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Beyond the Plantation: PTPN IV Palm Co as a State-Owned Developmental Platform for Indonesia's Sustainable Palm Oil Transformation

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ABSTRACT

Indonesia's palm oil sector occupies a strategic but contested position at the intersection of agricultural productivity, rural livelihoods, industrial development, export competitiveness, energy security, and environmental sustainability. This article examines the role of PTPN IV PalmCo, Indonesia's state-owned palm oil subholding, in strengthening the performance and developmental contribution of the national palm oil sector. Using a qualitative narrative-integrative literature review rather than a systematic literature review, the study synthesises recent peer-reviewed research published primarily between 2020 and August 2026 and triangulates it with official corporate information and contextual evidence. The analysis identifies six interconnected pathways through which PalmCo can generate sectoral and public value: operational productivity and sustainable intensification; smallholder inclusion and upgrading; downstream industrialisation; energy security and circular bioeconomy development; sustainability governance and traceability; and employment, fiscal, and wider public value. The findings indicate that PalmCo's recent financial and operational improvement increases its capacity to perform developmental functions, but corporate profitability should not be interpreted automatically as evidence of economy-wide welfare impact. Its longer-term contribution depends on converting organisational scale into productivity gains, inclusive smallholder services, higher domestic value addition, credible environmental governance, and disciplined innovation. The article proposes a "State-Owned Developmental Platform" framework and recommends an integrated performance system combining commercial, agronomic, social, environmental, technological, and public-value indicators.

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Introduction

Palm oil is simultaneously an agricultural commodity, an industrial feedstock, a source of rural livelihoods, an export product, and an increasingly important component of Indonesia's energy system. Its significance therefore extends far beyond plantation production. The commodity links plantations and smallholders to mills, refineries, food manufacturing, oleochemicals, logistics, international trade, and bioenergy. For Indonesia, this broad economic architecture means that changes in palm oil productivity or governance can generate effects across rural incomes, manufacturing activity, trade, land use, energy policy, and environmental outcomes. Recent literature consequently treats the palm oil economy not merely as a plantation industry but as a complex socio-ecological and agro-industrial system [1-6].

The developmental importance of palm oil nevertheless coexists with substantial controversy. Oil-palm cultivation can generate higher farm income and commercially productive land use, yet poorly governed expansion has historically been associated with deforestation, biodiversity decline, peatland emissions, land conflict, and unequal access to benefits. The relevant policy question is therefore no longer adequately captured by a binary choice between "palm oil development" and "environmental conservation." A more constructive question concerns the institutional and technological conditions under which production, value creation, inclusion, and environmental protection can be improved simultaneously, while recognising situations in which genuine trade-offs remain unavoidable [7-10].

This question has become increasingly important because the future of Indonesian palm oil cannot sustainably depend on continuous area expansion. Agronomic research indicates considerable scope for raising production through replanting, better planting material, improved nutrient management, harvesting discipline, and other forms of sustainable intensification. Closing yield gaps on existing agricultural land offers a potentially more defensible route for meeting rising food, industrial, and energy demand, provided productivity improvements are accompanied by land-protection mechanisms that prevent a rebound into further ecosystem conversion [11-14]. Recent research on Indonesian smallholders reinforces this conclusion by showing that low productivity often reflects interacting constraints involving ageing palms, poor-quality planting material, inadequate fertilisation, limited liquidity, knowledge gaps, and weak institutional access rather than an inherent limitation of small-scale production.

Smallholders are particularly important to this transformation. More than 40 per cent of Indonesia's oil-palm area is reported to be managed by smallholders, but their production systems are highly heterogeneous in farm size, tenure status, market integration, skills, financing, planting materials, certification, and relationships with mills. Consequently, strategies that assume a representative or homogeneous "smallholder" risk overlooking important differences between plasma farmers, contract growers, independent farmers with established market access, and more marginal producers [15-18].

Within this national setting, PTPN IV Palm Co represents a distinctive institutional case. Palm Co emerged through the consolidation of state-owned plantation operations, including the merger of PTPN V, PTPN VI and PTPN XIII into PTPN IV and the spin-off of relevant assets from PTPN III. According to company information, Palm Co currently manages approximately 648,000 hectares of planted area, operates 71 palm oil mills across a geographic network extending from Sumatra to Sulawesi, and supports more than 70,000 workers. Its emerging downstream portfolio encompasses oleofood, oleochemical and energy-related opportunities as well as industrial development associated with the Sei Mangkei Special Economic Zone. These figures make PalmCo relevant not simply as a large plantation operator but as an organisational platform capable, at least potentially, of coordinating multiple stages of a national value chain. The organisational scale and downstream orientation reported here are based on PalmCo's own disclosures and are therefore treated as company-reported evidence [19].

The company's recent financial trajectory gives this institutional question additional relevance. PalmCo reported audited net profit of Rp7.08 trillion in 2025, an increase of 90.3 per cent from Rp3.72 trillion in 2024. EBITDA reached Rp13.27 trillion, return on assets was reported at 9.2 per cent, and CPO production increased to approximately 2.70 million tonnes [20]. The company subsequently approved dividends of approximately Rp2.83 trillion, representing 40 per cent of 2025 net profit [21]. In the first half of 2026, PalmCo reported unaudited consolidated net profit of Rp3.23 trillion, revenue of Rp23.41 trillion, and EBITDA of Rp6.05 trillion [22].

These results are substantively important, but they must be interpreted carefully. Profitability is evidence of corporate financial performance; it is not, by itself, proof of improved farmer welfare, lower emissions, additional national income, or better environmental outcomes. A company may become more profitable through commodity-price movements, productivity improvement, cost reduction, asset optimisation, or some combination of these factors. The developmental importance of profitability depends on subsequent transmission mechanisms-for example, whether stronger cash generation permits productive investment, farmer upgrading, environmental improvement, industrial diversification, fiscal transfers, innovation, and resilient employment. This distinction between **corporate performance, sectoral contribution**, and **causal developmental impact** is central to the analytical framework of this article.

PalmCo is also unusual because state ownership creates a broader set of expectations than would normally be applied to a purely private plantation company. State-owned enterprises are hybrid organisations in which commercial objectives coexist with governmental, strategic, developmental, and sometimes distributional objectives. The literature on state-owned multinational and commercial enterprises demonstrates that their strategies can be shaped by multiple principals and multiple goals; this creates opportunities to undertake long-horizon strategic investments but also generates governance risks when commercial and policy mandates are poorly specified [23,24]. Research specifically addressing Indonesian state-owned plantation enterprises similarly argues that circular-economy and sustainability objectives need to be embedded into corporate performance systems rather than treated as peripheral corporate social responsibility activities [25].

This article therefore asks five questions. First, how does PalmCo's institutional position as a state-owned palm oil subholding shape its strategic role across Indonesia's upstream, midstream, and downstream value chain? Second, through what mechanisms could its corporate capabilities contribute to productivity, smallholder upgrading, domestic value addition, employment, fiscal returns, exports, and energy security? Third, how can these functions be reconciled with environmental sustainability, traceability, and social inclusion? Fourth, what constraints could prevent PalmCo from realising such contributions? Fifth, what combination of corporate strategy and public policy would strengthen PalmCo's developmental contribution in a comprehensive, holistic, and sustainable manner?

The article advances the proposition that PalmCo is most usefully conceptualised as a **state-owned developmental platform**. Under this interpretation, its principal strategic value is not the simple accumulation of plantation acreage or maximisation of short-term CPO production. It lies instead in its potential capacity to coordinate assets, mills, farmers, finance, technology, downstream processing, sustainability systems, public programmes, and markets. The following sections develop this proposition through a qualitative literature review and thematic synthesis.

Literature Review

Palm Oil as an Integrated Agro-Industrial Value Chain

Upstream Production, Agronomy, and Sustainable Intensification

The upstream oil-palm economy begins with land, planting material, nursery quality, plantation establishment, fertilisation, harvesting, crop maintenance, labour, water and soil management, and eventually replanting. Productivity is shaped by the interaction among these components across a crop cycle lasting decade. Consequently, plantation performance cannot be understood only through annual fertiliser use or annual harvest volume; current yield often reflects investment and agronomic decisions made many years earlier.

The literature increasingly emphasises the importance of **yield-led rather than land-led growth**. show that substantial opportunities exist for climate-smart intensification of oil palm, while demonstrate the strategic importance of replanting and yield improvement for mitigating future production constraints in Indonesia. Experimental work with Indonesian smallholders similarly shows that better management practices can raise productivity but require sustained implementation, appropriate nutrient management, and careful assessment of costs and risks.

This is particularly important for ageing plantations. Replanting can replace low-yielding stands and illegitimate or poor-quality planting material with higher-performing varieties, but it imposes a temporary income loss because farmers must wait several years before new palms enter commercial production. Petri et al.

(2024) show that replanting barriers therefore extend well beyond access to seedlings: household liquidity, alternative income, land documentation, institutional processes, labour, knowledge, and risk perceptions influence farmer decisions. further argue that a replanting subsidy alone may be insufficient to empower farmers when complementary financial and institutional barriers remain unresolved.

Nutrient management presents another structural constraint [26]. find that smallholder oil-palm systems may experience inadequate or imbalanced nutrient supply, while more recent research demonstrates that fertiliser decisions are shaped simultaneously by agronomic needs and socio-economic constraints such as affordability, access, information, and perceived return on investment. This implies that an institution seeking to improve national productivity cannot rely on agronomic prescriptions alone; technical recommendations must be embedded within financing, procurement, training, and market systems.

Sustainable intensification must also incorporate environmental boundaries. Higher yields can reduce the amount of new land required for a given output target, but intensification does not automatically produce land sparing. If higher profitability creates incentives for additional expansion, yield growth may generate a rebound effect. Consequently, productivity strategy should operate alongside enforceable land-use rules, conservation of high-value ecosystems, transparent sourcing, and landscape-level governance [27,28].

Smallholders as Producers and Institutional Partners

Oil-palm smallholders are central to rural development but differ considerably in their productive and institutional capabilities. Oil palm can improve household welfare and commercial asset accumulation, yet dependence on a single commodity can also expose households to production and price risk [29]. Moreover, participation in higher-standard markets requires farmers to possess documentation, organisation, agronomic capability, and information that are not evenly distributed. Multi-province evidence likewise indicates that smallholder sustainability performance varies across economic, social, institutional, and environmental dimensions, reinforcing the need for context-specific support [30].

Certification research demonstrates these inequalities. identify significant obstacles to sustainable palm oil certification among Indonesian smallholders, while de Vos et al. (2023a) show that pre-certification conditions vary substantially across independent farmers [31]. similarly identify institutional and behavioural factors influencing adoption of Indonesian Sustainable Palm Oil requirements. Earlier work on non-state certification in Sumatra shows that external facilitation, organisational support, documentation, training, and links to certified mills can be decisive for independent smallholders [32]. while a broader review finds that certification alone has produced only limited and uneven sustainability upgrading [33]. More recent choice-experiment evidence further indicates that training and credible economic incentives can raise smallholder willingness to adopt certification [34]. Certification therefore cannot be treated purely as an auditing exercise; for poorly resourced producers, compliance is also an upgrading problem involving extension, organisation, finance, land legality, record keeping, and market access.

Evidence also cautions against assuming that certification automatically generates large economic benefits. [35]. examine the relationship between sustainability certification and village-level well-being and poverty, while [36]. analyse smallholder RSPO certification in relation to economic outcomes and agrochemical use. The findings across this literature suggest that the value of certification depends on the institutional setting, costs of compliance, agronomic changes, buyer relationships, and access to complementary services; this interpretation is consistent with the broader evidence synthesis of Certification is therefore best understood as one component of a wider upgrading architecture rather than as a substitute for rural development policy.

The organisation of farmer–company relationships also matter [37]. analyse corporate-farming arrangements as a possible mechanism for strengthening sustainable CPO supply chains, while [38]. highlight the importance of trust, social capital, local knowledge, and farmer participation in sustaining company–farmer partnerships [39]. further demonstrate that farmer resilience depends on capabilities, skills, assets, and institutional support rather than production alone. These findings have direct implications for PalmCo: an effective smallholder strategy should be relational and service-based, rather than limited to purchasing fresh fruit bunches.

Milling, Procurement, and Traceability

Fresh fruit bunches are perishable, and the interval between harvesting and processing affects quality. The mill therefore occupies a critical institutional position between plantation production and crude palm oil manufacture. Harvesting frequency, ripeness standards, transportation, collection networks, grading, and processing discipline influence both farmer incentives and extraction performance. for example, show how harvest intervals and management practices can affect outcomes in Indonesian smallholder systems [40].

Mills also increasingly function as governance nodes. Sustainability requirements require buyers to understand where raw material originates, whether farms comply with legal and environmental standards, and how independent suppliers are connected to the processing system. Yet stronger traceability can have exclusionary effects when smallholders lack geolocation data, legal documentation, digital capacity, or organisational support. identify both opportunities and limitations for smallholder participation in zero-deforestation supply-chain initiatives, while find uneven participation by independent and contract smallholders in certified mill markets [41].

These findings suggest a critical distinction between compliance traceability and developmental traceability. The former records enough data to satisfy buyers and regulators. The latter uses the same information infrastructure to provide agronomic advice, organise replanting, evaluate productivity gaps, facilitate finance, monitor environmental performance, and connect farmers to markets. A large mill network can potentially support the second model, but only if traceability is designed as a service platform rather than simply an exclusion filter.

Digital capability is becoming particularly important. find that digital inclusion and appropriately designed incentives can strengthen smallholder readiness for sustainability-oriented changes, while demonstrate the potential of unmanned aerial vehicles and multi-criteria approaches to improve sustainability assessment at plantation level. For PalmCo, digitalisation can therefore connect productivity management with environmental monitoring and farmer inclusion [42,43].

Downstreaming and Value-Chain Upgrading

Indonesia's long-term palm oil strategy increasingly involves moving beyond the export of relatively undifferentiated crude products toward greater domestic processing. In global value-chain terms, this involves process upgrading, product upgrading, and particularly **functional upgrading** into higher-value activities. Downstream products include refined edible oils, specialty fats, oleochemicals, surfactants, personal-care and industrial inputs, biodiesel, and potentially more advanced renewable fuels.

Purnomo et al. demonstrate why economic and environmental outcomes need to be examined across the value chain rather than plantation production in isolation specifically analyse policy support for Indonesian palm-oil downstreaming, while examine export intensity and competitiveness in major CPO markets. The central industrial-policy implication is that national benefit depends not only on the number of tonnes produced but also on the domestic capabilities, processing margins, technology, labour productivity, and knowledge embodied in each tonne [44,45].

Downstreaming is not automatically beneficial, however. Capital-intensive processing can destroy rather than create value when investment decisions are driven principally by production targets rather than competitive economics. A state-owned company therefore requires disciplined portfolio selection, technology assessment, market analysis, and lifecycle sustainability evaluation. Downstreaming should be treated as a means for increasing resilient domestic value added, not an end in itself.

Bioenergy and Circularity

Palm oil also occupies a prominent position in Indonesia's energy strategy. Biodiesel can reduce fossil-diesel dependence and create domestic demand for vegetable oil, but the sustainability of such strategies depends on feedstock production, land-use effects, processing efficiency, emissions, and opportunity costs. review the opportunities and challenges of Indonesian palm-oil biodiesel, while evaluate renewable-energy prospects through an energy-return framework. Lifecycle research by further emphasises that the environmental performance of biodiesel must be evaluated across production stages rather than inferred solely from the renewable origin of its feedstock [46-48].

Circularity provides a related opportunity. Oil-palm mills generate significant biomass and liquid residues, including empty fruit bunches, fibre, shells, and palm oil mill effluent review the potential utilisation of palm-oil residues in bioenergy and transport systems. In state-owned plantation enterprises, argue that circular-economy objectives should become part of performance management because resource recovery, energy generation, and waste minimisation require operational integration rather than isolated environmental projects [49].

The circular-bioeconomy proposition is therefore stronger than the conventional idea of "waste management." It seeks to transform biological residues into energy, fertiliser, materials, or industrial inputs, thereby reducing waste intensity while creating an additional stream of economic value. Yet each project still requires commercial, technical, and environmental validation.

Sustainability, Governance, and the Development-Environment Trade-Off

Indonesia's palm-oil sustainability regime is characterised by overlapping public regulation, private certification, buyer standards, international market requirements, corporate commitments, and local implementation demonstrates the interaction between public and private governance in palm-oil sustainability, while identify ambiguities and rescaling challenges in Indonesian Sustainable Palm Oil certification similarly highlight the institutional complexity of palm-oil governance in Indonesia [50-52].

This institutional pluralism can be productive where different governance instruments reinforce one another. Public regulation can provide universal minimum requirements, while market-based standards can encourage higher performance among firms seeking differentiated markets. However, governance fragmentation can also generate inconsistent definitions, duplicated auditing, uncertain compliance responsibilities, and additional costs for farmers. For PalmCo, an important strategic opportunity is therefore to develop traceability and sustainability systems that are interoperable across domestic regulation, certification schemes, and buyer requirements.

Environmental governance also extends beyond certification. Research on palm-oil landscapes indicates that maintaining ecological functions requires active management of riparian zones, biodiversity areas, habitat fragments, and surrounding landscapes. find that mature-oil-palm riparian buffers can have inconsistent ecological effects, whereas show that properly designed riparian buffers can help mitigate biodiversity declines [53,54]. This illustrates the difference between simply setting aside a strip of vegetation and managing it for ecological function.

Broader landscape design can also improve biodiversity outcomes. Zemp et al. show that strategically established tree islands can enhance biodiversity and ecosystem functioning within oil-palm landscapes. Related evidence on oil-palm agroforestry indicates that farmers may recognise environmental benefits while remaining concerned about income risk and management complexity, underscoring the need for incentive-compatible transition design [55]. However, ecological enrichment within plantations cannot replace the conservation of natural ecosystems. Xu et al. document the significance of oil-palm expansion into carbon-rich forests, while demonstrate that zero-deforestation strategies need careful ecological definition because biodiversity values are not confined to conventional humid forest categories.

Peatlands add further complexity because drainage and cultivation affect greenhouse-gas dynamics [56]. analyse methane and nitrous-oxide fluxes in Indonesian peat forests and oil-palm plantations, reinforcing the need for climate policy to address multiple greenhouse gases and long-term land-management effects. Climate change simultaneously poses a risk to oil-palm productivity itself through changes in rainfall, temperature, extreme weather, pests, and hydrology [57]. Sustainability should therefore be understood not only as reducing plantation impacts but also as building resilience to a changing climate.

Social sustainability is equally important. Berenschot and Dhiaulhaq analyse mechanisms of land dispossession and weak rights protection in Indonesian palm-oil contexts, showing why corporate legitimacy cannot rest exclusively on formal plantation licences. Rowland et al. demonstrate that oil-palm development can also have gendered effects on household labour and time allocation. These studies suggest that public-value assessment must include land rights, grievance mechanisms, occupational conditions, distributional impacts, and participation as well as production, profit, and environmental indicators [58,59].

Why State Ownership Matters

A private plantation company is ordinarily expected to maximise risk-adjusted value within regulatory constraints. A state-owned enterprise faces a more complex objective function. It must remain commercially viable because persistent financial weakness ultimately reduces its capacity to invest and may impose costs on the state. At the same time, governments may expect it to support strategic supply, employment, technological capability, rural development, market stabilisation, energy security, or other public objectives.

Rygh and Benito conceptualise state-owned multinational enterprises as organisations in which governmental goals can influence strategy, while connect such firms to the broader debate on contemporary state capitalism. The implication for PalmCo is not that state ownership automatically creates developmental value. Rather, state ownership creates developmental optionality: the firm may undertake coordinating and long-horizon functions that are difficult for fragmented private actors to perform, but only if governance, accountability, capital allocation, and performance metrics are appropriately designed.

This distinction is particularly relevant in palm oil because many sectoral problems are coordination failures. A farmer may require replanting finance before adopting new planting material. A bank may require legal documentation and an offtake agreement before financing the farmer. A mill may be reluctant to offer long-term support without assurance of supply. A sustainability buyer may require traceability that a farmer cannot independently finance. A research institution may have technology but lack a commercial-scale implementation partner. Government agencies may have subsidy programmes but limited implementation capacity. A large SOE can potentially connect these actors.

Consequently, the conceptual contribution of this article is to define PalmCo as a possible State-Owned Developmental Platform (SODP). The platform comprises six interdependent pillars: (1) productivity and operational excellence; (2) smallholder inclusion and upgrading; (3) downstream value addition; (4) energy security and circular bioeconomy; (5) sustainability governance and traceability; and (6) fiscal, employment, and wider public value.

Method

Review Design

This study employs a qualitative narrative-integrative literature review with thematic synthesis. It is explicitly not a Systematic Literature Review (SLR) and does not claim exhaustive identification of every publication, PRISMA compliance, protocol registration, formal meta-analysis, or statistically representative coverage of the literature. This distinction is deliberate because the purpose of the study is conceptual integration across several literatures-agronomy, agricultural economics, smallholder development, corporate governance, state-owned enterprises, sustainability, industrial policy, and bioenergy-rather than estimation of a narrowly specified average treatment effect.

Qualitative and integrative reviews can be rigorous without replicating the procedures of an SLR when source identification, interpretive decisions, evidence boundaries, and synthesis methods are transparent. emphasise the craft and methodological discipline required in qualitative review, while provide guidance for integrative and state-of-the-art knowledge synthesis. These approaches support iterative literature identification and thematic comparison when the research objective concerns conceptual relationships rather than exhaustive article counting [60-63].

Literature Identification and Source Boundaries

The review focuses on peer-reviewed journal literature published from 2020 to August 2026, with priority given to research concerning Indonesia and to comparative or conceptual research directly relevant to palm oil, smallholders, SOEs, sustainability, value-chain upgrading, and bioenergy. Searches and citation tracing were undertaken through scholarly and publisher search interfaces covering major indexed journal ecosystems, followed by backward and forward tracing from high-relevance anchor papers.

Search combinations included terms such as oil palm, palm oil, Indonesia, smallholder, yield gap, replanting, fertilizer, certification, traceability, RSPO, ISPO, deforestation, biodiversity, downstreaming, oleochemical, bioenergy, circular economy, state-owned enterprise, and public value. Selection was purposive rather than mechanical. Articles were retained because of substantive relevance, methodological credibility, theoretical contribution, direct Indonesian evidence, or capacity to provide important contradictory evidence.

The core academic corpus underlying this review comprises more than 50 peer-reviewed journal articles published since 2020. Non-journal materials, including PalmCo corporate disclosures and the literature that provided the initial contextual stimulus for the study, were used only for case-specific factual context and do not count toward the journal-article threshold. This separation helps preserve a clear evidence hierarchy between peer-reviewed analytical literature and company- or media-reported case information [64].

Analytical Procedure

The analytical unit was structured as a sequential interpretive chain linking role, mechanism, outcome, constraint, and strategic implication. This structure was used consistently to distinguish what PalmCo does, how a given role could generate effects, what outcomes are reported or theoretically plausible, what factors condition those outcomes, and what strategic implications follow.

For example, smallholder replanting was not coded simply as "farmer support." It was interpreted through the mechanism by which access to planting material, finance, technical assistance, documentation, and offtake could affect yield and income, together with constraints such as immature-period income loss and institutional barriers.

First-cycle coding identified recurrent concepts including productivity, yield gap, replanting, fertilisation, mills, FFB procurement, farmer financing, certification, traceability, biodiversity, carbon, circularity, downstreaming, employment, public value, and governance. In the second cycle these codes were organised into the six developmental-platform pillars. Contradictory and negative evidence was intentionally retained so that environmental damage, exclusion risks, land disputes, investment risk, and the limitations of certification or intensification were not suppressed by the corporate-performance narrative.

Triangulation and Limitations

Company-provided data were treated according to evidentiary status. Statements such as PalmCo's 2025 net profit are described as audited company results because the company explicitly reports them as based on audited financial statements. By contrast, first-half 2026 financial figures are labelled unaudited. Claims concerning farmers, employment, industrial projects, and renewable-energy initiatives are phrased as "PalmCo reports" or "the company states" unless independently validated.

This review cannot establish causal effects of PalmCo programmes on national welfare because it does not employ counterfactual programme evaluation. It instead identifies theoretically and empirically plausible contribution pathways. Future farm-level panel studies, quasi-experimental evaluation, lifecycle analysis, and natural-capital accounting are needed to determine the magnitude and additionality of specific PalmCo interventions.

Results: Thematic Findings

Organisational Consolidation Creates a Platform, Not an Automatic Developmental Outcome

The first thematic finding concerns scale. PalmCo's consolidation provides a large asset base, geographical reach, processing infrastructure, workforce, and organisational interface with farmers and government. The company reports approximately 648,000 hectares of planted area, 71 palm oil mills, and more than 70,000 workers. These assets create potential economies in procurement, technical standardisation, digital systems, research adoption, capital investment, and product marketing. These scale indicators are reported by the company and are not treated as independently verified sectoral outcomes.

However, scale alone does not guarantee efficiency. Large organisations may also experience slower decision-making, uneven managerial quality, legacy systems, duplicated functions, weak local responsiveness, and difficulty integrating data. The developmental value of consolidation therefore depends on whether PalmCo can convert administrative integration into operational integration.

Its recent performance suggests that this process may be generating measurable commercial improvement. Audited 2025 net profit reached Rp7.08 trillion, compared with Rp3.72 trillion in 2024, while EBITDA rose to Rp13.27 trillion. PalmCo also reported CPO production of 2.70 million tonnes and an average CPO selling price of Rp14,223 per kilogram, approximately 10.4 per cent above the previous year. These data indicate that both market conditions and company-level production and efficiency influenced financial results. The figures are reported in PalmCo's audited 2025 performance disclosure.

The distinction matters because the sustainability of profit growth depends on its sources. Price-driven profit is partly cyclical and largely exogenous; productivity, cost control, extraction efficiency, asset utilisation, and organisational learning are more persistent internal capabilities. PalmCo's first-half 2026 figures are consistent with continued operational emphasis: the company reported unaudited revenue of Rp23.41 trillion, EBITDA of Rp6.05 trillion, net profit of Rp3.23 trillion, a cash cost of approximately Rp3,707/kg, and continued efforts to standardise field and milling processes. These first-half figures remain unaudited.

The more important developmental question is what happens after corporate performance improves. The 2025 dividend of approximately Rp2.83 trillion illustrates one direct pathway from profitability to fiscal or shareholder value. Retained earnings create another pathway by financing replanting, mills, digital systems, farmer programmes, environmental investments, and downstream capacity. Thus, profitability should be seen as an enabling condition for developmental contribution, not the contribution itself. The dividend figure is reported in the company's 2026 distribution announcement.

Sustainable Intensification is the Strongest Upstream Development Pathway

A second major finding is that PalmCo's most defensible route to greater national production lies in increasing output per unit of existing productive land rather than relying on extensive expansion. Research consistently identifies opportunities to close yield gaps through improved genetics, better agronomy, nutrient management, harvesting, and replanting.

This is strategically important for a state-owned company. PalmCo can potentially act as a large-scale demonstration system for high-productivity, low-expansion palm-oil production. Standardised operating procedures across a large estate network could generate agronomic learning, while digital plantation information could identify low-performing blocks, fertiliser inefficiency, harvest losses, and crop-age profiles. The benefits could then extend beyond company estates if knowledge, planting material, and services are shared with surrounding farmers.

Replanting is especially significant. Ageing and low-quality stands threaten future supply, yet replacing them imposes costs and delayed income. Research by demonstrates that successful replanting requires institutional and economic support in addition to agronomic justification. The problem is therefore ideally suited to a platform model: the SOE can help assemble government replanting support, certified seedlings, farm documentation, cooperatives, technical assistance, bridge finance, and future offtake.

PalmCo reports that it facilitated technical recommendations covering 23,188 hectares of smallholder replanting activity during 2025 and another 2,287 hectares by February 2026. These should be read as company-reported implementation figures rather than independently estimated impact. Their significance nevertheless lies in demonstrating the type of coordinating function that a state-owned plantation company can perform. The 2026 replanting implementation figure is reported by PalmCo [65].

Nutrient management provides a parallel opportunity. The evidence on fertiliser constraints suggests that yield gaps cannot be closed by simply advising farmers to apply more fertiliser. Appropriate nutrient diagnosis, balanced application, access to genuine inputs, credit, bulk purchasing, training, and evaluation of economic returns are needed. A mill-centred service system could aggregate demand and reduce some transaction costs while linking recommendations to plot-level production data.

Sustainable intensification must nevertheless include an explicit no-expansion safeguard for high-conservation-value and high-carbon ecosystems. demonstrate that profitability and ecological multifunctionality can conflict, while document the importance of forest carbon in the expansion debate. Scenario analysis for Indonesia likewise shows that reconciling future demand with environmental protection requires coordinated productivity and land-use policies rather than yield growth alone Sustainable productivity policy must therefore link higher yields to land-use governance, otherwise more profitable production can increase rather than reduce incentives for expansion.

Smallholder Upgrading is Central to Palmco's Developmental Legitimacy

PalmCo's relationship with smallholders is arguably the most important test of its developmental mandate. Company estates can generate profit and production, but the broader social contribution of a state-owned platform depends in part on whether its assets improve opportunities for producers outside corporate boundaries.

PalmCo reports that it purchased approximately 3.26 million tonnes of fresh fruit bunches from farmers in 2025 and 1.73 million tonnes during the first six months of 2026. It further states that approximately 30 per cent of industrial raw material is sourced from smallholders and that by June 2026 its programmes involved 28,786 farmer households covering approximately 54,148 hectares. These numbers indicate considerable potential reach, although their welfare effect cannot be inferred without farm-level evaluation. These procurement and farmer-participation figures are company-reported [66].

The literature suggests four complementary dimensions through which an anchor company can improve smallholder outcomes. These dimensions concern market access, technical capability, finance, and sustainability compliance, and they are analysed separately below while recognising that farmers often face several constraints simultaneously.

First, it can reduce market risk through predictable offtake. Proximity and stable access to mills can reduce dependence on opaque intermediaries and may improve incentives for timely harvesting and quality, although intermediary networks can also provide useful transport and financing services and should not be assumed to be inherently exploitative.

Second, PalmCo can reduce technology and knowledge constraints through extension, certified planting material, demonstration plots, soil and leaf analysis, and farmer field schools. identify education and capability as important determinants of resilience, while demonstrate the importance of on-farm testing and management learning.

Third, PalmCo can reduce financial constraints by making farmers more bankable. Long-term offtake contracts, verified farm data, cooperative aggregation, and production histories can lower information asymmetry for lenders. This could be especially important during replanting, when farmers incur establishment costs while temporarily losing palm income.

Fourth, it can reduce sustainability-compliance constraints by treating certification and traceability as shared infrastructure. Research shows that independent smallholders can be underrepresented in certified supply chains because compliance costs, documentation requirements, and organisational barriers are difficult to bear individually.

PalmCo itself describes four farmer-support modalities: single-management arrangements, provision of certified superior seedlings, independent/offtaker partnerships, and strengthening farmer cooperatives. These approaches are broadly compatible with the literature, but their effectiveness will depend on design. Single-management models could improve technical performance yet reduce farmer autonomy if contracts are not transparent. Cooperative models can reduce transaction costs but require genuine participation and trusted governance. show why social capital and local institutional legitimacy are important for partnership durability.

A differentiated smallholder strategy is therefore preferable to a single template. Farmers with highly productive, legally documented holdings may primarily require certification and market access. Farmers with poor planting material may require replanting, whereas farmers with severe liquidity constraints may require income-bridging finance. Farmers in environmentally sensitive areas may require conservation incentives and land-use assistance. similarly suggest that digital capability and ecosystem-oriented incentives can influence readiness for sustainability-oriented change.

The developmental target should consequently be measured not only by tonnes of FFB purchased or hectares enrolled. Better indicators include farmer yield, net income, replanting completion, share of traceable supply, reduction in rejected fruit, certification achievement, loan repayment, participation of women, grievance resolution, and the proportion of value retained by farmers.

Mills can Become Local Development and Traceability Hubs

The thematic synthesis identifies PalmCo's mill network as one of its most strategically underappreciated assets. A mill is ordinarily viewed as a processing facility that converts FFB into CPO and palm kernel products. Yet in a developmental-platform model, the mill can simultaneously function as a procurement centre, quality-control node, farmer database, extension hub, traceability checkpoint, logistics coordinator, and circular-bioeconomy facility.

This interpretation has several advantages. Because FFB must reach processing facilities rapidly, farmers and mills are already linked through repeated transactions. These interactions generate information on quantity, quality, delivery timing, and supplier identity. With appropriate governance, these transaction records can be linked to plot characteristics, planting material, crop age, agronomic support, and certification information.

Digital traceability should therefore be constructed around value creation for the farmer, not solely external surveillance. A farmer who provides accurate geolocation and farm data should receive something in return: better advice, faster payment, access to inputs, lower-cost finance, simplified certification, replanting support, or premium market access. Without reciprocal benefits, traceability risks becoming a compliance burden.

Ekaputri et al. demonstrate the uneven participation of independent smallholders in certified mill markets, illustrating why simply increasing sustainability standards may exclude exactly those producers who most need upgrading. The policy objective should thus be traceability with inclusion, not traceability through exclusion.

Technology can support this goal. UAV and spatial-assessment methods can improve plantation mapping and sustainability monitoring while digital platforms can connect farmers, agronomists, mills, lenders, and certification systems. Yet technology should remain proportionate to user capability. Sophisticated data systems that smallholders cannot use or afford may deepen rather than reduce institutional inequality.

Downstreaming Can Convert Production Scale into Greater Domestic Value Added

PalmCo's next developmental pathway concerns movement beyond CPO. The economic rationale is straightforward: when crude commodities are processed into more specialised products, a larger share of manufacturing activity, technology, skills, and industrial margins may remain within the domestic economy. Downstreaming can therefore reduce dependence on primary-commodity margins and diversify sources of earnings.

PalmCo has publicly identified opportunities in oleofood, oleochemicals, margarine, cocoa-butter equivalents, cocoa-butter substitutes, integrated biodiesel, and circular-economy activities, alongside industrial development in the Sei Mangkei area. These plans place the company within a broader Indonesian

policy shift toward higher-value processing analysed by Husin et al. (2023). These downstream opportunities are described in PalmCo's corporate disclosure on employment and downstream development.

The value-chain perspective suggests three forms of potential benefit. Product upgrading occurs when PalmCo moves into more sophisticated derivatives. Process upgrading occurs when technology raises efficiency or consistency. Functional upgrading occurs when the firm develops capabilities in product design, R&D, specialised marketing, formulation, and integrated industrial services.

The third is particularly important. A country can process more CPO domestically without necessarily creating substantial technological capability if production remains concentrated in standard products with thin margins. The strategic objective should therefore be to deepen domestic knowledge and innovation rather than merely increase physical processing.

State ownership creates both an advantage and a risk. PalmCo may have the scale and longer investment horizon needed for industrial infrastructure or research partnerships that individual producers would struggle to finance. However, large downstream investments can become inefficient if projects are selected because they align rhetorically with "hilirisasi" rather than because they possess credible market demand, technological readiness, input economics, and risk-adjusted returns.

A disciplined downstream portfolio should therefore rank projects using at least five criteria: expected domestic value added; global or domestic demand; technological and execution capability; lifecycle environmental performance; and resilience under alternative CPO-price scenarios. Commercial discipline is not opposed to the developmental mandate-it is what allows developmental investment to remain financially sustainable.

Energy Security and the Circular Bioeconomy Offer Strategic Opportunities, But Require Lifecycle Discipline

Palm oil's relationship with energy expands PalmCo's potential developmental role. Biodiesel can create stable domestic demand and reduce exposure to imported fossil fuels, while biomass and mill effluent offer additional energy opportunities. collectively show that palm-based energy offers genuine economic and energy-security possibilities but that its sustainability depends on production pathways and lifecycle assumptions.

PalmCo's scale makes it particularly relevant to the circular bioeconomy because large volumes of processing generate concentrated residues. Palm oil mill effluent can be treated in systems that capture methane and generate biogas or biomethane; fibre and shells can provide process energy; empty fruit bunches can be composted or converted into higher-value materials; other residues may support emerging biorefinery pathways.

The economic logic is compelling where a waste-management liability can become a productive input. It can reduce uncontrolled emissions or disposal costs while creating energy or materials. But circularity should be assessed by net system performance. A project that technically converts waste into a product may still be unattractive if it requires excessive capital, energy, transport, or subsidy.

PalmCo is also pursuing research collaboration on palm-based biogasoline with Institut Teknologi Sepuluh Nopember. The April 2026 memorandum of understanding covers renewable-energy research and a broader ambition for zero-waste technological development over a five-year cooperation period. At this stage, the initiative should be interpreted as an R&D and technology-development programme, not evidence that commercial-scale biogasoline is already economically or environmentally proven. The research collaboration is documented in PalmCo's April 2026 announcement.

This distinction illustrates a broader policy principle. State-owned companies can serve an important "first-mover" function in demonstration and technology scale-up, especially when social returns from learning exceed the returns that an individual firm can capture. Yet demonstration projects should contain explicit stage gates: laboratory feasibility, pilot performance, lifecycle analysis, commercial demonstration, market validation, and only then large-scale capital commitment.

Figure 1 summarises the first major synthesis of this review. It positions PalmCo not at one point in the value chain but as a potential coordinating platform that links upstream productivity, farmers, milling, downstream processing, energy, sustainability information, and markets. The arrows should be read as possible transmission mechanisms rather than automatically realised impacts.

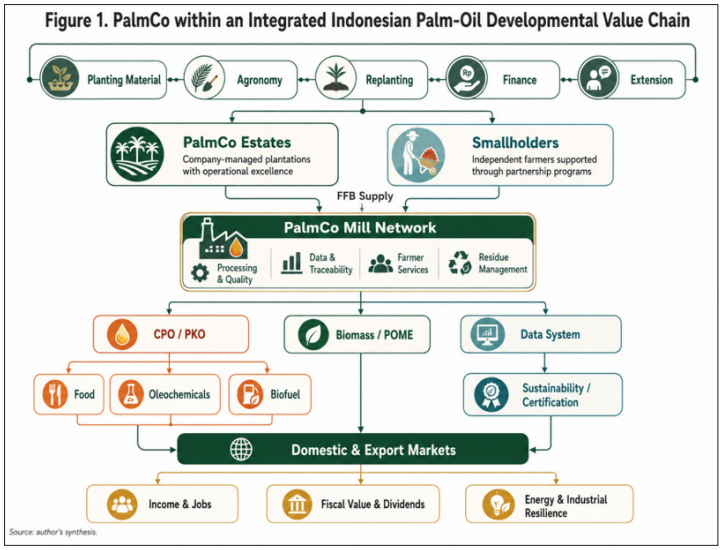

Figure 1: Palmco Within an Integrated Indonesian Palm-Oil Developmental Value Chain

Figure 1 highlights why PalmCo's 71-mill network and estate scale can be more developmentally valuable when treated as infrastructure for coordination rather than simply as production assets. The decisive issue is the quality of the linkages: procurement should connect to farmer upgrading; processing should connect to traceability; residues should connect to circularity; and financial performance should connect to reinvestment and public value. The reported 71-mill network is drawn from PalmCo's corporate disclosure (PTPN IV PalmCo, 2026c).

Employment and Fiscal Returns Broaden the Definition of Corporate Performance

PalmCo reports employment of more than 70,000 workers across its operating network. Direct employment is only one component of labour impact because plantation activity also creates demand for transportation, maintenance, contracting, inputs, services, downstream processing, and farmer labour. Nevertheless, employment quantity alone is an incomplete development indicator. The workforce figure is company-reported.

Employment quality matters: worker productivity, wages, occupational safety, social protection, gender equality, skills formation, and career development determine how effectively commercial operations translate into human development. Downstream industrialisation may also alter the skill profile of the workforce, increasing demand for engineering, laboratory, digital, logistics, automation, sustainability, and technical-management capabilities.

This is one reason that PalmCo's industrial transformation should incorporate a human-capital strategy. Industrial upgrading without skills upgrading can result in technological dependence and limit the domestic capture of knowledge-based value. Partnerships with universities and technical institutions can therefore be evaluated not only for research output but for training, certification, apprenticeships, joint laboratories, and technology transfer.

Fiscal value creates another direct link between corporate and public outcomes. The approximately Rp2.83 trillion dividend approved on 2025 earnings demonstrates a measurable financial return to shareholders within the state-owned system. Other channels include taxes and the preservation or appreciation of state-controlled productive assets. The dividend amount is reported by PalmCo.

However, dividend maximisation can conflict with investment if the payout rate leaves insufficient retained earnings for replanting, mill modernisation, environmental infrastructure, and downstream development. A public shareholder should therefore evaluate dividends together with the expected return on retained capital. In some years, greater reinvestment may create more long-term public value than a higher payout; in others, weak investment opportunities may justify larger distributions.

Environmental Stewardship Must Become an Operational Capability

The environmental literature shows that sustainability cannot be reduced to certification status. Certification provides governance infrastructure, but ecological outcomes ultimately depend on management practices, land-use decisions, habitat protection, water systems, peat management, fire prevention, and supply-chain behaviour.

Luke et al. demonstrate the value of large-scale field experimentation for understanding more sustainable plantation management show that riparian management can influence biodiversity, although outcomes depend on habitat condition and design. demonstrate that ecological enrichment within plantation landscapes can improve biodiversity and ecosystem functioning, while show that some smallholder management changes can improve environmental efficiency without requiring a simple sacrifice of output [68,69].

These findings suggest an important role for PalmCo as a living laboratory. Its geographic scale means that conservation management, reduced-input strategies, riparian restoration, biodiversity enrichment, methane capture, soil management, and climate adaptation could be implemented through replicated field experiments across environments. Results could then inform operational standards and, where appropriate, national practice.

At the same time, ecological restoration inside plantations should never be used to justify new conversion of high-value natural ecosystems. underline the importance of landscape context and carbon and biodiversity values. The hierarchy should remain: avoid conversion first, minimise impacts second, restore degraded functions where possible, and compensate only where legitimate residual impacts remain.

State ownership raises the standard of accountability. PalmCo is not merely required to comply with minimum law; its developmental legitimacy can be strengthened by demonstrating measurable improvements in GHG intensity, methane recovery, biodiversity condition, water quality, soil health, fire risk, and restoration outcomes.

The Major Constraints are Institutional, Not Merely Technical

The literature synthesis identifies nine interconnected constraints that may limit PalmCo's future contribution. These constraints span agronomic, institutional, social, environmental, commercial, technological, organisational, political, and market-access dimensions, indicating that transformation cannot be reduced to a single operational problem.

Agronomically, ageing palms, suboptimal planting material, fertiliser constraints, climate variability, labour availability, and harvesting losses can limit yields. Research on replanting and nutrient management shows that these are partly technical but strongly mediated by finance and institutions.

Institutionally, land documentation and licensing can prevent smallholders from accessing replanting finance or certification. Small farms also face high per-unit costs for mapping, audit preparation, record keeping, and sustainable-practice verification.

Socially, partnership models may be undermined by distrust, unclear contracts, weak cooperatives, unequal bargaining power, or unresolved land claims and show why relational legitimacy and rights protection are integral to sustainability rather than secondary social issues.

Environmentally, expansion pressures, degraded riparian areas, peat emissions, biodiversity loss, and climate risk can create ecological and reputational liabilities. Recent environmental-efficiency evidence also shows that, under some management conditions, smallholders can improve output while reducing biodiversity losses, suggesting scope for carefully designed incentives rather than a simple production-conservation dichotomy.

Commercially, PalmCo remains exposed to commodity prices, exchange rates, global demand, input prices, and changing destination markets. demonstrate the importance of export competitiveness, while highlight the vulnerability of complex palm-oil supply systems to major external disruption. This exposure reinforces the need for market diversification, disciplined cost management, and resilience planning across the value chain [70].

Technologically, advanced downstream and renewable-energy projects create scale-up risk. Laboratory success does not guarantee plant reliability or cost competitiveness. PalmCo's emerging biogasoline initiative should therefore move through evidence-based development stages.

Organisationally, the integration of previously separate plantation entities requires common data architecture, performance standards, procurement rules, risk systems, culture, and investment governance. Without such integration, large formal scale may conceal fragmented operational systems.

Politically, multiple objectives can become an advantage or a source of mission overload. An SOE asked simultaneously to maximise dividends, keep consumer prices low, purchase farmer output, develop new technology, expand downstream capacity, employ large numbers of workers, and meet environmental targets may face contradictory instructions unless objectives are prioritised and compensated transparently.

Finally, sustainability requirements in global markets can produce a compliance–inclusion paradox. More stringent traceability may improve environmental credibility while excluding smallholders unable to meet documentation requirements therefore point toward the need for assisted rather than exclusionary supply-chain transformation.

Discussion and Analysis

From Plantation Holding to State-Owned Developmental Platform

The most important synthesis arising from the evidence is that PalmCo's developmental significance should not be measured primarily through hectares controlled or even tonnes of CPO produced. Its comparative institutional advantage lies in connectivity. It controls productive assets while interacting with farmers, mills, industrial markets, government, researchers, financiers, employees, and sustainability institutions.

A platform produces value partly by reducing transaction and coordination costs among otherwise fragmented actors. In PalmCo's case, this could occur when farmer registration data facilitates financing; when mill procurement supports traceability; when corporate nurseries provide certified planting material to replanting farmers; when research institutions use company assets for industrial-scale technology demonstration; or when downstream plants transform the company's feedstock into products with higher domestic value added.

This interpretation also resolves an apparent tension between commercial and developmental mandates. A commercially weak PalmCo would have limited capacity to finance public-purpose initiatives. Yet a highly profitable PalmCo that generated little productivity spillover, farmer inclusion, environmental improvement, technological capability, or public value would not fully realise the potential advantages of state ownership. The objective is therefore commercially sustainable developmental additionality.

Figure 2 illustrates this distinction. Corporate profit is located early in the transmission chain rather than at its end. Strong financial performance matters because it expands strategic capacity, but developmental value is produced only when resources move through additional channels such as reinvestment, smallholder upgrading, innovation, downstreaming, environmental improvement, and fiscal transfer.

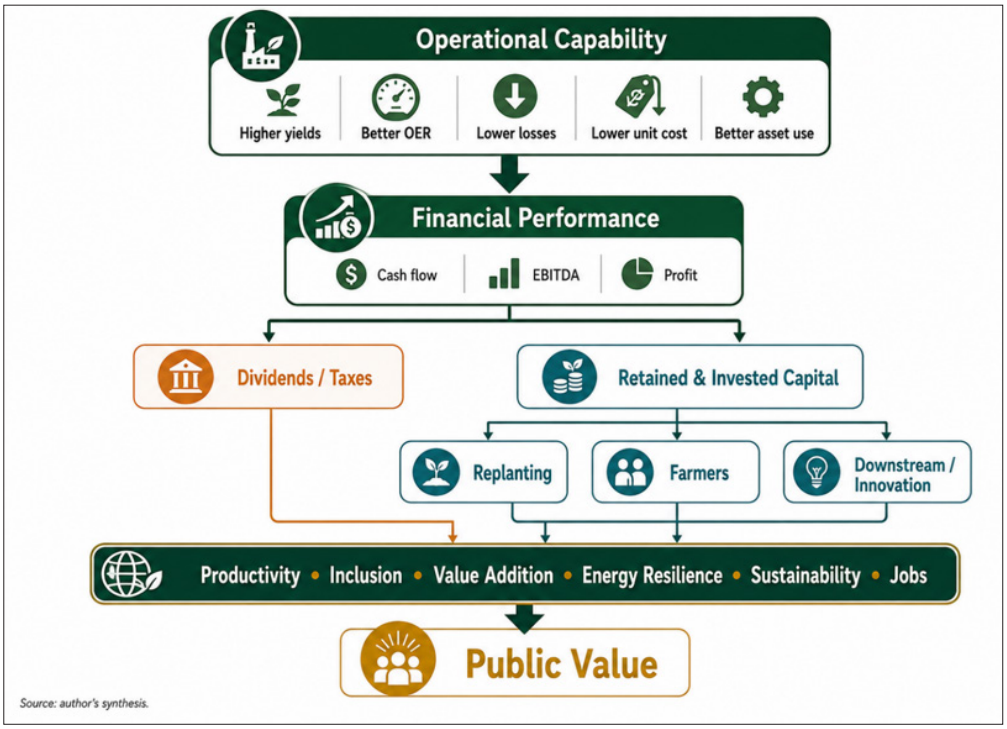

Figure 2: Transmission from Corporate Performance to National and Public Value

The framework clarifies why the audited 2025 profit of Rp7.08 trillion is substantively relevant but analytically insufficient. The key empirical question for future research is how much additional public value is generated through each transmission mechanism and whether it exceeds the opportunity cost of the capital involved.

The Smallholder–Mill Interface Should Become Palmco's Primary Developmental Platform

Among the six pillars, the most immediate opportunity is likely to lie in connecting mill infrastructure to smallholder upgrading. This conclusion emerges from the convergence of agronomic, certification, replanting, and supply-chain literature.

Smallholders often do not face one isolated problem. A farmer with ageing low-quality palms may simultaneously lack cash for replanting, clear land documentation, technical knowledge, access to certified planting material, income during the immature period, and a future buyer. Solving only one constraint is unlikely to transform productivity.

PalmCo can instead construct a bundled Smallholder Service Platform around its mills. The package could include farm registration, geolocation, agronomic assessment, replanting planning, seed supply, cooperative strengthening, input procurement, financial referral, certification preparation, guaranteed offtake, digital payment, and performance monitoring.

Such bundling addresses transaction-cost problems. A bank receives verified production and offtake information; government receives better programme targeting; PalmCo receives more reliable future FFB supply; farmers receive services and market certainty; sustainability buyers receive traceability. The institutional surplus arises because one information system serves multiple purposes.

Recent studies collectively support the importance of organisation, resilience, digital inclusion, market relationships, and partnership design for smallholder upgrading. Taken together, this evidence suggests that technical assistance is most effective when it is embedded in durable institutional relationships rather than delivered as a stand-alone intervention.

However, the service model should preserve farmer choice. Developmental coordination should not become monopsony dependence. Transparent grading, price information, contract terms, complaint mechanisms, and data-governance rules are necessary to ensure that integration increases farmer agency rather than merely corporate control.

Productivity and Conservation Should be Institutionally Linked

The traditional palm-oil debate frequently assumes that production and conservation are opposing objectives. The literature suggests a more nuanced formulation. Higher yields on existing plantations can reduce the amount of additional land theoretically required for a given output level, but only governance can ensure that this theoretical land saving becomes actual conservation.

PalmCo can help institutionalise this linkage by adopting a productivity-for-conservation compact. Under such a model, all major yield-enhancement programmes would be accompanied by explicit controls on expansion into natural ecosystems, transparent geospatial monitoring, HCV/HCS protection, riparian management, and restoration targets.

This creates a stronger sustainability narrative than simply reporting certification coverage. It demonstrates that higher productivity is being deliberately used as an alternative to extensive growth. Such an approach responds directly to the evidence.

Padmanaba et al. additionally show the importance of jurisdictional and regulatory approaches to high-conservation-value designation. This means PalmCo's conservation strategy should extend beyond estate boundaries by coordinating with local government, communities, neighbouring farmers, and landscape initiatives [71].

Downstreaming Should be Judged by Value Added, not by Processing Volume

Indonesia's downstream ambitions can create industrial upgrading, but headline processing capacity can obscure whether real economic upgrading has occurred. A refinery that simply converts CPO into a low-margin standard product represents a different developmental outcome from an integrated complex producing high-value specialty ingredients, oleochemicals, renewable materials, or technology-intensive products.

PalmCo should therefore measure downstream strategy using domestic value added per tonne, not simply tonnes processed. Other metrics should include downstream EBITDA, export unit value, number of technologically sophisticated products, domestic knowledge content, patents or proprietary processes, skilled employment, R&D intensity, and reduction in exposure to commodity-price cycles.

Husin et al. provide a policy perspective on Indonesian downstreaming, while Purnomo et al. (2020) emphasise the importance of value-chain dynamics. also remind policymakers that plantation and investment expansion interacts with broader questions of land use and food security; industrial development must therefore be evaluated systemically.

For a state-owned company, the hurdle should in fact be higher than for a private investor because unsuccessful capital allocation represents an opportunity cost for public assets. Every major downstream project should pass transparent commercial, technological, market, environmental, and strategic tests.

Circularity can Convert Sustainability Cost into Productive Capability

Environmental policy is often perceived by firms as a compliance cost. Circular bioeconomy strategy changes this logic where environmental improvement produces a commercially useful output.

Capturing methane from POME, for example, can simultaneously reduce greenhouse-gas emissions and generate energy. Biomass utilisation can replace external fuel inputs or create saleable materials. Nutrient recovery can reduce waste and potentially substitute some purchased inputs. These are examples of environmental productivity-the same resource generates more economic service with lower residual impact.

Trisyulianti et al. are particularly relevant because they locate circularity within the performance-management system of state-owned plantation enterprises. PalmCo should therefore move from measuring waste compliance to measuring waste valorisation rates, methane avoided, renewable energy generated, fossil energy displaced, circular revenue, and economic return on circular investments.

A danger nevertheless exists when "circular" becomes a label applied without lifecycle evidence. Wahyono et al. demonstrate why environmental effects must be evaluated across system boundaries. This principle should also govern emerging biofuel and biogasoline projects.

Sustainability Should Enter Capital Allocation and Executive Performance Metrics

One of the strongest implications of the qualitative synthesis is that sustainability cannot remain a parallel ESG reporting function. If plantation expansion, downstream investment, mill modernisation, procurement, farmer sourcing, and executive incentives are decided through conventional financial criteria while sustainability is measured separately, operational decisions will continue to dominate environmental commitments.

PalmCo therefore needs an integrated performance architecture. Such an architecture should make sustainability, inclusion, and public value visible in the same decision system as profitability, productivity, and capital efficiency, rather than treating them as parallel reporting domains.

Figure 3 presents the proposed PalmCo Sustainable Developmental Platform. The six pillars are mutually dependent and rest on three enabling capabilities: integrated information and traceability; finance and disciplined capital allocation; and organisational/ human capability.

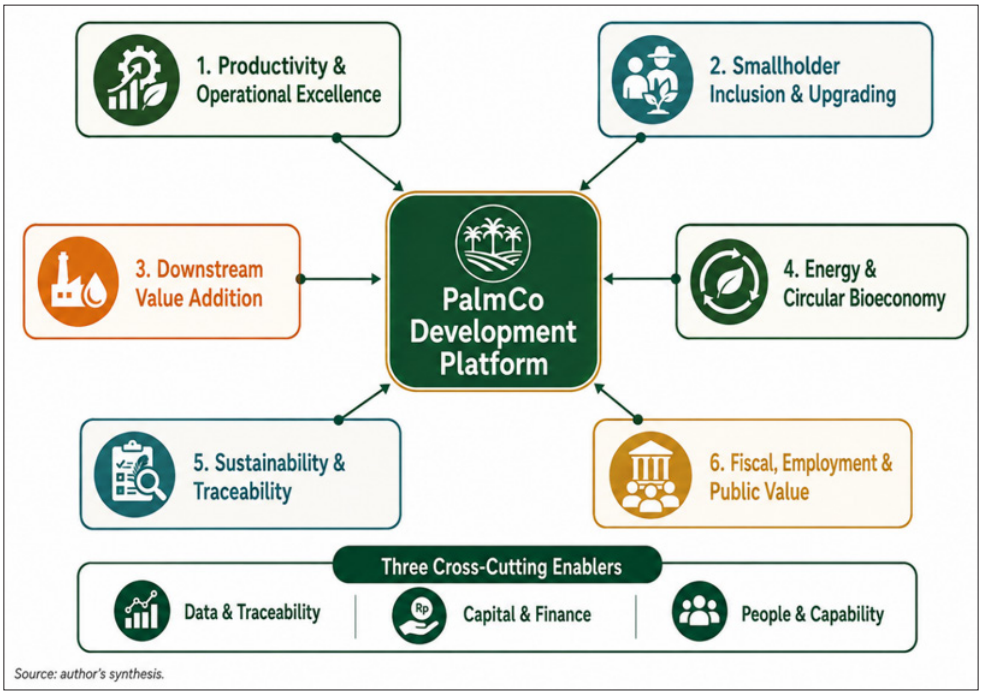

Figure 3: The Palm Co Sustainable Developmental Platform

The figure shows why no single KPI can adequately capture PalmCo's success. Higher EBITDA accompanied by declining soil productivity would not represent durable performance; increased farmer purchases accompanied by stagnant farmer yields would indicate shallow inclusion; more renewable-energy capacity accompanied by adverse lifecycle effects would not constitute credible sustainability.

A multidimensional dashboard should therefore combine conventional financial metrics with FFB and CPO yield per hectare, OER, harvesting losses, replanting age profile, cash cost, farmer productivity, farmer income, replanting completion, traceability, certified supply, GHG intensity, methane capture, biodiversity indicators, worker safety, training, downstream value added, innovation, and fiscal contribution. The value of this dashboard lies not in the number of indicators but in linking them to management accountability, capital allocation, and transparent reporting.

Such integration would also improve accountability for the multiple-objective nature of a state-owned enterprise. Rather than leaving developmental mandates vague, government shareholders can specify measurable targets and distinguish commercially compensated policy obligations from ordinary business activity.

The Central Strategic Challenge is Managing Trade-Offs Rather than Denying them

An academically credible model of sustainable PalmCo development must recognise that not all goals are mutually reinforcing. Some interventions create genuine synergies; others involve trade-offs.

Higher yields can raise farmer income and reduce pressure for expansion, but higher profitability can also increase expansion incentives. Traceability can improve environmental credibility but exclude farmers without documentation. Higher dividends increase short-term fiscal receipts but reduce retained capital available for investment. Domestic biofuel can improve energy security but increase competition for feedstock. Mechanisation can improve productivity but alter labour demand. Downstream industrialisation can generate value added but expose public capital to technological and market risk.

Figure 4 categorises the strategic choices into areas of high synergy and areas where explicit balancing mechanisms are required. The purpose is not to imply that every trade-off can be eliminated, but to ensure that conflicts are made visible before investment or policy decisions are taken.

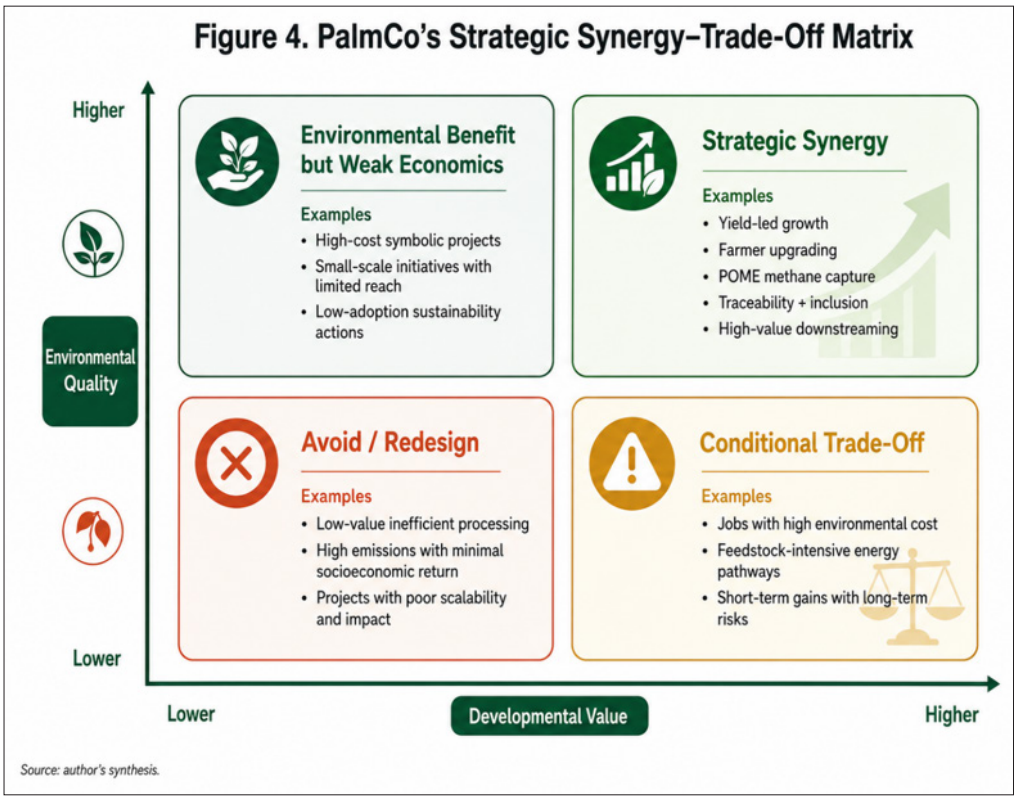

Figure 4: Palm co's Strategic Synergy–Trade-Off Matrix

The preferred strategic space is the upper-developmental, high-environmental-quality quadrant: interventions that create both economic/social value and environmental improvement. When activities fall into the trade-off quadrant, decision-makers need explicit safeguards, compensation, transition policies, or alternative technologies.

Policy and Corporate Agenda

The findings support a coordinated agenda rather than isolated initiatives. The following priorities are framed as mutually reinforcing components of the proposed developmental platform, with implementation sequenced according to commercial feasibility, smallholder needs, and environmental safeguards.

First, PalmCo should institutionalise yield-led growth. Replanting, genetics, balanced fertilisation, crop-age management, harvest discipline, mill efficiency, and digital agronomy should receive priority over extensive expansion. The objective should be more sustainable output from existing productive assets, consistent with evidence on climate-smart intensification and better management practices.

Second, the company should establish a mill-centred Smallholder Service Platform. Farm mapping, technical assessment, replanting, seed supply, finance, certification, cooperative strengthening, and offtake should be bundled around long-term farmer relationships. PalmCo's reported procurement of 1.73 million tonnes of farmer FFB in the first half of 2026 means that a substantial transactional foundation already exists. The reported first-half 2026 procurement figure is drawn from PalmCo's disclosure.

Third, traceability should be designed as shared development infrastructure. Farmers who provide credible data should receive tangible services in exchange. Open or interoperable standards should be preferred to closed systems that lock farmers into one buyer. Data-privacy and farmer-consent rules will become increasingly important as spatial and production information becomes more granular.

Fourth, downstream investment should be subjected to disciplined portfolio governance. PalmCo should publish or internally apply clear hurdle rates, technology-readiness criteria, scenario analysis, lifecycle sustainability requirements, and post-investment reviews. This is particularly important for capital-intensive specialty products and renewable-fuel technologies.

Fifth, circular bioeconomy investment should prioritise solutions with dual environmental and financial returns. Methane capture from POME, biomass utilisation, nutrient recovery, and energy efficiency are promising where proven through lifecycle and project economics. More experimental technologies should progress through staged demonstration rather than immediate full-scale investment.

Sixth, sustainability indicators should influence executive incentives and capital allocation. A developmentally meaningful corporate scorecard should combine profit and dividend with yield, GHG intensity, farmer outcomes, traceability, biodiversity, safety, circularity, and downstream value creation.

Seventh, the shareholder should clarify PalmCo's public-service obligations. If the state asks the company to undertake

commercially unattractive activities for strategic reasons, those obligations should be explicit and their costs measurable. Otherwise, management cannot be held meaningfully accountable for commercial efficiency.

Eighth, PalmCo should become stronger research and learning platform. Large estates and mills can support replicated field trials on fertilisation, biodiversity enrichment, methane reduction, climate adaptation, digital agronomy, and harvesting. Collaboration with universities should produce both publishable evidence and operational adoption.

Ninth, policy should protect smallholders from exclusion during sustainability transition. Certification, geolocation, and zero-deforestation requirements should be accompanied by assistance rather than relying solely on sanctions or procurement exclusion. Evidence from makes this particularly important.

Finally, transparency should become a strategic asset. PalmCo can strengthen its legitimacy by reporting audited financial outcomes alongside consistently defined productivity, smallholder, environmental, labour, and public-value indicators. A state-owned company capable of demonstrating both commercial and sustainability performance could function as a benchmark for broader sectoral transformation [76].

Conclusion

This qualitative literature review has examined the strategic role of PTPN IV PalmCo in Indonesia's palm-oil economy through a framework that integrates corporate performance, agronomic productivity, smallholder development, industrial upgrading, energy security, sustainability governance, and public value. The analysis deliberately moves beyond two common simplifications: that a state-owned plantation company should be judged only by its financial performance, or that developmental contribution can be assumed merely from state ownership.

PalmCo's recent performance establishes a stronger economic foundation for transformation. The company reported audited 2025 net profit of Rp7.08 trillion, EBITDA of Rp13.27 trillion, and CPO production of approximately 2.70 million tonnes, and it subsequently distributed approximately Rp2.83 trillion in dividends. First-half 2026 unaudited results indicate continued positive performance. These achievements matter because a profitable organisation possesses greater capacity to invest. They should not, however, be interpreted as automatic proof of farmer welfare, additional national income, reduced emissions, or broader sustainability.

The literature instead suggests that PalmCo's greatest strategic value lies in its ability to act as a State-Owned Developmental Platform. Its plantation scale, mill infrastructure, farmer relationships, workforce, access to government institutions, and emerging downstream capabilities allow it potentially to coordinate activities that are difficult to organise through fragmented market transactions.

Six pathways are particularly important. First, PalmCo can promote sustainable intensification through better agronomy, replanting, improved planting material, and mill efficiency. Second, it can use its mills and procurement relationships to provide integrated upgrading services to smallholders. Third, it can deepen domestic value creation through commercially disciplined downstream industrialisation. Fourth, it can support energy security and circular bioeconomy development through biodiesel, biomass, methane capture, and carefully staged advanced-fuel innovation. Fifth, it can strengthen sustainability governance through traceability, conservation, and landscape management. Sixth, it can convert financial performance into public value through employment, skills, dividends, tax contributions, productive reinvestment, and technology development.

The most important policy implication is that these pathways should not be managed independently. Productivity without conservation can stimulate expansion. Traceability without support can exclude smallholders. Downstreaming without commercial discipline can destroy public capital. Bioenergy without lifecycle assessment can produce misleading environmental claims. Dividends without adequate reinvestment can weaken future productive capacity. Conversely, sustainability policies detached from profitability can undermine the financial base required to maintain them.

PalmCo should therefore adopt a multidimensional performance framework in which commercial and developmental indicators are integrated. The long-run objective should not be simply to become a larger palm-oil company, but to increase the developmental productivity of every hectare, mill, rupiah of state capital, farmer relationship, unit of biomass, and unit of organisational knowledge under its influence.

Such an approach is also consistent with the central lesson of contemporary palm-oil scholarship. Indonesia does not face a simple choice between economic use of palm oil and sustainability. Its challenge is institutional: creating systems in which greater productivity and value addition can occur while expansion pressure, greenhouse-gas emissions, biodiversity loss, social exclusion, and weak governance are progressively reduced.

For PalmCo, this means that its next transformation should be measured not merely by the next increase in profit, output, or assets, but by whether corporate capability is successfully transmitted into resilient farmers, higher land productivity, higher-value domestic industries, cleaner energy systems, credible environmental stewardship, skilled employment, and demonstrable public value. If that transmission can be achieved and independently verified, PalmCo could perform a role that is substantially more consequential than that of a conventional plantation holding: it could become an institutional mechanism for the sustainable transformation of Indonesia's palm-oil economy.

Future research should test this proposition empirically. Priority areas include quasi-experimental evaluation of PalmCo's farmer programmes; longitudinal comparison of participating and non-participating smallholders; productivity and profitability benchmarking between PalmCo, private estates, and independent growers; lifecycle assessment of PalmCo's bioenergy projects; natural-capital accounting; analysis of gender and labour outcomes; and estimation of the additional national value created by downstream investment. Such evidence would enable future assessments to progress from plausible developmental contribution to quantitatively demonstrated developmental impact.

References

1. Qaim M, Sibhatu KT, Siregar H, Grass I (2020) Environmental, economic, and social consequences of the oil palm boom. Annual Review of Resource Economics 12: 321-344.
2. Meijaard E (2020) The environmental impacts of palm oil in context. Nature Plants 6: 1418-1426.
3. Purnomo H, Okarda B, Dermawan A, Ilham QP, Pacheco P, et al. (2020) Reconciling oil palm economic development

and environmental conservation in Indonesia: A value chain dynamic approach. Forest Policy and Economics 111: 102089.
4. Murphy DJ, Goggin K, Paterson RRM (2021) Oil palm in the 2020s and beyond: challenges and solutions. CABI Agriculture and Bioscience 2: 39.
5. Krishna VV, Kubitza C (2021) Impact of oil palm expansion on the provision of private and community goods in rural Indonesia. Ecological Economics 179: 106829.
6. Ayompe LM, Schaafsma M, Egoh BN (2021) Towards sustainable palm oil production: the positive and negative impacts on ecosystem services and human wellbeing. Journal of Cleaner Production 278: 123914.
7. Grass I (2020) Trade-offs between multifunctionality and profit in tropical smallholder landscapes. Nature Communications 11: 1186.
8. Xu Y, Yu L, Ciais P, Li W, Santoro M, et al. (2022) Recent expansion of oil palm plantations into carbon-rich forests. Nature Sustainability 5: 574-577.
9. Fleiss S (2023) Implications of zero-deforestation palm oil for tropical grassy and dry forest biodiversity. Nature Ecology & Evolution 7: 250-263.
10. Zemp DC, Guerrero-Ramirez N, Brambach F (2023) Tree islands enhance biodiversity and functioning in oil palm landscapes. Nature 618: 316-321.
11. Monzon JP, Slingerland MA, Rahutomo S (2021) Fostering a climate-smart intensification for oil palm. Nature Sustainability 4: 595-601.
12. Zhao J, Elmore AJ, Lee JSH, Numata I, Zhang X, et al. (2023) Replanting and yield increase strategies for alleviating the potential decline in palm oil production in Indonesia. Agricultural Systems 210: 103714.
13. Woittiez LS, Slingerland M, van Noordwijk M, Silalahi AJ, van Heerwaarden J, et al. (2024) People, palms, and productivity: testing better management practices in Indonesian smallholder oil palm plantations. Agriculture 14: 1626.
14. Xin Y, Sun L, Hansen MC (2022) Oil palm reconciliation in Indonesia: balancing rising demand and environmental conservation towards 2050. Journal of Cleaner Production 380: 135087.
15. Watts JD (2021) Challenges faced by smallholders in achieving sustainable palm oil certification in Indonesia. World Development 146: 105565.
16. de Vos RE (2023a) pre-certification conditions of independent oil palm smallholders in Indonesia: Assessing prospects for RSPO certification. Land Use Policy 130: 106660.
17. Hendrawan D, Musshoff O (2024) Risky for the income, useful for the environment: predicting farmers' intention to adopt oil palm agroforestry using an extended theory of planned behaviour. Journal of Cleaner Production 475: 143692.
18. Ekaputri AD, Gaveau DLA, Heilmayr R, Carlson KM (2025) Uneven participation of independent and contract smallholders in certified palm oil mill markets in Indonesia. Communications Earth & Environment 6.
19. PTPN IV PalmCo (2026c) PalmCo Serap 70 Ribu Tenaga Kerja, Bidik Peluang Baru dari Hilirisasi Sawit. 1 May 2026.
20. PTPN IV PalmCo (2026a) Tembus Rp7,08T, Laba Bersih PTPN IV PalmCo Melonjak 90,3 Persen pada 2025, Ditopang Produksi dan Efisiensi. 29 June 2026.
21. PTPN IV PalmCo (2026g) Konsisten, PTPN IV PalmCo Tahun Ini Bagikan Dividen Rp2,83 Triliun. 7 July 2026.
22. PTPN IV PalmCo (2026b) Lanjutkan Tren Positif, PTPN IV PalmCo Raup Laba Bersih Rp3,23 Triliun pada Semester I 2026. 25 July 2026.
23. Rygh A, Benito GRG (2022) Governmental goals and the international strategies of state-owned multinational enterprises: a conceptual discussion. Journal of Management and Governance 26: 1155-1181.
24. Panibratov A, Klishevich D (2023) Emerging market state-owned multinationals: a review and implications for the state capitalism debate. Asian Business & Management 22: 84-117.
25. Trisyulianti E, Prihartono B, Andriani M, Suryadi K (2022) Sustainability performance management framework for circular economy implementation in state-owned plantation enterprises. Sustainability 14: 482.
26. Lim YL (2023) Too little, too imbalanced: Nutrient supply in smallholder oil palm fields in Indonesia. Agricultural Systems 210: 103729.
27. Purwanto E, Santoso H, Jelsma I, Widayati A, Nugroho HYSH, et al. (2020) Agroforestry as policy option for forest-zone oil palm production in Indonesia. Land 9: 531.
28. Yani A (2020) Feasibility assessment of converting forest into palm oil plantation and its implication for forest policy and palm oil sustainability challenges: a case study in Melawi Regency of West Kalimantan Province, Indonesia. Frontiers in Sustainable Food Systems 4: 521270.
29. Mehraban N, Kubitza C, Alamsyah Z, Qaim M (2021) Oil palm cultivation, household welfare, and exposure to economic risk in the Indonesian small farm sector. Journal of Agricultural Economics 72: 901-915.
30. Supriatna J, Djumarno D, Saluy AB, Kurniawan D (2024) Sustainability analysis of smallholder oil palm plantations in several provinces in Indonesia. Sustainability 16: 4383.
31. Denashurya NI, Nurliza, Dolorosa E, Kurniati D, Suswati D (2023) Overcoming barriers to ISPO certification: Analyzing the drivers of sustainable agricultural adoption among farmers. Sustainability 15: 16507.
32. Apriani E, Kim YS, Fisher LA, Baral H (2020) Non-state certification of smallholders for sustainable palm oil in Sumatra, Indonesia. Land Use Policy 99: 105112.
33. Ogahara Z, Jespersen K, Theilade I, Nielsen MR (2022) Review of smallholder palm oil sustainability reveals limited positive impacts and identifies key implementation and knowledge gaps. Land Use Policy 120: 106258.
34. Reich C, Musshoff O (2025) Oil palm smallholders and the road to certification: insights from Indonesia. Journal of Environmental Management 375: 124303.
35. Santika T, Wilson KA, Law EA (2021) Impact of palm oil sustainability certification on village well-being and poverty in Indonesia. Nature Sustainability 4: 109-119.
36. Renner S, Ruml A, Lakemann T, Nuryartono N, Tjoa A, Corre MD, et al. (2024) Smallholder RSPO certification, economic benefits and agrochemical use. Environmental Research Letters 19: 114093.
37. Witjaksono J, Djaenudin D, Fery Purba S, Yulianti A, Fadwiwati AY, et al. (2024) Corporate farming model for sustainable supply chain crude palm oil of independent smallholder farmers. Frontiers in Sustainable Food Systems 8: 1418732.
38. Baka WK, Rianse IS, Zulfikar L (2024) Palm oil business partnership sustainability through the role of social capital and local wisdom: evidence from palm oil plantations in Indonesia. Sustainability 16: 7541.
39. Hendrawan D, Chrisendo D, Musshoff O (2024) Strengthening oil palm smallholder farmers' resilience to future industrial challenges. Scientific Reports 14: 12105.
40. de Vos RE (2023b) Shortening harvest interval, reaping benefits? A study on harvest practices in oil palm smallholder farming systems in Indonesia. Agricultural Systems 211: 103753.

41. Rafik, Walen S, Carlson KM (2024) Smallholder participation in zero-deforestation supply chain initiatives in the Indonesian palm oil sector: Challenges, opportunities, and limitations. Elementa: Science of the Anthropocene 12: 00099.
42. Hasmin H, Salman D, Demmallino EB, Nurung J, Darhamsyah D (2026) Digital inclusion and ecosystem-based incentives as predictors of smallholder readiness for sustainability-oriented change in Indonesian oil palm landscapes. Discover Environment 4.
43. Wong YB, Gibbins C, Azhar B, Phan SS, Scholefield P, et al. (2023) Smallholder oil palm plantation sustainability assessment using multi-criteria analysis and unmanned aerial vehicles. Environmental Monitoring and Assessment 195: 577.
44. Husin S, Wijaya C, Ghafur AHS, Machmud TMZ, Mardanugraha E (2023) Trade Policies Support for Palm Oil Downstreaming in Indonesia. JEJAK: Journal of Economics and Policy 16: 302-322.
45. Rosyadi FH, Mulyo JH, Perwitasari H, Darwanto DH (2021) Export intensity and competitiveness of Indonesia's crude palm oil to main destination countries. Agricultural Economics 67: 189-199.
46. Farobie O, Hartulistiyoso E (2022) Palm oil biodiesel as a renewable energy resource in Indonesia: Current status and challenges. BioEnergy Research 15: 93-111.
47. Prananta W, Kubiszewski I (2021) Assessment of Indonesia's future renewable energy plan: A meta-analysis of biofuel energy return on investment (EROI). Energies 14: 2803.
48. Wahyono Y, Hadiyanto H, Gheewala SH (2023) Evaluating the environmental impacts at the end point level of the biodiesel production process from multiple feedstocks in Indonesia through life cycle assessment methodology. Waste and Biomass Valorization 14: 3115-3131.
49. Kaniapan S, Hassan S, Ya H, Nesan KP, Azeem M (2021) The utilisation of palm oil and oil palm residues and the related challenges as a sustainable alternative in biofuel, bioenergy, and transportation sector: A review. Sustainability 13: 3110.
50. Brandi C (2021) The interaction of private and public governance: The case of sustainability standards for palm oil. The European Journal of Development Research 33: 1574-1595.
51. Choiruzzad SAB, Tyson A, Varkkey H (2021) The ambiguities of Indonesian Sustainable Palm Oil certification: internal incoherence, governance rescaling and state transformation. Asia Europe Journal 19: 189-208.
52. Putri EIK, Dharmawan AH, Hospes O (2022) The oil palm governance: challenges of sustainability policy in Indonesia. Sustainability 14: 1820.
53. Pashkevich MD (2022) Riparian buffers made of mature oil palms have inconsistent impacts on oil palm ecosystems. Ecological Applications 32: 2552.
54. Deere NJ (2022) Riparian buffers can help mitigate biodiversity declines in oil palm agriculture. Frontiers in Ecology and the Environment 20: 459-466.
55. Petri H, Hendrawan D, Bähr T, Musshoff O, Wollni M, et al. (2024) Replanting challenges among Indonesian oil palm smallholders: a narrative review. Environment, Development and Sustainability 26: 19351-19367.
56. Swails E, Hergoualc'h K, Verchot L, Novita N, Lawrence D (2021) Spatio-temporal variability of peat CH4 and N2O fluxes and their contribution to peat GHG budgets in Indonesian forests and oil palm plantations. Frontiers in Environmental Science 9: 617828.
57. Wulandari R, Abas A, Abdullah A (2025) Understanding the impact of climate change on oil palm plantation: a systematic literature review. Frontiers in Sustainable Food Systems 9: 1621217.
58. Berenschot W, Dhiaulhaq A (2023) The production of rightlessness: palm oil companies and land dispossession in Indonesia. Globalizations.
59. Rowland D, Zanello G, Waliyo E, Ickowitz A (2022) Oil palm and gendered time use: A mixed-methods case study from West Kalimantan, Indonesia. Forest Policy and Economics 137: 102682.
60. Wilson SM, Anagnostopoulos D (2021) Methodological guidance paper: the craft of conducting a qualitative review. Review of Educational Research 91.
61. Dhollande S, Taylor A, Meyer S, Scott M (2021) Conducting integrative reviews: a guide for novice nursing researchers. Journal of Research in Nursing 26: 427-438.
62. Kraus S, Breier M, Lim WM (2022) Literature reviews as independent studies: guidelines for academic practice. Review of Managerial Science 16: 2577-2595.
63. Barry ES, Merkebu J, Varpio L (2022) State-of-the-art literature review methodology: A six-step approach for knowledge synthesis. Perspectives on Medical Education 11: 281-288.
64. Bisnis Indonesia (2026) Transformasi Berbuah Nilai, PalmCo Menatap Lompatan Berikutnya. Bisnis Indonesia – Edisi Khusus 81 Tahun Indonesia Merdeka, 15 August 26.
65. PTPN IV PalmCo (2026e) Realisasi Rekomtek PSR Capai 2.287 Ha, PalmCo Lampaui Target Awal Tahun hingga 25%. 2 April 2026.
66. PTPN IV PalmCo (2026d) Dukung B50 dan Ketahanan Pangan, PTPN IV PalmCo Perkuat PSR, Serap 1,73 Juta Ton TBS Petani.
67. PTPN IV PalmCo (2026f) Disaksikan Mentan: PTPN IV PalmCo dan ITS Teken MoU Inovasi Biogasoline Dorong Ketahanan Energi Nasional.
68. Luke SH (2020) Managing Oil Palm Plantations More Sustainably: Large-Scale Experiments Within the Biodiversity and Ecosystem Function in Tropical Agriculture (BEFTA) Programme. Frontiers in Forests and Global Change 2: 75.
69. Dalheimer B, Parikoglou I, Brambach F, Yanita M, Kreft H, et al. (2024) On the palm oil-biodiversity trade-off: environmental performance of smallholder producers. Journal of Environmental Economics and Management 125: 102975.
70. Hafiz N, Mohd Azmi KMK, Nimfa DTT, Abdul Latiff AAS, Abd Wahab S (2021) COVID-19 and its implications to the assessment of sustainable palm oil supply chain management: an Indonesian perspective. Frontiers in Sustainability 2: 738985.
71. Padmanaba M (2023) Jurisdictional approaches to High Conservation Value area designation using regulatory instruments: an Indonesian pilot project. Frontiers in Environmental Science 11: 1226070.
72. de Vos RE (2026) Fertilizer use in Indonesian oil palm smallholder systems: agronomic and socio-economic constraints and opportunities. Environment, Development and Sustainability.
73. Fosch A (2023) Replanting unproductive palm oil with smallholder plantations can help achieve Sustainable Development Goals in Sumatra, Indonesia. Communications Earth & Environment 4: 378.
74. Hasudungan A, Raeskyesa DGS, Fromm I (2024) Analysis of the foreign direct investment, oil palm expansion, and food security in Indonesia: Sumatra and Kalimantan case studies. Discover Sustainability 5: 287.

75. Li TM (2024) Securing oil palm smallholder livelihoods without more deforestation in Indonesia. Nature Sustainability 7: 387-393.

76. Zhao J, Cochrane MA, Lee JSH, Zhang X, Chalil D (2026) Indonesia's new replanting subsidy is insufficient to empower smallholder farmers to replant aging oil palms. npj Sustainable Agriculture.