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Research Article

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Smallholder Oil Palm Transitions to Responsible Sourcing Production: Sustainable Practices, Adoption Barriers, and Socioeconomic Outcomes

Angga Eko Emzar[1*], Frendy Ahmad Afandi[2] and Zulkifli Alamsyah[3]

[1]*Nahdlatul Ulama Institute of Technology and Science of Jambi, Department of Agronomy, Jambi, Indonesia*
[2]*Coordinating Ministry for Economic Affairs, Performance Management and Cooperation Bureau, Jakarta, Indonesia*
[3]*University of Jambi, Department of Agribusiness, Jambi, Indonesia*

[*]**Corresponding author**
Angga Eko Emzar, Aahdlatul Ulama Institute of Technology and Science of Jambi, Department of Agronomy, Jambi, Indonesia.

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ABSTRACT

Smallholder oil palm production systems, particularly in Indonesia and Malaysia, have increasingly incorporated sustainable land management practices to align with global efforts toward responsible sourcing and deforestation-free supply chains. This review synthesizes current evidence on smallholder adoption of sustainability-enhancing practices, such as reduced and targeted fertilisation, mechanical weed control, agroforestry integration, precision agriculture, and participation in certification schemes, including the Roundtable on Sustainable Palm Oil (RSPO), the Indonesian Sustainable Palm Oil (ISPO), and the Malaysian Sustainable Palm Oil (MSPO). Despite growing interest in sustainability, adoption rates for agroforestry, climate-smart agriculture, and other best management practices remain uneven and context-dependent. Key enabling factors include perceived economic and environmental benefits, prior farming experience, cooperative or association membership, education levels, policy incentives, and improved access to technical and financial resources. Nonetheless, smallholders face a range of persistent barriers, including fragmented nature of supply chains, limited financial capacity, high implementation costs, restricted access to information and extension services, unclear land legality status, unfavourable market conditions, and weak institutional support. A significant constraint is the absence of tailored financial mechanisms such as low-interest credit, risk-sharing models, and targeted subsidies, which could ease the transition toward sustainable practices. Certification programmes and institutional interventions provide partial support; however, compliance with international sustainability standards remains a major challenge. Recent innovations, including digital monitoring platforms and remote sensing technologies, offer promising avenues to strengthen sustainability outcomes. Ultimately, enhancing adoption among smallholders requires adaptive strategies that integrate inclusive policies, innovative financing models, and long-term capa\-city-building initiatives to bridge the gap between global sustainability expectations and on-the-ground realities.

Keywords: Agroforestry, Capacity-Building, Certification Schemes, Deforestation-Free Supply Chains, Financial Mechanisms, Fragmented Supply Chain, Land Legality, Smallholder Oil Palm, Sustainable Land Management

Introduction

Pendrill et al. proved that over 90% of forest loss from 2000 to 2019 was linked to global agricultural activities [1]. In line with deforestation, Cabernard et al. present another concerning finding: international agri-food trade continues to drive biodiversity loss, particularly through changes in land use. Oil palm (Elaeis guineensis Jacq.) is among the most important tropical and agri-food commodities, supplying global food, energy, and industrial markets [2]. The production of these crops by Indonesia and Malaysia accounts for more than 85% of global production [3,4]. While important for maintaining rural economies, these crops also lead to deforestation, biodiversity loss, and greenhouse gas emissions, especially on peatlands.

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These impacts have heightened global scrutiny and accelerated demands for sustainable production, traceable supply chains, and commitments to deforestation-free.

Recent initiatives and regulatory measures required indicators such as deforestation-free, geospatial traceability and legality. Fewer than 12% of companies currently disclose geolocation data for their suppliers, which highlights persistent transparency challenges in the sector [5]. In response, buyers and a range of stakeholder groups have begun adopting landscape and jurisdictional approaches to strengthen compliance and promote greater inclusion of smallholders. Leading certification organizations such as RSPO, ISPO, and MSPO have continuously amended their standards to reflect shifts within the industry. Many experts remain unconvinced that these updates effectively translate into greater inclusivity or genuine credibility.

Smallholders, who grow more than 40% of the oil palm in Indonesia and Malaysia are very important for the economies of rural areas [6,7]. Furthermore, they consistently face substantial challenges, including limited access to finance, insecure land tenure, and inadequate institutional support [8,9]. Although sustainable practices, such as targeted fertilizer application, integrated pest management, agroforestry, and digital traceability, have shown promise, the adoption is constrained by high costs, knowledge gaps, and a lack of reliable incentives and inclusivity [10,11].

This study critically examines the sustainability practices adopted by smallholders, the barriers to their integration, and the socioeconomic implications of incorporating them into responsible sourcing supply chains.

Material and Methods

This study employed a multi-method design combining systematic review, bibliometric mapping, and meta-analysis to assess the effects of sustainable practices and certification schemes on smallholder incomes. The review followed PRISMA guidelines [12]. Searches were conducted in Web of Science, Scopus, ScienceDirect, and SpringerLink for 2010–2025, complemented with grey literature from RSPO, WWF, CIFOR, and EFI. Eligible studies focused on smallholder systems (<50 ha), included sustainability practices or certification schemes, and reported income or livelihood outcomes. From 2,550 records screened, 100 studies were retained for qualitative synthesis and 30 provided sufficient data for meta-analysis.

Bibliometric mapping was undertaken in VOSviewer 1.6.20, using metadata from eligible and supplementary Scopus-indexed studies. Two thematic clusters emerged: process-oriented research on yield optimization, fertilizer efficiency, and pollution reduction, and governance-oriented work on deforestation, land tenure, and certification frameworks. Then, a random-effects meta-analysis was conducted to examine outcomes related to income. The size of the sample weighted the sizes of the effects, and I^2 and Cochran's Q were used to measure variance and heterogeneity. Subgroup analyses were performed based on intervention type, region, and certification scheme, guaranteeing comparability across contexts. This triangulated approach aligns with recent applications in agroecological and sustainability research, providing a robust and multifaceted picture of how sustainable practices impact the lives of smallholder farmers [13].

Results and Discussion

The evidence suggests that certification and sustainable practices lead to measurable productivity and income gains for smallholders; however, their adoption remains highly uneven due to structural and institutional constraints. Malaysia's mandatory MSPO scheme, supported by subsidies, training, and coordinated facilitation, has expanded certification coverage to nearly three-quarters of the independent smallholder area. In comparison, Indonesia has managed to certify less than 1% of its smallholder plantations under ISPO. This low figure is largely tied to persistent land legality challenges, cumbersome registration processes, and a noticeable lack of institutional support [14]. Thailand offers a different model, where collaboration between cooperatives, NGOs, and buyers has resulted in a 66% increase in RSPO-certified areas between 2022 and 2024, now involving over 9,000 independent smallholders [15]. This strategy currently involves over 9,000 independent smallholders [15]. Comparative experiences across these countries confirm that access to finance, facilitation, and collective action are stronger predictors of certification uptake than farmer attitudes alone [16].

Legality and compliance have become central to market access under emerging global regulations such as the deforestation-free regulations, which require commodities to be produced both legally and traceable to their origin [17]. Certification and any claims cannot exclude operators from conducting a due diligence process, including verification of legality, governance, and land tenure systems. In practice, two common pathways exist for demonstrating that products are responsibly produced within supply chains: 1) the certification process and 2) non-certification approaches such as Good Agricultural Practices (GAP) and traceability platforms. Persistent issues of overlapping claims, unclear land titles, and bureaucratic licensing remain particularly significant in Indonesia, severely constraining smallholder access. Initiatives such as participatory mapping and jurisdictional approaches have shown potential in aligning smallholder practices with buyer requirements while reducing legal uncertainty. Without credible legality verification, however, even certified farmers may face risks of market exclusion.

A meta-analysis of thirty studies in this review found that smallholders practising sustainable farming, predominantly through certification, experienced an average household income increase of about 10%, with a confidence interval ranging from 7 to 13%. Although heterogeneity was moderate, the positive effect was consistent across diverse regions, including Indonesia, Malaysia, Ghana, and Latin America. These findings confirm that certification delivers tangible financial benefits, comparable to or greater than other interventions targeting smallholder livelihoods. Variation across studies highlights the influence of contextual factors such as plantation age, access to training and credit, and degree of market integration. The outcomes illustrated in Figure 1 synthesize the strength of evidence linking certification and sustainable practices to both economic and social dimensions. On the economic side, strong evidence shows gains in productivity, household income, income stability, and access to resources, while price premiums and employment

effects are supported by only moderate evidence. On the social side, certification has a strong impact on quality of life and community empowerment; however, equity and inclusion remain weakly supported, reflecting the persistent exclusion of women and poorer farmers.

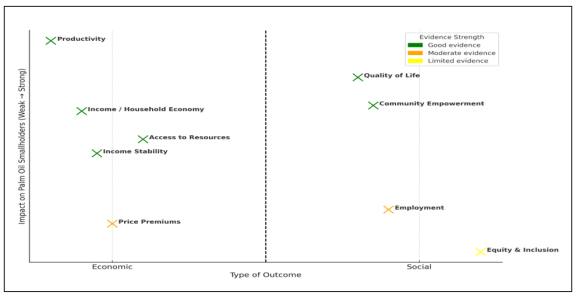

Figure 1: Evidence Strength of Economic and Social Outcomes from Certification and Sustainable Practices

Note: X-axis (Type of Outcome): left area represents economic outcomes, and right area represents social outcomes, and the Y-axis (Impact on Palm Oil Smallholders – Weak → Strong) shows how strongly each factor is discussed in the literature and its relative importance or demonstrated impact. Points higher on the axis = stronger evidence of positive impact on smallholders. Lower positions = weaker or more uncertain impact.

The bibliometric analysis conducted in this study further demonstrates how research has evolved to support sustainability transitions. Two dominant thematic trajectories were identified: one centred on process-oriented interventions, such as fertilizer efficiency, pest management, and yield optimization, and the other on governance issues, including deforestation, legality, and certification frameworks. Complementing these insights, Figure 2 illustrates how sustainability commitments can be structured across the palm oil supply chain. Smallholders, plantations, mills, traders, retailers, and consumers each contribute to practices such as GAP, zero-deforestation, traceability, and eco-labelling, and in return can access layered rewards that include economic incentives, social benefits, environmental services, and future-oriented innovations. This integrated framework highlights how interconnected actors co-produce value and ensure that sustainability commitments are translated into equitable and tangible benefits.

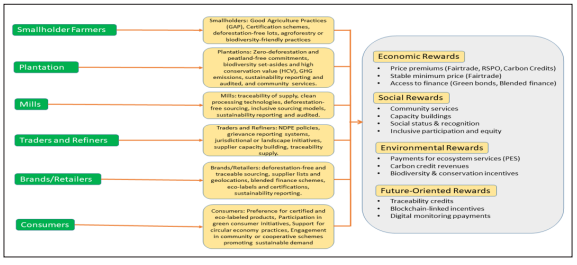

Figure 2: Pathways to Nature Rewards across the Palm Oil Supply Chain

In consideration of experiences from Malaysia, Indonesia, and Thailand, it is evident that state regulation, corporate accountability, and farmer-centred strategies are each essential but inadequate. A hybrid governance model that combines these elements strikes a balance between economic feasibility, smallholder inclusion, and environmental sustainability, translating responsible sourcing commitments into tangible improvements in livelihoods and verifiable sustainability outcomes. Within this broader model, it is essential to recognize that responsible production can be demonstrated not only through certification but also through non-certification approaches such as GAP and traceability platforms, both of which are increasingly vital to sustaining smallholder participation in markets.

Conclusions

This study demonstrates that the sustainability of smallholder oil palm production relies not only on certification, good agricultural practices (GAP), and traceability but also on essential enabling conditions such as land tenure status, access to finance, collective action, and direct benefits. While evidence suggests consistent benefits in productivity and livelihoods, these outcomes remain inconsistent in the absence of supporting institutions and adherence to the law. Integrating these conditions into hybrid governance frameworks is vital for aligning farmer inclusion with emerging sustainability and deforestation-free initiatives. Therefore, responsible sourcing can evolve beyond mere compliance to achieve equitable, verifiable, and enduring sustainability outcomes.

References

1. Pendrill F, Gardner TA, Meyfroidt P, Persson UM, Adams J, et al. Disentangling the numbers behind agriculture-driven tropical deforestation. Science. 2022. 377: eabm9267.
2. Cabernard L, Pfister S, Hellweg S. Biodiversity impacts of recent land-use change driven by increases in agri-food imports. Nature Sustainability. 2024. 7: 1512-1524.
3. FAO. FAOSTAT statistical database. Food and Agriculture Organization of the United Nations. 2024.
4. Varkkey H, Tyson A, Choiruzzad SAB. Palm oil intensification and expansion in Indonesia and Malaysia: Environmental and socio-political factors influencing policy. Forest Policy and Economics. 2018. 92: 148-159.
5. ZSL Sustainable Palm Oil Transparency Toolkit. Palm oil industry not yet prepared for new EU regulations. SPOTT. org. London: Zoological Society of London (ZSL). 2023.
6. Chrisendo D, Siregar H, Qaim M. Oil palm cultivation improves living standards and human capital formation in smallholder farm households. World Development. 2022. 159: 106034.
7. Tang A, Thukral N, Christina B. Insight: Old trees and ageing farmers worsen outlook for top palm oil exporters. Reuters. 2025.
8. Li TM. Securing oil palm smallholder livelihoods without more deforestation in Indonesia. Nature Sustainability. 2024. 7: 387-393.
9. Watts JD, Pasaribu K, Irawan S, Tacconi L, Martanila H, et al. Challenges faced by smallholders in achieving sustainable palm oil certification in Indonesia. World Development. 2021. 146.
10. Reich C, Musshoff O. Oil palm smallholders and the road to certification: Insights from Indonesia. Journal of Environmental Management. 2025. 375: 124303.
11. Susanti A, Marhaento, H., Permadi, D. B., Budiadi, B., Imron, M. A., Hermudananto, H., Nurjanto, H. H., Susanto, D, Santoso H, Bakhtiar I, Maimunah S. Smallholders' oil palm agroforestry: Barriers and factors influencing adoption. Jurnal Ilmu Kehutanan. 2021. 15: 69-81.

12. Traldi R. Progress and pitfalls: A systematic review of the evidence for agricultural sustainability standards. Ecological Indicators. 2021. 125: 107490.
13. Sánchez AC, Kamau HN, Grazioli F, Jones SK. Financial profitability of diversified farming systems: A global meta-analysis. Ecological Economics. 2022. 201: 107595.
14. KAMI (Sustainability of Malaysian and Indonesian Palm Oil). Inclusion of Indonesian smallholders in European Union supply chains under the EU Deforestation Regulation: Challenges and potential mitigation measures. KAMI Project Brief. 2025. https://efi.int/sites/default/files/files/flegtredd/KAMI/Resources/Smallholder_challenges.pdf
15. RSPO. Impact update 2025. 2025. https://rspo.org/wp-content/uploads/Impact-Update-2025.pdf.
16. De Vos RE, Suwarno A, Slingerland M, van der Meer PJ, Lucey JM. Pre-certification conditions of independent oil palm smallholders in Indonesia. Assessing prospects for RSPO certification. Land Use Policy. 2023. 130: 106660.
17. EC (European Commission). Regulation on deforestation-free supply chains. Official Journal of the European Union. 2023.