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Research Paper

Optimizing agroforestry in Tanjung Beringin Village increases farmers' income through effective planting patterns and crop combinations

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Abstract
Agroforestry is a land use system that integrates agricultural and forestry crops in the same area, providing a balance between production and conservation for social, economic and ecological benefits. Farmers at the Lembah Bukit Besak Village Forest Institute, Tanjung Beringin Village, South Merapi District, have implemented this system. The research aims to identify planting patterns and composition of agroforestry plants, evaluate the most optimal plants to increase income, and formulate strategies for adopting the best planting patterns. This study used a census method to collect data from 75 farmers in the Rimba Bukit Besar Village Institution group. After conducting a sampling method using a purposive stratified random sampling method, 24 farmer respondents were obtained. The research results show two main planting patterns: a random mixture, applied by 66.67% of farmers, and tree along border pattern, applied by 33.33%. The most profitable crops are coffee, rubber, jengkol, durian and eggplant (Solanum melongena). The "Tree Along Border" pattern has proven to be more effective in preventing erosion and providing shade for plantation and vegetable crops compared to random mixture patterns which focus more on forestry and plantation crops. The strategy for adopting the best planting patterns includes the development of pilot demonstration plots, intensive counseling, dissemination of information on research results, as well as the involvement of the government and related agencies in supporting superior commodities. This approach is expected to increase farmers' income and welfare in a sustainable manner. From the adoption of additional horticultural crop types, farmers' income increased by 9.264 to 30.83 percent when compared to the application of a combination of plant types without horticultural commodities.

Keywords
Agroforestry, farmer income, social forestry, village forest

1. INTRODUCTION

Agroforestry is a land use system that combines agricultural and forestry crops on the same land, with the aim of optimizing land use in a sustainable manner to meet food needs and improve community welfare (Martini et al., 2017; Mukti et al., 2024). In Indonesia, agroforestry can be applied to social forest areas, such as village forest schemes that involve community participation in forest management (Istomo and Hartarto, 2019).

Agroforestry planting patterns provide economic and ecological benefits by encouraging crop diversification and the development of sustainable agricultural systems. Factors such as education level, land area, and types of plants planted influence the success of an agroforestry system (Wanderi et al., 2019; Idris et al., 2019).

Tanjung Beringin Village, in South Merapi District, Lahat Regency, implements an agroforestry planting pattern with the support of a social forestry scheme. However, there has been no research that determines the best planting methods or plant varieties that can improve the welfare of local communities. This research is expected to provide new strategies in planting patterns, especially in forest and agricultural border areas so that farmers' incomes can increase without having to damage the forest. Therefore, this research aims determine the best planting methods or plant varieties that can improve the welfare of local communities.

Although agroforestry has great potential to improve welfare, the right combination of plants and good management are very important to produce optimal production (Fauziyah and Sanudin, 2021; Mataputung et al., 2019). Research will examine patterns and types of plants that can be integrated in agroforestry to achieve better and more sustainable results.

2. EXPERIMENTAL SECTION

2.1 Research Design

This study uses mixed methods (qualitative and quantitative) to analyze agroforestry optimization in increasing

farmers' income in Tanjung Beringin Village, South Merapi District, Lahat Regency, South Sumatra. The quantitative method uses descriptive quantitative percentages and different tests on planting patterns. While for qualitative, it explains the identity of respondents to interpret the research results. This method refers to the approach proposed by (Brown et al., 2001) for model and impact determination.

2.2 Description of Research Location and Time

The research was conducted in June 2024 in Tanjung Beringin Village, South Merapi District, Lahat Regency, South Sumatra. The Bukit Besak Valley Village Forest, covering an area of 313 ha, is included in the social forestry area based on the Certificate of the Minister of Forestry of the Republic of Indonesia No: SK. 10702/MENLHK-PSKL/PKPS/PSL.0/9/2023, which was issued on September 29, 2023. The location map can be seen in Figure 1.

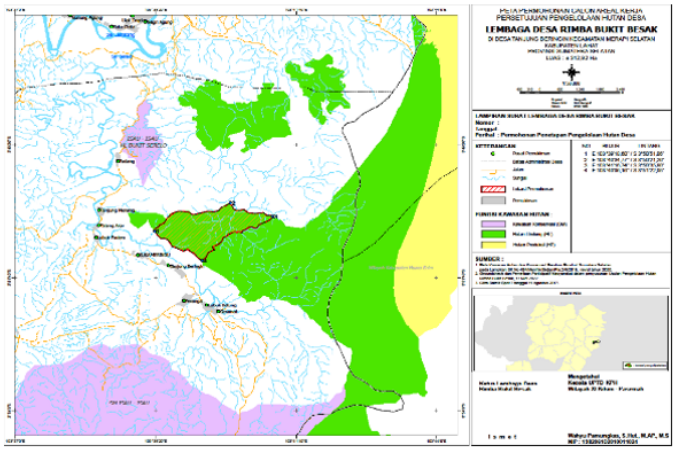

Figure 1. Map of the Research Location

2.3 Types and Data Sources

The data used are primary and secondary data. Primary data include the identification of plant types, agroforestry planting patterns, planting area, and agroforestry management constraints obtained through field observations, surveys, and structured interviews with farmers. Secondary data includes village monographs, literature, research reports, and related documents (Creswell and Creswell, 2018).

2.4 Data Collection Methods

This study used a census method to collect data from 75 farmers in the Rimba Bukit Besar Village Institution group. After conducting a sampling method using a purposive stratified random sampling method, 24 farmer respondents were obtained in the Bukit Besar Forest Village Institution group. This method ensures adequate representation of each strata of the population. The sample selection used purposive sampling because the research sample was taken from farmer groups who utilize forests as an effort to fulfill food needs.

2.5 Data Collection and Analysis Techniques

Primary Data Collection: Through direct observation and structured interviews with farmers regarding land conditions, crop types, production costs, and income from agroforestry.

2.6 Data Analysis

Farmers' income is quantitatively analyzed using the agroforestry business income formula (Syamsudin et al., 2019), which calculates total income based on commodity prices, production products, and costs incurred. This study uses statistical tests using a difference test (t-test) to compare planting patterns based on income value.

3. RESULTS AND DISCUSSION

3.1 Characteristics Responden

This study involved 24 respondents from Rimba Bukit Besar Village, South Merapi District. Based on the data, the majority of farmers are between the ages of 34 and 81, with most being 34-50 years old, reflecting farmers who are still productive and open to agricultural innovation. A total of 18 respondents work primarily as farmers or gardeners, while 6 have side jobs and primarily work as teachers, entrepreneurs, or in the private sector.

Most of the farmers in this group have a high school education (9 people), followed by junior high school (8 people), elementary school (5 people), and graduate (2 people). Higher education levels are expected to increase the competence and ability of farmers in managing farming businesses.

3.2 Patterns and Types of Agroforestry Plants in the Bukit Besar Jungle Village Institution Group

To see the planting pattern applied by farmers, we can see in Figure 2a and Figure 2b. For the Agroforestry Tree Along Border planting pattern, it can be seen in Figure 2a, while for the Agroforestry Random Mixture planting pattern, it can be seen in Figure 2b. The community still uses agroforestry traditionally and has not used the Random Mix planting pattern much and created added value from this agroforestry. While 2 other patterns, namely Alley Croping and Alternative Rows, were not found This is due to limited knowledge and counseling of farmers and minimal innovation (Widianto et al., 2003).

The application of patterns and types of plants on agroforestry land in the Rimba Bukit Besar Village Institute, Tanjung Beringin Village, South Merapi District, found 1 combination system that is included in the agroforestry system, namely agrisilviculture and also found 2 agroforestry planting patterns, namely random mixture planting patterns of 66.67% or 16 farmers then applied the tree planting pattern along the border as much as 33.33% or 8 farmers who

(a) Planting pattern of Tree Along Border

(b) Random Mixture planting pattern

Figure 2

applied from A total of 24 farmers responded. To see the recapitulation of plant types and growers listed in Table 1. In the case of agroforestry in Lampung, in the use of planting patterns, where the income of agroforestry farmers is Rp 11,675,317.07 (68.67%), and the income of non-agroforestry businesses is Rp 5,327,804.88 (31.33%). Therefore, to increase agroforestry, it is necessary to increase added value by processing bananas to be processed into banana chips, honey cultivation, or bamboo and rattan crafts or planting additional crops as an additional income for farmer families (Syofiandi et al., 2016; Mercer, 2004). Some of the cultivated plants are plants that are developed from their own needs and requests from outside the region. Cultivation habits are obtained from the knowledge passed down and the ability to train from experiential knowledge and assistance from extension workers (Soegeng, 2023; Ikhwan and Rita, 2018).

3.2.1 Types of Cultivated Plants

Of the 24 farmers, the five main crops cultivated were coffee (79.16%), rubber (Hevea brasiliensis) (58.33%), Durian (Durio zibetinus) (41.66%), Jengkol (Pithecellobium lobatum) (37.5%), and Eggplant (Solanum melongena) or vegetables (29.16%) . In addition, there are rare plants such as tobacco (Nicotiana tabacum) and lempeni (Ardisia elliptica), which are only found in a few areas.

3.2.2 Land Area and Planting Pattern

The area of farmers' land varies between 0.5 to 3 hectares, and the larger the land, the more types of crops are planted. The "Trees Along Border" planting pattern, which combines forestry and vegetable crops, has proven to be more profitable and increases land productivity (Firdaus, 2018; Hasdiana, 2018). The compensation received by farmers applies a model that is adjusted to land conditions (Akbar, 2021). This provides security for the preservation of nature without damaging the original environment (Hartoyo et al., 2019; Hardaningsih et al., 2024). This is a great advantage for small farmers with a land area of less than 1 ha, many additions are accepted and can be developed with innovations adopted from various farming concepts that are developed (Manyamsari et al., 2014).

3.3 Farmers' Income and Expenditure

Farmers' income depends on the type of crops cultivated. Plantation crops such as coffee and rubber have a high price, while vegetables are lower. Planting patterns that combine forestry crops and vegetables also provide additional advantages, such as erosion prevention and plant protection. Farmers' expenditures vary depending on the land area and crop type, with higher production costs for larger plots and more crop types. To see the level of farmer income obtained from farmers' income and expenditure during the period (January to June) of 2024, see Table 2. inflow is the gross income received by farmers after selling agricultural products per hectare. While the Assumption income area per hectare is an estimate obtained by farmers from normal calculations (concepts).

Farmers who apply the "Trees Along Border" planting pattern by interspersing vegetable crops produce higher income than the "Random Mix" planting pattern, because vegetable crops can be harvested faster. This pattern also increases land productivity and reduces soil erosion, while providing protection for plants from direct sunlight. The price of plantation crops such as coffee and rubber is high, while the price of vegetables is lower. Production costs, including spending on herbicides, fertilizers, and labor, vary

depending on the area of land and the type of crops grown. Farmers' income is influenced by production results, selling prices, and production costs. The use of forest land used as production forests gives the perception that it is able to provide welfare for people's lives (Mamuko et al., 2016; Maulana, 2017; Wheeler, 2014).

Socialization and evaluation of research results are carried out to provide information to farmers about the results of research and recommendations for selecting the right plant types and planting patterns. This activity aims to encourage the adoption of agroforestry systems that can increase farmers' income, especially members of the Bukit Besar Rimba Village farmer group. After socialization, farmers began to adopt planting patterns by combining forestry, plantation, and horticultural crops, such as oyong, katuk, long beans, and eggplant. The addition of vegetable crops increases farmers' incomes, with fast yields for household and market needs. Plantation and forestry crops have a longer harvest period. This ability is based on the ability of farmers to build agricultural product management capabilities that are able to provide added value to the business they manage. Other than that, the ability to combine forest products and plant products has a productivity value that provides economic value twice as much as building an agroforestry economy (Larasati et al., 2019; Rajagukguk, 2017; Timbulus, 2015).

Table 3 above shows an increase in farmers' income when they add horticultural crops to the cultivated land. Significant increases ranging from 9.264 to 30.83 percent indicate better adoption by farmers if the cultivated land is only used for plantation and forestry crops. The results of the difference test show that the t-count value is 18.44 while the t-table value is 2.145. From this data, it shows that the t-count value is > from the t-table value, so it means that there is a difference between before and after the application of random mix at a significance level of 0.05. In other words, the intervention or treatment given has a significant effect. Thus, this adoption is expected to continue to be implemented so that it can increase farmers' income. The area of agroforestry land and the type of crops planted will affect the ability of farmers to meet their household needs, according to the opinion of Kuyah et al. (2020) stating that diverse types of crops as well as the area of agroforestry land can have an impact on meeting the needs of farmers' households. The more types of crops that have been produced on agroforestry land with a fast harvest period, the more diverse types of food will be available so that it will have an impact on farmers' income.

Coffee is a leading commodity cultivated in Tanjung Beringin Village, South Merapi District. The government and related agencies have played an active role in developing the coffee business in this area. On June 14, 2024, the Lahat Regency Plantation Office together with Agricultural Extension Officers held a coffee cultivation training for farmers. In addition, on July 16, 2024, the South Sumatra Coffee Council in collaboration with Master Trainers from Scoppy and Tokopedia held post-harvest training and coffee marketing. As a further effort, coffee from Lahat Regency has successfully submitted a Geographical Indication (IG) to the Ministry of Law and Human Rights on July 17, 2024, which was ratified on September 12, 2024, which is expected to increase the competitiveness of coffee in the market. In addition, the Lahat Regency Plantation Office also provided assistance with post-harvest coffee equipment, such as tarpaulins, solar dryers, para-para, and roasting machines, to improve the quality and selling value of coffee products. The Lahat Regency Food Crops, Horticulture and Livestock Office also provides vegetable and fruit seed assistance to farmers in this village through farmer groups, to support crop diversity and increase farmers' income (Wulandari et al., 2014; Widianto et al., 2003). With various innovations in the diversity of planting patterns and following the market structure and community needs for food, it is able to provide economic value and profitability of farmers' land to be good and productive (Amelia et al., 2024; Rahim et al., 2024). The economic value of land depends on the area of land managed by farmers based on the manufactory and innovations adopted can provide added value for farmers. The Random Mix planting pattern has more advantages than the Trees Along Border planting pattern. This is reinforced by the analysis of different test results that Random Mix has the advantage of (1) obtaining economic value more quickly, (2) farmers can maintain and utilize the existing forest value and obtain benefits from forest products.

4. CONCLUSION

The random mix planting pattern has high economic value and is effective in increasing farmers' economic productivity. This planting pattern can be applied widely by considering the land contour, legality of border forests, and planting season. From the application of plant types, farmers' income has increased by 9.264 to 30.83 percent when compared to the application of a combination of plant types without horticultural commodities.

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Table 1. Recapitulation of plant types and grower farmers

No	Plant type		Number of Farmers Planter
	Local Names	Latin Names	
1	Coffee	*Coffea robusta*	19
2	Rubber	*Hevea brasiliensis*	14
3	Durian	*Durio zibetinus*	10
4	Jengkol	*Pithecellobium lobatum*	9
5	Eggplant	*Solanum melongena*	8
6	Jowar Kandang/Jahar	*Cassia siamea*	7
7	Bambang	*Michelia champaca L*	7
8	Pinang	*Areca catechu*	6
9	Bamboo	*Bambusoideae*	5
10	Coklat	*Theobroma cacao*	4
11	Lumai	*Solanum nigrum*	4
12	Jati	*Gmelina arborea*	4
13	Katuk	*Sauropus androgynus*	3
14	Kisik/Oyong	*Luffa acutangula*	3
15	Lada	*Piper ningrum*	3
16	Lempenes	*Ardisia elliptica*	2
17	Chili	*Capsicum frutescens*	2
18	Petai	*Parkia spesiosa*	2
19	Tobacco	*Nicotiana tabacum*	1
20	Oil palm	*Elaeis guinensis*	1
21	Galangal	*Alpinia galanga*	1
22	Avocado	*Persia americana*	1
23	Long Beans	*Vigna unguiculata ssp*	1
24	Angsana	*Pterocarpus indicus*	1
25	Abasia	*Albizia chinensis*	1
26	Banana	*Musa paradisiae*	1
27	Cassava	*Manihot esculenta*	1

Remarks: Primary Data After Processing, 2024

Table 2. Farmers' Income Levels from the Implementation of Agroforestry Patterns

Farmer number	Land (Ha)	Agroforestry Pattern	Inflow (IRD) (000)	Outflow (IRD) (000)	Income (IRD) (000)	Assumption income area 1 (Ha)/ (IRD) (000)
a	b	c	d	e	*f*	*g*
1	0,5	Trees Along Border (1)	11.750	1.305	*10.445*	*20.890*
2	0,5	Trees Along Border (1)	12.690	1.520	*11.170*	*22.340*
3	0,75	Trees Along Border (1)	17. 350	1.620	*15.730*	*20.920*
4	1	Trees Along Border (1)	25.060	1.765	*23.295*	*23.295*
5	1	Trees Along Border (1)	26.150	2.740	*23.410*	*23.410*
6	1,5	Trees Along Border (1)	4.480	1.880	*2.600*	*1.716*
7	1,5	Trees Along Border (1)	12.350	1.760	*10.590*	*6.989,4*
8	2,25	Trees Along Border (1)	30.936	2.290	*28.646*	*12.604*
9	0,75	Random Mix (4)	12.400	1.940	*10.460*	*13.911*
10	0,50	Random Mix (4)	12. 150	2. 255	*9.895*	*19.790*
11	0,50	Random Mix (4)	12.400	1.765	*10.635*	*21.270*
12	0,50	Random Mix (4)	13.200	2.620	*10.574*	*21.148*
13	1	Random Mix (4)	8.100	1.520	*6.580*	*6.580*
14	1	Random Mix (4)	12.960	2.030	*10.930*	*10.930*
15	1	Random Mix (4)	12.400	1.430	*10.970*	*10.970*
16	1	Random Mix (4)	11.100	2.075	*9.025*	*9.025*
17	1	Random Mix (4)	20.690	1.900	*18.970*	*18.970*
18	2	Random Mix (4)	23.850	2. 945	*20. 905*	*10.452,5*
19	1	Random Mix (4)	19.720	3.195	*16.525*	*16.525*
20	1	Random Mix (4)	16.700	2.210	*14.490*	*14.490*
21	1	Random Mix (4)	11.460	1.430	*10.030*	*10.030*
22	1,5	Random Mix (4)	22.600	3.420	*19.180*	*12.658,8*
23	2,5	Random Mix (4)	31.820	3.740	*28.080*	*11.232*
24	3	Random Mix (4)	31.100	3.195	*27.905*	*9.301*

Remarks: Primary Data After Processing, 2024

Table 3. Results of the Implementation of Farmer Adoption after the addition of Horticultural plant types

Number Responden	Land (Ha)	Agroforestry Pattern	Income Area 1 Ha		Percentage Increase (%)
			Before Combination of Forestry + Plantation IRD in (000)	After Adoption Combination of Forestry + Plantation + Horticulture IRD in (000)	
a	b	c	d	e	f
1	0,5	Trees Along Border	20.890	22.825	9,26
2	0,75	Trees Along Border	20.920	23.560	12,61
3	1,5	Trees Along Border	6.989.4	8.585	22,83
4	0,75	Random Mix	13.911.8	15.725	13,03
5	0,50	Random Mix	19.790	21.842.5	10,37
6	0,50	Random Mix	21.270	23.323	9,65
7	0,50	Random Mix	21.148	23.512	11,18
8	1	Random Mix	6.580	8.485.5	28,95
9	1	Random Mix	10.930	13.125	20,08
10	1	Random Mix	10.970	13.380.5	23,61
11	1	Random Mix	18.970	21.895	15,42
12	2	Random Mix	10.452.5	13.675	30,83
13	1	Random Mix	16.525	19.580	18,49
14	1	Random Mix	14.490	17.445	20,39
15	1	Random Mix	10.030	12.535.5	24,98

Remarks: Primary Data After Processing, 2024