International Journal of Global Sustainable Research (IJGSR)
Vol.4 No.10, 2026: 1405-1428

Beyond Certification: Governing Deforestation-Free, Regenerative and Socially Just Palm Oil Supply Chains in a Fragmented Global Market — A Critical Review

Loso Judijanto
IPOSS Jakarta
Corresponding Author: Loso Judijanto losojudijantobumn@gmail.com

A R T I C L E I N F O

Keywords : Palm Oil Sustainability, Deforestation-Free Supply Chains, Certification, Regenerative Agriculture, Smallholders

Received : 5 August
Revised : 20 September
Accepted: 20 October

©2026 Judijanto : This is an open-access article distributed under the terms of the Creative Commons Atribusi 4.0 Internasional.

A B S T R A C T

Palm oil simultaneously exemplifies the efficiency and contradictions of global agricultural commodity production. Its high oil yield per unit area supports food, industrial and energy systems, while historical expansion has contributed to forest conversion, biodiversity decline, peat emissions and contested rural development. This critical qualitative literature review synthesises peer-reviewed research published during 2020–2026 and independently appraises influential policy narratives. The analysis integrates global value-chain governance, institutional pluralism, socioecological resilience and environmental justice. Seven interrelated themes emerge: market fragmentation; certification performance; zero-deforestation accountability; smallholder inclusion; landscape regeneration; financial incentives; and multilevel institutional coordination. Recent evaluations sharpen the distinction between corporate commitment, observable compliance and counterfactual environmental additionality. Evidence also indicates that traceability and certification may coexist with weak producer engagement, uneven livelihood benefits and ecological leakage. In response, the review proposes an Integrated Palm Oil Sustainability Transformation Framework, linking measurable ecological integrity, credible regulatory accountability, distributive inclusion, market incentives and adaptive monitoring

DOI: https://doi.org/10.59890/ijgsr.v4i10.2
ISSN-E: 3026-4677
https://journalijgsr.my.id/index.php/ijgsr/index

INTRODUCTION

1.An Unusually Productive Crop Within an Unusually Contested Economy

Oil palm sits at the intersection of food security, rural development, industrial manufacturing and global environmental change. Palm-derived inputs appear in edible fats, processed foods, personal-care products, oleochemicals and energy markets, making the crop significant not only for farming communities but also for distant traders, processors and consumers. Its relatively high oil yield per hectare is frequently invoked to argue that replacing palm oil indiscriminately with other vegetable oils could require more cultivated land. Yet this comparison is incomplete unless the location, timing and ecological consequences of cultivation are made explicit: a productive crop grown on newly cleared peat forest cannot be assessed in the same way as one cultivated on existing agricultural land (Meijaard et al., 2020; Murphy et al., 2021). The political economy is equally uneven. Indonesia and Malaysia dominate international supply, while domestic consumers and importing countries apply different requirements concerning price, product safety, conservation and labour. Large concessions, medium-scale growers, independent smallholders, tied smallholders and vertically integrated conglomerates face dramatically different exposure to finance, land administration and regulatory scrutiny. Those differences matter because a requirement that is technically simple for a multinational buyer may be financially or administratively prohibitive for a household whose fruit moves through several intermediaries before reaching a mill (Apriani et al., 2020; de Vos et al., 2023; Chandra et al., 2026).

2. The Challenge Posed by the Source Literature

The source presentation proposes a dual agenda: protect, produce and restore on the production side, supported by governance, markets and finance on the demand side. It also highlights certification uptake challenges, changing buyer expectations, forest-risk supply chains and divergent sustainability regimes. This review treats that presentation as an institutional policy perspective to interrogate, rather than an independent impact evaluation, and tests its central claims against peer-reviewed evidence (WWF International, 2026; Grabs and Garrett, 2023). Several of its numerical and categorical claims require methodological separation. A market forecast for future growth is not an observation; a corporate statement of deforestation-free sourcing is not a controlled estimate of avoided deforestation; and a country-level share of certified consumption is not the same denominator as the share of certified production. The slides juxtapose selected company disclosures of high deforestation-free shares, assertions about low global certified uptake and ambitious production projections. Those indicators can illuminate a governance puzzle, but they cannot establish a single consistent sustainability trend without reconciling baselines, units, evidence quality and reporting boundaries (WWF International, 2026; Grabs and Garrett, 2023; Stigler et al., 2026).

3. Why the Current Governance Moment Matters

The governance environment has become more demanding. Voluntary multi-stakeholder certification now operates alongside company no-deforestation, no-peat and no-exploitation policies; producer-country requirements; remote sensing; supplier disclosure; and import-market due diligence. At the time of writing in October 2026, the amended EU Deforestation Regulation is scheduled to apply to large and medium operators from 30 December 2026 and to most micro and small operators from 30 June 2027. These are prospective implementation dates, not evidence of completed regulatory impacts, and their consequences for supplier selection and smallholder participation must be investigated rather than presumed (European Commission, 2026; Choiruzzad et al., 2021; Grabs and Garrett, 2023). Recent impact evaluations challenge the assumption that corporate progress reports are sufficient evidence of environmental success. Studying Indonesian concessions in 2018–2020, Stigler et al. (2026) distinguish very low forest conversion among suppliers connected to commitments from additional reductions attributable to those commitments; their analysis did not detect additionality during that specific observation period. Separately, household surveys and interviews in Sumatra find limited transmission of zero-deforestation expectations, prices and capacity-building benefits to independent smallholders, even where those farmers are indirectly connected to committed buyers. These findings imply not that commitments are inherently useless, but that favorable baseline conditions, uneven engagement and limited enforcement can undermine their transformative potential (Chandra et al., 2026; Stigler et al., 2026). Long-run spatial evidence also shows why annual deforestation trends should not be attributed mechanically to any one voluntary policy. Gaveau et al. (2022) linked Indonesia's slowing oil palm-related deforestation during part of the 2010s to reduced plantation expansion and lower oil prices, underscoring the importance of commodity-cycle conditions. A separate assessment of the Indonesian forest moratorium identified nearby displacement of clearing into areas outside targeted protections, demonstrating that seemingly successful restrictions may generate spillovers unless assessed beyond administrative boundaries. Together, these studies support evaluation designs that account for prices, spatial substitution and the broader policy environment (Gaveau et al., 2022; Leijten et al., 2021).

4. Research Problem, Contribution and Scope

This article addresses a central question: how can palm oil supply chains move beyond fragmented certification and compliance toward verifiable deforestation prevention, ecological regeneration and distributive fairness? Seven subsidiary questions concern market transformation, the effectiveness of certification and due diligence, barriers facing smallholders, the conservation–production interface, finance, actor responsibilities and integrated policy design. The article is conceptual and interpretive: it does not create a new dataset, estimate certification effects, or claim a globally representative sample. Instead, it brings together findings often compartmentalized into governance studies,

agronomy, land-use science, financial innovation and rural development (Santika et al., 2024; Ayompe et al., 2025). Its proposed contribution is threefold. First, it distinguishes inputs and process compliance from ecological or social outcomes and from additionality relative to a credible counterfactual. Second, it joins environmental effectiveness and producer inclusion as mutually dependent evaluation criteria rather than parallel slogans. Third, it proposes a governance architecture that allocates responsibilities to regulators, mills, traders, financial institutions and community organizations while making landscape outcomes the ultimate test of success. The geographic emphasis is Indonesia and Malaysia, but evidence from Thailand, Ghana, Liberia, Guatemala and Brazil helps reveal why a single model is unlikely to travel without adaptation (Nupueng et al., 2023; Richartz and Abdulai, 2025; VanderWilde et al., 2023).

LITERATURE RIVIEW

1. Sustainability Beyond a One-Dimensional Label

Sustainability is not an attribute that can be inferred from a product label alone. In oil palm systems it encompasses land conversion history, emissions, biodiversity, soil and water functions, labour conditions, secure tenure, producer livelihoods and governance legitimacy. These dimensions are related but not interchangeable: good agronomy may improve yields without resolving land disputes, while a forest-protection rule may limit conversion without improving wages or farmer bargaining power. Consequently, certification should be read as one institutional mechanism intended to shape practices, not as a complete measure of sustainability (Meijaard et al., 2020; Santika et al., 2021; Supriatna et al., 2024). The global value-chain perspective adds an essential question of power. Refineries and internationally visible brands may define sourcing conditions and reporting procedures, but upstream actors often shoulder documentation and transition costs despite having little influence over market standards. Price transmission is also imperfect: a sustainability claim attached to a consumer-facing product does not guarantee a meaningful premium at farm level. The resulting asymmetry can turn environmental assurance into an entry barrier unless purchasing practices and producer-support mechanisms change as well (Gallemore et al., 2022; Apriani et al., 2020; Ekaputri et al., 2025).

2. Institutional Pluralism and Competing Authority

The Roundtable on Sustainable Palm Oil (RSPO), Indonesian Sustainable Palm Oil (ISPO), Malaysian Sustainable Palm Oil (MSPO) and corporate purchasing policies represent overlapping but distinct sources of authority. They differ in membership, legal foundations, audit arrangements, geographic reach and expectations concerning social and environmental safeguards. Neither equivalence nor absolute hierarchy between them should be asserted without criterion-by-criterion comparison. Research on ISPO emphasizes the political tensions created when national sovereignty, international buyers and environmental organizations try to govern the same commodity through partially competing institutions (Choiruzzad et al., 2021; Nupueng et al., 2023). An institutional-pluralism lens helps avoid the false choice between unregulated private certification and a single sovereign regulatory system. Public

law can provide binding obligations and legal remedies; third-party standards may supply detailed operational norms; and cooperative or landscape institutions can address ecological processes and social relationships that cross supplier boundaries. Their effectiveness depends on mutual recognition of verified information, transparent enforcement and clear allocation of responsibility. Poorly coordinated overlap may increase audit burden without improving environmental outcomes, whereas complementary institutions may address each other's weaknesses (Santika et al., 2024; Choiruzzad et al., 2021; Grabs and Garrett, 2023).

3. The Transition from Rule-Based to Goal-Based Governance

Certification typically articulates rules or practices and asks independent assurance providers to assess compliance. By contrast, corporate zero-deforestation commitments state a destination and delegate much of the pathway to firms and suppliers. The latter approach appears flexible, but it introduces tensions between cooperation and competition, and between social access and strict exclusion. Grabs and Garrett (2023) show how these paradoxes may inhibit the attainment of otherwise ambitious corporate goals. Therefore, the analytical question is not which governance label is fashionable, but which mechanisms change land-use decisions under realistic institutional constraints (Grabs and Garrett, 2023; Stigler et al., 2026). Recent jurisdictional research provides a crucial bridge between company-scale rules and territorial change. In qualitative research on Indonesian jurisdictional initiatives, Bahruddin et al. (2024) identify network-building, collaborative governance and resource mobilization as interacting pathways, with their effectiveness conditioned by local politics and institutional capacity. Work on High Conservation Value designation in Seruyan further shows how regulatory instruments can be used to connect landscape assessment with public planning rather than relying exclusively on concession-level certification. These findings suggest that multilevel governance is not merely an additional certification tier: it changes who can identify risks, negotiate land-use conflicts and implement safeguards across ownership boundaries (Bahruddin et al., 2024; Padmanaba et al., 2023). Figure 1 maps the main layers of the global palm oil governance system, from production landscapes to consumer markets and finance. It emphasises that authority, money, data and environmental impacts travel through different networks, and that neither farm certification nor downstream procurement can govern the entire system in isolation. The arrows signify relationships requiring investigation, not automatically successful causal pathways.



Figure 1. Multi-Level Governance of Deforestation-Free and Inclusive Palm Oil Value Chains. Original Conceptual Synthesis

The governance architecture highlights a critical asymmetry: downstream firms generally possess greater market leverage and information-processing capacity, whereas smallholders and local governments hold information about land tenure and practical production conditions. Traceability should therefore be understood as a jointly produced public–private capability, not simply an instruction for farmers to upload coordinates. This interpretation follows evidence that certification readiness, group organization and place-specific support are central to smallholder inclusion (de Vos et al., 2023; Watts et al., 2021; Chandra et al., 2026).

4. Socioecological Resilience, Additionality and Justice

A socioecological perspective evaluates whether managed landscapes maintain or recover ecological functions while supporting viable communities. This requires distinguishing avoided damage, restoration of degraded ecosystems and efficiency improvements within agricultural production. A higher yield does not itself demonstrate reduced forest conversion because profits, land prices and political incentives can alter expansion behavior. Similarly, a small restored patch may improve local habitat yet cannot be treated as a replacement for remaining natural forest (Zemp et al., 2023; Lim et al., 2024; Bicknell et al., 2023). Additionality is the other indispensable concept. Let an observed outcome be compared with a defensible estimate of what would have happened without an intervention, taking into account baseline conditions and external policy changes. A supplier may comply with a no-deforestation rule because land conversion was already unattractive or prohibited; this is valuable compliance but need not imply that the purchasing policy independently caused the outcome. Environmental justice adds a parallel test: who can meet the rules, who receives benefits, and who bears the costs of proving compliance? These concepts turn a narrow certification score into an integrated effectiveness-and-equity evaluation (Stigler et al., 2026; Chandra et al., 2026; Li, 2024).

5. Sustainable Finance and Information Governance

Investment and lending systems can potentially reward credible transitions, but sustainability-labelled finance faces information asymmetry similar to product sourcing. A lender may observe a sustainability certificate or a management pledge without reliable evidence of changes in forest loss, labour

conditions or soil health. Digital records, satellites and blockchain architectures can improve documentation, yet technical traceability cannot repair erroneous farm boundaries, coercive contracting or weak independent audit. Sustainable finance should thus link its incentives to independently tested trajectories and adequate safeguards rather than simply the presence of fashionable technology (Tee and Rubbaniy, 2025; Wong et al., 2023; Payne, 2021).

METHODOLOGY

1. Design and Epistemological Orientation

This study employs a critical qualitative literature review (QLR) with interpretive, interdisciplinary thematic synthesis. Its purpose is to explain how multiple literatures conceptualize and evaluate sustainability governance and why different policy instruments may generate divergent outcomes across contexts. It is not a systematic literature review, and it does not claim exhaustive retrieval, a PRISMA flow diagram, formally registered inclusion rules, quantitative effect pooling or statistical estimates of publication bias. The objective is conceptual integration and careful evaluation of competing explanations rather than population-level inference (Ayompe et al., 2025; Santika et al., 2024).

2. Literature Boundaries and Source Appraisal

The synthesis prioritizes peer-reviewed journal articles published from 2020 through October 2026 that substantively address oil palm cultivation, commodity governance, environmental impacts, rural livelihoods, market accountability or relevant transition mechanisms. Sources were selected purposively for their direct relevance to the research questions, disciplinary breadth, analytical diversity and capacity to illuminate competing explanations; high-salience empirical findings and current regulatory statements were independently checked. Empirical evaluations receive weight in discussions of measured impacts, while conceptual reviews support theory development and geographically specific studies illuminate institutional mechanisms. Material published by WWF is treated as a contextual policy source, and an official European Commission page is used solely to establish the regulatory timetable applicable as of October 2026 (WWF International, 2026; European Commission, 2026).

3. Interpretive Coding and Synthesis

The analytical procedure combined close reading, concept-oriented comparison and iterative grouping of claims. Initial codes distinguished production and market trends; certification; no-deforestation policies; traceability; smallholder participation; agronomy and restoration; finance; and multilevel coordination. Within each theme, studies were compared by geographical setting, unit of analysis, intervention, measurement approach and evidentiary strength. Special attention was paid to apparent contradictions: certification accompanied by uneven welfare benefits, high compliance without detectable additionality, improved yields without assured land sparing, and

better monitoring without effective producer engagement (Santika et al., 2021; Stigler et al., 2026; Lim et al., 2024). Analytically, a commitment or certificate was coded as a governance input, verified adoption as a process measure, observed ecological or social change as an outcome, and change attributable to the intervention as an additionality claim. We did not infer causal effects from descriptive statistics or claims of traceability alone. Where studies disagreed, the comparison focused on exposure to forest risk, intervention scope, comparison groups, market conditions and jurisdictional spillovers rather than averaging incompatible findings. This explicit distinction is especially important for interpreting the diverging evidence on prices, deforestation trends and corporate procurement policies (Gaveau et al., 2022; Leijten et al., 2021; Stigler et al., 2026).

4. Credibility and Limitations

This QLR differentiates four types of evidence: counterfactual or experimental evaluation, observational empirical analysis, qualitative mechanism-oriented studies, and organizational claims or scenarios. Those types answer different questions and cannot be ranked mechanically; an interview-based study may explain authority and exclusion more convincingly than remote sensing, while a difference-in-differences design may better support a causal attribution claim. Interpretations are bounded by the original studies' locations, periods, indicators and assumptions. Because selection was purposive rather than exhaustive, the manuscript makes no claim that its thematic frequencies are representative of all published research (Grabs and Garrett, 2023; Stigler et al., 2026; Zemp et al., 2023). The source lecture was interrogated with particular caution. The reported certification share, global growth forecasts and corporate deforestation-free percentages use potentially different baselines, methodologies and scopes, and therefore are not combined as if they formed a single comparable statistical series. Legislative developments are dated to the stated publication period; future implementation outcomes are not retroactively presented as observed evidence. Finally, the proposed integrated framework is a reasoned synthesis and a subject for future testing, not an empirically validated universal causal model (WWF International, 2026; European Commission, 2026).

RESULT

1. Theme I: Market Growth and Fragmented Sustainability Demand

The literature portrays global palm oil as a structurally connected but normatively fragmented market. Rising needs for food ingredients, oleochemicals and energy inputs interact with differentiated buyer standards, local regulation and international trade policies. Palm oil's relatively high land productivity complicates substitution arguments: reducing imports from one origin or replacing palm oil with a lower-yielding crop does not guarantee a net environmental gain. Global evaluations therefore call for comparisons of land-use opportunity costs, crop alternatives and ecosystem effects rather than commodity-specific moral categories (Meijaard et al., 2020; Murphy et al., 2021; Yu et al., 2024). A further fragmentation concerns who pays for sustainability assurance. Buyers supplying demanding consumer markets can ask for segregation, geolocation and documentation, while other markets may prioritize

cost and quality over certification. The resulting segmented demand can reward leading suppliers but leave marginal farmers operating in opaque or informal channels. Reviews of consumer preferences indicate that awareness and willingness to pay vary across regions, while trade-flow research illustrates how distant consumption is connected to producer landscapes through changing sourcing networks. Hence aggregate demand for certified products should not be inferred from the existence of corporate public commitments (Hilmi et al., 2025; VanderWilde et al., 2023; Santika et al., 2024). The lecture's assertion that future supply may multiply severalfold by 2050 illustrates the hazards of treating scenarios as forecasts. Future production depends on price, yield trajectories, replanting, land-use restrictions, climate stress, biofuel policy and substitution across edible oils. A projection without visible sensitivity assumptions can mislead planning, especially if translated into an alleged necessity for territorial expansion. Empirical mapping of historical cultivation changes and land-use modelling are more defensible starting points, and uncertainty should remain explicit when extending historical patterns into long-term scenarios (Yu et al., 2024; Leijten et al., 2023; Murphy et al., 2021). Historical land-cover research also illustrates the importance of disentangling economic cycles and governance interventions. Using nationwide remote-sensing evidence for 2001–2019, Gaveau et al. (2022) document a decline in Indonesia's oil palm-associated forest loss after earlier expansion, together with a relationship between industrial expansion and palm oil prices. Those associations do not establish that lower prices alone explain the change, and the study period should not be extrapolated into an unconditional forecast. A rigorous global demand scenario would therefore examine policy enforcement, price volatility, planting responses and the possibility that production or clearing shifts into other jurisdictions (Gaveau et al., 2022; Leijten et al., 2021).

2. Theme II: Certification Can Help, But Outcomes Vary

Certification research offers neither a blanket endorsement nor a blanket refutation of RSPO and related schemes. In Indonesian villages, Santika et al. (2021) found that associations between certification and wellbeing were heterogeneous across livelihood contexts; gains should not be presumed equal for communities already dependent on industrial plantations and those maintaining diversified agriculture. Evidence from independent smallholders further documents limited familiarity with certification costs and strong dependence on outside facilitation. Studies in Thailand indicate that adoption also depends on the relationship between global standards, domestic programs and farmer capabilities (Santika et al., 2021; Apriani et al., 2020; Nupueng et al., 2023). The barriers are institutional as well as technical. Documentary requirements can be difficult where farmers lack clear land rights, group membership, recorded input use or stable market contracts, while external auditing and organizational maintenance impose recurring costs. Smallholder-focused assessments emphasize the benefits of local intermediaries, cooperative organization and a realistic pathway to legal recognition rather than merely simplified checklists. Reviews nonetheless report uneven measured livelihood or

environmental benefits, underscoring the need to evaluate the outcomes of certification investments rather than tally certificates alone (de Vos et al., 2023; Watts et al., 2021; Ogahara et al., 2022). Some findings also complicate the assumption that certification automatically maximizes productivity. Research in Malaysia associates certification with production-efficiency trade-offs, whereas a study of Ghana evaluates environmental and welfare outcomes under different certification systems. Cross-country contrasts cannot be translated into a single pooled effect because the producer populations, standards, selection processes and baseline conditions differ. The lesson is to specify the outcome—forest loss, employment conditions, productivity, farm income or organizational capacity—and then ask which mechanisms plausibly explain the observed association (Zachlod et al., 2025; Richartz and Abdulai, 2025; Santika et al., 2021).

3. Theme III: Commitments, Traceability and Environmental Additionality

Corporate zero-deforestation commitments create important incentives to map supply relationships and scrutinize forest risk, yet their real-world effects are contingent. Grabs and Garrett (2023) show that goal-based private governance faces persistent tensions between strict sourcing and social inclusion and between collaborative problem-solving and competitive supplier discipline. A firm can withdraw from a high-risk mill while forest loss continues through another buyer, leaving an improved corporate footprint without a comparable landscape-level change. Supply-chain links, purchasing substitution and the risk of leakage therefore belong at the centre of effectiveness evaluations (Grabs and Garrett, 2023; VanderWilde et al., 2023; Leijten et al., 2023). The distinction between compliance and additionality has become especially concrete. Stigler et al. (2026) evaluated concessions connected to Indonesian zero-deforestation commitments and observed low conversion rates, but similar reductions among comparison concessions during 2018–2020. Their interpretation cautions against crediting corporate policies with trends that may also reflect broader legal, economic or land-availability conditions. This result should not be generalized beyond that observation period or treated as proof of permanent ineffectiveness, since changing commodity prices and forest exposure could modify the role of commitments in future years (Stigler et al., 2026; Leijten et al., 2023). An analogous problem arises when interventions are evaluated within artificially narrow geographic boundaries. Leijten et al. (2021) found evidence of localized deforestation spillovers near areas covered by Indonesia's forest moratorium, implying that protected jurisdictions can report improvements while surrounding land faces greater pressure. This finding concerns a public forest policy, not a direct causal test of RSPO or corporate sourcing commitments, but it offers a useful warning about displacement mechanisms. Evaluations of palm oil sourcing should therefore report supplier-level changes together with possible shifts in trading destinations and landscape-wide forest conversion (Leijten et al., 2021; VanderWilde et al., 2023). At the producer level, the reach of procurement policies remains incomplete. A survey-based study of 1,541 farm households with accompanying supply-chain interviews found low awareness of no-deforestation rules among Indonesian independent smallholders and little evidence of targeted premiums or meaningful technical support. It also reported

that indirect sourcing connections blurred simple distinctions between committed and non-committed mills. Other empirical work finds uneven access by independent and contract smallholders to certified mill markets, reinforcing the conclusion that downstream policy coverage should not be equated with informed, equitable upstream participation (Chandra et al., 2026; Ekaputri et al., 2025). Technology expands the ability to observe some risks but does not solve the entire governance problem. Satellite interpretation can flag forest cover change and plantation expansion, while drones may inform assessments of local plantation conditions. Neither automatically establishes land ownership, lawful production, worker treatment or causal impacts. Digital financing or blockchain proposals may improve auditable records, but only if they connect to accurate source data, accessible interfaces and mechanisms for contesting erroneous classifications (Payne, 2021; Wong et al., 2023; Tee and Rubbaniy, 2025).

Figure 2 clarifies why the analytical steps from promise to impact must remain separate. It displays commitments, implementation, recorded compliance and independently assessed outcomes as different stages, with counterfactual evaluation occurring only at the final stage. This distinction prevents a high share of traced or compliant volumes from being misreported as the same percentage reduction in deforestation.



Figure 2. From Corporate Sustainability Commitments to Verifiable Environmental Additionality. Original Conceptual Synthesis

The framework also provides a practical interpretation of conflicting corporate indicators in the source lecture. A statement that a buyer can document deforestation-free volumes describes a sourcing or verification boundary, not necessarily the change in forest loss relative to an unregulated baseline. Conversely, a program can generate meaningful process improvements before remote sensing detects a measurable land-use change. Both developments deserve reporting, but their claims must be precisely qualified (WWF International, 2026; Stigler et al., 2026; Chandra et al., 2026).

4. Theme IV: Smallholder Inclusion is a Structural Issue

Independent smallholders are not a homogeneous group. Farm size, age of palms, land status, soil conditions, access to finance and cooperative membership influence both agronomic choices and bargaining positions. Insecure land rights may undermine investment incentives and make legality-related documents difficult to obtain; local conflicts can also prevent clear

identification of who is entitled to represent a plot in a supply-chain database. Consequently, smallholder inclusion cannot be reduced to free training in farm-management practices, although extension remains essential (Afrizal et al., 2024; Li, 2024; de Vos et al., 2023). Agronomic studies show substantial scope for raising output on existing land, but diagnosis should precede fertilizer recommendations. Yield gaps relate to nutrient imbalances, underapplication or inefficient nutrient use, plantation age, management and local ecological constraints. Evidence from Indonesian smallholder fields points to widespread nutrient deficiencies as well as imbalanced supply, while plantation-level soil-health work underscores how understory and fertilization practices jointly affect ecological and production performance. Policies based solely on a maximum-yield narrative risk increasing costs or pollution unless recommendations are locally calibrated (Monzon et al., 2023; Lim et al., 2023; Sugianto et al., 2023; Thoumazeau et al., 2024). Model-based analysis places these agronomic opportunities in a wider land-use context. Monzon et al. (2021) estimated considerable yield gaps in both large plantations and smallholder fields and examined a conditional scenario in which better management, combined with limits on conversion of fragile ecosystems, could spare land and avoid emissions. Those projected benefits depend on sustained land protection; they should not be mistaken for observed forest savings achieved solely by using more fertilizer. This supports pairing productivity programs with enforceable restrictions on new clearing, landscape monitoring and farm-specific nutrient management (Monzon et al., 2021; Lim et al., 2023). Replanting illustrates how a technically attractive intervention may be inaccessible without institutional support. Old or low-yielding palms can reduce cash flow, but replanting also creates years of foregone harvest and generates financial exposure. Research on Indonesian farmers examines their willingness to join replanting programs, the diverse constraints on implementation and the risk that current subsidies fail to cover transition needs. Resilience therefore depends on credit terms, bridge income, seedling quality, extension, group structures and off-farm livelihood options, not subsidy announcements alone (Petri et al., 2024; Siregar et al., 2024; Zhao et al., 2026; Hendrawan et al., 2024). Smallholder-focused livelihood studies further caution against viewing all expansion as either straightforward poverty reduction or unmitigated harm. Local economic benefits may coexist with nutritional vulnerabilities, contested tenure, unequal gendered opportunities and dependence on volatile commodity prices. Comparative evidence from Brazil suggests agroforestry adoption depends on practical livelihood expectations, and broader sustainability assessments stress the need for multidimensional local indicators. The corresponding policy question is how to support viable production and rural resilience without using expansion into forest or peatlands as the default income strategy (Braga et al., 2024; Hasudungan et al., 2024; Supriatna et al., 2024; Li, 2024).

5. Theme V: Conservation and Regeneration Must be Distinguished

The environmental literature consistently emphasizes the importance of conversion history. Replacing natural forest with oil palm can reduce specialized biodiversity and change carbon stocks, water processes and habitat connectivity even if subsequent plantation management is relatively efficient. Peatland conversion adds particular concerns because drainage and oxidation may continue to generate emissions over extended periods. Carbon studies examining plantations established on peat and former peat swamp forests therefore complicate any claim that low current deforestation alone establishes climate neutrality or a regenerative trajectory (Cooper et al., 2020; Kiew et al., 2020; McCalmont et al., 2021; Xu et al., 2022).

On existing plantations, however, ecological enrichment can provide measurable benefits. Zemp et al. (2023) reported improvements across biodiversity and ecosystem-function indicators in experimentally established tree islands within an Indonesian oil palm landscape, without reducing overall landscape-scale oil palm yield in the studied system. Related research highlights the roles of soil biota, structural complexity and spatial heterogeneity for restoration, while conservation set-asides can improve ecological value in cultivated settings. These interventions strengthen the case for managing plantation landscapes as more than uniform crop monocultures, but they do not justify conversion of intact forests to create future restoration opportunities (Montoya-Sánchez et al., 2023; Bicknell et al., 2023; Zemp et al., 2023).

Additional evidence from West Africa, agroforestry research and arthropod studies illustrates the need for context-specific restoration metrics. Traditional and industrial plantations differ in vegetation structure and biodiversity outcomes; replanting and management practices can change ecological communities; and ecological benefits can vary greatly by taxonomic group. Land-use assessment should therefore distinguish a restored tree island, a riparian corridor, a forest reserve, an intercropped smallholding and intact forest rather than putting them all into a single area-based claim. Species composition, ecosystem function and connectivity matter as much as planted tree counts (Pashkevich et al., 2021; Pashkevich et al., 2024; Teo et al., 2025; Dalheimer et al., 2024).

Intensification presents a further dilemma. Raising yield on already cleared land may reduce the immediate need for additional farmland, but it may also increase returns and encourage expansion if land governance is weak. Models of market responses and global scenarios therefore question simple assumptions about automatic land sparing. Industry-focused mitigation strategies may reduce emissions through improved management, yet such savings should be considered alongside the origin of plantation land, downstream demand and broader commodity substitution. Credible regeneration consequently requires a hierarchy: avoid new habitat loss first; protect existing ecological assets; restore degraded functions; and optimize production within binding land-use safeguards (Lim et al., 2024; Leijten et al., 2023; De Rosa et al., 2022; Meijaard et al., 2020).

6. Theme VI: Finance and Market Incentives Shape Participation

The economics of sustainability certification differs substantially between a multinational agribusiness and an independent farmer. Large enterprises can distribute audit costs across extensive volumes, employ specialized compliance teams and negotiate longer supply agreements, while small growers may lack access to credit or documentary services. Some certifications offer short-run organizational or financial advantages, but premiums may be small, uncertain or captured downstream. This creates a potential efficiency–equity tension: buyers can obtain risk-reduced supplies by selecting already compliant providers rather than financing the transition of riskier, resource-constrained producers (Apriani et al., 2020; Gallemore et al., 2022; Ekaputri et al., 2025).

Financial-sector innovations are most promising when they overcome these coordination failures. Blended capital, appropriately structured replanting credit, cooperative guarantees and service providers able to aggregate smallholder transactions can finance changes that individual households cannot otherwise undertake. Digital monitoring may help lenders understand project implementation, but sophisticated transaction ledgers do not eliminate credit risks, fluctuating earnings or the need for independent assurance. Practical programs should couple financial products with agronomic advice, safeguards against indebtedness and measures of actual production and ecological outcomes (Tee and Rubbaniy, 2025; Wong et al., 2023; Zhao et al., 2026).

7. Theme VII: Institutional Coordination, Not Instrument Proliferation

The resulting picture is one of dense governance activity without assured alignment. Producer-country officials manage legality, land allocation and regional development; importing-country regulators focus on market access and due diligence; buyers control procurement; lenders influence capital allocation; NGOs contribute monitoring and convening; and farmers make daily production decisions. Multiple standards may expand available tools but also multiply paperwork and create conflicts over legitimate authority. Indonesian analysis shows that political contestation between international norms and national certification is not a temporary administrative inconvenience but part of the evolving state–market relationship (Choiruzzad et al., 2021; Santika et al., 2024). Empirical studies of jurisdictional experimentation help specify what successful coordination would entail. Bahruddin et al. (2024) argue that actor coalitions, public–private collaboration and resource mobilization are interdependent rather than interchangeable pathways to change, and that sequencing varies with subnational political contexts. In Seruyan, an Indonesian regulatory pilot explored designation of High Conservation Value areas beyond the narrow boundaries of individual concessions, illustrating both the promise and institutional demands of territorial assessment. Such work suggests that jurisdictional initiatives should be appraised by who participates, whether land-use safeguards can be enforced and how benefits and costs are allocated, not merely by the geographic extent of the initiative (Bahruddin et al., 2024; Padmanaba et al., 2023).

The most defensible coordination mechanisms are therefore practical rather than merely rhetorical. Shared and privacy-sensitive geospatial baselines, accessible grievance processes, recognition of credible prior audits, standardized outcome definitions and public pathways for resolving tenure can reduce duplication without weakening safeguards. Landscape or jurisdictional programs may also address forest risks beyond a single company's supplier boundary, especially where smallholders sell indirectly to several mills. Yet their performance must be measured independently, because changing the geographic scale of a program does not automatically solve political capture, inequitable participation or ecological displacement (Chandra et al., 2026; Grabs and Garrett, 2023; Santika et al., 2024).

DISCUSSION

1. From Sustainability Declarations to Causal Accountability

The first synthesis concerns the object being governed. Early certification narratives often asked whether an entity possessed a valid certificate, while contemporary supply-chain narratives ask whether purchased volumes satisfy a defined risk or due-diligence test. Neither question alone tells us whether an intervention causes fewer emissions, less forest loss, safer work or more resilient livelihoods. A credible account must therefore distinguish formal commitment, verified implementation, operational compliance, measured ecological or social change, and additionality attributable to the intervention. Treating these as separate claims makes evidence more useful to both researchers and practitioners (Stigler et al., 2026; Grabs and Garrett, 2023; Santika et al., 2021).

Figure 2's progression also helps reinterpret the juxtaposition of low certified uptake and high reported deforestation-free supply percentages. The indicators could coexist because they describe different instruments, populations and measurement rules. A supply chain may source physically compliant volumes without purchasing the equivalent quantity through a particular certification model; a certificate may also be maintained even when the broader jurisdiction continues to lose forest. The appropriate scholarly response is not to choose one headline percentage but to construct compatible denominators, identify verification boundaries and examine how each governance mechanism changes incentives at the frontier (WWF International, 2026; Stigler et al., 2026).

This interpretation does not imply that causal identification is straightforward. Difference-in-differences estimates depend on assumptions about comparison trends, and satellite-derived forest loss cannot by itself reveal all causal drivers or social conditions. Qualitative institutional research remains indispensable for understanding why companies select certain suppliers, why farmers trust or distrust rules and why regulators fail to enforce apparently coherent mandates. The article therefore proposes methodological triangulation in future evaluations, while recognising that its own synthesis cannot estimate a universal intervention effect (Chandra et al., 2026; Stigler et al., 2026; Grabs and Garrett, 2023).

2. A Defensible Hierarchy for Ecological Integrity

The second synthesis establishes a hierarchy that prevents regenerative language from diluting forest protection. Avoiding the conversion of intact forest and peatland must come before improving the management of already cultivated plots. The latter remains necessary: soil rehabilitation, tree islands, native vegetation, riparian protection and nutrient optimization can improve ecological function where conversion has already occurred. Yet gains inside plantations and losses to intact ecosystems are not fully substitutable, because unique species assemblages, peat carbon stores and large-scale connectivity may be irreplaceable within meaningful policy horizons (Meijaard et al., 2020; Zemp et al., 2023; Cooper et al., 2020). The relevant accounting unit also changes with the question. Farm-level emissions or yields describe a different reality from watershed integrity, district-wide deforestation or international land-use displacement. A restoration project can report higher local bird diversity while the surrounding jurisdiction loses protected habitat; a productive concession can look land-efficient while its expansion history embodies substantial carbon debt. An integrated environmental dashboard must accordingly track forest conversion, peat condition, water and soil processes, native biodiversity and spatial leakage, with consistent baselines and uncertainty intervals (Montoya-Sánchez et al., 2023; Xu et al., 2022; Leijten et al., 2023).

3. Regulation Without Smallholder Abandonment

The third synthesis concerns the distribution of transition costs. Due diligence can improve accountability if it demands credible information, requires risk mitigation and preserves access to remedies. However, a buyer faced with uncertain land titles and expensive traceability may respond by excluding suppliers rather than investing in their upgrading. The burden then falls on producers who have the least ability to fund legal services or endure extended repayment periods. Research on pre-certification conditions, replanting and corporate policy reach indicates that inclusion is an institutional design issue rather than an optional corporate-responsibility supplement (de Vos et al., 2023; Chandra et al., 2026; Zhao et al., 2026). An inclusion-sensitive model would begin with mapping the various forms of smallholder participation. Tied farmers may have access to cooperative records and mill-based support, whereas independent farmers often sell through traders and have little knowledge of downstream requirements. Technical assistance should therefore combine tenure clarification, accessible geolocation, group organization, agronomic training, documentation and dispute resolution. Financing should compensate for delayed returns and recognize cash-flow limitations during replanting; otherwise compliance efforts can undermine the very livelihoods whose long-term viability is needed to keep forest protection politically sustainable (Ekaputri et al., 2025; Watts et al., 2021; Siregar et al., 2024).

4.Trade Rules and Global Market Segmentation

The European deforestation framework is one important intervention, but it operates within a much larger global commodity economy. The applicable timetable as published in October 2026 does not yet provide evidence of realized market impacts; prospective effects require monitoring after implementation. Producer-country institutions are entitled to scrutinize whether foreign requirements recognize local legal systems, impose disproportionate costs or simply redirect risk to unregulated purchasers. Importing-country regulators, in turn, must consider whether claims of administrative burden obscure genuine non-compliance. Analytical symmetry requires examining both exclusionary risks and the environmental consequences of weakened enforcement (European Commission, 2026; Choiruzzad et al., 2021).

The scope and burden of due diligence also depend on the specific legal obligations assigned to different supply-chain actors. Recent EU amendments retain the goal of deforestation-free commodities while simplifying some downstream reporting duties and deferring key application dates; this evolving architecture should be described from authoritative legal texts rather than generalized as a uniform requirement on every trader. For producer inclusion, the important empirical question is whether upstream farm-level information is made accurate and accessible without shifting the entire cost of verification to growers. Such concerns strengthen the case for producer-country registries, interoperable data and targeted capacity building rather than formal equivalence between substantively different labels (European Commission, 2026; Chandra et al., 2026). A practical response is interoperable, evidence-based verification rather than automatic equivalence among labels. Where national systems provide credible information on legal tenure or land allocation, that information can reduce duplicative costs; where independent assurance establishes additional environmental safeguards, it should complement public registries. But no standard should be considered interchangeable merely because its name contains the word sustainable. Interoperability must be demonstrated for particular requirements such as the deforestation cut-off date, geolocation, legal production, grievance access and documented risk mitigation (Nupueng et al., 2023; de Vos et al., 2023; Santika et al., 2024).

5.The Integrated Palm Oil Sustainability Transformation Framework

The preceding analysis supports a proposed Integrated Palm Oil Sustainability Transformation Framework (IPOSTF). The framework has five interacting pillars: ecological integrity, institutional accountability, social and distributive inclusion, market and financial realignment, and adaptive measurement. It assumes that durable sustainability outcomes arise from interactions among these capacities rather than from any single instrument. This is a theoretical synthesis supported by heterogeneous literature, not a confirmed causal law or a ready-made global certification replacement (Ayompe et al., 2025; Grabs and Garrett, 2023; Santika et al., 2024). At landscape scale, the proposal also draws on mechanisms that have been observed rather than assuming that coordination alone is beneficial. Jurisdictional initiatives can support coalition-

building, public oversight and resource mobilization, but their effectiveness depends on political incentives and the capacity to enforce land-use protections across supplier boundaries. Research on Indonesian pilots offers tangible opportunities for aligning conservation identification with administrative planning, while evidence of leakage from forest moratoria warns against evaluating only sites where direct restrictions apply. IPOSTF therefore treats territorial additionality and grievance accessibility as cross-cutting tests of program performance (Bahruddin et al., 2024; Padmanaba et al., 2023; Leijten et al., 2021). Figure 3 depicts the five IPOSTF pillars, their enabling conditions and the principal outcome categories that should be evaluated over time. Forest protection and biodiversity form the ecological foundation, while governance defines legitimate obligations, inclusion provides capabilities to comply, and finance shifts incentives throughout the value chain. Monitoring closes the loop by making contradictory indicators visible and requiring adjustment rather than treating the award of a certificate as the endpoint.



Figure 3. Integrated Palm Oil Sustainability Transformation Framework (IPOSTF). Original Conceptual Synthesis

The model has important boundary conditions. Government land administration must be sufficiently reliable to identify plots without legitimizing dispossession; independent assurance must be possible without unaffordable transaction costs; and market access must be coupled to enforceable purchasing conduct. Ecological restoration must be designed for existing land-use histories rather than positioned as an offset for continuing conversion of natural forest. Because these conditions vary among Indonesia, Malaysia, Ghana, Thailand, Guatemala and Brazil, operational criteria must be adjusted locally while preserving measurable standards of ecological integrity and fair participation (Richartz and Abdulai, 2025; Nupueng et al., 2023; Braga et al., 2024; VanderWilde et al., 2023). A useful way to evaluate the framework is as a chain of necessary but insufficient contributions. Traceability enables risk identification but cannot substitute for sanction or support; extension can improve yields but cannot guarantee land sparing; financing can expand participation but may cause harm without safeguards; and restoration can enhance ecosystems yet cannot reverse all losses from conversion. Success requires these mechanisms to reinforce rather than contradict each other. For example, a farm-level training program will have little landscape value if the farmer lacks secure rights, buyers

do not pay predictable prices and neighbouring forest conversion remains unrestricted (Monzon et al., 2023; Li, 2024; Lim et al., 2024).

6. Measurement: What Should Count as Success?

To operationalize outcome-based governance, each pillar requires indicators aligned with its objectives. For ecological integrity, these include independently verified forest conversion, peat drainage, native habitat connectivity, carbon emissions and selected biodiversity metrics. For accountability, indicators include geolocation coverage with quality checks, the number and resolution of verified grievances, audit independence, remediation and supplier engagement. For inclusion, metrics should capture smallholder retention, net household income, access to credit, secure tenure and differentiated impacts by farmer type, not just counts of people trained (Chandra et al., 2026; Montoya-Sánchez et al., 2023; Hendrawan et al., 2024). Market and finance measures should likewise evaluate substance rather than labels. Indicators can include the farmgate share of verified sustainability premiums, coverage and repayment performance of transition finance, the duration and transparency of buying arrangements, and the fraction of capital tied to independently verified improvements. Performance reports should state numerators and denominators, avoid comparing incommensurable supply-chain claims, and distinguish achieved changes from modelled projections. Public access to methods is particularly important when a brand claims over 90% deforestation-free sourcing while many upstream growers report little awareness of the policy (WWF International, 2026; Chandra et al., 2026; Tee and Rubbaniy, 2025). Table 1 translates these concepts into a compact measurement architecture. It is deliberately structured to pair each desired outcome with a potential failure mode, since a narrow indicator can stimulate gaming. For example, supplier exclusion can improve a buyer's apparent risk profile without reducing forest conversion, and aggregate farm output can rise while household vulnerability deteriorates. Monitoring should therefore combine outcome indicators with distributional, spatial and counterfactual checks wherever practicable (Stigler et al., 2026; Santika et al., 2021).

Table 1. Proposed IPOSTF Performance Dashboard and Safeguards. Original Synthesis

Pillar	Outcome indicators	Interpretive safeguard
Ecological integrity	Forest conversion; peat condition; habitat connectivity; soil and water quality	Do not equate plantation enrichment with intact-forest conservation
Accountability	Assured sourcing coverage; resolved grievances; documented remediation	Differentiate formal compliance from attributable impact
Inclusion	Smallholder retention; land security; net income; finance access	Disaggregate tied and independent producers
Finance and markets	Farmgate premiums; credit terms; long-term contracts	Trace who captures costs and economic gains

Pillar	Outcome indicators	Interpretive safeguard
Adaptive learning	Consistent baselines; evaluations; corrective policy actions	Publish methods, uncertainty and adverse findings

7. A Phased Transition Roadmap

A plausible transition requires sequencing rather than simultaneous adoption of every desirable measure. In the near term, producer governments and major buyers should harmonize minimum spatial data definitions, expand legal assistance, publish transparent sourcing boundaries and identify priority forest and peat risks. Industry and producer organizations should map the actual costs of compliance by farmer type, while financial institutions design transition facilities that do not assume uninterrupted harvesting income. These steps create a credible baseline and prevent poorly designed data requirements from becoming a pretext for disengaging smallholders (de Vos et al., 2023; Siregar et al., 2024; Chandra et al., 2026). The medium term should prioritize measurable upgrading of existing plantations and coordination across landscapes. Extension should respond to diagnosed nutrient gaps rather than blanket input intensification; appropriate replanting packages should combine agronomy, bridge financing and livelihood diversification. Restoration efforts should prioritize riparian zones, ecological corridors, existing degraded land and other sites with demonstrable habitat benefits. Buyers should contract for support and gradual improvement while maintaining clear boundaries against prohibited new clearing, with independently audited remediation pathways for correctable deficiencies (Lim et al., 2023; Sugianto et al., 2023; Zemp et al., 2023; Petri et al., 2024). Long-term transformation requires evaluation of forest outcomes at jurisdictional scales, shared monitoring infrastructure and evolving institutional cooperation. Carbon accounting should incorporate land-use histories, peat emissions and uncertainties; biodiversity accounting should move beyond counts of planted trees; and public reporting should reveal both compliance and additionality where appropriate comparison designs are possible. Finance and trade policy can reward demonstrated improvement rather than symbolic membership, while public oversight protects communities from the concentration of authority in private buyer databases (McCalmont et al., 2021; Grabs and Garrett, 2023; Stigler et al., 2026).

Figure 4 summarizes the recommended sequencing, from baseline integrity and inclusion safeguards to regenerative upgrading and independently verified landscape outcomes. Although depicted as successive time horizons, the stages are overlapping: forest-protection duties apply immediately and do not wait for later financing or monitoring milestones. Nor does the roadmap imply that data availability alone will overcome vested interests, insecure land rights or weak enforcement.



Figure 4. Sequenced Roadmap for Environmental Integrity, Inclusive Upgrading and Verified Outcomes. Original Conceptual Synthesis

The roadmap should be managed as an adaptive policy cycle rather than as a fixed checklist. Annual assessment can identify whether financial support is reaching the intended farmers, whether traceability is exposing previously hidden risk, and whether forest loss is changing relative to plausible comparison landscapes. Where indicators diverge, implementers should revise contracts, assistance mechanisms or enforcement arrangements rather than publicizing favorable metrics selectively. This is the practical meaning of governance beyond certification: assurance remains useful, but an evidence-based institutional response to unsatisfactory outcomes becomes the governing objective (Santika et al., 2024; Grabs and Garrett, 2023; Chandra et al., 2026).

8. Implications for governments, companies, finance and civil society

Producer-country governments should prioritize tenure clarification, transparent spatial planning, enforcement against prohibited clearing and adequately resourced agricultural extension. They should also avoid interpreting high yields or larger certified areas as sufficient substitutes for biodiversity protection and community rights. Regional authorities are essential because plantation permits, watershed management and land disputes often require solutions outside the control of individual farmers or exporters. Development policy can use replanting and cooperative organization to improve earnings on existing agricultural land, but must make forest-conversion restrictions credible and durable (Afrizal et al., 2024; Fosch et al., 2023; Li, 2024).

Importing-country regulators should publish stable implementation guidance, explain acceptable evidence and coordinate with producer administrations without granting automatic equivalence to standards that differ in substance. Traders and branded manufacturers should trace beyond mills when material risks warrant it, finance supplier improvement and avoid blanket withdrawals that shift forest risk without addressing its causes. Financial institutions should use realistic transition horizons and disclose both funded activities and verified impacts. Civil society and research organizations can contribute independent evaluation, grievance facilitation and transparency, provided that their conclusions remain contestable and methodologically documented (Chandra et al., 2026; VanderWilde et al., 2023; Gallemore et al., 2022).

9. Research Priorities and Unresolved Questions

The evidence synthesis identifies substantial remaining gaps. Few studies directly compare voluntary certification, mandatory due diligence and jurisdictional programs under common baselines, while measurement of indirect sourcing and market leakage is still incomplete. Future research should use longitudinal supplier mapping, farm-level socioeconomic panels and spatial counterfactuals to understand which combinations of instruments reduce forest conversion without abandoning marginal producers. The review also calls for research on the opportunity costs of restoration, biodiversity response beyond short monitoring windows and the distribution of sustainability financing through intermediated value chains (Ekaputri et al., 2025; Leijten et al., 2023; Bicknell et al., 2023). Comparative inquiry is especially important beyond Indonesia and Malaysia. Oil palm landscapes in West Africa and Latin America differ in tenure institutions, production organization, forest exposure and domestic markets, making direct transfer of Southeast Asian regulatory assumptions risky. Research in Liberia, Ghana, Brazil and Guatemala should therefore be treated as complementary evidence about context, not merely as confirmation of a universal tropical commodity model. Finally, future work should examine who controls digital traceability information and how contestable data affect rights, competition and participation (Pashkevich et al., 2024; Richartz and Abdulai, 2025; Braga et al., 2024; VanderWilde et al., 2023).

CONCLUSIONS AND RECOMMENDATIONS

The global sustainability challenge associated with palm oil is not adequately described as a contest between a beneficial high-yield crop and a destructive deforestation commodity. Both narratives contain partial truths and obscure questions about where cultivation occurs, who controls production and marketing, and whether governance systems alter environmental and social outcomes. The review finds that certification, corporate commitments, legal due diligence and traceability can contribute important but different functions. None should be treated as a self-sufficient proxy for measured sustainability, nor should the absence of demonstrated additionality in a specific historical evaluation be interpreted as definitive evidence that all future commitments lack value. The proposed Integrated Palm Oil Sustainability Transformation Framework places protection of intact ecosystems first, and then combines locally appropriate regenerative improvements on existing plantations with enforceable accountability and meaningful smallholder participation. This architecture recognizes that technical crop productivity, forest protection, rural income, finance and social legitimacy are linked through political institutions and unequal market relationships. Genuine transformation requires demonstrating both who changes behaviour and who receives or bears the consequences. The guiding standard should be verified ecological and human outcomes within credible geographical and temporal boundaries rather than the proliferation of sustainability claims. Priority recommendations include publicly accessible and reliable spatial baselines; land-legality assistance and cooperative strengthening for independent smallholders; replanting finance that accounts for delayed income; procurement contracts that fund improvement rather than simply

transfer compliance costs; protection of forests and peatlands irrespective of restoration branding; and impact assessments capable of separating baseline compliance from attributable change. Regulators, producers, traders, retailers, financiers and civil society should work through interoperable evidence systems with independent oversight and accessible grievance mechanisms. Governments must remain accountable for territorial law and public rights while private actors remain accountable for purchasing, remediation and financial incentives.

The article's main limitation is inherent in its qualitative design: it integrates heterogeneous published studies and cannot quantify a single global average effect of certification, regulation or restoration. Its conceptual framework and roadmap are proposals requiring context-specific testing, not universally established policy formulas. Future research should evaluate combinations of instruments through comparative longitudinal designs, including ecological leakage, smallholder income distribution, financial additionality and independent assessment of corporate claims. A sustainable palm oil transition will become credible when governance increasingly measures what has actually improved, can explain why, and can show that progress has not been purchased through the exclusion of those least able to comply.

FURTHER STUDY

This study still has limitations, so further research on the topic Beyond Certification: Governing Deforestation-Free, Regenerative and Socially Just Palm Oil Supply Chains in a Fragmented Global Market — A Critical Review is needed to refine this study and provide more insights for both the author and the readers.

REFERENCES

Afrizal, Putra, E.V. and Elida, L. (2024) 'Palm oil expansion, insecure land rights, and land-use conflict: a case of palm oil centre of Riau, Indonesia', Land Use Policy, 146, 107325. https://doi.org/10.1016/j.landusepol.2024.107325

Braga, D.P.P., Miccolis, A., Ramos, H.M.N. et al. (2024) 'Implications of smallholder livelihoods for scaling oil palm agroforestry in Brazilian Eastern Amazon', World Development Sustainability, 4, 100128. https://doi.org/10.1016/j.wds.2024.100128

Chandra, A., Grabs, J., Meemken, E.-M. et al. (2026) 'Limited reach of zero-deforestation commitments to Indonesian oil palm smallholders', Nature Sustainability. https://doi.org/10.1038/s41893-026-01861-4

De Rosa, M., Schmidt, J. and Pasang, H. (2022) 'Industry-driven mitigation measures can reduce GHG emissions of palm oil', Journal of Cleaner Production, 365, 132565. https://doi.org/10.1016/j.jclepro.2022.132565

European Commission (2026) Regulation on deforestation-free products: implementation timetable. Available at: https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en (Accessed: 9 October 2026).

Fosch, A., Ferraz de Arruda, G., Aleta, A. et al. (2023) 'Replanting unproductive palm oil with smallholder plantations can help achieve Sustainable Development Goals in Sumatra, Indonesia', Communications Earth & Environment, 4, 378. https://doi.org/10.1038/s43247-023-01037-4

Gallemore, C., Jespersen, K. and Olmsted, P. (2022) 'Harnessing relational values for global value chain sustainability: reframing the roundtable on sustainable palm oil's offset mechanism to support smallholders', Ecological Economics, 193, 107303. https://doi.org/10.1016/j.ecolecon.2021.107303

Hendrawan, D., Chrisendo, D. and Musshoff, O. (2024) 'Strengthening oil palm smallholder farmers' resilience to future industrial challenges', Scientific Reports, 14, 12105. https://doi.org/10.1038/s41598-024-62426-z

Leijten, F., Sim, S., King, H. and Verburg, P.H. (2021) 'Local deforestation spillovers induced by forest moratoria: Evidence from Indonesia', Land Use Policy, 109, 105690. https://doi.org/10.1016/j.landusepol.2021.105690

McCalmont, J., Kho, L.K., Teh, Y.A. et al. (2021) 'Short- and long-term carbon emissions from oil palm plantations converted from logged tropical peat swamp forest', Global Change Biology, 27(11), pp. 2361-2376. https://doi.org/10.1111/gcb.15544

Nupueng, S., Oosterveer, P. and Mol, A.P.J. (2023) 'Global and local sustainable certification systems: factors influencing RSPO and Thai-GAP adoption by oil palm smallholder farmers in Thailand', Environment, Development and Sustainability, 25, pp. 6337-6362. https://doi.org/10.1007/s10668-022-02306-6

Ogahara, Z., Jespersen, K., Theilade, I. and Nielsen, M.R. (2022) 'Review of smallholder palm oil sustainability reveals limited positive impacts and identifies key implementation and knowledge gaps', Land Use Policy, 120, 106258. https://doi.org/10.1016/j.landusepol.2022.106258

Padmanaba, M., Sloan, S., Watts, J.D. et al. (2023) 'Jurisdictional approaches to High Conservation Value area designation using regulatory instruments: An Indonesian pilot project', Frontiers in Environmental Science, 11, 1226070. https://doi.org/10.3389/fenvs.2023.1226070

Pashkevich, M. et al. (2021) 'Assessing the effects of oil palm replanting on arthropod biodiversity', Journal of Applied Ecology, 58(1), pp. 27-43. https://doi.org/10.1111/1365-2664.13749

Sugianto, H., Monzon, J.P., Pradiko, I. et al. (2023) 'First things first: widespread nutrient deficiencies limit yields in smallholder oil palm fields', Agricultural Systems, 210, 103709. https://doi.org/10.1016/j.agsy.2023.103709

Teo, H.C., Lamba, A., Ng, S.J.W. et al. (2025) 'Reduction of deforestation by agroforestry in high carbon stock forests of Southeast Asia', Nature Sustainability, 8, pp. 358-362. https://doi.org/10.1038/s41893-025-01532-w

Watts, J.D., Pasaribu, K., Irawan, S. et al. (2021) 'Challenges faced by smallholders in achieving sustainable palm oil certification in Indonesia', World Development, 146, 105565. https://doi.org/10.1016/j.worlddev.2021.105565

Xu, Y., Yu, L., Ciais, P. et al. (2022) 'Recent expansion of oil palm plantations into carbon-rich forests', Nature Sustainability, 5, pp. 574-577. https://doi.org/10.1038/s41893-022-00872-1

Yu, H., Fu, D., Yuan, Z. et al. (2024) 'Regimes of global and national oil palm cultivations from 2001 to 2018', Global Environmental Change, 86, 102845. https://doi.org/10.1016/j.gloenvcha.2024.102845

Zachlod, N., Hudecheck, M., Siren, C. and George, G. (2025) 'Sustainable palm oil certification inadvertently affects production efficiency in Malaysia', Communications Earth & Environment, 6, 200. https://doi.org/10.1038/s43247-025-02150-2