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Strengthening Cocoa Farmers' Capacity for EUDR Compliance: A Policy Review of Agricultural Education and Extension in Indonesia

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ABSTRACT

The European Union Deforestation Regulation (EUDR) presents significant challenges for cocoa-producing countries by requiring compliance with strict standards related to traceability, geolocation, and deforestation-free production. As a major cocoa producer, Indonesia must strengthen the capacity of smallholder farmers to meet these emerging sustainability requirements. This study aims to review the role of agricultural education and extension policies in supporting cocoa farmers' readiness for EUDR compliance. A policy review approach was employed using secondary data obtained from academic publications, government regulations, policy documents, and reports from international organizations related to agricultural education, extension services, sustainability governance, and cocoa development. Data were analyzed through thematic content analysis to identify policy priorities, implementation challenges, and capacity-building opportunities. The findings indicate that agricultural education and extension systems play a crucial role in enhancing farmers' knowledge, environmental awareness, digital literacy, and traceability capabilities. However, existing policies remain constrained by limited institutional coordination, unequal access to extension services, and insufficient integration of EUDR-related competencies into farmer training programs. Strengthening policy coherence, expanding sustainability-oriented extension initiatives, and promoting digital learning mechanisms are essential for improving farmers' preparedness. This study contributes to the literature on agricultural education and provides policy recommendations for supporting sustainable cocoa production and EUDR compliance in Indonesia.

Keywords: *Agricultural Education; Agricultural Extension; Cocoa Farmers; EUDR Compliance; Capacity Building; Indonesia*

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INTRODUCTION

The European Union Deforestation Regulation (EUDR) represents one of the most significant policy developments affecting global agricultural commodity trade in recent years. The regulation requires commodities entering the European Union market, including cocoa, to be produced on land free from recent deforestation and supported by robust traceability and due diligence systems (European Commission, 2023). By introducing stricter sustainability requirements, the EUDR has fundamentally reshaped expectations for

producer countries and agricultural supply chains, particularly those dominated by smallholder farmers.

Indonesia is among the world's leading cocoa-producing countries, with the cocoa sector serving as an important source of income for rural households and contributing significantly to agricultural exports. Most cocoa production in Indonesia is undertaken by smallholder farmers who operate on limited landholdings and often face constraints related to technology adoption, market access, and institutional support (Neilson, 2022). These conditions create substantial challenges for compliance with emerging sustainability regulations that require accurate farm-level data, geolocation information, environmental monitoring, and transparent production records.

The implementation of EUDR introduces new capacity requirements for cocoa farmers. Compliance is no longer limited to improving agricultural productivity or product quality but increasingly involves the ability to understand sustainability regulations, maintain traceability systems, utilize digital technologies, and demonstrate environmentally responsible production practices (Auld et al., 2024). Consequently, strengthening farmers' capacity has become a strategic priority for governments, development agencies, and supply-chain actors seeking to maintain access to international markets.

Agricultural education and extension services play a crucial role in supporting farmers' capacity development. Agricultural education provides the knowledge base necessary for understanding sustainable farming practices, environmental stewardship, and market requirements. Meanwhile, extension services function as practical mechanisms through which knowledge, skills, and innovations are transferred to farming communities (Davis & Sulaiman, 2022). Together, these systems contribute to farmers' ability to adapt to changing technological, environmental, and institutional conditions.

Recent studies have highlighted the importance of capacity-building approaches that integrate sustainability principles into agricultural learning systems. Such approaches emphasize not only technical competencies but also environmental awareness, problem-solving abilities, and adaptive capacities required to respond to emerging sustainability challenges (Brundiers et al., 2021). In the context of cocoa production, capacity development has become increasingly important as farmers face growing expectations related to traceability, certification, and sustainable land-use management.

Agricultural extension systems are also undergoing transformation in response to sustainability transitions. Traditional extension models focused primarily on productivity enhancement and technology dissemination. However, contemporary sustainability challenges require extension services to address broader issues such as climate adaptation, environmental governance, digital literacy, and market compliance (Knook et al., 2023). Effective extension programs can facilitate farmer learning, improve access to information, and support the adoption of practices necessary for compliance with international sustainability standards.

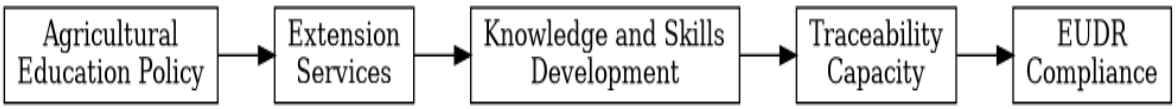
Another important dimension of farmer capacity development concerns digital literacy. The growing use of digital technologies in agriculture has altered the ways farmers

access information, communicate with stakeholders, and participate in value chains. Traceability systems associated with EUDR implementation increasingly depend on digital tools such as geospatial mapping, electronic record-keeping, and online reporting platforms. Farmers with stronger digital competencies are generally better positioned to meet these requirements and maintain market participation (Trendov et al., 2021; Klerkx et al., 2024).

Despite growing attention to EUDR implementation, much of the existing literature has focused on regulatory impacts, sustainability governance, and supply-chain adjustments. Comparatively limited attention has been given to the role of agricultural education and extension policies in strengthening farmers' compliance capacity. Understanding how these policy instruments contribute to farmer preparedness is particularly important in Indonesia, where smallholder cocoa farmers remain central actors in national production systems.

This study addresses this gap by reviewing agricultural education and extension policies relevant to cocoa farmers' readiness for EUDR compliance in Indonesia. Through a policy review approach, the study examines how existing educational and extension frameworks contribute to capacity development and identifies opportunities for strengthening policy interventions. The study proposes that effective agricultural education and extension systems enhance farmers' knowledge, environmental awareness, digital literacy, and traceability capacity, which collectively improve readiness for EUDR compliance.

Figure 1. Policy Framework for Strengthening Cocoa Farmers' Capacity for EUDR Compliance



Source: Developed by the authors based on agricultural education, extension services, capacity-building, and EUDR compliance literature.

The framework illustrates how agricultural education policies support the provision of extension services that facilitate the development of farmers' knowledge and skills. Enhanced knowledge and skills contribute to improved traceability capacity, which is a key requirement for compliance with the European Union Deforestation Regulation (EUDR). The framework suggests that strengthening educational and extension systems is essential for improving cocoa farmers' preparedness to meet emerging sustainability standards and maintain access to international markets.

This study contributes to the growing literature on agricultural education, extension systems, and sustainability governance by providing a policy-oriented perspective on strengthening cocoa farmers' capacity for EUDR compliance. The findings also offer practical recommendations for policymakers, extension agencies, and other stakeholders involved in the sustainable development of Indonesia's cocoa sector.

METHOD

This study employed a policy review approach to examine the role of agricultural education and extension policies in strengthening cocoa farmers' capacity for compliance with the European Union Deforestation Regulation (EUDR) in Indonesia. Policy review and document analysis are widely used qualitative approaches for examining policy frameworks, institutional arrangements, and governance interventions associated with emerging sustainability challenges (Bowen, 2009; Johnston, 2017). This approach was considered appropriate because the study aimed to synthesize existing evidence and assess how educational and extension policies contribute to farmers' preparedness for evolving sustainability requirements.

The study relied exclusively on secondary data obtained from multiple sources, including peer-reviewed journal articles, government regulations, policy documents, institutional reports, and publications from international organizations. Relevant materials were collected from organizations involved in agricultural development, sustainability governance, and cocoa sector management, including the European Commission, Food and Agriculture Organization (FAO), International Cocoa Organization (ICCO), World Bank, United Nations Development Programme (UNDP), and the Ministry of Agriculture of Indonesia. To ensure relevance and currency, priority was given to publications issued between 2020 and 2026, while earlier publications were included selectively when they provided important theoretical or methodological foundations related to agricultural education, extension systems, and capacity development.

The reviewed materials were selected based on their relevance to agricultural education, agricultural extension, farmer capacity building, sustainability governance, cocoa production, traceability systems, and EUDR implementation. Sources were required to originate from reputable academic journals, official government publications, or recognized international organizations and to provide conceptual, empirical, or policy-related insights relevant to smallholder farmers and sustainability transitions. Documents unrelated to agricultural capacity development, sustainability education, or cocoa supply chains, as well as sources lacking sufficient credibility or methodological transparency, were excluded from the review.

Data collection was conducted through a systematic search of academic databases and institutional repositories using keywords such as "agricultural education," "agricultural extension," "capacity building," "cocoa farmers," "traceability," "EUDR," "deforestation-free supply chains," and "sustainability governance." Relevant publications were screened through title, abstract, and full-text reviews before being organized into thematic categories corresponding to the analytical focus of the study, namely agricultural education policy, extension services, farmer capacity development, traceability requirements, and EUDR compliance.

The collected data were analyzed using thematic content analysis, which facilitates the identification of recurring themes, patterns, and relationships across diverse forms of documentary evidence (Braun & Clarke, 2022). The analysis involved an iterative process of document review, coding, categorization, and thematic synthesis. Relevant information was

coded according to issues associated with agricultural education, extension systems, farmer capacity development, and EUDR-related requirements. Similar codes were subsequently grouped into broader categories representing major policy issues and implementation challenges. The identified themes were then synthesized to develop an integrated policy framework explaining how agricultural education and extension systems contribute to cocoa farmers' readiness for EUDR compliance.

To enhance the credibility of the findings, source triangulation was employed by comparing information derived from academic publications, government policies, and reports from international organizations (Patton, 2015). This procedure helped validate recurring findings and reduce potential bias associated with reliance on a single source of information. By integrating evidence from multiple sources, the study provides a comprehensive assessment of policy developments, institutional arrangements, and educational strategies relevant to strengthening cocoa farmers' capacity for compliance with emerging sustainability regulations.

FINDING AND DISCUSSION

RESEARCH RESULT

The review of policy documents, academic literature, and institutional reports indicates that compliance with the European Union Deforestation Regulation (EUDR) requires a broader set of capacities than those traditionally associated with cocoa production. Beyond technical farming skills, cocoa farmers are increasingly expected to understand sustainability regulations, maintain traceability records, utilize digital technologies, and demonstrate environmentally responsible production practices. These requirements have elevated the importance of agricultural education and extension systems as mechanisms for strengthening farmer preparedness and supporting sustainable market participation.

The findings reveal that agricultural education policies play an important role in facilitating capacity development for sustainability transitions. Existing educational initiatives in Indonesia have increasingly incorporated themes related to sustainable agriculture, environmental conservation, climate resilience, and value-chain development. These efforts provide an important foundation for enhancing farmers' understanding of sustainability-related issues. However, the reviewed literature suggests that EUDR-specific competencies, including traceability management, geolocation requirements, due diligence procedures, and deforestation-free verification, have not yet been systematically integrated into most agricultural education programs. As a result, many farmers remain unfamiliar with the specific compliance requirements associated with the new regulation.

Table 1. Key Capacity Requirements and Policy Responses for EUDR Compliance

Capacity Requirement	Role of Agricultural Education	Role of Extension Services	Expected Outcome
Sustainability knowledge	Environmental education	Farmer training	Improved awareness
Traceability skills	Curriculum and learning materials	Practical guidance	Better record-keeping
Digital literacy	Digital learning programs	Technology assistance	Improved data management
Environmental compliance	Sustainability modules	Monitoring support	EUDR readiness

Table 1 summarizes the key capacity requirements associated with EUDR compliance and highlights the complementary roles of agricultural education and extension services in addressing these requirements. The findings indicate that compliance readiness depends on the development of multiple competencies, including sustainability knowledge, traceability skills, digital literacy, and environmental awareness. Agricultural education contributes by providing foundational knowledge and learning opportunities, while extension services facilitate the practical application of these competencies at the farm level. Together, these mechanisms support the development of traceability capacity and strengthen farmers' ability to comply with emerging sustainability regulations. The table further demonstrates that EUDR compliance is not solely a regulatory issue but also an educational and institutional challenge that requires coordinated interventions across agricultural education, extension systems, and sustainability governance frameworks.

The review further indicates that agricultural extension services represent one of the most influential channels through which sustainability-related knowledge reaches farming communities. Extension programs facilitate knowledge transfer, provide technical assistance, and support the adoption of new agricultural practices. Recent policy developments have encouraged extension systems to move beyond productivity-oriented approaches and incorporate broader sustainability objectives. Extension agents increasingly serve as intermediaries connecting farmers with information regarding environmental regulations, market standards, certification schemes, and digital technologies. This expanded role is particularly important in the context of EUDR implementation, where farmers require continuous guidance and practical support to adapt to changing compliance requirements.

Despite these positive developments, several challenges continue to limit the effectiveness of agricultural education and extension systems. One recurring issue concerns uneven access to extension services across regions. Smallholder farmers located in remote production areas often experience limited access to training opportunities, technical assistance, and institutional support. Resource constraints, limited numbers of extension personnel, and insufficient coordination among government agencies further reduce the

effectiveness of capacity-building initiatives. Consequently, significant disparities in knowledge and preparedness remain evident among cocoa-producing communities.

Another important finding relates to the growing significance of digital competencies in sustainability governance. EUDR compliance relies heavily on traceability mechanisms that require accurate data collection, geolocation mapping, and transparent record-keeping. These processes increasingly depend on digital technologies and information management systems. The reviewed literature suggests that farmers possessing stronger digital skills are generally better positioned to engage with traceability requirements and comply with sustainability standards. However, digital literacy remains unevenly distributed, particularly among older farmers and those residing in areas with limited technological infrastructure. This situation creates additional barriers to compliance and highlights the need for targeted digital capacity-building programs.

The findings also demonstrate that traceability capacity has emerged as a central component of farmer preparedness. Traceability systems enable stakeholders to verify commodity origins, monitor supply-chain activities, and demonstrate compliance with environmental regulations. Effective implementation requires farmers to maintain accurate records, document production activities, and participate in data-sharing processes. Farmers who have access to education, training, and institutional support are generally more capable of developing these competencies. Conversely, insufficient training and weak support systems often result in low levels of traceability readiness.

Furthermore, the review reveals increasing recognition among policymakers and development organizations that capacity development must be approached as a long-term process rather than a one-time intervention. Sustainable compliance requires continuous learning opportunities, adaptive extension systems, and institutional arrangements capable of responding to evolving regulatory demands. Several policy initiatives emphasize the importance of strengthening collaboration among government agencies, educational institutions, producer organizations, private-sector actors, and international development partners. Such collaborative approaches are considered essential for creating an enabling environment that supports farmer learning and compliance readiness.

Overall, the findings suggest that agricultural education and extension systems constitute critical foundations for strengthening cocoa farmers' capacity for EUDR compliance. Educational programs contribute to knowledge acquisition and environmental awareness, while extension services facilitate practical learning and technology adoption. Together, these mechanisms support the development of digital competencies and traceability capacity, ultimately enhancing farmers' preparedness to meet emerging sustainability requirements in international cocoa markets.

DISCUSSION

The findings demonstrate that strengthening cocoa farmers' capacity for EUDR compliance is fundamentally an educational and institutional challenge rather than merely a technical or regulatory issue. While EUDR is often discussed in terms of supply-chain governance and sustainability regulation, the results of this study suggest that compliance

ultimately depends on farmers' ability to acquire new knowledge, develop practical skills, and adapt to increasingly complex market requirements. Consequently, agricultural education and extension systems should be viewed as strategic mechanisms for supporting sustainability transitions within the cocoa sector.

As illustrated in Figure 1, agricultural education policies provide the foundation upon which extension services, knowledge development, and traceability capacity are built. Educational policies shape the content, priorities, and institutional arrangements through which farmers gain access to learning opportunities. Consistent with the literature on sustainability competencies, effective educational systems contribute not only to knowledge acquisition but also to the development of critical thinking, environmental awareness, and adaptive capacities required to respond to emerging sustainability challenges (Brundiers et al., 2021). In the context of EUDR implementation, these competencies are increasingly important because farmers must navigate new regulatory requirements that extend beyond conventional agricultural production practices.

The findings further indicate that extension services function as the primary interface between policy objectives and farmer-level implementation. Extension agents play a critical role in translating complex sustainability regulations into practical guidance that can be understood and applied by farming communities. This observation supports previous research suggesting that extension systems remain among the most influential institutional mechanisms for facilitating agricultural innovation and farmer learning (Davis & Sulaiman, 2022). However, the results also reveal that existing extension systems face substantial challenges related to resource limitations, uneven service coverage, and insufficient integration of sustainability-oriented content. These limitations may reduce the effectiveness of efforts to prepare farmers for compliance with EUDR requirements.

The discussion also highlights the importance of knowledge and skills development as intermediary factors connecting educational interventions with compliance outcomes. Farmers who possess a stronger understanding of sustainability standards, environmental regulations, and traceability procedures are generally better positioned to adapt to changing market conditions. This finding reinforces arguments that capacity development should not be restricted to technical production knowledge but should also encompass competencies related to environmental governance, documentation practices, and supply-chain transparency. Such competencies are increasingly necessary for maintaining competitiveness in international agricultural markets.

A particularly important finding concerns the growing role of traceability capacity in determining EUDR readiness. Traceability systems have become central instruments for verifying compliance with sustainability standards and ensuring transparency throughout commodity supply chains. The ability to maintain accurate records, document production activities, and provide verifiable information regarding product origins is now a prerequisite for participation in many international markets. The findings suggest that traceability capacity is not developed independently but emerges from the combined influence of agricultural education, extension support, and continuous learning opportunities. This relationship supports the conceptual framework proposed in Figure 1, which positions

traceability capacity as a key pathway through which educational interventions contribute to compliance outcomes.

Recent developments in global commodity governance further reinforce the strategic importance of traceability systems. Sustainability regulations increasingly require producers to demonstrate verifiable information regarding commodity origins, land-use history, and environmental performance. In cocoa supply chains, traceability has become a central mechanism for ensuring transparency and supporting zero-deforestation commitments (Garrett et al., 2023; Lambin et al., 2023). Consequently, farmers' ability to generate, manage, and communicate traceability data is becoming a critical determinant of market access and long-term competitiveness.

The increasing importance of digital technologies further strengthens the relationship between education and compliance. Contemporary traceability systems often rely on digital tools for geolocation mapping, data management, and reporting processes. Consequently, digital literacy has become an essential component of farmer capacity development. Consistent with the findings of Klerkx et al. (2024), digital transformation creates both opportunities and challenges for agricultural sustainability. While digital technologies can improve efficiency and transparency, unequal access to technological resources may exacerbate existing disparities among farmers. Educational and extension programs must therefore integrate digital competency development to ensure that smallholder farmers are not excluded from sustainability-oriented value chains.

From a policy perspective, the findings indicate that improving EUDR compliance requires a more integrated approach to capacity development. Rather than treating agricultural education, extension services, and sustainability governance as separate policy domains, policymakers should promote stronger coordination among these sectors. Collaborative efforts involving government agencies, educational institutions, producer organizations, private-sector actors, and development partners can create more effective learning environments and support systems for farmers. Such coordination is particularly important given the complexity of EUDR requirements and the diverse capacities needed for successful compliance.

The findings also suggest that sustainability-oriented capacity building should be regarded as a long-term investment rather than a short-term response to regulatory change. EUDR compliance is likely to represent only one component of broader sustainability transitions occurring within global agricultural markets. Future regulations may introduce additional requirements related to climate change, biodiversity conservation, and social responsibility. Strengthening agricultural education and extension systems today can therefore enhance farmers' resilience and adaptive capacity in the face of future sustainability challenges.

This study has several limitations. As a policy review, the analysis relies on secondary data and does not directly assess farmers' experiences or institutional practices in specific cocoa-producing regions. Consequently, the findings should be interpreted as conceptual and policy-oriented insights rather than empirical measurements of compliance readiness. Future studies may employ surveys, interviews, or mixed-method approaches to

validate the proposed framework and examine how agricultural education and extension interventions influence EUDR preparedness at the farm level.

This study argues that EUDR readiness is best understood as the outcome of a cumulative capacity-building process shaped by agricultural education policies, extension services, knowledge and skills development, and traceability capacity. The proposed framework contributes to the literature by highlighting the educational dimensions of sustainability governance and by demonstrating how policy interventions can support smallholder farmers in adapting to evolving international sustainability standards. These insights provide a useful foundation for designing more effective educational and extension strategies aimed at strengthening the long-term sustainability and competitiveness of Indonesia's cocoa sector.

CONCLUSION

This study reviewed the role of agricultural education and extension policies in strengthening cocoa farmers' capacity for compliance with the European Union Deforestation Regulation (EUDR) in Indonesia. The findings indicate that EUDR compliance extends beyond technical agricultural practices and requires farmers to develop a broad range of competencies related to sustainability governance, traceability systems, environmental management, and digital technologies. As a result, agricultural education and extension systems have become increasingly important in supporting farmers' adaptation to evolving international sustainability standards.

The review demonstrates that agricultural education policies provide the foundation for capacity development by enhancing farmers' knowledge, environmental awareness, and understanding of sustainability requirements. Extension services play a complementary role by translating policy objectives into practical learning opportunities and facilitating the adoption of traceability-related practices. Together, these mechanisms contribute to the development of knowledge and skills that are essential for successful compliance with EUDR provisions.

The findings further highlight that traceability capacity has emerged as a critical determinant of compliance readiness. Farmers who possess adequate knowledge, technical skills, and institutional support are generally better prepared to implement traceability systems and meet sustainability-related requirements. However, persistent challenges remain, including limited access to extension services, unequal digital literacy levels, and insufficient integration of EUDR-related competencies into existing educational and training programs.

From a policy perspective, strengthening cocoa farmers' capacity requires greater coordination among agricultural education institutions, extension agencies, government bodies, producer organizations, and private-sector actors. Sustainability-oriented learning initiatives, digital capacity-building programs, and traceability-focused training should be integrated into broader agricultural development strategies to support long-term compliance and market competitiveness.

In conclusion, the study proposes that EUDR readiness is the outcome of a cumulative capacity-building process in which agricultural education policies, extension services, knowledge and skills development, and traceability capacity interact to shape farmers' preparedness. Strengthening these interconnected dimensions will be essential for ensuring that Indonesia's cocoa farmers remain competitive and resilient in an increasingly sustainability-driven global market.

Future research should empirically examine the effectiveness of agricultural education and extension interventions in improving traceability capacity and EUDR compliance among cocoa farmers across different production contexts.

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