

# Cacao Agroforestry in Mahakam Ulu: Transformation Strategy from Traditional to Smart Agroforestry System

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## ABSTRACT

The Dayak community in East Kalimantan is well known for its traditional Agroforestry (AF) systems that are passed down over generations. Meanwhile, despite the long-term introduction of cacao in 1996 as a potential commodity in the AF practice, productivity concerns continue to persist. This study analyzed challenges and strategies for adapting and transforming traditional AF practices into Smart Agroforestry (SAF) systems for cacao. The implementation of cacao SAF is expected to enhance cacao productivity, improve the welfare of local communities, and preserve the forest's function as a crucial life support system for the Dayak Community in Mahakam Ulu (Mahulu) District. Data were collected through the Triangulation Method, using interviews of selected respondents with structured questionnaires, in-depth interviews with key informants, and focus group discussions to verify and validate data. Additionally, participatory mapping was carried out on AF cacao pattern to identify the area and its cultivation technique. Data were processed using qualitative descriptive analysis, gender, and SWOT analysis. The results showed that the development of cacao-based agroforestry in Mahulu District was carried out by applying the green economy concept and considering the potential for cacao marketing, socio-economic culture, gender, and traditional knowledge. However, further development efforts are needed to improve traditional cultivation towards SAF practices. This requires multi-stakeholder collaboration from the regional level, comprising farmers and village government to the central government. Several important factors should be considered for better management of cacao cultivation. These factors include intensifying input production to increase land productivity, assuring land ownership status, improving the quality of products, increasing access to capital, as well as strengthening local institutions for a more effective and efficient marketing process.

## KEYWORDS

Cacao; Traditional agroforestry practices; Deforestation; Strategy; Smart agroforestry.

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## 1. INTRODUCTION

Cacao plant (*Theobroma cacao* L.) is native to tropical South America (Pemkab Mahulu, 2018a; Zhang & Motilal, 2016) and belongs to the Malvaceae family (Kim et al., 2011; Knight, 1999). The plant is an evergreen tree that reaches 6 to 12 m in height and grows in a limited geographical zone from approximately 20° North to 20° South of the Equator (Kim et al., 2011). Dillinger et al. (2000) stated that cacao plantations spread across the equatorial regions covering over 70,000 km<sup>2</sup> worldwide. Approximately 70% of the global production originates from West Africa, while the rest is from Central and South America, the West Indies, and tropical areas of Asia (Dillinger et al., 2000).

Indonesian cacao production contributed 14.26% to the total world cacao production (Ditjenbun, 2022; ICCO, 2024, analyzed). The use of cacao has been most known for its processing into chocolate, in both solid and liquid forms. Furthermore, significant quantities are used for numerous foods and beverages.

Cacao, as an estate crop, holds excellent prospects for development in tropical countries and has become an important plantation commodity in Indonesia (Ariningsih et al., 2019; Hasibuan et al., 2012; W. A. Wulandari & Widjojoko, 2021). It is a significant source of foreign exchange besides palm oil (Choiruzzad, 2019; Rahman et al., 2021; Sultan et al., 2019) and natural gas (Sinaga et al., 2019). Indonesia is the third-largest cacao producer and exporter worldwide (Fahmid et al., 2022; Tothmihaly et al., 2017) after Côte d'Ivoire and Ghana (Kongor et al., 2016). Production in 2021 reached 728,046 tons (FAO, 2024) but slightly decreased to 667,296 tons in 2022 (Ditjenbun, 2022) and was classified into three groups, namely Private Large Plantations (Perkebunan Besar Swasta/PBS), State Large Plantations (Perkebunan Besar Negara/PBN) and community plantations (Perkebunan Rakyat/PR). From 2013-2022, community plantations (PR) dominated, with an average cocoa production reaching 98.29% annual contribution of the entire Indonesian plantation area, while the rest 1.71% was contributed by PBS and PBN (Kementan, 2022).

In Indonesia, cacao plantations are carried out either in monoculture (without shade) (Santhyami et al., 2018) or mixed cropping system/agroforestry (Utomo et al., 2016). Naturally, the plant grows in wet tropical forests (Schroth et al., 2011) and develops under the shade of the forest (De Almeida & Valle, 2008). Therefore, cacao should be planted with other shade plants to protect from direct sunlight with an agroforestry (AF) pattern (Kemenhut, 2012; Sumilia et al., 2019).

AF is an integrated land-use system (Lassoie et al., 2015; Schroeder, 1993) widely practiced (Achmad et al., 2022) by the community in Mahulu District located at the Indonesia - Malaysia boundary. It is defined as a land-use system where trees are managed together with crops and/or animal production systems in agricultural settings within or outside forest areas, through spatial and temporal arrangements, simultaneously or alternately (FAO and ICRAF, 2019). AF systems are dynamic, ecologically based, natural resource management frameworks that diversify and sustain production to increase social, economic, and environmental benefits for land users at all scales (FAO, 2021). Despite widespread practice over generations, the productivity of cacao AF has not been optimal due to several factors, including farmers' lack of knowledge regarding cultivation practices and post-harvest handling. Based on the current condition of the cacao AF practice in Mahulu, we suggest that improving cacao AF practices is crucial to achieving the standards of Smart Agroforestry (SAF). In this context, SAF refers to agricultural and silvicultural practices aimed at not only improving environmental parameters, including climate change mitigation and adaptation, biodiversity enhancement, as well as soil and water conservation but also increasing profits and resilience for farmers (Octavia et al., 2022).

AF is also an alternative solution to achieve sustainable forest management, specifically in forest areas adjacent to community settlements that in many cases have induced forest conversion into agricultural land (Singh et al., 2021). Conversions have caused problems such as decreased soil fertility (Widyati et al., 2022), erosion (Wasis et al., 2020), decline in floral diversity (van Vuuren et al., 2006), fauna diversity (Dunn, 2004; Outhwaite et al., 2022), soil fungal diversity (Navarro-Noya et al., 2021), soil microbial diversity (Merloti et al., 2019), soil organic matters (Chen et al., 2020), and increased frequency and incidence of floods (Netzer et al., 2019), and droughts (Staal et al., 2020). The issue primarily concerns the impact of climate change on land productivity, biodiversity, and livelihoods of local communities. This phenomenon also

occurred in West Kutai and Mahulu Districts between 1990 – 2009 where forest cover decreased due to the conversion of the forest land into agricultural land (van der Laan et al., 2018). Therefore, the introduction of cacao SAF practices can help resolve challenges of balancing the need for land for tree-crop farming.

Therefore, this study aimed to examine the challenges in cacao AF development as well as formulate adaptation and transformation strategies from traditional cacao AF into cacao SAF. The goal is to increase productivity, improve the welfare of local communities, and maintain the function of forests as life support systems in Mahulu District. The main gap that needs to be bridged is to match cacao-based AF development with local government programs and traditional knowledge about natural resource management. Another key aspect is examining how the implementation of cacao-based AF development in Mahulu District is in line with Indonesia's commitment to reduce carbon emissions and protect remaining tropical rainforests.

## 2. MATERIALS AND METHODS

### 2.1 Theoretical framework

Many Indonesian farmers use traditional farming patterns that combine fruit trees with coffee or rice (Sardjono et al., 2003), a combination of trees and crops, or a complex mix of trees and herbs (Michon & de Foresta, 1995, 1996). Despite its existence for several decades (Achmad et al., 2022) to hundreds of years (Michon & de Foresta, 1996), this pattern has not received significant attention. Intercropping patterns known as “agroforestry” entail using crops and woody perennials on the same land management unit (Aumeeruddy-Thomas & Michon, 2018; Brown et al., 2018; Zerihun, 2020). It is a strategy adopted by local people to ensure daily, weekly, and monthly income and subsistence. Agroforestry allows farmers to work and earn from diverse plant species including fruits, cash crops, food crops, wood, and other by-products (Murniati et al., 2022a; Octavia et al., 2022). This approach has become a complex pathway for achieving important objectives in natural resource management and poverty alleviation, and increasingly as a strategy to address climate change (Nair, 2012; Octavia et al., 2023; van Noordwijk, 2019).

AF practices in Indonesia are motivated mainly by the need for livelihoods (Murniati et al., 2022b; Parhusip et al., 2019). These practices are typical of simple resource-poor conditions (Arnold, 1983) indicated by limited land ownership, where intensive farming may require greater capital, materials, and equipment (Murniati et al., 2022a; Yeny et al., 2021). Agroforestry operations, therefore, are crucial in enabling farmers to maximize land use with limited resources, including land, capital, and access. The selection of crop combinations typically has considered subsistence, commercial, and land suitability principles. Some of the best practices of AF have become benchmarks for community success in forest management such as in Kenya (Quandt et al., 2019), Pakistan (Ahmad et al., 2021), Sri Lanka (Dissanayaka et al., 2023), and Central Himalaya (Sharma & Vetaas, 2015). There are numerous examples of best AF practices in Indonesia, including Repong Damar agroforestry in Krui-Lampung (Wijayanto & Hartono, 2015); the integration of local tubers with cacao farming in Lore Lindu National Park, Central Sulawesi (Pribadi et al., 2021); the common practice of intercropping cacao (*Theobroma cacao*) with various fruit tree crops in Paru Village Forest, West Sumatra (Yeny et al., 2021); and the development of an agroforestry system with diverse forest tree and multipurpose tree species in Gunung Kidul, Yogyakarta (Sulistiyowati et al., 2023).

In many cases, effective and sustainable agroforestry requires increased integration of not only trees, but also people, considering technological, economic, and

social conditions. There is a need to further adjust existing agroforestry patterns towards more effective practices, known as “agroforestry plus” or SAF. Agroforestry plus refers to a combination of agricultural and silvicultural knowledge meant to improve environmental parameters, such as biodiversity enhancement, soil, water conservation, and coping with climate change, while ensuring sustainable landscape management which will increase profits and resilience for farmers. (Octavia et al, 2022). SAF is a typification of sustainable agricultural practices which not only have ecological and economic sustainability principles but also consider components of the ecosystem (humans, flora, fauna), in ways that are adaptive and socially flexible (Kementan 2014).

SAF has subsequently developed into a scientifically supported approach that helps traditional and contemporary agricultural systems accomplish significant objectives for natural resources management and socioeconomic gains. However, despite many benefits, application on a larger scale still requires knowledge and collaboration with various stakeholders to achieve sustainable land and forest management (Octavia et al., 2022; Zerihun, 2020). In terms of tenurial status, farmers practicing SAF are more likely to request clarity on the tenure status of the land being worked on. This is related to the certainty of long-term business sustainability for optimal profit.

In Indonesia, various forest management schemes are in line with transforming perspectives on AF as an efficient means to promote long-term land-use management. Nandini et al. (2023) stated that developing agroforestry under forest stands is a wise and viable option to increase productivity and income, specifically in private forests. Some basic and critical points that distinguish traditional AF with SAF are presented in Table 1.

**Table 1.** The main distinctions between AF and SAF

Parameters	Agroforestry (AF)	Smart Agroforestry (SAF)
Institutional	<ul style="list-style-type: none"> <li>● Mostly informal and based on agreement and norms agreed among members</li> </ul>	<ul style="list-style-type: none"> <li>● Strengthening local institutions by adopting more formalized norms and rules (farmer organization)</li> </ul>
Knowledge base	<ul style="list-style-type: none"> <li>● Traditional knowledge-based across generations</li> <li>● No cross-sectoral coordination</li> <li>● Locally adopted and adapted according to the requirement of local conditions</li> </ul>	<ul style="list-style-type: none"> <li>● Considering local resources, by adopting knowledge (both advanced and traditional), technology, and management</li> </ul>
Tangible benefits	<ul style="list-style-type: none"> <li>● For subsistence use with low external input</li> <li>● Having a diverse production system that does not rely too heavily on a single resource</li> </ul>	<ul style="list-style-type: none"> <li>● Farming practices both for subsistence and commercial use with proper resource use to provide high economic added value and business diversification</li> <li>● Emphasize quality and production sustainability</li> </ul>
Intangible benefits	<ul style="list-style-type: none"> <li>● Capable of dealing with climate change</li> <li>● Mostly relies on natural regeneration and prefers extension farming</li> </ul>	<ul style="list-style-type: none"> <li>● Capable of dealing with climate change</li> <li>● More effective and efficient farming practices with intensive cropping patterns</li> </ul>

[Source: Adopted and modified from (Ntawuruhunga et al., 2023; Octavia et al., 2023)]

Cacao-based AF practiced by Dayak people in Mahulu, East Kalimantan Province reflects how traditional knowledge has been refined and implemented to optimize land use (Aziz et al., 2023; YKAN, 2021b). Although a combination of traditional and modern knowledge systems has been applied, productivity still needs to be improved (Aziz et al. 2023; YKAN, 2021). The sustainability in using natural resources is not only limited to the benefits generated, but also the characteristics and complexity of existing resources, extent, and quality, including the condition and readiness of the community. Resource potential and risk are elements that must be considered, specifically land typology, land tenure, and the potential of agricultural area expansion. When determining land use techniques, smallholder farmers must consider the tradeoffs of different land uses, such as profitability and cultural disposition. In other words, it should comply with the concept of “green economy” that prioritizes economic, social, and environmental sustainability in a balanced way (Hidayat et al., 2023; UNEP, 2023).

The development of cacao agroforestry in Mahulu District and Indonesia generally requires an operational strategy that continues to adopt best practices based on traditional knowledge. However, it should be supported by adaptation efforts in line with the dynamics of change and the demands of the season. The concept of ‘Green economy’ in Indonesia thus supports the achievement of sustainable development goals. This approach emphasizes a low-carbon economy that is resource-efficient and socially inclusive. (Darmayanti et al., 2023; Sara et al., 2023).

## **2.2 Logical framework**

This study focused on the efforts of a local government to improve cacao farmers’ welfare by identifying challenges in AF development as well as formulating adaptation and transformation strategies toward SAF practices. In its implementation, there are several primary challenges including intensifying input production to increase land productivity, assuring land ownership status, improving the quality of products, increasing access to capital, as well as strengthening local institutions for a more effective and efficient marketing process that must be addressed in the development of cacao in Mahulu Regency.

The history of cacao plantations in Mahakam Ulu District began in early 1996. However, this commodity just begun to develop widely in 2006. Meanwhile, local government support related to the formal development of cacao commodities started in 2019 through the Strategic Plantation Plan of East Kalimantan Province, which aimed to intensify cacao cultivation in the province. The strategic plan focuses on the development of traditional cacao AF.

In addition, Indonesia has committed to participate in emissions reductions programming through the Nationally Determined Contribution (NDC) 2010-2030 and aims to reduce GHG emissions by 31.89% with its own efforts and 43.2% with international support until 2030. In 2015, East Kalimantan was appointed as a pilot location for the Forest Carbon Partnership Facility Framework (FCPF)-Carbon Fund Program. Since the 2016-2019 period, the site implemented its preparation phase, and in 2020-2024 the implementation phase sought to reduce emissions by 22 MtCO<sub>2</sub>e in the land-based sector (Forestry and Plantation). Developing programs and policies to reduce emissions and climate change mitigation actions can be carried out by involving cocoa farmers through sustainable farming development. Land-based sector emissions reductions program policies at the provincial level are in line with policies at the district/city level as outlined in the Governor of East Kalimantan Regulation Number 522, 2022, concerning the Establishment of a Greenhouse Gas Emission Reduction Program Management Team within the FCPF of East Kalimantan Province.

SAF programming anticipates that the development of cacao initiatives will increase community resilience in facing the impacts of climate change and provide significant additional income for farmers. In addition, since cacao seedlings were planted mostly on unproductive land and as additional plants among the existing tree crops, such efforts will significantly increase land productivity of cultivated land. Subsequently, obtaining significant additional income from the cacao yield to meet community needs will reduce the community's dependence on the surrounding forest resources. The chances of land encroachment/land grabbing which can trigger deforestation and carbon emissions can be minimized substantially.

The central research question that drives this research is: What strategy and adaptations are necessary to facilitate the transformation from traditional cacao AF practices into SAF practices to improve community welfare while simultaneously supporting Indonesia's efforts to reduce emission? The logical framework is presented in Figure 1.

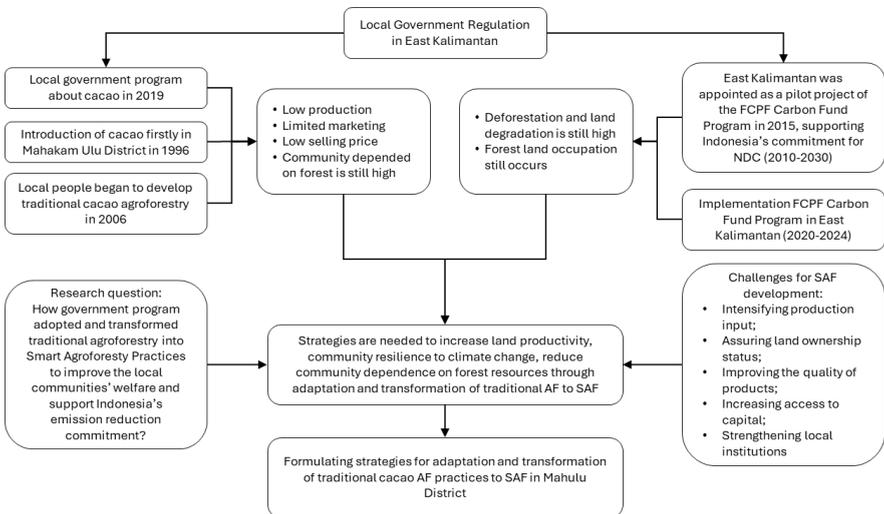


Figure 1. Study Logical Framework

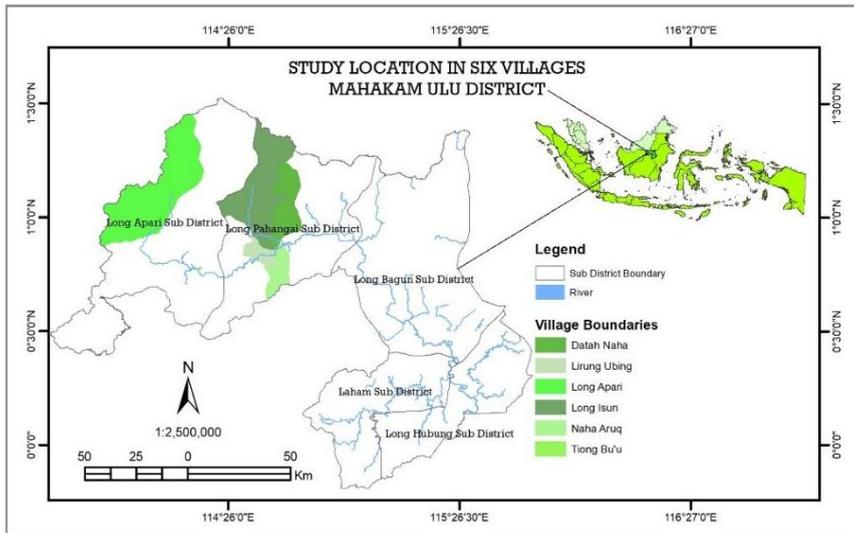
### 2.3 Study location and time

This study was conducted from June to December 2022 in Mahulu District, East Kalimantan Province. A total of six villages were selected representing various Sub-districts, ethnic groups, and AF types. The villages included Lirung Ubung, Long Isun, Data Naha, and Naha Aruq Villages in Long Pahangai Sub-district, as well as Long Apari and Tiong Bu'u Villages in Long Apari Sub-district (Figure 2). The selected villages had the most considerable cacao potential in Mahulu District. The region has an altitude of about 100 – 2,000 meters above sea level with an average annual rainfall of 75 – 150 mm/month (BPS Kutai Barat, 2023; Dishut Kaltim, 2021).

### 2.4 Sampling and data collection

Primary data were obtained using the Triangulation Method comprising interviews with respondents selected purposively, in-depth interviews with key informants, and focus group discussion (FGD). Field observation and participatory mapping were also carried out to acquire a more detailed description of cacao AF practices. The respondents interviewed in this study were between 10 - 30 people from each village, with a total of 119 respondents, including cacao farmers and cacao bean collectors, village

government, customary institutions, and community leaders. We also conducted 6 FGDs and 18 Key Informant Interviews (KII). The data collected includes the layout of cacao farm and management, tenure status, land selection, land preparation, shade plant species, seeds preparation, seeding, planting, fertilizing, pruning, pest control, harvesting, post-harvest handling, marketing, farmer institutions, government support, and gender roles in cacao cultivation, including their problems and challenges. The secondary data collected included the socio-economic condition of the community in the six villages and all data related to cacao conditions in Mahakam Ulu District.



**Figure 2.** Map of the Study Location

## 2.5 Data analysis

Data were processed using descriptive analysis, gender, and SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis using Excel. Traditional cacao agroforestry practices at the study site were compared to the SAF principles. Furthermore, a strategy for adapting and transforming traditional cacao agroforestry practices was formulated.

## 3. RESULTS AND DISCUSSION

### 3.1 Cacao development program and traditional cacao agroforestry system in Indonesia

#### 3.1.1 Policy and development program of cacao in Indonesia

Indonesia started cultivating cacao around 1560 and exporting in 1825 (Kementan, 2019). At its peak, the country was the third-largest global cacao producer after Cote d'Ivoire and Ghana (Andriessa, 2022). However, production fluctuated and tended to decrease over the last ten years. The decrease was in line with the reduction in the area of cacao plantations during the same period, although productivity tended to increase (Table 2). The average plantation area, production, and productivity of cacao per hectare (ha) per year over the last ten years were 1,578,962 ha, 684,121 tons, and 436.40 kg/ha, respectively (Ditjenbun, 2022).

Before 2010, Indonesia exported raw cacao beans to various countries, including the United States, China, India, and Malaysia (Ditjenbun, 2021). Subsequently, to

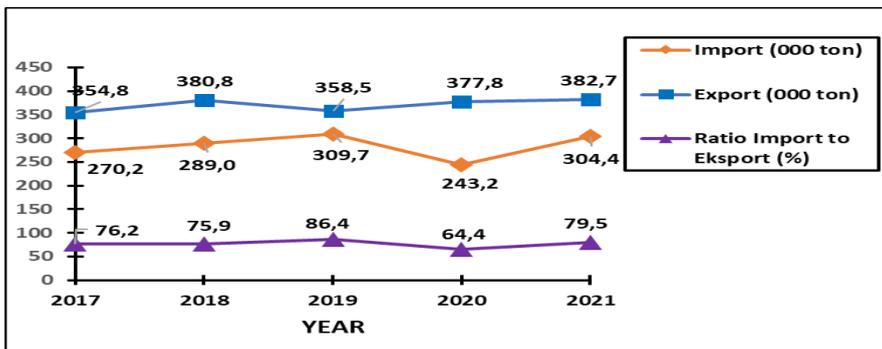
increase the added value of cacao beans and support investment in the processing industry, the government restricted cacao bean export through Regulation of the Minister of Finance Number 67 of 2010 concerning the stipulation of exported goods subject to export duties and tariffs (Hermawan, 2019). The regulation reduced cacao bean exports and increased processed cocoa (Harsanti et al., 2017; Naully et al., 2014). On the other hand, it promoted the development of multi-national cacao processing industry (Hermawan, 2019). Unfortunately, the increase has not been matched with cacao bean production due to the decline in national production (Rubiyo & Siswanto, 2012). This condition has led to Indonesia importing cacao beans to fulfill domestic needs and meet the industry’s raw material requirement. The volume ratio of import and export of cacao over five years (2017 to 2021) ranged from 64% to 86% (Figure 3) showing the need to increase production for the domestic processing industry. To address the issue, the Government of Indonesia imposed a revitalization program to strengthen cacao production through intensification, rehabilitation, and rejuvenation (Ditjenbun, 2023). The intensification program entails various strategies, with the most effective being the introduction of SAF (Ntawuruhunga et al., 2023; Octavia et al., 2023).

**Table 2.** Production, plantation area, and productivity of Indonesian cacao over the last ten years

Year	Production (ton)	Plantation area (ha)	Productivity (kg/ha)
2014	728,414	1,727,437	421.67
2015	593,331	1,709,284	347.12.00
2016	658,399	1,720,773	382.62
2017	590,684	1,658,421	356.17.00
2018	767,28	1,611,014	476.27.00
2019	734,769	1,560,944	470.72
2020	720,661	1,508,955	477.59.00
2021	688,21	1,460,396	471.25.00
2022*	667,296	1,442,403	462.63
2023**	692,168	1,389,994	497.96
Average	684,121	1,578,962	436.40.00

Note: \*: preliminary, \*\*: prediction

[Source: (Ditjenbun, 2022) analyzed]



**Figure 3.** The volume ratio of import and export of cacao during five years (2017 to 2021)

[Source: (Ditjenbun, 2022) analyzed]

*3.1.2 Traditional cacao agroforestry practices in Indonesia*

Cacao cultivation in Indonesia is dominated by community or smallholder plantations (Ditjenbun, 2022). Although the planting pattern can be carried out in monoculture (Saleh, 2020; Sumilia et al., 2019; Widjanto & Gailea, 2008), most of the smallholder

plantations use traditional AF planting patterns, where cacao trees are planted mixed with other crops and forest trees (Murniati et al., 2022a; Santhyami et al., 2018). In Central Sulawesi, cacao plantations in the form of AF have become a major land use system, supporting high biodiversity levels thereby profiting from ecosystem services provided by different species including birds and bats (Maas et al., 2017). Meanwhile, cacao AF development at a conservation forest area in Lampung Province has become an alternative to resolve land use conflicts. The management of the forest area permitted the community to cultivate forest land for their livelihoods, even providing them with legal permits to do so. This win-win solution for the restoration of degraded conservation forests has enhanced forest function, driven by the community's willingness to implement a multi-layered canopy AF system (Murniati et al., 2022b). However, the farmers who practice cacao agroforestry based on inherited knowledge, often lack sufficient capital and technical expertise for SAF (Murniati et al., 2022a).

Sari et al. (2022) who studied the balancing litterfall and decomposition in cacao AF in Konawe District, Southeast Sulawesi revealed that the seasonal pattern of litterfall production and relatively slow decomposition rates of complex AF systems supported a permanent litter layer over the year, ensuring protection of the soil surface from erosion and direct heating. Saputra (2022) also stated that most cacao AF developed in Southeast Sulawesi was mixed with fruit trees such as mango, durian, cashew nuts, forest trees (teak), and spices (chili), thereby potentially increasing the income of farmers. Furthermore, the system contributed to carbon sequestration capacity and litter accumulation by 46% and 47% higher than cacao monoculture, respectively.

Wartenberg et al. (2020) reported that shade trees within cacao AF in Southeast Sulawesi had a net negative effect on cacao tree growth but no net impact on the yields. Based on another study, cacao, and associated tree density influenced production in an AF system in Lampung. Optimal cacao production was achieved at 1,253 trees/ha of total tree density (Murniati et al., 2022a). Furthermore, cacao AF practices contributed significantly (75.63%) to the total farmers' income, fulfilling households' basic needs and alleviating poverty at the national level. Some other practices that contributed significantly to the farmers' income among others include cacao AF with nyatoh (*Palaquium rostratum*) in Sulawesi with a contribution of 46.7% (Jumiyati et al., 2018), mixed farming of cacao, cloves, nutmeg, coconuts and various fruit crops in West Seram Regency, Maluku, contributing 97.02% (Latue et al., 2019), and cacao AF with coffee and several fruit crops at The Wan Abdurahman Grand Forest Park, Lampung Province, which provided a 45.96% contribution (Riani et al., 2015).

### **3.2 Cacao Potential in Mahulu District**

#### *3.2.1 Cacao development policies and programs in Mahulu District*

Mahulu District, located in East Kalimantan Province originated from the expansion of West Kutai District based on the Law of the Republic of Indonesia Number: 2 of 2013. The total area is 1.9 million hectares (BPS Kaltim, 2023) and the capital is located in Ujoh Bilang Village-Long Bagun Sub-district. Mahulu is a strategic area due to its position, directly bordered by West Kalimantan to the West, North Kalimantan to the East, and Malaysia to the North. The area is currently dominated by dryland forest cover of 1,830,990 ha (92.29%) comprising primary (994,982 ha) and secondary (836,008 ha) (Dharmawan et al., 2020) (Figure 4). Furthermore, the topography is hilly and mountainous, most of which is dissected by the Mahakam River and its tributaries (Pembab Mahulu, 2018b). This area is significantly inversely proportional to the population estimated in 2020 to be 33,535 people with a population density of 2.12 people/km<sup>2</sup>. The population is mainly dominated by the Dayak ethnic groups of the sub-

ethnicities called the Bahau, Kayan, Aoheng, and Kenyah (BPS Kutai Barat, 2023).

According to Regulation Number 1/2021 concerning the Regional Spatial Plan of Mahulu District 2021-2041, the strategy for economic development in green plantation cultivation areas will be implemented with sustainable principles by promoting superior commodities of high economic value. The local government has allocated 260,960 ha to support this plan, including in Long Apari and Long Pahangai Sub-districts (Pemkab Mahulu, 2021). Based on the Regional Long-Term Development Plan of Mahulu District for 2016-2025, improving the welfare of farmers requires the development of plantation businesses that will produce comparative and competitive products with the integration of agribusiness systems from upstream, on-farm, downstream, and other life support system (Pemkab Mahulu, 2016).

Cacao is the leading estate crop commodity in Mahulu District, with an estimated plantation area of 1,519.6 ha and a production of 289 tons in 2022. The largest production in Long Pahangai Sub-district reached 130 tons in 2022 (Table 3). Furthermore, cacao development is included in the Strategic Plan of the Food Security and Agriculture Office of Mahulu District 2021-2026. In this strategic plan, the potential of cacao plantations is carefully mapped including the Long Apari, Laham – Long Hubung, and Long Pahangai (DKPP Mahulu, 2021).

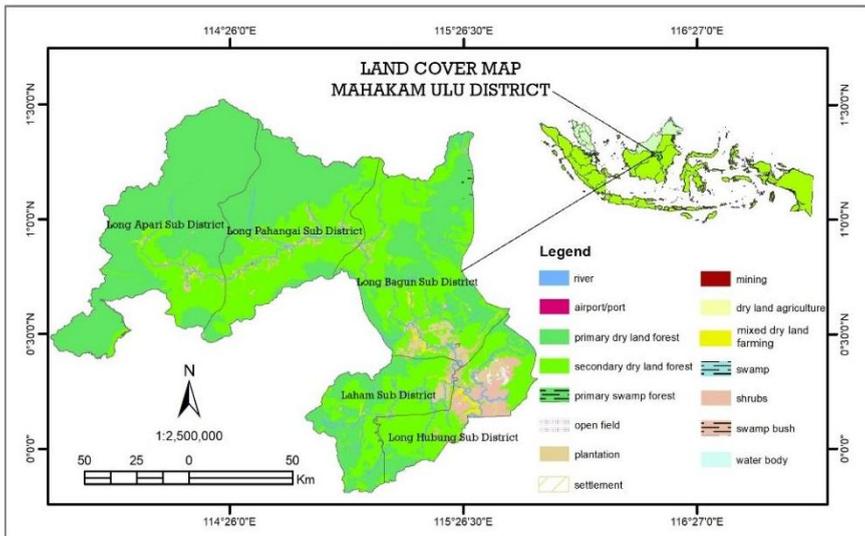


Figure 4. Land Cover Map of Mahulu District (BAPLAN, 2021, processed)

Table 3. Areas of plantations and amount of dry cacao bean production in Mahulu District

Sub-district	Area (hectares)			Sum (ha)	Production (Ton)	Average production (kg/Ha)	Number of farmers (head of family)
	Not yet produce	Has produced	Does not produce / damage				
Long Hubung	787,6	135	15	936	13	96,30	77
Laham	151	125	0,5	277	33	264,00	19
Long Bagun	441	85	10	536	67	788,24	69
Long Pahangai	50	377	0,5	428	130	344,83	30

Sub-district	Area (hectares)			Sum (ha)	Production (Ton)	Average production (kg/Ha)	Number of farmers (head of family)
	Not yet produce	Has produced	Does not produce / damage				
Long Apari	90	69	0,5	160	46	666,67	29
Total	1.519,6	791	26,5	2.337	289	365	224

[Source: (DKPP Mahulu, 2022)]

According to the Strategic Plan of Estate Crop Services of East Kalimantan Province, plantation development is closely related to environmental issues. Hence, management in the plantation sector must follow the principles of environmentally friendly development. In this context, the development of cacao agroforestry in the Mahulu District applies to the concept of a Green Economy. In the Strategic Plan, implementation aims to improve the product, environmental quality, and sustainable economic growth (Disbun Kaltim, 2019). Additionally, it must follow sustainable plantation development, by considering economic, socio-cultural, and ecological aspects (Pemprov Kaltim, 2018).

The implementation of the Green Economy contained in The Strategic Plan of the East Kalimantan Provincial Estate Crop 2019–2023 for cacao AF development, including in Mahulu District is in accordance with the commitment of the government to support the Low Carbon Development Policy by implementing the Forest Carbon Partnership Facility-Carbon Fund (FCPF-CF) (Wiati et al., 2022). It is also supported by East Kalimantan Governor Regulation Number 22 of 2011 concerning Guidelines for the Implementation of Green East Kalimantan (Pemprov Kaltim, 2011), Regulation Number 7 of 2019 concerning Climate Change Adaptation and Mitigation (Pemprov Kaltim, 2019), and Regulation Number 33 of 2021 concerning Benefit Sharing Mechanisms in Land-Based Greenhouse Gas Emission Reduction Programs (Pemprov Kaltim, 2021).

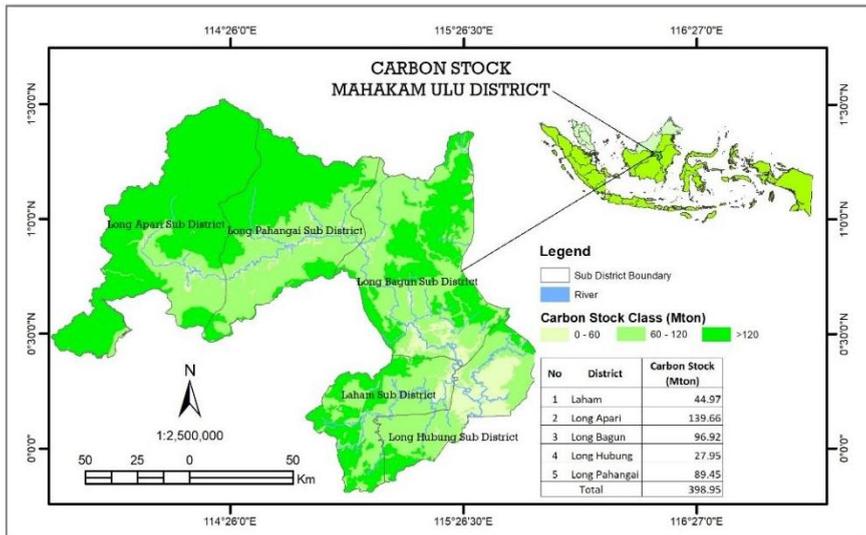


Figure 5. Carbon Stock Mapping of Mahulu District (BAPLAN, 2021, processed)

Based on carbon stock potential, Mahulu District has Carbon storage of 398.95 Megatons, with 98.6% originating from primary and secondary forest land cover (Figure

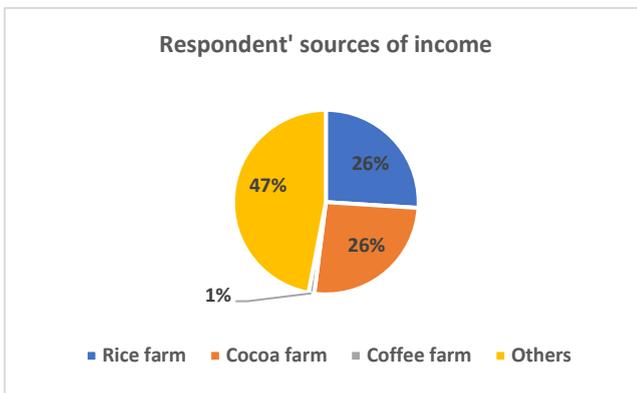
5). The remaining 1.4% comes from non-forest land cover, including cacao AF. Niether et al. (2020) and Ballesteros-Possú et al. (2021) found the total carbon stored in an AF system, encompassing both above-ground and root biomass) of cocoa and the shade trees, is 2.5 times higher than a monoculture system. Additionally, the AF system provides a buffering effect against average and extreme temperatures.

East Kalimantan Province aims to reduce emissions to 22 million tons (t) of carbon dioxide (CO<sub>2</sub>) equivalent (e) or tCO<sub>2</sub>e by 2024. The plantation sector contributed 51% of GHG emissions in the land sector between 2006 – 2016 (Indonesian Government, 2019). Figure 5 shows the importance of Mahulu District in implementing jurisdiction-based emissions reduction programs through the FCPF Carbon Fund.

### 3.2.2 Characteristics of socio-economic conditions of local communities in Mahulu District

Long Pahangai Sub-district has an area of about 3,420.40 km<sup>2</sup> with a total population of 5,450 people and population density of 1.6 people/km<sup>2</sup>, while Long Apari Sub-district has values of 5,490.70 km<sup>2</sup>, 4,445 people and 0.81 people/km<sup>2</sup> respectively (Long Pahangai Sub-district in Figures, 2021; Long Apari Sub-district in Figures, 2021). The people in the study location were classified into three dominant ethnicities, namely Dayak Bahau Umaaq Suling and Busaang in Long Pahangai Sub-district, as well as Dayak Aoheng in Long Apari Sub-district where most of the people are Catholic. The Mahulu District Government, through Regulation Number 7/2018, provides protection and maintenance of cultural sites, customs, local wisdom, and customary law communities (Pembab Mahulu, 2018a). This is contained in Strategic Plan of Mahulu District Community and Village Empowerment Service 2021–2026, stating that the activities include the determination of customary law communities and villages, identification, as well as inventory (DPMK Mahulu, 2021).

The livelihoods of Mahulu people still depend on the surrounding natural resources such as swidden and cocoa farmers, carpenters, craftsmen, and traditional gold miners. A distribution of community livelihood in six villages is presented in Fig. 6, where rice and cacao farms are dominant sources of income. The average income of the people at Long Pahangai and Long Apari Sub-districts is estimated at 1-5 million rupiah (IDR) or equal to US \$ 64–320,5 per month.



**Figure 6.** Sources of livelihood of respondents at six villages of the study site

Villages in Long Pahangai and Long Apari Sub-districts are generally located on the banks of the Mahakam River, making boats the main means of transportation access. However, during the dry season, some villages in Long Pahangai can be accessed by road. Limited means of transportation is one of the challenges in developing a region's

economy.

### 3.2.3 Characteristics of cacao-based agroforestry in Mahulu District

Cacao plants were first introduced to the community in Mahulu in 1996 from Malaysia. Subsequently, the development started attracting more people in 2006 after one farmer named Haji Samunteq brought cacao seeds from Sulawesi and planted in Long Pahangai Sub-district. From the Haji Samunteq farm, cacao cultivation then started spreading throughout the district. Cacao planted from seeds or seedlings is usually obtained from family or neighbors. Some people in Long Pahangai Sub-district also received seeds through the government's free seedling distribution program.

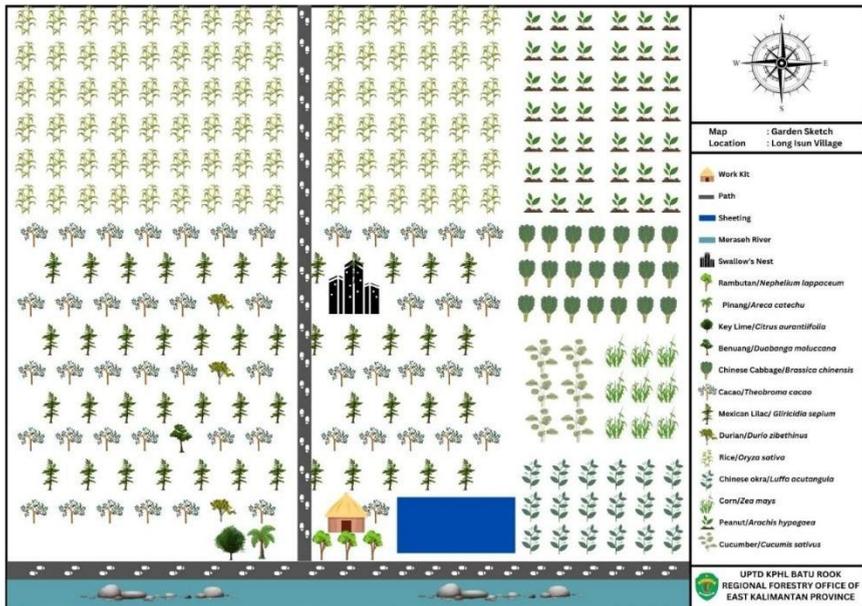


Figure 7. Sketch of one of the cacao agroforestry in Tiong Bu'u Village

Generally, cacao plantations are developed in fields considered to be no longer productive. Seedlings are usually planted in relatively flat areas, riverbanks, and close to forests but mostly far from farmers' residence, taking 1-2 hours by boat. Mixed farming is commonly applied along with other crops such as *Gliricida sepium* (gamal), *Durio zibethinus* (durian), and *Nephelium lappaceum* L. (rambutan), (Figure 7). These crops not only provide shade but also serve as a strategy to meet household needs while earning cash. Joachim et al. (2016), Joachim (2013), and Deheuvelds et al. (2012) mentioned that cacao could be integrated with various types of Dipterocarp forests, including meranti (*Shorea roxburghii*), lime (*Dryobalanops* sp.), and other species such as kapok (*Ceiba pentandra*), and durian (*Durio zibethinus*) in dynamic AF systems. Similarly, rubber (*Hevea brasiliensis*) and oil palm (*Elaeis guineensis*) can also be planted with cacao as the upper and middle layers of the system. The relatively narrow cultivated land accompanied by efforts to optimize land use by planting various types of plants confirms the theory by Arnold (1983), stating that AF practices are mostly although not always typical of simple resource-poor conditions and mostly motivated by the need for livelihoods (Parhusip et al., 2019). Therefore, in such conditions, practicing agroforestry becomes the best option to ensure daily, weekly, and monthly income (Aumeeruddy-Thomas & Michon, 2018) as well as enable farmers to get

multiple products from various plant species including fruits, cash crops, food crops, wood, and other by-products (Murniati et al., 2022a; Octavia et al., 2022).

The average cacao agroforestry production remains relatively low (Aziz et al., 2023; Desmiwati et al., 2021; YKAN, 2021b). Therefore, increased and specialized knowledge of local tree species selection as well as local socio-economic and environmental conditions is needed. There is also a need to establish and enable alternative markets for AF products. This can contribute to the further adoption and sustainability of cacao AF systems (Niether et al., 2020; Nuddin et al., 2019).

### 3.2.4 Traditional cacao agroforestry practice in Mahulu District

People in Mahulu District continue to apply traditional methods in the cultivation of cacao. Although cacao is a relatively new crop to farmers, specific techniques must be adopted or developed in cultivation. Farmers treat cacao similarly to dry field paddy or fruit, where the plants are left unattended after planting and only maintained during fruit production.

Cacao farmers use local knowledge to select suitable areas for cultivation characterized by black soil with a smooth sandy structure. Simple methods are used in land preparation and maintenance activities, considering the practicality and cost. Traditional farmers in Mahulu clear land, which is often a former forest area or shifting cultivation land abandoned for decades with tall trees or former gardens overgrown with various unprofitable plants. The land is prepared by cutting down and burning the remaining plants. The land-clearing method is still commonly found in Kalimantan due to its simplicity, low cost, and potential ability to increase soil fertility from organic material left over from burning ash. Despite using the swidden technique, farmers apply fallow periods for the natural decomposition process of plant residue and burning ash, which later act as fertilizer. When the land is ready, various short-term agricultural commodities, including rice, chili, corn, and tomatoes can be planted, and interspersed with cacao as well as multiple types of plants beneficial for the community, namely fruit and other multipurpose tree species (MPTS). The early rice harvests provide initial income and a food stock for farmers. Rice can be cultivated until the growing cacao and other cultivated plants create excess shade. When cultivation is no longer feasible, farmers turn to short-term fruit crops, such as bananas, to obtain additional income, while cacao starts bearing fruit in the third year.

Traditional cacao cultivation with minimal modern knowledge is also evident in the non-use of chemical fertilizers due to the relatively high price. Farmers are accustomed to the traditional slash-and-burn land management pattern, which generally only relies on organic soil from burning residue and decomposition of the litter as a natural fertilizer. This underscores the need for more initiative to make compost or natural fertilizer from leftover cacao shells or pruning residues. The planting methods or other traditional agricultural patterns used by the farmer in Mahulu are presented in Table 4.

**Table 4.** Cacao cultivation method used traditional knowledge in Mahulu District

Activities	Cultivation method	
	Long Pahangai	Long Apari
Land preparation	Swidden	Swidden
Collecting cacao seed	Seeds or seedlings from other farms and government program	Seeds or seedlings from another farm
Spacing arrangement	2.5x2.5 meter or 3x3 meter	2.5x2.5 meter, 3x3 meter, or without specific plant spacing
Preparing planting holes	40x40x40 or no specific size using traditional tools	No particular size using traditional tools
Planting	At the beginning of the rainy	At the beginning of the rainy

Activities	Cultivation method	
	Long Pahangai	Long Apari
	season without seeding, some people sow first before planting	season without seeding
Maintenance	Cleaning of grass or weeds without fertilizer application	Cleaning of grass or weeds without fertilizer application
Pruning	No or rarely done (1-3 times a year)	No or rarely done (1-3 times a year)
Pest and disease control (cacao fungus)	Cutting off affected branches, no spraying of herbicides	Cutting off affected branches, no spraying of herbicides

In cacao cultivation, every member of a farming family in Long Pahangai and Long Apari Sub-districts generally works together, though there is a division of tasks between men and women. Men typically handle activities that require more energy, such as land preparation, clearing, burning, stake planting, making planting holes, and marketing. Meanwhile, women focus on activities such as seeding and drying. Both men and women can also have the same role, for example, in planting activities (Table 5), and can even replace each other when necessary. Dery & Dongzagla (2020) and Kuhn et al. (2023) stated that women contribute significantly to cacao production as direct or indirect labor, positioned on the margins of the supply chain.

Bulkis et al. (2020) showed that time allocation for cacao fruit harvesting activities for men and women was 26.31 hours and 32.80 hours, respectively. Meanwhile, in marketing, the time allocation for males and females was 0.26 hours and 0.09 hours, respectively. Men dominate decision-making regarding cocoa cultivation, harvesting, and post-harvest activities, while marketing activities are decided jointly by men and women.

**Table 5.** The role of farmers based on gender in cacao cultivation activities

Activity	Sub-district	
	Long Pahangai	Long Apari
Land preparation	Mf	Mf
Clearing	Mf	M
Burning	Mf	M
Nurseries	F	mF
Stake planting	Mf	Mf
Making planting holes	Mf	Mf
Planting	MF	MF
Maintenance	M	Mf
Weeding	M	Mf
Pruning	M	Mf
Harvesting	M	Mf
Splitting cocoa pods	Mf	M
Drying	F	F
Marketing	M	M

Notes: M: male play a big role, F: Female play a big role, m: male play a little role, f: female play a little role

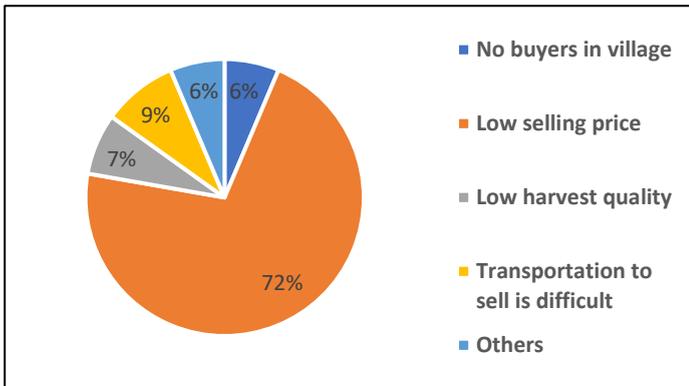
### 3.2.5 System of harvesting and marketing of dried cocoa beans in Mahulu District and its challenges

Harvesting occurs once or twice a month, depending on the ripeness of cocoa fruit, which is red or yellow-orange. Post-harvest handling is performed in a very simple way, namely by splitting cacao beans, and drying in the sun. In some villages, marketing cocoa beans is easy due to the presence of collectors who buy the product directly from

farmers. However, cacao bean collectors are not available in all villages, leaving farmers to sell the products themselves, necessitating transportation to the nearest market (Figure 8).

Dried cacao beans are sold at various prices, ranging from IDR 20,000 (US\$ 1.25<sup>1</sup>) – IDR 30,000 (US\$ 1.88<sup>1</sup>) per kg. In Berau District, prices are more stable ranging from IDR 25,000 (US\$ 1.57<sup>1</sup>) – IDR 26,000 (US\$ 1.63<sup>1</sup>) per kg and may increase to IDR 35,000 (US\$ 2.19<sup>1</sup>) per kg after subjecting the product to the fermentation process (YKAN, 2021a). Village collectors transport cacao beans to a large collector in Long Pahangai Sub-district capital who then delivers to an agent in Samarinda City (the capital of East Kalimantan Province). From Samarinda, the dried cacao beans are sent by ship to Sulawesi for further processing into various products.

The main challenge in marketing dried cacao beans is the low selling price at the farmer level (Figure 8) primarily due to the low quality of cacao produced. Many farmers lack the knowledge of fermentation techniques that can increase cacao bean quality. Additionally, the low quality of dried cacao beans from Long Pahangai and Long Apari sub-districts is attributed to minimal maintenance with no fertilizer application and premature harvesting. The low price of cocoa beans is also partly due to farmers typically marketing products individually, which allows collectors to set prices, leading to a weak bargaining position. This individual marketing is due to the lack of local institutions at the farmer level. Furthermore, the existence of Village-Owned Enterprises (Badan Usaha Milik Kampung/BUMKa) is not yet able to accommodate farmer products and markets outside the village. Collective marketing will strengthen farmer bargaining position.



**Figure 8.** Respondents' challenge in marketing cocoa beans

To support cacao development in Mahulu District, the local government has encouraged the establishment of cacao farmer groups in each village. Joining these groups enables farmers to become part of a larger network, share knowledge, and find government support (Penot et al., 2022). In addition, the government has provided agricultural extension workers in sub-districts that have work areas for various villages, with one extension worker per 3 villages. For effective marketing, cacao farmers can use BUMKa already established in the villages. However, not all BUMKa are active or consider purchasing cacao from farmers as a business potential. In the Strategic Plan of Mahulu District Community and Village Empowerment Office 2021 – 2026, the government aims to empower BUMKa and inter-village cooperation institutions.

<sup>1</sup> USD 1 = IDR 16,000

District government also intends to facilitate the development of community economic businesses and assist village governments in increasing income (DPMK Mahulu, 2021).

Regarding capital, cacao farmers face difficulties in accessing credit from the bank. Although local banks in Mahulu District such as Bank Kaltimtara have a program for cocoa farmers, the lack of legal land ownership poses a significant obstacle. Despite most farmers claiming private ownership, none have a legal ownership certificate from the government. This is because almost all cacao farmland is in forest areas. Salim et al. (2021) asserted that communities residing in state forests require legal recognition to access and protect resources. Some cacao farmers take capital loans from non-government financing institutions, such as the Dayak Lestari Credit Union (CU). However, despite the low loan interest, many farmers remain hesitant due to the low chance of success in cocoa cultivation.

#### **4. STRATEGY TO IMPROVE TRADITIONAL CACAO AGROFORESTRY PRACTICES IN MAHULU DISTRICT**

Traditional cacao AF practices in the study site face several challenges, causing the management to be ineffective and unable to provide optimal productivity. To address these challenges, various efforts are needed such as adopting climate-smart agricultural practices to increase production, which is also a strategy for sustainable adaptation and mitigation of climate change. Dissanayaka et al. (2023) and Sileshi et al. (2023) stated that AF is one farming system that serves as a strategic intervention in climate-smart agriculture. It plays a significant role in achieving three main goals, namely increasing production, improving food security, and climate resilience.

AF plays an important social and economic role in society, in global ecology, and in maintaining environmental quality. The significance is increasing as global climate projections convey a gloomy picture regarding the future of agriculture in several African and Asian countries. According to these projections, climate change affects rainfall patterns and causes variations in average annual temperatures in Africa and Asia, influencing agricultural land productivity, and impacting crop yields, food security, and people's livelihoods (Besar et al., 2020; Feliciano et al., 2018; Tuturop et al., 2022; C. Wulandari, 2021). To overcome this situation, various adaptation and modification efforts are needed to implement SAF cultivation patterns.

As explained previously, SAF is a series of agricultural and silvicultural knowledge systems aimed at not only improving environmental parameters, including climate change mitigation and adaptation, biodiversity enhancement, as well as soil and water conservation, but also increasing profits and resilience for farmers (Octavia et al., 2022). Optimized forest land use could be achieved by applying silvicultural and crop cultivation techniques to maximize productivity as well as meet sustainability and adaptability objectives. SAF implies modifying farming techniques by adopting modern technology but also considering agricultural best practices based on traditional knowledge which has been proven to withstand various changes related to social, economic, and environmental issues.

SAF has evolved into a science-based pathway for traditional and modern AF to achieve better results for natural resource management and provide socio-economic benefits. Several studies proved that SAF practices benefit human life and the environment, playing crucial roles in promoting soil water conservation and soil health (Dollinger & Jose, 2018; Kumar Avaneesh et al., 2020). Other functions include moderating microclimate, mitigating and adapting to climate change (Muschler, 2016), providing the daily needs of society (Duffy et al., 2021; Murniati et al., 2022a), as well as increasing biodiversity of flora and fauna (Santos et al., 2022; Udawatta et al., 2019). For further and broader development, SAF should become a distinct paradigm,

specifically for policymakers, to create rules and regulations that support the implementation of AF on a larger scale, both in forest areas and privately owned land.

Cacao cultivation in Mahulu District follows the guidelines of SAF principle, although not all. Table 6 shows a comparison between SAF, and traditional cacao agroforestry practiced at the study site (Table 6).

**Table 6.** Comparison between SAF and traditional cacao AF practices in Mahulu District

<b>Activity</b>	<b>SAF</b>	<b>Traditional Cacao AF practices</b>
Land Suitability	Land management will be adjusted to the land suitability class	Does not consider the land suitability class, but the farmer usually chooses black soil with a smooth sandy structure
Land preparation	Manually without burning, mechanically or chemically, hence, cacao plants grow optimally but still maintain natural ecosystems such as springs and protected areas	Manually with swidden system but very much maintaining natural ecosystems such as springs and protected areas
Shade plant planting	To increase soil fertility, consider economic value, source of organic pesticide, and non-cacao competitor species	Consider only economic benefits
Plant Diversification	Maximizing revenue and minimizing risk	To meet daily needs more, in addition, to maximizing income and minimizing risk
The use of superior seedlings	Use superior seedlings, but not Genetically Modified Organism (GMO) crops	Based on the availability of existing seedlings
Seedling propagation	Generatively or vegetatively (grafting or budding)	More often generated by sowing seeds and wild seedlings
Planting	Carried out at the beginning of the rainy season on fields with 30-50% shade and certain planting spacing	Carried out at the beginning of the rainy season without considering shading and planting spacing
Plant maintenance	Cleaning the land around cacao trees, pruning, and fertilizing are regularly done. Fertilization with organic and inorganic fertilizers is carried out according to the condition of the land, age, and plant variety.	Irregular cleaning of land around cacao plants and pruning without fertilization
Plant rejuvenation	Conducted to increase crop yields on less productive cacao plants	None
Cacao – livestock integration	Use of forage from cacao pod shells as animal feed and utilization of livestock manure as organic fertilizer and biogas	Only use cacao pod shells to remove odors in the chicken/duck coop
Harvesting and post-harvest activities	Harvesting is carried out routinely every 2 – 3 weeks on the right ripe cacao fruit and carries out post-harvest treatment stages (fruit	Fruit is not harvested routinely, and the right ripe cacao fruit is not considered. Harvested cacao bean was later dried in the sun, stored temporarily or directly for sale

Activity	SAF	Traditional Cacao AF practices
	sorting, fruit cracking, bean fermentation, soaking and washing beans, drying beans, sorting and classifying dry beans, and quality control of beans during storage)	

[Source: (Kementan, 2014) and primary data (survey, processed)]

Cacao cultivation using traditional AF techniques needs corrective input actions related to development. Based on the results of the SWOT analysis (Appendix), the following strategies were developed in an effort towards SAF practice in Mahulu District.

1. Providing support to cacao farmers by engaging in a good plantation development program through the Local Government Agencies of Mahulu District.
2. Increasing farmers' knowledge, skills, and attitudes through field schools and Training of Trainers (ToT) activities to generate experts for optimal and sustainable cacao plantation production.
3. Optimizing and encouraging the role of Village-Owned Enterprises (BUMKa) to be engaged in purchasing dried cacao beans from farmers in the village, as well as working with existing Credit Unions and local banks to provide capital assistance.
4. Establishing collaboration with timber companies around the village or Forest Management Unit of the East Kalimantan Provincial Forestry Service to develop cacao cultivation through the Social Forestry program with the Forestry Partnership scheme.
5. Building cacao farming demonstration plots by applying the principles of SAF to increase farmers' ability to overcome some challenges, including anticipating the impacts of climate change by building fire blocks and water reservoirs. Cacao farmers must increase crop yields while adapting agriculture to future environmental, land, and socio-economic uncertainties. Knowledge about the basics of good cacao cultivation is needed as well as determining factors for the success of farmer activities (Ballesteros-Possú et al., 2021; Bernard et al., 2020; Lojka et al., 2017).

The SWOT analysis results showed that lots of facilitation, support, and cross-sector coordination are needed for effective and profitable cacao-based AF management in Mahulu District. SAF requires integrating the components, not only between the tree crops, but also between trees and people, considering technological, economic, and social conditions. Combining cacao AF best practices based on traditional and contemporary knowledge will achieve natural resource management objectives and socio-economic benefits while increasing community's resilience to climate change (Nair, 2012; Octavia et al., 2022; Zerihun, 2020).

## 5. CONCLUSION

Cacao-based AF in the Mahulu District is being developed by applying the concept of a green economy and considering the potential and opportunities of marketing, socio-economic culture, gender, and traditional knowledge. Further development efforts are needed to shift from traditional to SAF practices. Cacao development requires multi-stakeholder cooperation from the regional level, comprising farmers and village government, to the central government. Key challenges and practical considerations for the development of cacao SAF in Mahulu include the provision of production inputs, efficient marketing strategies, access to capital, and the establishment of strong local

institutions to enhance the bargaining power of cacao farmers.

Several important factors to consider in improving management include intensifying cacao farming while producing more inputs to increase land productivity, ensuring land status, improving the quality of products for more effective and efficient marketing, increasing access to capital, and strengthening local institutions. With secure legal access to cultivated farmland, farmers will be more enthusiastic about cultivating cacao plants.

Provision of legal access can be developed by engaging farmers in the Social Forestry Program initiated through the Forestry Partnership scheme or other schemes such as Community Forestry and Village Forests. Therefore, further studies are needed to evaluate the most suitable option to provide legal access for farmers to cultivate the land in state forests considering biophysical conditions and community readiness.

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## APPENDIX

### SWOT Analysis for strategy development towards SAF practice in Mahulu District

External	Internal	
	Strength/S:	Weakness/W:
	<ul style="list-style-type: none"> <li>• There are many cacao farms in Mahulu District</li> <li>• Mahulu peoples have the spirit of cacao cultivation</li> <li>• There are cacao farmer groups;</li> <li>• There are BUMKa that can facilitate the purchase and sale of cacao farmers;</li> <li>• The village government supports cacao development by funding equipment and training.</li> </ul>	<ul style="list-style-type: none"> <li>• Cacao farmers have not implemented SAF in cacao cultivation;</li> <li>• The presence of pests and diseases of cacao plants;</li> <li>• The quality of dried cacao beans is low;</li> <li>• The cacao market is still controlled by intermediary sellers;</li> <li>• Assistance of cacao farmers is still low.</li> </ul>
Opportunities/O:	S-O Strategy:	Strategy W-O:
<ul style="list-style-type: none"> <li>• There is support from the Government of Mahulu District such as seeds, fertilizers,</li> </ul>	<ul style="list-style-type: none"> <li>• Support cacao farmers by including cacao development in the Regional Apparatus</li> </ul>	<ul style="list-style-type: none"> <li>• Increasing the knowledge, skills, and attitudes of cacao farmers through Field Schools;</li> </ul>

<ul style="list-style-type: none"> <li>training, markets, funding;</li> <li>Cacao SAF is available as a good cacao cultivation guideline;</li> <li>Available BUMKa at the village level as the economic board of the community;</li> <li>The need and market for cacao is still wide open;</li> <li>Opportunities for cooperation with timber enterprises and the Social Forestry Program.</li> </ul>	<p>Organization program of the Mahulu District Government.</p> <ul style="list-style-type: none"> <li>Intensively managing cacao plantations with the implementation of SAF</li> <li>Encourage BUMKa to include buying and selling dried cacao beans in the business;</li> <li>Encouraging timber companies to develop cacao cultivation through the Social Forestry Program</li> </ul>	<ul style="list-style-type: none"> <li>ToT to cacao farmers to become cacao doctors;</li> <li>Optimization of the role of BUMKa as an economic institution that functions as buyers and sellers of cacao.</li> </ul>
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Threats (T):	S-T Strategy:	W-T Strategy:
<ul style="list-style-type: none"> <li>Most cacao plantations are in forest areas</li> <li>Cacao commodities have not been a top priority in livelihoods;</li> <li>Middlemen still handle the price of cacao;</li> <li>The impact of climate change (floods, forest fires, prolonged droughts, landslides) threatens the existence of cacao plantations</li> </ul>	<ul style="list-style-type: none"> <li>Development of Social Forestry programs for cacao plantations within forest areas;</li> <li>Cooperation with the Forest Management Unit (Kesatuan Pengelolaan Hutan/KPH) by forming cacao Forest Farmer Group;</li> <li>Using access to funding from Credit Unions and Local Banks</li> </ul>	<ul style="list-style-type: none"> <li>Development of cacao Demonstration Plot by implementing GAP;</li> <li>Increased production of existing cacao farms;</li> <li>Overcoming the impact of climate change by taking preventive measures against the existence of cacao plantations (making fire blocks, making water reservoirs, implementing SAF)</li> </ul>

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