



Strengthening Smallholder Cocoa Plantation Management in Response to the European Union Deforestation Regulation (EUDR)

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ABSTRACT

This study aims to formulate strategies to strengthen the management of smallholder cocoa plantations in response to the European Union Deforestation Regulation (EUDR) policy. This research was conducted from January to June 2026. The research employs a descriptive-analytical method based on a literature review approach. Data and information were gathered from various sources, including Statistics Indonesia, Directorate General of Estate Crops (Ministry of Agriculture), Ministry of Trade, scientific journals, international agency reports, government regulations, trade organization publications. The findings indicate that the implementation of the EUDR could potentially hinder Indonesian cocoa exports. Current conditions on smallholder cocoa plantations are characterized by limited technology and weaknesses in plantation management, administration, documentation, and farmer organizational structures. Strengthening smallholder cocoa plantation management can be achieved by enhancing technical cultivation practices, farmer institutions, digitalization and traceability systems, and government policy support. These strengthening efforts are crucial to ensure that smallholder cocoa remains competitive in the international market and meets global trade standards aligned with EUDR principles and sustainability.

Keywords: anti-deforestation policy, smallholder cocoa plantation management, digitalization, farmer institutions, traceability.

1. INTRODUCTION

Cocoa is a strategic plantation commodity that plays a vital role in national economic development. Based on Data Center and Information System of Ministry of Agriculture, Indonesia's cocoa production potential is enormous, with a total cocoa plantation area expected to reach 1.37 million hectares by 2025. Indonesia is one of the world's largest cocoa producers, after Ivory Coast and Ghana. Cocoa not only serves as a source of foreign exchange through exports but also contributes to employment, increased smallholder income, and rural development. Cocoa is the highest-grossing export commodity. Indonesia's cocoa exports are expected to reach US\$2.62 billion in 2024, with exports reaching countries in Europe, America, and Asia. Within the

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international trade structure, cocoa is a commodity with high economic value as it is the primary raw material for the chocolate-based food and beverage industry. Indonesia's cocoa plantation sector is dominated by smallholder plantations, contributing more than 90% to the total national area and production. This indicates that the sustainability of the national cocoa industry depends heavily on the ability of smallholder farmers to manage their plantations productively and competitively. Smallholder cocoa plantations are spread across almost all of Indonesia, particularly in Sulawesi, Sumatra, East Nusa Tenggara, and parts of Java. In addition to serving as a source of livelihood for millions of farming households, smallholder cocoa plantations also drive the local economy in production centers (Perdana et al., 2022; Susanti, et al, 2025).

Despite its significant potential, the management of smallholder cocoa plantations still faces a number of complex challenges. One major issue is the low productivity of cocoa plants compared to their optimal production potential. Based on 2024 FAOSTAT data, cocoa productivity in Indonesia is considered low compared to competing nations. Indonesia's cocoa productivity stands at only around 476 kg/ha, lower than that of Ghana (approximately 576 kg/ha) and Côte d'Ivoire (approximately 496 kg/ha) (FAO, 2025). This low productivity is caused by several factors, including the use of inferior seeds, minimal application of cultivation technology, pest and disease attacks, and limited farmer capacity for intensive plantation management. Furthermore, the quality of cocoa beans produced by smallholder farmers often does not meet international market standards due to suboptimal post-harvest handling, such as fermentation and drying. Another increasingly important challenge in global trade is the issue of environmental sustainability. In recent years, export destination countries have begun implementing various regulations related to environmental protection and reducing deforestation. One of the policies of primary concern is *European Union Deforestation Regulation* (EUDR) issued by the European Union. This policy stipulates that certain products entering the European Union market, including cocoa, must be ensured not to originate from deforested or degraded land after the date specified in the regulation (Nagara et al., 2024, Rahman et al., 2024).

The implementation of the EUDR poses a significant challenge for the Indonesian cocoa sector, particularly for smallholder plantations, many of which still face limitations in their administration and documentation systems. This regulation mandates a clear traceability system, including information on plantation geolocation, land legality, and assurance that production processes are conducted without damaging forest areas. For smallholder farmers, meeting these



requirements is challenging due to limited access to technology, low institutional capacity, and minimal technical assistance. If Indonesian cocoa products fail to meet EUDR requirements, there is a risk of product rejection in the European Union market, which could result in a decline in exports and weaken the competitiveness of national cocoa commodities. This risk not only affects exporters and the cocoa processing industry but also directly impacts the income of smallholder farmers, the primary actors in production. Therefore, the readiness of the national cocoa sector to face the EUDR policy is crucial to maintaining sustainable global market access (European Commission, 2023; Nagara et al., 2024).

On the other hand, the EUDR policy can also be seen as an opportunity to encourage the transformation of smallholder cocoa plantation management towards a more sustainable and modern production system. The Indonesian government is encouraging the adoption of good agricultural practices in smallholder cocoa plantations. Strengthening smallholder cocoa plantation management is a strategic step to enable farmers to meet global market demands while simultaneously increasing productivity and quality of production. Strengthening smallholder cocoa plantation management encompasses not only the technical aspects of cultivation but also the institutional, administrative, farm data digitization, product traceability systems, and human resource capacity building for farmers. Synergy between the government, business actors, supporting institutions, and farmers is essential to create a smallholder cocoa management system that is adaptive to changing global regulations. Therefore, strengthening smallholder cocoa plantation management is expected to increase the competitiveness of Indonesian cocoa in the international market while supporting sustainable plantation development (Perdana et al., 2022; FAO, 2024).

The novelty aspect of this research is the strategy for strengthening the management of smallholder cocoa plantations through implementation of good agriculture practice, sustainability, digitalization and traceability to meet the demands of anti-deforestation regulations stipulated in the EUDR. Previous research has focused on increasing the productivity and production of smallholder cocoa plantations, such as Ruhimat (2021) study on strengthening farmer institutions in the management of smallholder cocoa *agroforestry* and research by Fazera et al. (2025) on the role of farmer groups in increasing cocoa production. Similar research was conducted by Ingesti (2024) on strengthening farmer group institutions in an effort to increase cocoa farming income and research by Suparyana et al. (2025) on strengthening farmer groups in controlling cocoa and



coffee plant pests. Previous research related to EUDR is still general for all plantation commodities, such as the study by Afandi et al. (2024) on Indonesian plantation strategies in dealing with *European Union on Deforestation-free Regulation* (EUDR) and KAMI (2024) study on the involvement of Indonesian smallholders in the European Union supply chain under the EU deforestation regulation: challenges and feasible mitigation measures.

The objectives of this research are as follows: (1) To synthesize the potential implications of EUDR policies on the management and marketing of smallholder cocoa in Indonesia; (2) To identify the actual conditions and various weaknesses in the management of smallholder cocoa plantations, both from the technical, institutional and administrative aspects of farming; (3) To formulate strategies for strengthening the management of smallholder cocoa plantations that are oriented towards compliance with EUDR standards.

2. RESEARCH METHOD

This research uses a literature study method (*library research*) with a qualitative descriptive approach. The literature study method was chosen because the discussion in this study focuses on theoretical studies, policies, and various previous research results related to the management of smallholder cocoa gardens and their implementation of *European Union Deforestation Regulation* (EUDR). A literature review is a research method conducted through the collection, review, and analysis of various reference sources relevant to the research topic. These reference sources include scientific journals, books, official reports from national and international institutions, government regulations, European Union policy documents, and previous research related to the sustainable cocoa sector and supply chain governance of plantation commodities (Creswell, 2018; Moleong, 2017).

Source *database* used in this research include books *Outlook Cocoa Plantation Commodities* (Center for Agricultural Data and Information Systems, 2025), *Indonesian Cocoa Statistics* (BPS, 2024), *Regulation (EU) 2023/1115 on Deforestation-free Products (EUDR)* (European Commission, 2023), and the results of the FAO study (2024) on *Evaluation of the project: Promoting zero-deforestation cocoa production for reducing emissions in Côte d'Ivoire*, and the results of our study -*European Forest Institute* (2024) on the Involvement of Indonesian Smallholders in the European Union Supply Chain under the EU Deforestation Regulation: Challenges and Possible Mitigation Measures. Data and information searches were conducted





using the keywords European Union anti-deforestation policy, cocoa plantation development, smallholder cocoa plantations, strengthening farmer institutions, and developing sustainable cocoa plantations. The criteria for selecting articles used in the study included aspects of substantive relevance, credibility, and currency, resulting more than 30 articles for analysis. Therefore, the study's results are expected to provide a comprehensive overview of efforts to strengthen smallholder cocoa plantation management, oriented toward sustainability and export competitiveness.

3. RESULTS AND DISCUSSION

The Impact of EUDR Policy on Smallholder Cocoa Plantations

Implementation of the *European Union Deforestation Regulation* (EUDR) has the potential to pose a new challenge to Indonesia's cocoa export performance to the European Union market. This regulation requires all cocoa products entering the EU market to meet deforestation-free standards, be equipped with geolocation information on production areas, and have a verifiable traceability system. For the Indonesian smallholder cocoa sector, compliance with these requirements still faces various obstacles because the majority of farmers have limited administrative records, plantation documentation, and plantation data management. Failure to meet EUDR requirements can increase the risk of product rejection in destination markets and increase the costs and complexity of the export process (Nagara et al., 2024). This situation has the potential to reduce the competitiveness of Indonesian cocoa compared to other producing countries that have developed more transparent and well-documented supply chain systems from plantation to market.

The EUDR also emphasizes the importance of implementing a traceability system capable of identifying the origin of cocoa products from the plantation level to the end consumer. The information required includes production location, producer identity, land legality, and product distribution channels. This requirement poses a significant challenge for smallholder cocoa plantations in Indonesia, as the marketing structure still involves numerous intermediaries, making it difficult to accurately trace product origins. Furthermore, the low level of plantation record-keeping at the farmer level further exacerbates implementation barriers (European Commission, 2023; KAMI, 2024). Therefore, efforts to digitize plantation data, strengthen farmer organizations, and integrate supply chain systems are needed to effectively implement traceability standards. The



EUDR regulation requires that cocoa products marketed to European Union countries be traceable from upstream to downstream.

The implementation of the EUDR also has economic consequences in the form of increased compliance costs (*compliance cost*), particularly for land mapping, geospatial data collection, certification, and the development of supply chain monitoring systems. For smallholder farmers, these additional costs pose a serious challenge due to limited access to capital and technology. On the other hand, exporting companies need to allocate additional investment to establish due diligence mechanisms and sustainability verification systems. Without policy support and collaboration between actors, high compliance costs can limit smallholder farmers' participation in global export supply chains (European Commission, 2023; FAO, 2024). Interventions in the form of technical assistance, subsidies, and strengthening farmer institutions are needed so that the adaptation process to the EUDR can be carried out gradually and inclusively across all smallholder cocoa farms.

Apart from the cost and administrative aspects, the implementation of EUDR also has the potential to give rise to risks *market exclusion*, namely the exclusion of products from the European Union market due to the inability to meet established sustainability standards. This risk is a major concern for the smallholder cocoa sector because most farmers are still unprepared to provide evidence of traceability and deforestation-free verification. Products that cannot clearly demonstrate their origins will face barriers to international market access. The impact could include decreased export volumes, reduced demand for smallholder cocoa, and even lower farmer incomes. In the long term, this situation could also impact the image and reputation of Indonesian cocoa in global trade (European Commission, 2023; KAMI, 2024).

Current Conditions of Smallholder Cocoa Plantations in Indonesia

Indonesia is one of the world's leading cocoa producers and holds a key position in the global cocoa trade after Ivory Coast and Ghana. Data from the Central Bureau of Statistics (BPS) shows that Indonesia's cocoa plantations area in 2023 reached 1.39 million hectares with a production of 632,120 tons per year. In 2025, the cocoa plantations area decreased to 1.37 million hectares with a production of 630,590 tons per year. The table below shows that the area and quantity of cocoa production continue to decline year after year, so support from all parties is needed to maintain Indonesia's cocoa potential. In terms of business status, cocoa s in Indonesia are dominated by smallholder plantations, which control more than 95% of the total area, while the



remainder is managed by state-owned and private companies. This condition indicates that the sustainability and competitiveness of the national cocoa industry is largely determined by the capacity of smallholder farmers to manage their plantations productively, efficiently, and sustainably. Cocoa plantations are spread across almost all of Indonesia, but significant cocoa production is concentrated on the island of Sulawesi, particularly in the provinces of Central Sulawesi, South Sulawesi, Southeast Sulawesi, and West Sulawesi, which have agroecological characteristics that support the development of smallholder cocoa (BPS, 2024; Susanti et al., 2025). Despite its vast area, Indonesian cocoa production still experiences fluctuations due to various constraints, such as declining plant productivity, pest attacks, climate change, and low plantation management intensity. Furthermore, many cocoa plants have entered their senescence phase, resulting in a continued decline in production capacity.

Table 1. Area and Production of Indonesian Cocoa Plantations

Year	State Plantations		Private Plantations		Smallholder Plantations		Total	
	Area (ha)	Production (tons)	Area (ha)	Production (tons)	Area (ha)	Production (tons)	Area (ha)	Production (tons)
2014	15.171	11.438	26.088	18.542	1.686.178	698.434	1.727.437	728.414
2015	15.171	11.616	26.776	19.369	1.667.337	562.346	1.709.284	593.331
2016	14.793	12.362	27.342	16.193	1.678.638	629.844	1.720.773	658.399
2017	14.747	12.073	22.414	14.360	1.615.955	558.813	1.653.116	585.246
2018	12.384	7.716	14.497	7.880	1.584.133	751.685	1.611.014	767.280
2019	7.499	1.620	10.741	3.806	1.542.704	729.371	1.560.945	734.795
2020	4.809	976	11.558	3.084	1.492.588	716.601	1.508.955	720.660
2021	674	171	8.218	1.596	1.451.504	686.443	1.460.396	688.210
2022	264	53	4.995	1.165	1.415.750	649.394	1.421.009	650.612
2023	228	27	4.995	740	1.388.386	631.350	1.393.390	632.117

Source: Central Statistics Agency (2024)

The development of cocoa plantation area and production as listed in Table 1 above shows



that the overall area of Indonesian cocoa plantations has declined from year to year. In 2014, the area of cocoa plantations was recorded at 1,727,437 hectares with a production of 728.14 tons and in 2023 it decreased to 1,393,390 hectares with a production of 632,117 tons. The decline in area and cocoa production was very large in both state and private plantations. State-owned cocoa plantations in 2014 were recorded at 15,171 hectares with a production of 11,438 tons, and in 2023 the area of plantations decreased to 228 hectares with a production of 2 tons. The area of privately owned cocoa plantations was recorded at 26,088 hectares with a production of 18,542 tons, and then decreased to 4,995 hectares with a production of 740 tons. Meanwhile, smallholder cocoa plantations experienced only a slight decline, where in 2014 they were recorded at 1,686,178 hectares with a production of 698,434 tons, and then in 2023 they decreased to 1,388,386 hectares with a production of 631,350 tons.

The productivity of smallholder cocoa plantations in Indonesia remains below the potential yields achieved by superior cocoa plants. Average productivity of smallholder plantations generally ranges from 700–900 kg of dry beans per hectare per year, while technically productivity can reach more than 2 tons per hectare if cultivation practices are carried out optimally and intensively. This low productivity is influenced by technical and structural factors, particularly the high proportion of old, damaged, and unrejuvenated plants. Most smallholder cocoa plants are more than two decades old, resulting in a significant decline in their fruit-bearing capacity, impacting farming efficiency (Susanti et al., 2025a).

In addition to plant age, low productivity is also related to the suboptimal application of cultivation technology at the farmer level. Many cocoa farmers have not yet fully implemented Good Agricultural Practices (GAP) principles, such as the use of superior planting materials, fertilization according to plant needs, regular pruning, garden sanitation, and integrated pest control. This condition prevents plants from maximizing their genetic potential. Furthermore, pests and diseases remain major obstacles to national cocoa production. Common pests include the cocoa pod borer (*Conopomorpha cramerella*), a fruit rot disease caused by *Phytophthora palmivora*, as well as disease *vascular-streak dieback* (VSD). Farmers' limited knowledge and ability to control these pests results in significant crop losses in smallholder cocoa gardens (Refolta, 2024; Almulqu, et al., 2026).

Smallholder cocoa productivity is also affected by limited access to financing and agricultural production inputs. High input prices, such as fertilizer, and farmers' limited access to



business credit often result in suboptimal plantation maintenance. Consequently, the quality and quantity of cocoa production are low, reducing farmers' incomes. In the long term, this situation could reduce the competitiveness of Indonesian cocoa in the international market. Therefore, productivity improvements need to be directed through plant rejuvenation programs, strengthening the implementation of GAP, increasing access to financing, and developing farmer capacity to make smallholder cocoa businesses more competitive and sustainable (FAO, 2024; Perdana et al., 2022).

Weaknesses in Smallholder Cocoa Plantation Management

The management of smallholder cocoa plantations in Indonesia continues to face various multidimensional challenges, encompassing technical, economic, institutional, and environmental sustainability aspects. These obstacles contribute to low productivity, business efficiency, and the competitiveness of Indonesian cocoa in both domestic and international markets. As a sector dominated by smallholder farmers, the success of cocoa plantation development depends heavily on professional farm management and adaptability to market changes and global standards. Therefore, identifying and addressing weaknesses in plantation management is a crucial step in strengthening the sustainability of the national cocoa industry.

Unclear Land Legality. Most land developed into smallholder cocoa plantations lacks clear legal standing. Some smallholder cocoa farmers still cultivate land based on hereditary ownership, village certificates, or other informal evidence without official certificates. This weakens farmers' legal standing in proving land tenure rights. Furthermore, some smallholder cocoa plantations are located in areas with unclear administrative spatial status or are indicated to be in areas with land use restrictions. This problem often arises from a history of land clearing that occurred before more systematic mapping and spatial planning were implemented. Smallholder plantations face significant challenges related to land use rights, including documentation and data demonstrating compliance. A Cultivation Registration Certificate (STD-B) is a basic legal requirement for smallholder farmers cultivating agricultural commodities and serves as proof of the legality of their plantations (EFI, 2024; Nagara et al., 2024).

Another weakness faced in the management of smallholder plantation commodities, including cocoa, is the still limited access of smallholder farmers to traceability systems (*traceability system*) and the difficulty of separating products based on production origin. Limited access to traceability systems is primarily due to the lack of adequate spatial data and plantation



administration. Many smallholder farmers lack accurate plantation geolocation information, such as officially documented land coordinates or boundary maps. Furthermore, recording of farming activities, farmer identities, production volumes, and harvest distribution channels is still rudimentary or even undocumented. This situation makes it difficult to link marketed products to clear and verifiable production locations. Another challenge arises from the complexity of commodity supply chains, which involve numerous intermediaries. The involvement of many actors who are not formally registered makes information regarding product origins increasingly difficult to trace. Under these conditions, products from various sources are often mixed at the collection stage, thereby losing the identity of the product's origin before it reaches the processing industry (KAMI, 2024; Nagara et al., 2024).

Weak Farm Administration. Farm administration is a crucial component of plantation management, supporting the planning, organization, implementation, and evaluation of production activities. However, on smallholder cocoa plantations, administrative practices are still relatively low and often not yet part of the process from farmers' routine activities. Most business management is still carried out conventionally based on experience without adequate record-keeping and documentation. This condition is evident in the lack of written business plans, the lack of documented production cost structures, and the lack of evaluation of business results. As a result, farmers experience difficulties in calculating profits, developing business development strategies, and making rational investment decisions. Administrative weaknesses also limit access to formal financing, as financial institutions generally require administrative records as a basis for assessing business feasibility. Furthermore, limited documentation hinders meeting sustainability certification standards, which require transparency and recording of cultivation activities. Therefore, improving farm administrative capacity is a crucial foundation for modernizing smallholder cocoa farm management (Afriansyah et al., 2022; Nagara et al., 2024).

Lack of Plantation Recording. Plantation recording is a key element of a modern plantation management system because it provides the information needed for data-driven decision-making. Recording activities include production input use, labor, harvest volume, plant condition, and even pest and disease incidence. However, most smallholder cocoa farmers in Indonesia still do not implement routine and structured record keeping. The absence of historical data makes it difficult for farmers to evaluate their plantation productivity and the effectiveness of their cultivation techniques. As a result, management decisions are based more on habit and





experience than on data analysis. This situation also has the potential to lead to inefficient use of fertilizers and pesticides, increasing production costs and reducing business yields. Furthermore, weak record keeping hinders the implementation of quality control and product traceability systems, which are now essential requirements for international cocoa trade. Poor record keeping skills are generally related to limited education, lack of training, and minimal technical assistance for farmers. Therefore, strengthening administrative and record keeping competencies is a strategic step towards transforming smallholder plantation management into a more modern one (Hanggana, 2017; Nagara et al., 2024).

Technological Limitations. Low levels of technology adoption are a major contributing factor to the low productivity of smallholder cocoa plantations in Indonesia. Most farmers still employ simple cultivation methods with limited innovation, both in the production and post-harvest stages. The use of superior varieties, recommended fertilization, regular pruning, integrated pest control, and processing techniques have not been optimally implemented. Contributing factors include limited capital, low access to information, uneven quality of extension services, and high technology investment costs. Furthermore, post-harvest management remains a weakness, as many farmers do not ferment cocoa beans according to standards, resulting in beans that do not meet industry needs. Poor post-harvest quality directly impacts the selling price of products at the farm level. Furthermore, the use of digital technologies such as business recording applications, market price information, and decision support systems remains very limited. Yet, digitalization has the potential to increase production efficiency and market access. In the context of climate change, technological adaptability is also crucial for farmers to cope with changing weather patterns and the pressure of plant pests. Therefore, accelerating Dissemination of appropriate technology is a strategic agenda for the development of people's cocoa (Ruhimat, 2021; Alfian, et al., 2024; Anam, et al., 2025).

Weak Farmer Organizations. Farmer organizations play a strategic role in supporting the development of smallholder plantations through learning, economic cooperation, increased bargaining power, and market access. However, cocoa farmer organizations in various regions still face various limitations in governance and member participation. Many farmer groups were formed as an administrative requirement for programs, resulting in organizational activities that have not been sustainable. Irregular group meetings, weak organizational administration, and minimal program planning have prevented these organizations from providing tangible benefits to



their members. This situation also impacts farmers' low bargaining power in the marketing chain, as harvest sales are still conducted individually to collectors. As a result, farmers find it difficult to obtain more competitive prices or establish partnerships with processing industries. Furthermore, weak institutions slow the dissemination of information and the adoption of technological innovations at the farmer level. Strengthening farmer organizations is a critical priority because effective institutions can expand access to financing, strengthen marketing networks, increase business efficiency, and support the competitiveness of Indonesian cocoa in the global agribusiness system (Anam et al., 2022; Ingesti, 2024).

Strategy for Strengthening the Management of Smallholder Cocoa Plantations

Strengthening the management of smallholder cocoa plantations is a strategic step to increase productivity, business efficiency, harvest quality, and the sustainability of the plantation system. These efforts need to be implemented in an integrated manner through strengthening technical aspects, institutional aspects, digitalization, and policy support so that smallholder cocoa development can adapt to global market demands, including meeting sustainability and traceability standards as stipulated in *European Union Deforestation Regulation* (EUDR). A comprehensive approach is needed so that farmers can not only increase production yields but also strengthen their competitiveness and access to international markets in a sustainable manner (European Commission, 2023; FAO, 2024).

Strengthening Technical Aspects

Implementation *Good Agricultural Practices* (GAP). The implementation of GAP is one of the main approaches to improving cocoa farming performance through productive, efficient, and environmentally friendly cultivation practices. In the cocoa cultivation system, GAP includes the use of superior planting materials, regular plant maintenance, fertilization based on plant needs, garden sanitation, integrated pest control, and the application of standardized harvesting and post-harvest techniques. The implementation of these practices contributes to increasing the productivity and quality of cocoa beans while maintaining the sustainability of natural resources. In addition to increasing production yields, the implementation of GAP also helps reduce the negative impacts of excessive use of chemical inputs on the environment. For GAP implementation to be effective, support is needed through extension programs, field training, technology demonstrations, and ongoing mentoring so that farmers are able to adopt cultivation standards according to the needs of industry and export markets (Alfian, et al., 2023; Nagara, et al.,





2024).

Sustainable Intensification. Sustainable intensification is a strategy to increase agricultural productivity while maintaining ecological balance and environmental carrying capacity. On smallholder cocoa plantations, this approach can be realized through the rehabilitation of old plants, the use of superior varieties, balanced fertilization, soil and water conservation, and more environmentally friendly management of plant pests. Given that most smallholder cocoa plants have reached their unproductive age, a rejuvenation program is a crucial component of this strategy. The use of superior seeds that are resistant to pests and diseases and have high productivity needs to be combined with efficient use of production inputs to maintain business costs. In addition, the use of organic fertilizers and biological control can support soil quality improvement and reduce dependence on synthetic chemicals. In the face of climate change, sustainable intensification is also aimed at increasing farmers' adaptability to changing weather patterns and plant disease pressures so that productivity can be maintained in the long term (Perdana et al., 2022; Nagara et al., 2024).

Implementation of Agroforestry. Agroforestry is a land management system that integrates plantation crops with shade trees, forestry crops, or other commodities within a single spatial and temporal framework. In cocoa plantations, agroforestry is implemented by planting shade trees and diversified crops around cocoa areas to create a more resilient and sustainable production system. This approach provides various ecological benefits, including maintaining soil moisture, reducing erosion, increasing biodiversity, and improving microclimate conditions that support cocoa plant growth. From an economic perspective, agroforestry also opens up opportunities for income diversification through the production of additional crops such as fruit, timber, and other economically valuable crops. From a sustainability perspective and compliance with international standards, agroforestry systems are an important approach to supporting environmental conservation, increasing carbon sequestration, and reducing pressure on forest areas. For effective implementation in smallholder cocoa plantations, policy support, provision of supporting plant seedlings, and ongoing technical assistance for farmers are required (Ruhimat, 2021; Aziz, et al., 2023; Swiss Platform for Sustainable Cocoa, 2025).

Strengthening Institutional Aspects

Strengthening Farmer Groups and Cooperatives. Farmer groups and cooperatives play a strategic role in supporting the improvement of cocoa farmers' business capacity, welfare, and



competitiveness. Strong institutional frameworks enable farmers to obtain various economic benefits, such as efficient procurement of production inputs through collective purchasing, increased access to formal financing, strengthened bargaining power in the marketing chain, and expanded market networks. Therefore, the development of farmer institutions needs to be directed not only as administrative platforms but also as economic institutions capable of creating added value for their members. Strengthening efforts can be achieved through enhancing organizational management capabilities, developing leadership, improving transparent administrative governance, and establishing productive and sustainable business units. In the context of cocoa agribusiness, farmer cooperatives have the potential to become a collective marketing vehicle that enables farmers to obtain more competitive selling prices and reduce dependence on intermediaries. Furthermore, strong farmer organizations are also a supporting factor in the implementation of sustainability certification, product quality control, distribution of technical assistance, and development of partnerships with the private sector. With effective institutions, the process of coordination and strengthening farmer capacity can be more structured and sustainable (Anam et al., 2022; Ingesti, 2024).

Farmer-Industry Partnerships. Partnerships between cocoa farmers and the processing industry are a crucial approach to building a more sustainable and market-oriented cocoa agribusiness system. This partnership model creates a mutually beneficial relationship, where farmers receive support to increase production capacity, while the industry receives a guaranteed supply of raw materials that meet quality standards. Through the partnership scheme, farmers gain broader access to technological innovation, cultivation training, financial support, and market certainty for their produce. Meanwhile, processing companies benefit from a continuous supply and improved quality of raw materials to meet the needs of industry and export markets. Partnerships also play a role in encouraging the implementation of improved cultivation and post-harvest standards through technical assistance and knowledge transfer to farmers. For partnerships to be effective and provide long-term benefits, the principles of transparency, fairness, accountability, and sustainability are essential in the relationship between the parties. In this case, the government has a strategic function as a facilitator that provides regulations, incentives, and a conducive business environment to support the formation of inclusive and competitive agribusiness partnerships (Nagara, et al., 2024; FAO, 2024; Almulqu, et al., 2026).

Strengthening the Digitalization and Traceability Aspects





GPS-Based Garden Mapping. Garden mapping using technology of *Global Positioning System* (GPS) is a crucial foundation for building a more modern, documented, and integrated cocoa plantation management system. This technology allows precise identification of plantation locations, thereby supporting more effective inventory, monitoring, and supervision of production areas. In the context of sustainable plantation development, spatial mapping is a crucial instrument for ensuring compliance with international standards, including provisions of *European Union Deforestation Regulation* (EUDR), which requires cocoa products to originate from land not linked to deforestation. The availability of geographic coordinates allows for a more transparent, accurate, and accountable verification process for both the government and businesses. In addition to supporting the traceability system (*traceability*), GPS-based mapping also plays a role in improving the quality of decision-making at the farm level. The resulting spatial information can be used to analyze topographic conditions, soil characteristics, land-use patterns, and potential environmental risks that affect cocoa productivity. This data helps farmers and extension workers design more targeted and efficient cultivation strategies. Mapping can be implemented using various devices, from portable GPS devices and smartphone applications to drone-based technology and satellite imagery. However, the implementation of this technology still faces obstacles such as low digital literacy among farmers and limited technological infrastructure in several production centers. Therefore, training programs, technical assistance, and empowerment are needed to ensure inclusive access to technology for digital transformation (Fidayanti et al., 2023; Afandi et al., 2024; PASPI, 2024).

Farmer Database Development. Farmer database development is a key component in the digital transformation of the smallholder cocoa plantation sector. The database serves as an integrated information system containing data on farmer identity, land area and status, plantation productivity, production input use, and harvest marketing history. The availability of a complete and accurate database provides strategic benefits in supporting plantation sector development planning. The government can use this data to formulate more targeted policies, while financial institutions can utilize it to assess the feasibility of farming businesses and expand credit access for farmers. Furthermore, the database is a crucial element in supporting certification systems and meeting traceability requirements, increasingly required in international cocoa trade. In the context of EUDR implementation, the farmer database serves as an instrument to ensure the legality, transparency, and sustainability of cocoa production. Systematically documented data enables



faster and more efficient verification processes and supports monitoring of the implementation of sustainable cultivation practices at the farmer level. Developing a database system requires cross-stakeholder integration involving the central government, local governments, cooperatives, farmer groups, and the private sector. This integration is crucial to avoid duplication of information and to increase the effectiveness of inter-agency coordination. Utilization of technology-based *cloud computing* and digital applications are alternatives that can accelerate the modernization of smallholder plantation data governance (Pratama, et al., 2022; European Commission, 2023; Rifai, et al., 2023).

Supply Chain Information System. A supply chain information system is a digital mechanism that connects all actors in the cocoa agribusiness, from farmers and traders to cooperatives and processing industries to exporters. The primary objective of this system is to increase transparency, distribution efficiency, and product traceability throughout the value chain. In practice, the smallholder cocoa marketing chain in Indonesia tends to be long and involves many intermediaries, leading to inefficiencies and weakening farmers' bargaining power. Through a digital-based information system, data on prices, product quality, production volume, and market demand can be accessed more quickly, openly, and in an integrated manner, helping to create a more efficient market mechanism. Supply chain information systems also play a strategic role in supporting the implementation of *traceability* and compliance with international trade standards. With a digital system, every transaction and product movement can be documented and traced from the production stage to the end consumer. This transparency is crucial in meeting global market demands, which increasingly emphasize sustainability and product legality. In addition to supporting marketing, a digital supply chain system can also improve logistics efficiency, strengthen quality control, and provide supply certainty for the industry and market stability for farmers. However, successful implementation is highly dependent on the readiness of digital infrastructure, increased technological literacy, and collaboration between business actors and the government. Therefore, the development of an inclusive digital plantation ecosystem needs to be part of the national cocoa sector transformation strategy (OECD, 2021; Prihadianto et al., 2022; Badawi et al., 2025).

Strengthening Government Policy Support

Regulatory Support. Regulation plays a strategic role as a governance instrument in realizing a more sustainable cocoa plantation management system.





transparent and competitive. The government needs to design policies that not only encourage increased productivity and farmer welfare, but also ensure environmental protection and the sustainability of natural resources. In the context of implementation of *European Union Deforestation Regulation* (EUDR), strengthening regulations is important, especially in terms of land legality, product traceability systems (*traceability*), forest area protection, and the implementation of sustainability certification standards. Regulatory certainty will provide a clear legal basis for farmers and business actors to carry out cocoa production, distribution, and trade activities in a more targeted manner. Furthermore, simplifying administrative procedures and improving inter-agency coordination are crucial factors for effective policy implementation in the field. Policy synchronization between the plantation, forestry, trade, and environmental sectors is also necessary to create an integrated cocoa management system. Furthermore, public policies need to be designed inclusively so that smallholder farmers do not face barriers to accessing international markets due to limited capacity to meet increasingly stringent global standards (European Commission, 2023; Nagara et al., 2024).

Support for Land Legality. Regulations regarding cocoa refer to Law Number 39 of 2014 concerning Plantations, which serves as the primary foundation for cocoa plantation activities, as with other plantation commodities. In the upstream sector, this legality includes the legality of land status, evidenced by proof of land ownership and the legality of managing plantations, as evidenced by registration letters (STD-B) for smallholder farmers and plantation permits for companies. Clarity of the legal status of land developed by farmers into cocoa plantations is crucial in order to comply with EUDR regulations. Provisions in the EUDR that require compliance with local laws can be met by obtaining land legality in the form of Ownership Certificates (SHM), Land Certificates (SKT), Compensation Certificates (SKGR), Management Rights, customary land, and other rights such as Cultivation Rights (HGU). Proof of ownership or rights/claims to land is a requirement for obtaining a Plantation Business Registration Certificate for Cultivation (STD-B). Proof of official land ownership and STD B are prerequisites for smallholder farmers to obtain certification for their products. Therefore, the challenges faced in issuing STD-B also hamper ISPO certification. High costs, burdensome institutional requirements, and documentation also hinder smallholder farmers from achieving certification (EFI, 2024a; Nagara et al., 2024).

Financing and Incentives. Transforming cocoa plantation management toward a sustainable production system requires significant investment support, particularly for plant



rehabilitation, the implementation of technological innovation, the digitization of farming systems, and the fulfillment of certification requirements. Therefore, government involvement through the provision of financing and incentives is crucial to the success of this transformation process. Support can include low-interest loans, subsidies for production inputs, assistance with superior seeds, and fiscal incentives for farmers and economic institutions that implement sustainable cultivation practices. Financing also needs to be directed toward supporting the development of post-harvest facilities, strengthening information systems, and developing digital infrastructure in cocoa production centers. In addition to direct support, the government can expand access to financing through collaboration with the banking sector, financial institutions, and sustainability-based investments.

(*green financing* (). The green financing approach is becoming an increasingly relevant alternative to accelerate the transformation of smallholder plantations to be more environmentally friendly. Furthermore, providing incentives to farmers who implement agroforestry systems and maintain forested areas can be a mechanism to support natural resource conservation and climate change mitigation efforts (Perdana et al., 2022; KAMI, 2024).

EUDR Mentoring. The implementation of the EUDR presents new challenges for the Indonesian cocoa sector, requiring compliance with product traceability and assurance that production does not originate from deforested areas. Given that most smallholder cocoa farmers still face limitations in administration, technology, and understanding of international standards, a mentoring program is crucial. This mentoring can be provided through policy outreach, technical training on sustainable cultivation, facilitating plantation mapping, developing a farmer database, and providing support in land legalization and certification processes. The mentoring program needs to involve various stakeholders, such as agricultural extension workers, universities, research institutions, cooperatives, farmer organizations, and the private sector, to create synergy in the process of increasing farmer capacity. Furthermore, developing a national information system that supports cocoa commodity traceability is a crucial step to accelerate the verification process and improve data management efficiency. Externally, the government also needs to strengthen trade diplomacy to ensure that the implementation of the EUDR continues to take into account the conditions and capacities of developing producer countries. With systematic and continuous assistance, smallholder cocoa farmers are expected to be able to adapt to global market demands and maintain export access to the European Union market (KAMI, 2024; Nagara, et al.,



2024).

4. CONCLUSIONS

Implementation of *European Union Deforestation Regulation* (EUDR) is a strategic challenge for the Indonesian cocoa sector because it presents new standards in international trade that emphasize aspects of deforestation-free, product traceability (*traceability*), land legality, and supply chain transparency. For Indonesia, as one of the world's leading cocoa producers, much of whose production is supported by smallholder plantations, this policy has the potential to become an export barrier if the stipulated requirements cannot be adequately met. Potential risks include product rejection in the European Union market, increased compliance costs, decreased product competitiveness, and reduced international market access for smallholder farmers.

The current state of smallholder cocoa plantations in Indonesia demonstrates that various limitations persist in productivity, farm management, plantation records, technology adoption, farmer institutions, and traceability systems. Despite Indonesia's vast cocoa areas and significant contributions from the smallholder plantation sector, productivity remains relatively low compared to the crop's optimal potential. Furthermore, the high proportion of aging plants, weak farm administration, limited access to financing, low adoption of cultivation and post-harvest technologies, and suboptimal organization Farmers are a factor that influences the competitiveness of national cocoa in facing changes in global trade standards.

Therefore, strengthening the management of smallholder cocoa plantations is a strategic step to increase readiness for EUDR implementation while simultaneously strengthening the sustainability of the national cocoa industry. This strategy needs to be implemented in an integrated manner, through strengthening technical aspects through the implementation of *Good Agricultural Practices* (GAP), sustainable intensification, and agroforestry; institutional strengthening through the development of farmer groups, cooperatives, and farmer-industry partnerships; digitalization through GPS-based plantation mapping, farmer database development, and supply chain information systems; and policy support through adaptive regulations, sustainable financing, incentives, and assistance in implementing the EUDR. With an integrated approach, the Indonesian smallholder cocoa sector has the opportunity to maintain access to the European Union market, increase global competitiveness, and realize a more productive, inclusive, and sustainable cocoa farming system.



Suggestion

The government needs to accelerate the development and harmonization of policies that support the transformation of smallholder cocoa plantations toward a sustainable production system that meets international standards. This can be achieved by strengthening regulations related to land legality, product traceability systems, forest protection, and simplifying administrative procedures related to exports and certification. Furthermore, the government needs to expand farmer assistance programs through outreach, technical training, facilitating plantation mapping, building a farmer database, and developing a digital-based supply chain information system. Financial support in the form of soft loans, production input subsidies, plant rejuvenation assistance, and incentives for sustainable cultivation practices also needs to be strengthened to enable smallholder farmers to adapt to the demands of the EUDR.

Farmers need to increase their capacity to manage their farming businesses by implementing cultivation practices that are in accordance with the principles. *Good Agricultural Practices* (GAP), improving farm administration, regular farm records, and enhancing post-harvest management. Furthermore, farmers need to begin adapting to digital systems and product traceability through documenting farm locations, utilizing production data, and participating in sustainability certification programs. Strengthening farmer capacity is crucial to ensure cocoa farming is not only focused on increasing production but also meeting international market requirements.

Farmer groups and cooperatives need to be strengthened so that they function not only as administrative organizations but also as economic institutions capable of providing tangible benefits to their members. This strengthening can be achieved through improved organizational governance, administrative transparency, collective marketing, the development of productive business units, and facilitating access to financing and certification. Strong institutions can also serve as a means to accelerate the implementation of traceability systems and the distribution of technological innovations to farmers.

Industry and exporters need to strengthen partnerships with farmers through more inclusive and sustainable supply chain approaches. Support can be provided in the form of technology transfer, technical assistance, certification assistance, product tracking system development, and quality incentives. Strong collaboration between industry and farmers will help create a raw material supply that meets international market standards while increasing the



competitiveness of Indonesian cocoa.

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