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Productivity and Constraint in Multipurpose Tree Species Cultivation: A Case Study from Cilimus Village, Wan Abdul Rachman Forest Park, Indonesia

Ceng Asmarahman, Surnayanti*, Indriyanto, Machya Kartika Tsani, Trio Santoso

Departement Forestry, Faculty of Agriculture, University of Lampung, Bandar Lampung 35145, Indonesia

Corresponding Author Email: surnayanti@fp.unila.ac.id

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ABSTRACT

Cilimus Village serves as a crucial buffer for the Tahura Great Forest Park, a conservation area in Lampung province, Indonesia, that embraces a social forestry conservation partnership system. Within this system, local communities engage in agroforestry practices; however, the specific multi-purpose tree species (MPTS) cultivated, their productivity, and the challenges encountered during cultivation remain poorly documented. This study endeavors to catalog the variety of MPTS cultivated, identify the most economically viable species, and elucidate the challenges impeding farmers in the agroforestry process. Employing a mixed-methods approach, this research utilized questionnaires, distributing 40 to local farmers, complemented by direct observations in the MPTS plantations to corroborate questionnaire findings with field conditions. Subsequent data processing and analysis were conducted through descriptive, quantitative, and qualitative methods. Findings reveal the cultivation of 14 distinct MPTS commodities by forest farmers in Cilimus Village, with clove emerging as the predominant crop. Importantly, cloves yielded the highest average annual fruit production per hectare, measured at 19.57 kg $yr^{-1} \cdot ha^{-1}$, which translates to an economic value of 2,152,700 IDR $yr^{-1} \cdot ha^{-1}$. Additionally, alongside MPTS, farmers also cultivate a range of non-MPTS crops, including bananas, areca nuts, chilies, and vanilla. Productivity constraints extend beyond climatic and environmental factors; limitations in human resources also critically affect MPTS harvests. Consequently, a comprehensive approach that addresses both environmental conditions and human resource development is imperative for augmenting MPTS yield.

1. INTRODUCTION

Cilimus Village, situated as a peripheral buffer to the Tahura Wan Abdul Rachman Forest Park (WAR) in Lampung Province, is emblematic of the intersection between conservation efforts and agricultural livelihoods. Land within the Tahura boundaries has been partially repurposed for agricultural activities under a government-sanctioned agroforestry system that prohibits new land clearing (Law No. 5 of 1990). This integration of conservation and cultivation is aimed at balancing protection, sustainable use, and biological diversity, echoing the objectives outlined in the Minister of Forestry's Decree No. 107/Kpts-II/2003 and the Regional Regulation No. 3 of 2012 of Lampung Province.

In this context, the agroforestry system, which amalgamates crop cultivation with forestry or livestock in a rotational scheme reflective of indigenous practices, is posited as a multifaceted land management solution. This system, by design, seeks to augment the aggregate yield from the land, thus providing economic, social, and environmental dividends [1-3]. Within this framework, Cilimus Village has adopted the cultivation of multi-purpose tree species (MPTS) as a strategic economic maneuver. MPTS, characterized by their diverse utility in providing wood, leaves, and fruit, offer a sustainable model for enhancing farmer income while preserving forest integrity [4].

The MPTS model underscores both economic and ecological imperatives, enabling farmers to reap regular harvests without resorting to deforestation. Such an approach underpins the conservation mission of Tahura WAR by ensuring the forest's role in ecological balance is sustained. Adoption of MPTS within the agroforestry paradigm is particularly pertinent to community-managed lands like those in Cilimus Village, which abut the Tahura WAR area and are heavily reliant on agriculture as a primary livelihood.

Despite the critical nature of this agricultural system, there remains a dearth of detailed information on the management practices employed by local farmers, specifically concerning the variety of MPTS cultivated, their productivity levels, and the challenges encountered in cultivation. Prior research has largely focused on the socio-economic aspects of local communities [5, 6]; however, a comprehensive understanding of management issues is essential for optimizing harvest outcomes. This study, therefore, aims to elucidate the spectrum of MPTS planted, identify the species with the highest economic yield, and articulate the cultivation constraints faced by farmers in Cilimus Village. In achieving these objectives, the research will contribute to resolving the

impediments to enhancing MPTS productivity in the region.

2. MATERIAL AND METHODS

This research was conducted in September 2022 in the Tahura WAR area of the case study Tahura Buffer Village in Cilimus Village, Teluk Pandan District, Pesawaran Regency, Lampung Province (Figure 1). The target of this research is the forest farming community that farms in the Tahura area.

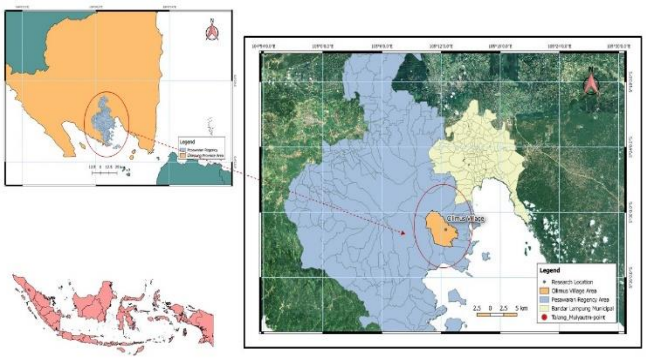

Figure 1. Reasecah location

The research tools used were GPS (Global Position System) and questionnaires. Interviews were conducted directly with farmers who have cultivated land in Tahura WAR. This interview was conducted using a questionnaire tool with an essay model with open questions.

(a) Interview by visiting the house

(b) Interview by inviting to gather in the village hall yard

Figure 2. Documentation during interviews with several forest farmers in Cilimus Village

Data collection techniques were carried out through open interviews. forty respondents. These respondents were selected who have cultivated land in various different locations, to represent the condition of the cultivated land of the Cilimus Village community. If the respondent has more than one cultivated land, only one is considered. The activity of filling out questionnaires for forest farmers is carried out in 2 ways, namely by visiting the houses of forest farmers in Cilimus village, and inviting them to the Village Hall (Figure 2). The purpose of the interview was to obtain data in the form of the number and type of MPTS plants cultivated, the harvest results obtained for each MPTS plant, commodity prices, and data on obstacles in MPTS cultivation. Data analysis in this study used qualitative and quantitative descriptive analysis. Qualitative and quantitative descriptive analyzes were carried out to find out what types of MPTS plants were planted and how productive they were, as well as what cultivation constraints faced by farmers in managing MPTS plants. The data obtained is processed and the average monthly results are calculated and even the projected annual profits are then tabulated or explained. The interview method was used because many farmers had limitations in filling out questionnaires directly. To strengthen the interview results, the researcher also made observations using the direct observation method. The aim is to carry out a cross check directly to the farmer's cultivation area, to match the suitability of the type of plant at the time of the interview with the actual situation. So that the data obtained is more valid or accurate.

Overall, Tahura consists of hilly areas and mountains that vary from gentle, steep and very steep plains. There are three types of soil in the Tahura area, namely Dystropept, Kanhapludult and Humitropept. Based on the Schmidt-Ferguson climate classification, it is included in climate zone B (wet area).

3. RESULTS AND DISCUSSION

The cultivation of MPTS plants is closely related to the productivity produced, this will determine the level of income or welfare of forest village communities in Cilimus Village. In recent years, farmers often experience crop failure which causes less than optimal yields, so in this study we examine why this can happen, what are the real causes so that we can provide the right solution in MPTS cultivation activities.

Based on the results of research conducted on forest farming communities in Cilimus Village, it is known that there are 14 types of MPTS crop commodities that they develop on their cultivated land (Table 1). MPTS plants are a class of woody plants that have many benefits [7]. MPTS plants are timber plants that are multi-purpose because they are beneficial from an ecological and economic perspective, and produce wood and non-timber commodities so that sharecroppers can take advantage of non-timber commodities from MPTS plants that are planted without logging trees. Multipurpose tree species (MPTS) are woody plant species but the parts that are utilized are: sap, fruit, leaves, flowers, fiber, and so on (Peraturan Menteri Kehutanan Republik Indonesia 2012). The MPTS plants planted are fruit plants that have multiple functions and have certain requirements, including; being suitable for growing areas and having high economic/market value, and can collect the produce/fruit without cutting down the trees.

Types of plants are classified into two, namely tolerant and intolerant MPTS plants. Based on the results of research on cilimus (Table 1) there are several types of plants that are included in the tolerance, namely clove, jengkol, coffee, melinjo, and jackfruit, while intolerant plant types are avocado,

sugar palm, duku, durian cocoa, candlenut, nutmeg, petai, and rambutan plants. The nature of plant tolerance is the ability of plants to the intensity of sunlight to obtain optimal growth [8], this is also supported by researches [9] and [10] that the ability of plants to receive sunlight is an ecological characteristic of plants, so that in the selection This type of plant is needed especially in a land that has many types of plants.

The types of plants developed by the forest farming community in Cilimus Village are MPTS plants that produce fruits, seeds, flowers and leaves. The consideration is that because the farmer's land is in a conservation area, cultivatorsare only allowed to take non-timber forest products from what the farmer grows on the land, such as fruits. Some of the plants developed by the community are already producing and some are still young (not yet producing), even old MTPS plants are not producing such as sugar palm, jackfruit and rambutan plants (Table 2). The land cultivated by the forest farming community of Cilimus Village is land that is planted with lots of plants. Based on direct observation of plants too tight results in not being able to grow and develop optimally, this is also in line with research [11] that there is plant tolerance for plants that receive sunlight. Plants will grow well if the growing space matches the ideal conditions for the plants, if the growing conditions do not match the site conditions and desired microclimate then the vegetative and generative growth of the plants will be disrupted.

Table 1. Nature and utilized parts of plants planted by forest farmers in Cilimus Village

Scientific Name	Local Name	Nature of Plants	Utilized Plant Parts
Persea americana	Avocado	Intolerant	fruits, leaves
Arenga pinnata	Sugar palm	Intolerant	fruit, sap
Syzygium aromaticum	Clove	Tolerant	flowers, leaves
Lansium domesticum var. *duku Hasskl*	Duku	Intolerant	Fruits
Durio zibethinus	Durian	Intolerant	Fruits
Archidendron pauciflorum	Jengkol	Tolerant	Fruits
Theobroma cacao	Cacao	Intolerant	fruits, seeds
Aleurites moluccana	Candlenut	Intolerant	Seed
Coffea canephora	Coffee	Tolerant	Seed
Myristica fragrans	Nutmeg	Intolerant	fruits, flowers, leaves
Gnetum gnemon	Melinjo	Tolerant	seeds, leaves
Artocarpus heterophyllus	Jackfruit	Tolerant	Fruits
Parkia speciosa	Petai	Intolerant	Fruits
Nephelium lappaceum	Rambutan	Intolerant	Fruits

Table 2. Production of MPTS plants planted by the people of Cilimus Village

Local Name	Plant Age, Years	Average Production, $yr^{-1} \cdot ha^{-1}$	Unit	Average Selling Price, IDR	Value of Yields, $IDR \cdot yr^{-1} \cdot ha^{-1}$
Avocado	3–20	5.94	kg	5.500	32.670
Sugar palm	9	not production	kg	-	-
Clove	1–20	19.57	kg	110.000	2.152.700
Duku	10–15	22.54	kg	5.000	112.700
Durian	1–40	117.42	fruit	10.000	1.174.200
Jengkol	3–20	55.74	kg	6.000	334.440
Cacao	3–25	52.15	kg	22.000	1.147.300
Candlenut	1–25	42.42	kg	6.000	254.520
Coffee	3–24	10.25	kg	22.000	225.500
Nutmeg	1–12	8.77	kg	45.000	394.650
Melinjo	7–35	106.56	kg	6.000	639.360
Jackfruit	5	not production	fruit	-	-
Petai	3–20	3.01	per 100 pieces	90.000	270.900
Rambutan	20	not production	kg	-	-
		Average yield			6.738.940

There are 11 types of MPTS plants planted by forest farming communities in Cilimus Village that are still productive (Table 2). The average age range of MPTS plants planted varies, from young plants that are 1 year old to MPTS plants that are 35–40 years old, such as melinjo and durian types. MPTS crops currently being developed by cultivators are durian, nutmeg, cloves, and candlenut. The considerations of farmers planting these 4 types of plants are that they are suitable for growing in local microclimatic conditions, the selling price is quite expensive and stable, and they are easy to market specifically for clove and nutmeg plants. analysis (Table 2) the clove plants of the MPTS type produced the highest average fruit per hectare per year, namely IDR 2,152,700, this yield was higher than the other types. Then followed by the type of durian per hectare per year, which is IDR 1,174,200. Apart from cocoa, the average cocoa yield per hectare per year is around IDR 1,147,300.

The next potential or choice of MPTS plants to be used as superior plants by forest farmers in Cilimus Village is cloves. This is also in line with the studies [12, 13], which researched that farmers would like to plant MPTS plants that have high economic value. Clove plants usually thrive in tropical soils such as in Indonesia. When the plants are mature and productive, clove plants can produce twice a year. However, in the area cultivated by farmers in Tahura WAR, they only harvest once a year, this is caused by many factors that influence it, namely the types of seeds that are of poor quality, due to climate change and uncertain seasons, as well as a lack of care, fertilization and plant maintenance by farmers.

Cloves are widely used as a cooking spice in European

countries and as the main ingredient in Indonesian kretek cigarettes. Almost all parts of the clove plant, namely flowers, stems and clove leaves, contain clove oil. Clove oil content in the three forms of harvest is clove flowers 12–15%, clove flower stalks 4–4.5%, and clove leaves 2–2.4% (Broto 2014). Clove oil comes from clove leaves, stems and flowers and overall has almost the same SNI standard value. This compound has wide applications in the food industry and has been used as a precursor in the synthesis of certain compounds by the pharmaceutical and cosmetic industries [8]. The compound 4-allyl-2-methoxyphenol (eugenol) which is the active component of cloves has been used traditionally in Asia as a popular medicine, especially as an antiseptic, analgesic, and antibacterial agent [14, 15].

Several years earlier, cacao was the main crop type for profit-sharing farmers in Cilimus Village because it has high productivity and stable prices. However, in recent years, this cocoa plant is no longer used as a superior crop because this type no longer gives optimal results, because cocoa plants are susceptible to disease, causing a decrease in quality and quantity. This problem occurs allegedly because sanitation in the cocoa planting area does not support plant development and growth. Cocoa plants are intolerant plants that can grow well if they get maximum sunlight.Forest farmers' orientation had changed before planting cocoa in a monoculture system, but now farmers prefer nutmeg and cloves. Selection of nutmeg is an attractive option for forest farmers because this plant has several advantages, namely: it can still grow and produce well even though it is planted in fairly dense stands, has relatively high commodity prices, is easy to market, and is quite resistant to pests and disease. This is supported by researches [16-18] that the nutmeg plant is also widely used in the pharmaceutical industry, besides having ecological functions such as providing a source of water and preventing erosion and erosion of trees.

Based on research results and information obtained in the field, most of the cocoa plants grow on papaya trees or other trees that have a fairly high canopy density, so that the cocoa plants are very protected and the environmental sanitation in which they grow is not good. In addition, the maintenance carried out by sharecroppers on MPTS plants is still minimal, such as activities without pruning, only some farmers carry out fertilization maintenance activities, pest and disease eradication activities are still very minimal, and maintenance only takes the form of weeding (Figure 3).

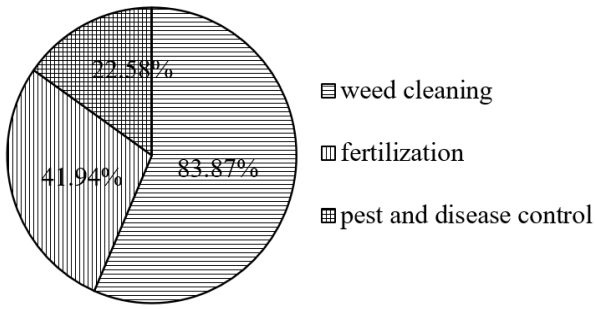

Figure 3. Percentage level of care for MPTS plants in Cilimus Village

This type of clove has the advantage that the production of clove is faster than other commodities so farmers expect to get yields faster [19]. The condition of clove in Indonesia experienced ups and downs due to high fluctuations in clove prices. The distinctive characteristic of clove is that clove experience a big harvest but are followed by a small harvest the following year, then there are times when the clove will be harvested in a certain period.

Apart from cultivated MPTS plants, forest farmers in Cilimus Village also planted several types of non-MPTS plants such as banana, betel nut, tabasco pepper, and vanilla plants (Table 3). Banana plants are usually planted by sharecroppers as intercropping plants which are planted in areas that are still empty under MPTS stands, as well as tabasco pepper plants which are planted on the sidelines of empty areas. Meanwhile, the betel nut plants are planted on the edge of the area as hedges, and the vanilla plants are planted under the MPTS stands as a platform for vines, because the vanilla plant is a type of liana that grows on other plants.

Table 3. Types of non-MPTS plants cultivated in Cilimus Village

Cultivated Non-MPTS Plants	Scientific Name	Plant Benefits
Banana	*Musa* × *paradisiaca* L.	Food crops
Betel nut	*Areca catechu* L.	As an export commodity
Tabasco pepper	*Capsicum frutescens* L.	Food crops
Vanilla	*Vanilla planifolia* Andrews	As a food and spice commodity

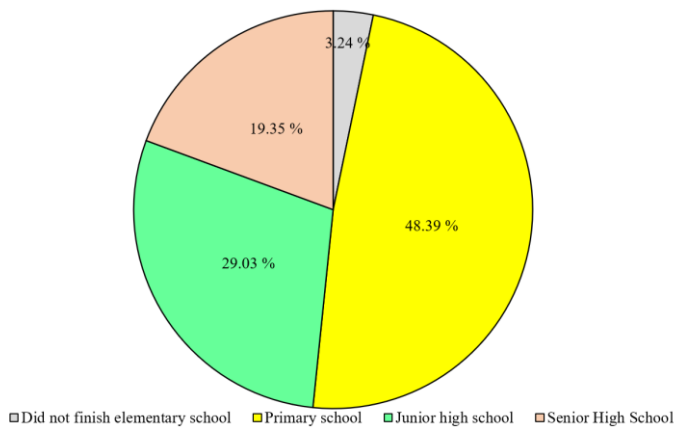

Figure 4. Percentage of the education level of forest farmers in Cilimus Village

Some forest farmers plant vanilla because the price is very tempting this type has a selling price of around 200,000 IDR to 250,000 IDR per kg. The high price of this commodity is due to the many benefits of the vanilla plant, which is a necessity in the food flavoring ingredient business. Another advantage of planting vanilla can be done on a narrow land.

Furthermore, a person's success in carrying out their activities is closely related to the educational background obtained so far. For this reason, in this research, a study was also carried out on the correlation between social aspects in the form of the level of education of a sharecropper in Tahura WAR in carrying out his agricultural activities. Based on the results of field research, the education level of farmers in Cilimus Village was classified into 4 groups, namely farmers with educational levels who did not finish elementary school, graduated from elementary school, graduated from elementary school, graduated from junior high school and graduated from high school (Figure 4). From these data, it can be seen that many residents of Cilimus Village have low education, namely elementary school graduates. Whereas human resources are an important factor and the main pillar in national development and regional development. Seeing conditions like this, the government and all stakeholders must be proactive in realizing cheap and quality education that can be accessed by all levels of society, both formal and non-formal education.

The higher a person's level of education will certainly affect a person's mindset/way of thinking in a better direction, so if a farmer has an adequate level of education, of course, the farmer's way of thinking in improving his standard of living will also be better in line with the education he gets.

In addition to the problem of education level, another problem is directly related to the agricultural activity itself, namely forest farmers still get very little counseling and guidance from related external parties about the agricultural activities carried out so farmers do not understand how to choose or get quality plant seeds, how to cultivating the right arable land, as well as good care so that the productivity of the plants they plant can produce optimally. They have not obtained basic things in agricultural activities like this at all so far, so of course, agricultural activities cannot provide guarantees for increasing their income and welfare this is in line with research [20] that the training aims to provide insight and skills regarding good crop management so that it can assist the community in increasing crop productivity.

Based on the results of interviews with forest farmers in Cilimus Village, the current climate conditions are difficult to predict, even though the climate has an important role in helping the growth and flowering processes of plants. In Cilimus Village, strong winds often damage the fruiting of plants. Plants whose fertilization often fails due to climate, namely the fertilization of durian and clove plants, this is in line with research [21] that climate can determine plant growth and even climate can inhibit plant growth.

In addition, pest and disease attacks also affect MPTS plants. Based on the results of interviews with forest farmers, the types of insects that often attack are insects/fruit flies. According to the community, these insects can cause fruit plants to rot, or fall even though they are still young. In the village of Cilimus, a disease attack that often attacks phytoptora plants, this type attacks most of the cocoa plants. Biological climate change will affect all life on earth, including humans, animals and plants. In the context of plant pests and diseases, climate change will also affect the incidence of disease and the occurrence of pest attacks on MPTS plants cultivated by farmers in Tahura WAR. Climate directly affects the bioecology of insect pests, such as drastic climate changes, which will disrupt the insect breeding process (decrease or increase) [22]. To reduce the risk of pest and disease attacks on MPTS plants, farmers are expected to select and plant quality MPTS plant seeds so that they can adapt to existing conditions. Furthermore, MPTS plants need intensive care starting from regular fertilization activities, cleaning weeds and controlling pests and diseases using pesticides and insecticides wisely.

4. CONCLUSIONS

Based on the results of research conducted in Cilimus Village, Wan Abdul Rachman Forest Park, it can be concluded as follows:

1. There are 14 types of MPTS crop commodities developed by Cilimus Village Forest farmers. The types of MPTS plants developed are avocado, sugar palm, clove, duku, durian, jengkol, cacao, candlenut, coffee, nutmeg, melinjo, jackfruit, petai, and rambutan types.
2. Clove-type MPTS plant is a superior plant because it produces the highest average yield per hectare per year compared to other types, which is around 2,152,700 IDR. Then followed by types of durians and cacao, with yields per ha per year respectively 1,174,200 IDR and 1,147,300 IDR.
3. The problems and obstacles found by farmers at the research location are that farmers' educational resources are still low, namely more than 50% of forest farmers in Cilimus Village have elementary school education, so this will influence a person's way of thinking. Another problem is the lack of extension activities and guidance from external parties or the government, as well as climate factors, strong winds, pest and disease attacks which also contribute to crop failure in MPTS plants.

5. RECOMMENDATIONS

It is necessary to carry out further research on the quality of the place where MPTS plants grow in the form of soil fertility values (both physical and chemical properties of the soil) in relation to increasing the productivity of the types of MPTS plants cultivated in Cilimus Village.

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