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Smallholder oil palm transitions to responsible sourcing production: sustainable practices, adoption barriers, and socioeconomic outcomes

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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 capacity-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