Rapat Village is currently prone to abrasion, which causes seawater intrusion into the mainland, resulting in higher salinity levels of underground water in Kedabu Rapat Village, reduced agricultural land, inappropriate planting locations, inappropriate planting patterns, and some communities that are not yet interested in cultivating Liberika Coffee. In order to use the existing land in Kedabu Rapat Village according to its designation, it is necessary to evaluate the land. Land evaluation is an approach to assessing the land resources' potential by emphasizing limiting factors, advantages, and disadvantages in practical land use in agriculture, plantation, forestry, animal husbandry, engineering, and others.

Considering that Liberika Rangsang Meranti Coffee already has a good reputation in the domestic and international markets, the people in Kedabu Rapat Village who are members of the community Cares for Liberika Rangsang Meranti Coffee (MPKLRM) are determined to maintain the prime quality of Liberika Rangsang Meranti Coffee so that the demand keeps on increasing. Furthermore, it will improve the living standard of Liberika coffee farmers in the Meranti Islands Regency. In addition, considering that the Liberika coffee plantation is planted on land in Kedabu Rapat Village, Rangsang Pesisir District, it is necessary to evaluate the land's suitability evaluation and then see how the physical and chemical properties of the soil are and what are the prospects for agroforestry development to improve the community's economy. Based on the

discussion above, research on "Evaluation of Land Suitability for Development of Liberica Coffee-Based Agroforestry in Kedabu Rapat Village, Meranti Islands Regency" is interesting to do.

This study aims to identify land characteristics, evaluate land suitability and determine the appropriate combination pattern of Liberika coffee-based agroforestry plants in Kedabu Rapat Village.

## 2. MATERIAL AND METHOD

### 2.1. Research Site

This research was conducted on land in Kedabu Rapat Village, Rangsang Pesisir District, Meranti Islands Regency. This research was carried out for 3 (three) months, from September 2019 to November 2019.

### 2.2. Equipment and Materials

The tools used are GPS, soil drill, meter, machete, sample plastic, sample ring, stationery, chest board, camera, pH meter, EC meter, and Arcgis 10.2 software.

The materials used are community plantation land in Kedabu Rapat Village, Map of Administrative Boundaries of Kedabu Rapat Village, Indonesian Map, Slope Map, Land Usage Map, Land Cover Map, Soil Type Map, Peat Depth Map, Sentinel-2 Satellite Imagery and rainfall data

### 2.3. Population and Observation Sample

This study's population includes plantation land and farmers in Kedabu Rapat Village, which are land units.

The observation samples in this study are agricultural land in Kedabu Rapat Village.

### 2.4. Research Method

The method used in this study is a survey method, taking soil samples with transect lines at 1-kilometer intervals proportionally to obtain soil characteristics data. Soil samples taken in the field were put into plastic samples, and then the soil samples were taken to the Soil Laboratory, Faculty of Agriculture, Riau University, for analyzing the soil's physical and chemical properties.

### 2.5. Data Collection Technique

Observation is a data collection technique not limited to people but also other natural objects (Sugiyono, 2018).

Research location observation, including the characteristics and quality of land that can be observed directly in the field in the form of soil texture and structure, peat depth, root depth, groundwater level, soil and water pH, as well as soil and water EC and then need to be tested in the laboratory as research data.

Interviews were conducted with the Head of Kedabu Rapat Village, Community Council at Kedabu Rapat Village, Head of KTH Liberika Coffee, and Liberika Coffee Farmers at Kedabu Rapat Village.

Soil analysis was carried out at the Soil Laboratory of the Faculty of Agriculture, Riau University, to determine the parameters in the form of C-organic data (%), CEC (me/100/gr soil), KB (%), N-total and available P2O2. Furthermore, laboratory results are analyzed following the Interpretation of Data from Analysis of Soil, Plants, and Fertilizers (Sri Rochayati, 2018).

### 2.6. Data Analysis

Scoring is also called a scale score, which results from a measurement in numeric (quantitative) data, where the interpretation of the score is normative, and the relative position corresponds to predetermined limits (Saidah *et al.*, 2015, Kunarso and Herdiana, 2017).

The scoring analysis technique was used to assign interval class values to 8 characteristic land parameters: rainfall, flood susceptibility, landslide and erosion susceptibility, peat depth, soil pH, C-Organic, and Cation Exchange Capacity (CEC), and Base Saturation (KB), which is calculated based on the data range and interval width.

The following formula calculates the data range and interval width:

$$R = x_t - x_r$$

$$i = \frac{R}{N}$$

Dimana :

R = Data Ranges

i = Interval width

$x_t$  = Largest Data

$x_r$  = Smallest Data

The value of the land suitability interval class is presented in Table 1.

Table 1. Interval Class

No	Value Interval /score	Level of Land Suitability
1	29 - 35	S1 (Strongly Suitable)
2	22 - 28	S2 (Suitable)
3	15 - 21	S3 (marginally suitable)
4	8 - 14	N (Unsuitable)

Source: Saidah, *et al.*, (2015); Sugiyono, (2016); Kunarso and Herdiana, (2017); Calculation result, (2020).

Then, matching the results of scoring eight parameters of land characteristics with the requirements for growing Liberika Coffee, Coconut, Pinang, and Geronggang plants using the "Intersect" application on ArcGIS 10.2 software in stages.

Data analysis by scoring and matching data on characteristics and quality of land with plant growth requirements will produce land suitability classes (Ritung, 2007).

Land suitability class for developing Liberika coffee-based agroforestry with shade plants in the form of Coconut, Areca, and Geronggang in Kedabu Rapat Village is the result of overlaying, matching, and intersecting with Liberika Coffee land suitability class with Coconut land suitability class, Areca, and Geronggang land suitability class.

### 3. RESULT AND DISCUSSION

#### 3.1. General Condition of Research Site

Administratively, Kedabu Rapat Village is located in Rangsang Pesisir District, Meranti Islands Regency, Riau Province, with an area of 24.4 km<sup>2</sup> (BPS Kab. Kep. Meranti, 2019).

Plant commodities cultivated by farmers in Kedabu Rapat Village are coconut, coffee, areca nut, and sago because these

commodities are considered to have high economic value.

#### 3.2. Land Characteristics at Kedabu Rapat Village

The average annual rainfall in Kedabu Rapat Village is 1,200-2,400 mm/yr (BPS Kab. Kep. Meranti, 2020).

The climate in Meranti Islands Regency is generally tropical, with maximum air temperatures ranging from 25°C - 32°C (BPS Kab. Kep. Meranti, 2019).

Kedabu Rapat Village is located in a swampy lowland with an altitude between 2-5 meters above sea level and flat topography with a slope classification (<3%).

According to Sutrisno (2015), the soil types in Kedabu Rapat Village are Organosol and Gleihumus.

The flood hazard category is included in the non-existent to moderate category, and the landslide and erosion hazard levels are included in the very light or not vulnerable category.

Direct observations of soil data were carried out on peat depth, pH, water level, pyrite depth, and vegetation around the observation point of the soil sample.

Data from observations of soil samples directly in the field are presented in Table 2.

Table 2. Land observation results conforming to the Observation site

Sample Point	Land Type	Peat Depth (cm)			pH	Water Level	Pyrit (cm)	Vegetation
		Total	Saprik	Hemic				
NTP 01	Peat	173	0-11	11-50	4,6	40	-	Coconut, Coffee, Areca
NTP 02	Peat	110	0-50	-	4,9	-	-	Coconut, Coffee, Areca
NTP 03	Mineral	-	-	-	6,1	-	36	Coconut
NTP 04	Mineral	-	-	-	6,8	-	-	Coconut, Areca
NTP 05	Mineral	-	-	-	7,8	29	2	Perepat, Mangrove
NTP 06	Mineral	-	-	-	7,3	-	2	Bushes, Mangrove
NTP 07	Mineral	-	-	-	7,1	-	2	Bushes, Mangrove
NTP 08	Mineral	-	-	-	7,1	-	2	Bushes
NTP 09	Mineral	-	-	-	5,3	-	-	Karet, Pinang
NTP 10	Peaty Minerals	42	-	-	5,1	-	-	Coconut, Coffee, Areca
NTP 11	Peat	185	0-50	-	4,5	-	-	Coconut, Coffee, Areca
NTP 12	Peat	740	0-50	-	4,0	-	-	Rubber, Coconut, Sago
NTP 13	Peat	453	0-53	-	4,0	58	-	Rubber
NTP 14	Peaty Minerals	46	-	-	4,4	-	-	Coconut
NTP 15	Mineral	-	-	-	5,0	-	-	Coconut, Coffee, Areca
NTP 16	Mineral	-	-	-	6,9	-	2	Mangrove

Based on Table 2 above, the depth of peat in Kedabu Rapat Village, according to the sampling point of the soil, is the thinnest at 42 cm (shallow peat), and the deepest is 740 cm (very deep peat), soil pH ranges from 3.9 to 7,8, this indicates that the soil conditions are classified as very acidic to slightly alkaline. The groundwater level in Kedabu Rapat Village is classified as very good. Based on field observations, the water level ranges from 29 cm to 58 cm.

The depth of pyrite at the soil sampling point is known to be between 2 cm to 36 cm.

Pyrite is a soil mineral  $\text{FeS}_2$  often found in swamps, especially tidal swamps. In wet or inundated conditions, pyrite is not harmful to plants. However, when exposed to air (oxidized), pyrite changes its form into iron (Al) and sulfuric acid, which can poison plants (Cahyana and Destina, 2014). Symptoms of poisoning in plants result in yellowing of plant leaves, dry shoots, stunted plants, and low crop yields.

The results of laboratory analysis of several soil chemical properties at each observation point are presented in Table 3.

Tabel 3. Laboratorium Analysis Result

Sample Point	C-orgk (%)	Ca (me/100g)	K (me/100g)	Mg (me/100g)	Na (me/100g)	KTK (me/100g)	KB (%)	Note
NTP 01	40,23	1,520	0,176	2,318	1,736	30,10	19,11	Peat
NTP 02	43,12	2,338	0,253	3,065	1,095	33,80	20,12	Peat
NTP 03	3,45	1,200	0,604	1,979	1,097	23,02	21,20	Mineral
NTP 04	2,98	2,014	0,491	2,737	1,463	24,19	27,71	Mineral
NTP 05	3,01	2,220	1,123	3,374	1,598	25,60	32,48	Mineral
NTP 06	3,14	2,187	1,059	3,038	1,474	24,01	32,31	Mineral
NTP 07	2,88	2,295	1,222	3,737	1,750	26,05	34,56	Mineral
NTP 08	3,25	2,015	0,877	3,087	1,310	23,46	31,07	Mineral
NTP 09	3,05	0,818	0,406	1,278	1,460	23,98	16,52	Mineral
NTP 10	3,32	1,187	0,194	1,195	0,947	22,04	15,98	Peaty Minerals
NTP 11	48,77	2,157	0,212	2,564	1,020	37,84	15,73	Peat
NTP 12	45,08	1,603	0,210	2,386	1,202	35,80	15,09	Peat
NTP 13	43,23	1,520	0,229	2,310	1,838	33,38	17,67	Peat
NTP 14	2,99	2,417	0,845	2,431	1,237	23,82	29,10	Peaty Minerals
NTP 15	3,08	2,180	0,756	1,918	1,052	22,97	25,71	Mineral
NTP 16	3,03	2,101	1,092	3,672	1,864	24,25	36,00	Mineral
Average	15,91	1,861	0,609	2,568	1,384	27,14	24,40	

Based on the results of laboratory analysis according to Table 3 above, the C-Organic content ranged from moderate to very high. Based on the technical criteria for evaluating land suitability, according to Djaenuddin et al. (2011) and the Ministry of Agriculture (2014), Liberika Coffee is very suitable (S1) in NTP 03 - NTP 10 and NTP 14 - NTP 16 with C-Organic content between 2 - 5% and not according to (N) on NTP 01 - NTP 02 and NTP 11 - NTP 13 with C-Organic content >15%. Coconut plants are very suitable (S1) at NTP 01 - NTP 16 with C-Organic content between > 0.8%, and Areca nut plants are very suitable (S1) at NTP 01 - NTP 16 with C-Organic content between > 1.2%.

The macronutrient values of Ca, K, Mg, and Na showed various contents. Elemental Ca with a content of 0.818 - 2.417 me/100g (very low - low) and an average value of 1.861 me/100g (very low), elemental K with a content of 0.176 - 1.222 me/100g (low - very high) and an average value of an average of 0.609 me/100g (high), elemental Mg with a content of 1.195 - 3.737 me/100g (medium-high) and an average value of 2.568 me/100g (high) and elemental Na with a content of 0.947 - 1.864 me/100g (high - very

high) and a mean value of 1.384 me/100g (very high).

The value of cation exchange capacity (CEC) ranged from medium to high, with an average value of 27.14 me/100g (high). Based on the technical criteria for evaluating land suitability, according to Djaenuddin et al. (2011) and the Ministry of Agriculture (2014), Liberika coffee is very suitable (S1) in NTP 01 - NTP 16 with CEC > 15 me/100g, coconut plants are very suitable (S1) in NTP 01 - NTP 16 with CEC not required and areca nut is very suitable (S1) in NTP 01 - NTP 16 with CEC >16 me/100g.

Base saturation values (KB) ranged from 15.09 - 36.00 % (very low - moderate) with an average value of 24.40 me/100g (low). Based on the technical criteria for evaluating land suitability according to Djaenuddin et al (2011) and the Ministry of Agriculture (2014), Liberika Coffee is very suitable (S1) in NTP 16 with KB > 35%, suitable (S2) in NTP 02 - NTP 08 and NTP 14 - NTP 15 with KB between 20-35% and marginally appropriate (S3) in NTP 01, NTP 09 - NTP 13 with KB <20%. Coconut plants

are very suitable (S1) on FTT 01 - FTT 15 with <35% and suitable (S2) on NTP 16 with KB between 35-50%. Areca nut is very suitable (S1) on NTP 16 with KB >35%, suitable (S2) on NTP 02 - NTP 08 and NTP 14 - NTP 15 with KB between 20-35% and marginally suitable (S3) on NTP 01, NTP 09 - NTP 13 with KB <20%.

### 3.3. Land Suitability Level of Kedabu Rapat Village

Spatial data analysis of 8 characteristic land parameters with scoring and matching techniques compared with plant growth requirements resulted in land suitability classes for Liberika Coffee, Coconut, Pinang, and Geronggang plants.

The results of overlay, matching and intersecting the Liberika Coffee land suitability class with Coconut land suitability class, Pinang land suitability class, and Geronggang land suitability class are land suitability classes for the direction of Liberika coffee-based agroforestry development with shade plants in the form of Coconut, Areca and Geronggang plants in the village. Kedabu Rapat as presented in Table 4.

Table 4. Liberika Coffee land suitability class with coconut, Areca, and Geronggang shade

Land Suitability Class	Area (ha)	Percent (%)
S1 (Strongly Suitable)	848,64	34,78
S2 (Suitable)	584,54	23,96
S3 (Marginal Suitable)	521,78	21,38
N (Unsuitable)	380,42	15,59
Residential	104,61	4,29
Total	2.440,00	100,00

Based on Table 4, the Liberika coffee-based agroforestry land suitability class in Kedabu Rapat Village with shade plants in the form of Coconut, Pinang, and Geronggang, the largest in the S1 class (very suitable), covering an area of 848.64 ha (34.78%), followed by the S2 (suitable) covering an area of 584.54 ha (23.96%), then S3 class (marginally appropriate) covering an area of 521.78 ha (21.38%) and class N (not suitable) covering an area of 380.42 ha

(15.59 %) temporary settlements 104.61 ha (4.29%).

### 3.4. Agroforestry Development

The combination pattern of agroforestry plants offered in this study is a spatial combination of plants spread horizontally. Horizontal distribution of agroforestry constituent plants is carried out by planting trees or woody shrubs planted around the land to function as border tree plantings/trees along the border, and trees (woody plants) and agricultural crops are planted in the form of lane/alley (alley cropping) (Sardjono *et al.*, 2003). Plants combined for agroforestry development are plants that generally already exist in Kedabu Rapat Village, namely Liberika Coffee, Coconut, Pinang, and Geronggang plants.

The selection of this combination pattern is considered the most appropriate and can be accepted by the community in Kedabu Rapat Village. This yield is because the pattern can provide better economic value and corresponds to local community habits and environmental aspects of good coffee-based agroforestry.

The pattern of combining Liberika coffee-based agroforestry plants with coconut, Pinang, and Geronggang shade plants in Kedabu Rapat Village is the planting of woody trees around the land to function as a living fence (border tree planting/trees along the border) and trees (woody plants) and plants. Agriculture is planted in lanes/alleys (alley cropping). The pattern of combining Liberika coffee-based agroforestry plants in Kedabu Rapat Village uses a combination of Liberika Coffee plants with a spacing of 2.5 x 2.5 m, coconut with a spacing of 10 x 10 m, Pinang with a spacing of 2.5 x 2.5 m and Geronggang with a spacing of 5 x 5 m. as Figure 2 and Figure 3.

Based on the results of interviews and facts in the field, it shows that there has been an increase in the economic level of the people in Kedabu Rapat Village from their results of liberika coffee gardening. To further improve the implementation of the agroforestry system in Kedabu Rapat Village, the local government can improve community road access to bring their plantation products

to the market. Besides that, the community is also given a good understanding of utilizing land resources through the agroforestry system without destroying the land.

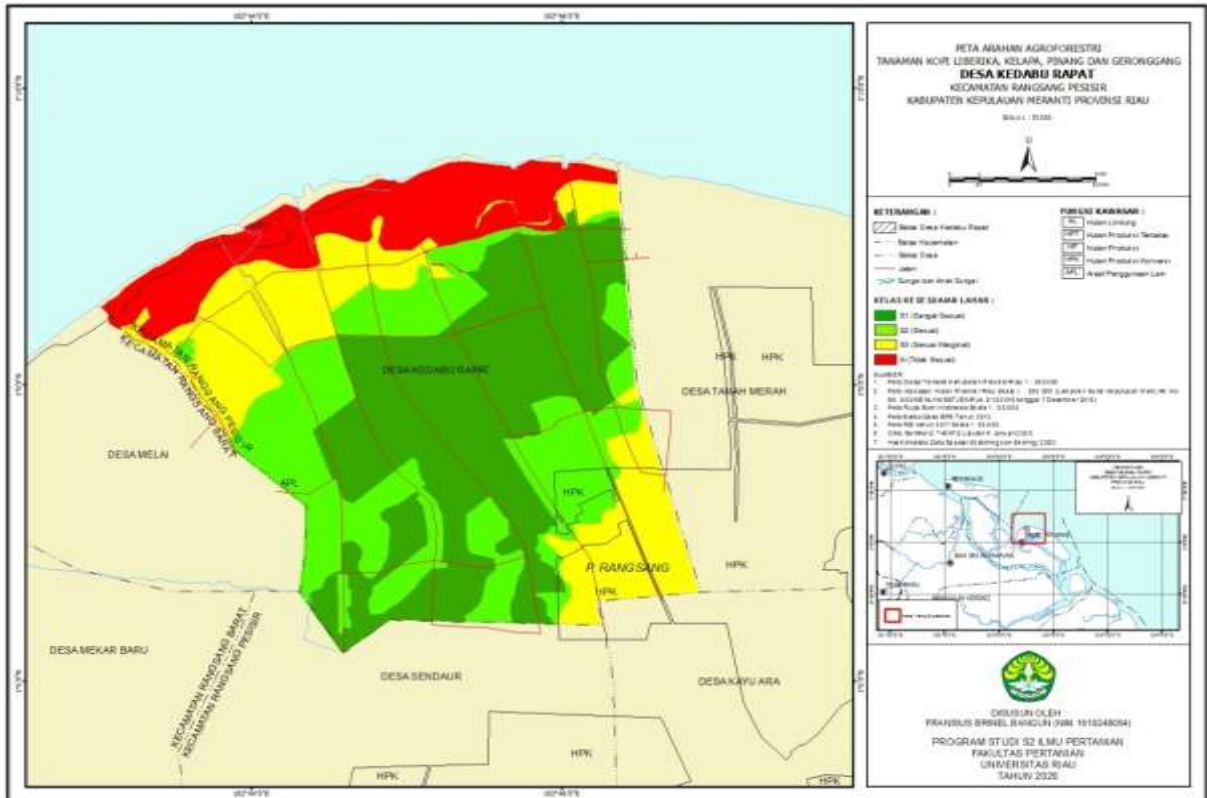


Figure 1. Map of directions for the development of Liberika coffee-based agroforestry

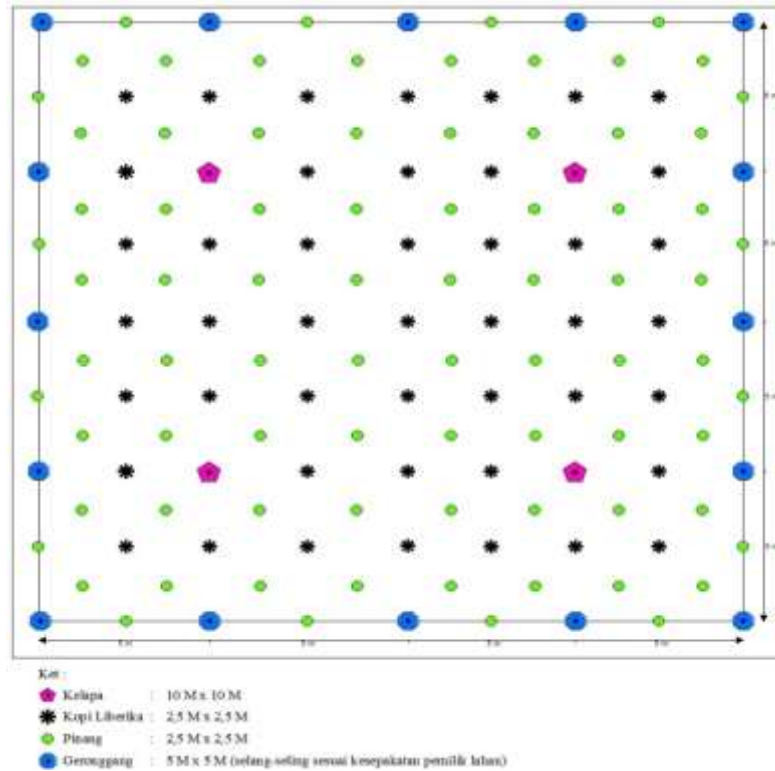




Figure 2. Combination pattern 1 (border tree planting/trees along the border)

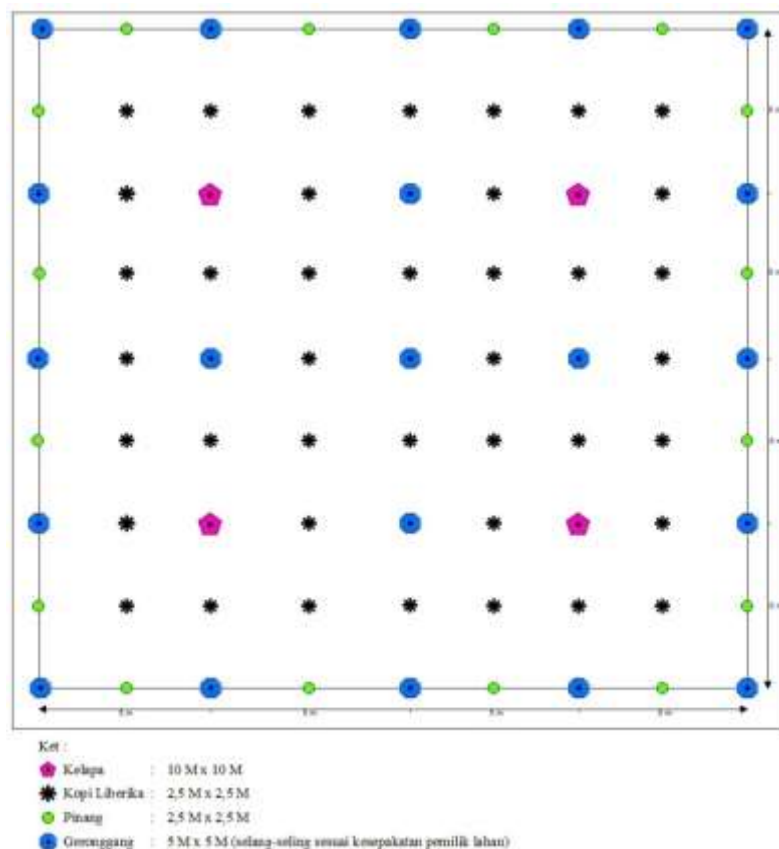


Figure 3. The pattern of 2 combinations (alley cropping)

#### 4. CONCLUSION

Characteristics of land in Kedabu Rapat Village, among others; average annual rainfall is 1,200-2,400 mm/year, air temperature is between 25°C - 32°C, the topography is flat with slopes (<3%), soil types are Organosol and Gleihumus, flood hazard consists of none to with moderate and the level of landslide and erosion hazard is very light or not prone. The level of land suitability for Liberika coffee-based agroforestry with shade plants in the form of Coconut, Areca, and Geronggang plants with a very suitable category (S1) covering an area of ± 848.64 ha (34.78 %), suitable (S2) covering an area of ± 584.54 ha (23.96%), marginally suitable (S3) covering an area of ± 521.78 ha (21.38%) and not suitable (N) covering an area of ± 380.42 ha ( 15.59%) while the settlement area is ± 104.61 ha (4.29%). The recommended pattern of combining Liberika coffee-based agroforestry plants with coconut, Pinang, and Geronggang shade plants in Kedabu Rapat

Village is planting woody trees around the land to function as living fences (border tree planting/trees along the border) and trees (woody plants). Moreover, agricultural crops are planted in lanes/alleys (alley cropping).

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