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AGROFORESTRY MODEL IN LEIMEA SORIN VILLAGE, ERMERA DISTRICT, TIMOR LESTE

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Abstract:
Agroforestry combines forestry and agricultural practices within a single land management unit, optimizing land use while considering physical, social, and economic conditions. It aims to enhance farmers' income, particularly in forest-adjacent areas, by encouraging active community participation and environmental restoration. This study, conducted in Leimea Sorin Village, Ermera Regency, Timor Leste, from March to May 2021, employs both qualitative and quantitative methods. Data were collected through direct interviews with 30 farmers using questionnaires. Financial analysis revealed an NPV of $220,184.66, a BCR of 28.7, and an IRR of 35%, indicating the agroforestry model's feasibility. Social analysis shows that the local Kemak community relies on crops like vanilla and coffee for livelihood. In contrast, the ecological analysis confirms that the agroforestry system is polyculture-based and offers diverse benefits compared to non-agroforestry systems. Recommendations include enhancing farmers' knowledge through training and socialization on agroforestry techniques and improving inventory practices to boost post-harvest profitability.

Keywords: Agroforestry Model, Economic, Ecological and Social Aspects

INTRODUCTION

Agroforestry is an optimal and sustainable land use management that combines forestry and agricultural activities in the same land management unit while considering the physical, social, and economic environmental conditions. The purpose of agroforestry is to increase farmers' income, especially around the forest, by prioritizing active community participation, improving damaged environmental conditions, and continuing with its maintenance. Agroforestry programs are usually directed at increasing and preserving resource productivity, ultimately improving the community's standard of living (Triwanto, 2002). According to Narain and Grewal (1994) and Nair (1989), agroforestry has the potential as an effort to conserve soil and water and ensure the sustainability of food, fuel, animal feed and wood production, especially from marginal and degraded lands. Agroforestry is a collective term for land use systems and technologies appropriately applied to marginal lands. Sustainable forest management means that forest resources are currently not experiencing degradation in either quantity or value. Maintaining this sustainability is very difficult because, for specific considerations, forests that are managed in a limited way will experience a reduction in the types of vegetation and production, which will usually be followed by an increase in inhibiting factors (Sumardi & Widyastuti, 2000).

One of the main goals of any agricultural business, including agroforestry, is sustainable production characterized by long-term production stability. Some indicators of the implementation of a sustainable agricultural system are the maintenance of natural resources as a support for long-term crop production, the use of relatively low labor, the absence of land hunger, the maintenance of soil and water environmental conditions, low greenhouse gas emissions and the maintenance of biodiversity. The economic value of forests can be interpreted as the characteristics or quality of

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goods and services from forests that cause these goods and services to be exchanged for something else to determine their benefits or usefulness for several advantages, and market services provide reasonable prices that give rise to social income values that the goods have a price in the community.

Agroforestry management in Ermera Regency, Timor Leste, uses crops such as vanilla, cocoa, pepper, orange, and papaya, secondary crops such as turmeric and ginger and forestry plants such as coconut trees, teak trees, jackfruit trees, agarwood trees, lamtoro trees, and Gamal trees.

The objectives of this study are as follows:

1. Calculating the value of farmer income from the results of the agroforestry model;
2. To determine the feasibility of agroforestry in terms of social, economic and ecological

METHODS

This research was conducted in Leimea Sorin Balu Village, Ermera Regency, Timor Leste. The research period began in March 2021. The location of this research is a location that implements the agroforestry model. The population in this study was 71 families consisting of members of the agroforestry model group in Leimea Sorin Village. The study used 30 respondents, who were carried out using purposive sampling (Sugiyono, 2012). Primary data collection was carried out by direct interviews with respondents (farmers) regarding the agroforestry model with the help of a questionnaire. Secondary data, such as the community's physical and socio-economic environmental conditions, were obtained from the village and agencies such as the Forestry Service, Plantations, Central Statistics Agency (BPS), and references from the Internet. The data collected were then analyzed using financial analysis NPV, BCR and IRR. The social and ecological analysis examined the characteristics of respondents and culture in Leimea Sorin Balu Village, and the biodiversity in Leimea Sorin Village was analyzed descriptively and qualitatively.

RESULT AND DISCUSSION

Respondent Characteristics based on age. Agroforestry managers in Leimea Sorin Balu Village, Ermera Regency, Timor Leste are Respondents aged 17 to 65 who work in agroforestry land. A person's age also affects activities and productivity in managing agroforestry land in Leimea Sorin Village, Ermera Regency, Timor Leste. Age also affects decision-making and absorption of developed technology and innovations. The characteristics based on age are presented in Table 1.

Table 1. Respondent characteristics based on age

No	Respondent Characteristics	Number of Respondent	
		People	%
1	Age (Years)		
2	16-25 years	4	13,3
3	26-35 years	5	16,6
4	36-45 years	10	33,3
5	46-55 years	6	20
6	56-65 years	3	10
7	66-75 years	2	6,6
	Total	30	100

Primary data sources 2021

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From Table 1, respondents aged 36-45 are generally the most dominant in the Leimea Sorin Balu village farmer group. This age is productive when someone is very busy with daily work to meet their needs.

Characteristics based on Education Level. The management of the agroforestry model in Leimea Sorin village is 11 illiterate people, 7 people with elementary school education, 7 people with junior high school education, 5 people with high school education, and no college.

Table 2. Characteristics Based on Education Level

No	Respondent Characteristics	Number of Respondents	
		People	%
1	Education		
2	Illiteracy	11	36,6
3	Elementary School	7	23,3
4	Junior High School	7	23.03
5	High School	5	16,6
	Total	30	100

Primary data analysis sources 2021

Based on Table 2, the respondents' general education level is mostly illiterate. The lowest is high school, with as many as 5 people. A person's high or low education level greatly influences their mindset in the management and development of agroforestry.

Respondents' characteristics are based on their main occupation. Most work as farmers, traders, or laborers, and some do not have side jobs. The number of family agrota ranges from 2 to 12 family members.

Table 3. Characteristics of respondents based on main occupation

No	Respondent Characteristics	Number of Respondents	
		People	%
1	Main occupation		
2	Farmer	24	80
3	Laborer	5	16,6
4	Civil servant	0	0
5	Trader	1	3,3
	Total	30	100

Primary data analysis sources 2021

Respondents' characteristics are based on the number of family members. The management of the agroforestry model in Leimea village is based on the number of family members, which ranges from 2 to 12. For more details, see the table.

Table 4. Respondents' characteristics based on the number of family members

No	Respondent Characteristics	Number of Respondents	
		People	%
	Number of Family Members		

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1	2 people	8	20
2	5 people	10	25
3	10 people	12	30
4	12 people	10	25
	Total	40	100

Primary data analysis sources 2021

The table above shows that most family members are 10 people, and the lowest is 2 people. This is because family members are internal household workers who help with daily work.

Respondent characteristics are based on the number of active family members in agroforestry land. The number of family members active in agroforestry land ranges from 2 to 5 people in one family who work actively in agroforestry land; all respondents are different. For more details, see Table 5.

Table 5. Respondent characteristics based on the number of family members who are active in agroforestry land

No	Respondent Characteristics	Number of Respondents	
		People	%
	Number of Family Members Active in Agroforestry Land		
1	2 people	6	28,7
2	3 people	8	38
3	4 people	7	33,3
	Total	21	100

Primary data analysis sources 2021

Land Ownership. On average, farmers in Leimea Sorin Village have garden land, yards, and agroforestry gardens. The total land area of respondents is 0.4 hectares of yard land, 1.23 hectares of garden land and 0.33 hectares of vanilla agroforestry land. In addition to houses, plants such as chocolate, oranges, pepper, mango, bananas, papaya, coconuts and other plants are also planted for yards. While for garden land, it is planted with a polyculture system such as coffee, porang, chocolate, pepper, jackfruit, sengon trees and other plants. At the same time, vanilla and porang plants dominate agroforestry gardens. But still traditional. Table 6 presents the average area of land ownership.

Table 6. Average Land Ownership of Respondents

No	Land Use Type	Area (ha)	Land status *)	Crop/farming pattern **)
1	Yard (home garden)	0,4	Owned	Polyculture
2	Garden	1,23/ha	Owned	Polyculture
3	Agroforestry garden	0,33/ ha	Owned	Polyculture

Primary data analysis sources 2021

Types of Commodities in Agroforestry Land. The commodities in Leimea Soring Village are vanilla, chocolate, gaharu, porang, areca nut, teak pepper, mahogany, bamboo, sengon and others

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(Table 3). Coffee and vanilla are the plants that dominate in Leime Sorin Village. Vanilla in Leimea Sorin Village is considered to have high economic value compared to other plants. The main plant is a plant that dominates in one composition, while the filler plant is a plant that does not dominate in one plant composition.

Table 7. Types of Agroforestry Commodities

No	Commodity Type	Number of plants	Age
1	Forestry Plants		
	Agarwood	56	5
	Teak	946	30
	Gamal	12965	8
	Jackfruit	24	20
	Mahogany	23	5
	Bamboo	28	
	Areca Palm	42	10
	Coconut	6	15
2	Plantation Crops		
	Cocoa	948	5
	Orange	48	20
	Pineapple	54	1
	Mango	24	20
	Avocado	18	18
3	Agricultural Plants		
	Vanilla	18503	8
	Turmeric		2
	Ginger		1
	Papaya	20	1
	Chili		1
	Porang		3

Primary data analysis sources 2021

External assurance is an independent examination of performance data disclosed in sustainability reporting. To increase the credibility of their sustainability reports, reporting organizations seek external assurance from accredited assurance providers. External confirmation that an organization's sustainability data is of high quality, reliability, and correctness is essential. The external assurance process also aids organizations in improving their reporting, data management, and accountability, all of which contribute to improved sustainability performance. Figure 5 shows that only twenty percent (20%) provided an external assurance.

Production Costs Incurred by Agroforestry Farmers. The costs incurred by agroforestry farmers in Lemea Sorin village are the purchase of agricultural tools such as crowbars, hoes, machetes, seedlings and labor wages. The total cost of agricultural tools for respondents is US$ 6,273.00. The total number of forestry plant seed respondents is gaharu seedlings. Gaharu seedlings/playback 25, so the total number of gaharu seedlings/respondents is 56 seedlings. For more details, see Table 8.

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Table 8. Costs incurred by agroforestry farmers

No	Cost Type	Amount	Price	Frequency
A.	**Forestry Plants**			
1	Seedlings	56 Gaharu	$ 1.400,00	1 x
2	Labor wages	10 people	$ 2.000	
3	Agricultural tools: machete, hoe, crowbar		$ 6.273,00	
B.	**Agricultural Plants**			
1	Vanilla seedlings	100 sticks	$ 260,00	1 x

Primary data analysis sources 2021

Production and sales of agroforestry and non-agroforestry agricultural products. Farmers' income is mainly obtained from Vanilla and porang plants, coffee and teak. Vanilla plants produce 1064 kg each year at a selling price of $ 18 US per kilogram. Jaran farmers sell in dry conditions because they do not know about the vanilla drying process. The nominal income from commodities in vanilla agroforestry land per year is $ 22,440.75 / year, while porang plants produce 1953 kg per year for 2.50 per kilogram. At the same time, pepper plants produce 290 kg per year for 2.50 per kg. At the same time, other plants are sold in the local market. For more details, see Table 9.

Table 9. Total production of agroforestry results

No	Commodity Type	Harvest frequency	Production per harvest (kg)	Unit price ($)	Total
A	Agroforestry				
1	Vanilla	Once a year	1064	$ 18	$ 19.152
2	Cocoa	Once a year	50	$ 1,75	$ 87,50
3	Pepper	Once a year	290	$ 1,25	$ 201,25
5	Citrus	Once a year	50	$ 15,00	$ 750,00
6	Porang	Once a year	1953	$ 2,50	$ 1.625,00
7	Agarwood	Once a year	25	$ 25,00	$ 625,00
	Total				$ 22.440,75
B	Non-Agroforestry				
1	Teak		25	$ 25,00	$ 625,00
2	Coffee	Once a year	15625	$ 0,30	$ 4.687,50
	Total				$ 5.312,50

Primary data analysis sources 2021.

Table 9 shows that out of 30 respondents, it is said that income in Leimea Sorin Village is vanilla as a plant with high economic value compared to other plants. This is because the community in Timor Leste has yet to widely plant vanilla, and there is no knowledge about vanilla plant management techniques.

Other income. Other income not from agroforestry is selling chickens, pigs, cows, and goats. These are sold at different prices but not yearly and are sold when urgently needed. For more details, see Table 10.

Table 10. Other income

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No	Source of Income	Amount	Selling price ($)	Frequency (per month/year)	Description
1	Chicken	850	$25 per head		
2	Goat	300	$250 per head		Depending on immediate needs
3	Pig	100	$600 per head		
4	Cow	450	$750 per head		

Primary data analysis sources 2021

Financial Analysis. The financial analysis is calculated based on price data taken in 2017-2021, with an interest rate of 10%. The NPV, BCR and IRR analysis results show that the vanilla agroforestry model in Leimea Sorin village is feasible to cultivate (Table 5). The NPV value for the vanilla agroforestry model is more profitable. This shows that in the model of plant types in agroforestry land, the plant with high economic value is Vanilla. For more details, see Table 11.

Table 11. Financial Analysis of the Agroforestry Model

Assessment Criteria	Agroforestry Model in Leimea Sorin Village
NPV	220.184,66
BCR	28,7
IRR	35%

Primary data analysis sources 2021

The financial analysis results show that the NPV is $ 220,184.66, BCR 28.7 and IRR 35%. It is because of the results of the financial analysis of NPV, BCR and IRR with a feasibility value (NPV> 0, BCR> 1, IRR> interest rate). The NPV value of agroforestry farming in Leimea Sorin village is feasible to be developed. According to research by Hardjanto (2001) and Achmad and Purwanto (2012), the agroforestry pattern causes farmers to manage land more intensively because they can manage various types of plants, such as forestry plants, plantations, and crops. Siregar et al. (2006) and Diniyanti et al. (2013) explain that farmers with narrow land tend to plant wood with an agroforestry pattern. This system is more profitable than non-agroforestry.

Ecological Aspects. Based on the results of observations of the agroforestry model in Leimea Sorin village, a description of the vegetation types of plants cultivated in the vanilla agroforestry system can be obtained:

1. Agricultural plants include Vanilla (Vanilla planifolia), turmeric (Curcuma longa), ginger (zingiber officinale), papaya (Carica papaya L), chili (Capsicum frutescens), pouring (Amorphophallus et al.)
2. Plantation crops include Jackfruit (Artocarpus heterophyllus), chocolate (Theobroma cacao), orange (Citrus sp.), mango (Mangifera sp.), banana (Musa paradisiaca), areca nut (Areca catechu), coconut (Cocos nucifera).
3. Woody plants (forestry) include Mahogany (Swietenia mahogany), teak (Tectona grandis), Saigon (Paraserianthes falcataria), Gamal (Gliricidia sp.), bamboo (Bambusa blumuena), Gaharu (Aquilaria malaccensis). The study results show that the agroforestry model in Leimea Sorin

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village is an agroforestry system with polyculture properties and provides various benefits for the community compared to non-agroforestry systems. The diversity of plant species in agroforestry communities is one effort to avoid the failure of single-commodity-based production while creating environmental balance and food security. In general, the type of vegetation found in several types of trees, such as Mahogany (Swietenia mahogany), teak (Tectona grandis), Saigon (Paraserianthes falcataria), Gamal (Gliricidia sp.), bamboo (Bambusa blumuena), Gaharu (Aquilaria malaccensis). Types of plantation crops such as Jackfruit (Artocarpus heterophyllus), chocolate (Theobroma cacao), orange (Citrus sp.), mango (Mangifera sp.), banana (Musa paradisiaca), areca nut (Areca catechu), coconut (Cocos nucifera). Types of agricultural plants such as Vanilla (Vanilla planifolia), turmeric (Curcuma longa), ginger (gingiber officinale), papaya (Carica papaya L), chili (Capsicum frutescens), porang (Amorphophallus Muelleri BI) from various types and compositions in Leimea Sorin Village residents can be utilized to meet daily economic needs both for food and medicine. In addition to land utilization with agroforestry, which is generally applied, the community also utilizes home yards with agroforestry systems such as chocolate, bananas, jackfruit, coconuts, and vanilla (Surawan et al., 2024). From observations, the community has a coffee plantation, usually planted using an agroforestry model. It is based on the experience and knowledge of the community related to the planting season and the type of farming for farming.

Social Aspects. Local communities from the Kemak ethnic group, which grow crops such as vanilla, coffee, teak, and others as their daily livelihoods, are social aspects of implementing agroforestry in Leimea Sorin Balu village. In managing the agroforestry model in Leimea Sorin Balu village, agroforestry management is planted using agroforestry techniques. Vanilla and coffee are the mainstay plants in Leimea village, which are considered to have high economic value and can contribute to community income for school and other social interests.

In Leimea village, vanilla was planted traditionally from 2004 to 2008. In 2009, vanilla agroforestry farmers attended training from the NCBA company's technical team on vanilla cultivation techniques to improve the ability of vanilla agroforestry farmers on vanilla plant cultivation techniques. After the agroforestry farmer training, vanilla was planted with a 2 x 1 m planting distance. In between, it was planted with cocoa, banana, ginger, orange, advocate, gaharu, and porang plants. Vanilla has a selling value when the plants are producing.

The Leimea Sorin Balu village agroforestry model is managed through group management and cooperation. Cooperation is a culture or tradition of the Leimea Sorin community. It is a concrete social behavior and a value system of the social life of the Timor Leste community.

Local institutions and culture are studied from a social aspect. The central institution that functions as a driving force for farmers in agroforestry management is the farmer group. The interview results found that almost all vanilla agroforestry farmers were involved in farmer groups as administrators or members. Farmer groups have several functions, such as increasing human resource capacity and facilitating various efforts to advance farmers in managing agroforestry. The Cooperative Coffee Timor Company Institution assists in seed procurement, mentoring, education, and buyers of vanilla, chocolate, porang and pepper products.

Non-formal institutions in Leimea Sorin village are recorded as only customary institutions that maintain agroforestry land's sustainability through customary laws. In the community in Timor Leste, especially in Ermera district, there is a prohibition on carrying out certain activities at a location equipped with customary sanctions if anyone violates it. The community calls the term customary law with the local name Tara bandu, a set of rules that protect humans and nature, including the prohibition of forest burning, prohibition of picking unripe fruits, prohibition of theft,

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and there are sanctions for violators such as fines for livestock and money for customary ceremonies for exemption from sanctions.

CONCLUSION

The financial analysis of the agroforestry model in Leimea Sorin village shows that it is feasible to develop because the NPV is $220,184.66, BCR 28.7 and IRR 35%. Agroforestry is the right choice for utilizing community land because it can provide short- and long-term income.

The Timor Leste government, especially the Ministry of Agriculture and Forestry, needs to improve farmers' knowledge through socialization, training and field practice on agroforestry techniques and stand inventory to determine the potential of agroforestry and wood in the post-harvest process of agroforestry plants so that farmers enjoy better profits.

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