NAVIGATING UNCERTAINTY: PALM OIL SECTOR OUTLOOK FOR 2026 THROUGH THE LENS OF SMALLHOLDER WELFARE AND SUSTAINABILITY IMPERATIVES

NAVEGANDO PELA INCERTEZA: PERSPECTIVAS DO SETOR DE ÓLEO DE PALMA PARA 2026 SOB A ÓTICA DO BEM-ESTAR DOS PEQUENOS PRODUTORES E DOS IMPERATIVOS DE SUSTENTABILIDADE

NAVEGANDO EN LA INCERTIDUMBRE: PERSPECTIVAS DEL SECTOR DEL ACEITE DE PALMA PARA 2026 DESDE LA ÓPTICA DEL BIENESTAR DE LOS PEQUEÑOS PRODUCTORES Y LOS IMPERATIVOS DE SOSTENIBILIDAD

https://doi.org/10.56238/sevened2026.008-062

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ABSTRACT

This qualitative literature review examines the outlook for Indonesia's palm oil sector in 2026, with particular emphasis on smallholder farmers' welfare and the interplay between production dynamics, policy drivers, and sustainability imperatives. Synthesizing evidence from the 2026 IPOSS Palm Oil Outlook, literature publications (2020-2025), and government reports. In industry analyses, we identify critical determinants shaping the sector's trajectory: biodiesel mandate expansion (B40-B50), climate variability following El Niño-La Niña cycles, implementation of the European Union Deforestation Regulation (EUDR), and persistent productivity gaps in smallholder plantations. Global crude palm oil (CPO) production is projected at 83 million metric tons in 2026, with Indonesia maintaining 59% market share despite land expansion constraints and bottlenecks in the replanting program (PSR). Domestic consumption intensification through bioenergy mandates creates a dual pressure on export capacity and farmer income stability. Price forecasts range from USD 1,050 to 1,200/MT, influenced by energy policy, geopolitical tensions, and sustainability compliance costs. Thematic findings reveal that smallholder welfare—measured through Farmers Terms of Trade (NTP) and multidimensional welfare indices—remains vulnerable to price volatility, limited market access, and certification barriers. We propose six evidence-based policy recommendations prioritizing accelerated replanting (200,000 ha/year target), price stabilization mechanisms, subsidized ISPO certification pathways, enhanced extension services, comprehensive welfare monitoring systems, and income diversification strategies. This review contributes to agricultural economics literature by synthesizing fragmented research streams and providing actionable insights for policymakers navigating the sustainability-development nexus in commodity-dependent economies.

Keywords: Palm Oil Outlook. Smallholder Welfare. Biodiesel Policy. ISPO Certification. Replanting Program. EUDR Compliance. Farmers' Terms of Trade. Sustainable Intensification. Indonesian Agriculture. Climate Adaptation.

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RESUMO
Esta revisão qualitativa da literatura examina as perspectivas do setor de óleo de palma da Indonésia em 2026, com ênfase particular no bem-estar dos pequenos produtores e na interação entre dinâmicas produtivas, direcionadores de políticas públicas e imperativos de sustentabilidade. O estudo sintetiza evidências provenientes do IPOSS Palm Oil Outlook 2026, de publicações científicas (2020–2025) e de relatórios governamentais e análises setoriais. Identificam-se determinantes críticos que moldam a trajetória do setor, incluindo a expansão do mandato de biodiesel (B40–B50), a variabilidade climática associada aos ciclos El Niño–La Niña, a implementação do Regulamento da União Europeia sobre Desmatamento (EUDR) e as persistentes lacunas de produtividade nas plantações de pequenos produtores. A produção global de óleo de palma bruto (CPO) está projetada em 83 milhões de toneladas métricas em 2026, com a Indonésia mantendo 59% de participação de mercado, apesar das restrições à expansão de área e dos gargalos no programa de replantio (Peremajaan Sawit Rakyat – PSR). A intensificação do consumo doméstico por meio de mandatos de bioenergia gera uma pressão dupla sobre a capacidade de exportação e a estabilidade da renda dos agricultores. As projeções de preços variam entre USD 1.050 e 1.200 por tonelada métrica, influenciadas por políticas energéticas, tensões geopolíticas e custos de conformidade com exigências de sustentabilidade. Os achados temáticos revelam que o bem-estar dos pequenos produtores — medido pelos Termos de Troca da Agricultura (NTP) e por índices multidimensionais de bem-estar — permanece vulnerável à volatilidade de preços, ao acesso limitado aos mercados e às barreiras à certificação. Propõem-se seis recomendações de políticas baseadas em evidências, priorizando a aceleração do replantio (meta de 200.000 ha/ano), mecanismos de estabilização de preços, vias subsidiadas para certificação ISPO, fortalecimento dos serviços de extensão rural, sistemas abrangentes de monitoramento do bem-estar e estratégias de diversificação de renda. Esta revisão contribui para a literatura em economia agrícola ao integrar correntes de pesquisa fragmentadas e oferecer subsídios acionáveis para formuladores de políticas que atuam no nexo entre sustentabilidade e desenvolvimento em economias dependentes de commodities.

Palavras-chave: Perspectivas do Óleo de Palma. Bem-Estar dos Pequenos Produtores. Política de Biodiesel. Certificação ISPO. Programa de Replantio. Conformidade com o EUDR. Termos de Troca da Agricultura. Intensificação Sustentável. Agricultura Indonésia. Adaptação Climática.

RESUMEN
Esta revisión cualitativa de la literatura examina las perspectivas del sector del aceite de palma de Indonesia en 2026, con especial énfasis en el bienestar de los pequeños productores y en la interacción entre las dinámicas de producción, los impulsores de políticas públicas y los imperativos de sostenibilidad. El estudio sintetiza evidencias del IPOSS Palm Oil Outlook 2026, de publicaciones científicas (2020–2025) y de informes gubernamentales y análisis sectoriales. Se identifican determinantes críticos que configuran la trayectoria del sector, entre ellos la expansión del mandato de biodiésel (B40–B50), la variabilidad climática asociada a los ciclos El Niño–La Niña, la implementación del Reglamento de la Unión Europea sobre Deforestación (EUDR) y las persistentes brechas de productividad en las plantaciones de pequeños productores. La producción mundial de aceite de palma crudo (CPO) se proyecta en 83 millones de toneladas métricas en 2026, manteniendo Indonesia una participación de mercado del 59%, a pesar de las restricciones a la expansión de la superficie cultivada y de los cuellos de botella en el programa de replantación (Peremajaan Sawit Rakyat – PSR). La intensificación del consumo interno mediante mandatos de bioenergía genera una doble presión sobre la capacidad exportadora y la estabilidad de los ingresos de los agricultores. Las proyecciones de precios oscilan entre USD 1.050 y 1.200 por tonelada métrica, influenciadas por las políticas energéticas, las tensiones geopolíticas y los costos de cumplimiento de los requisitos de sostenibilidad. Los hallazgos temáticos

revelan que el bienestar de los pequeños productores —medido a través de los Términos de Intercambio Agrícola (NTP) y de índices multidimensionales de bienestar— sigue siendo vulnerable a la volatilidad de precios, al acceso limitado a los mercados y a las barreras de certificación. Se proponen seis recomendaciones de política basadas en evidencia, priorizando la aceleración de la replantación (objetivo de 200.000 ha/año), mecanismos de estabilización de precios, rutas subsidiadas para la certificación ISPO, el fortalecimiento de los servicios de extensión, sistemas integrales de monitoreo del bienestar y estrategias de diversificación de ingresos. Esta revisión contribuye a la literatura de economía agrícola al sintetizar corrientes de investigación fragmentadas y proporcionar aportes prácticos para los responsables de políticas públicas que enfrentan el nexo entre sostenibilidad y desarrollo en economías dependientes de commodities.

Palabras clave: Perspectivas del Aceite de Palma. Bienestar de los Pequeños Productores. Política de Biodiésel. Certificación ISPO. Programa de Replantación. Cumplimiento del EUDR. Términos de Intercambio Agrícola. Intensificación Sostenible. Agricultura Indonesia. Adaptación Climática.

1 INTRODUCTION

1.1 BACKGROUND

The global palm oil industry stands at a critical juncture as it enters 2026, navigating between escalating production demands, stringent sustainability requirements, and imperative livelihood concerns for millions of smallholder farmers. Palm oil (*Elaeis guineensis*) has emerged as the world's most efficient vegetable oil crop, accounting for approximately 34% of global vegetable oil production despite occupying less than 10% of total oilseed cultivation area. This exceptional land-use efficiency—yielding 4-5 tons per hectare compared to soybean oil (0.5 tons/ha) and rapeseed oil (0.8-1 ton/ha)—has positioned palm oil as an indispensable commodity in global food systems, oleochemical industries, and increasingly, renewable energy sectors(Varqa, 2025).

Indonesia dominates this landscape as the world's largest producer, contributing approximately 59% of global crude palm oil (CPO) supply in 2025, followed by Malaysia at 24%. The sector's strategic importance to Indonesia's economy extends beyond production volumes: in 2024, palm oil and its derivatives contributed 6.5% to national GDP, employed over 16.8 million people directly and indirectly, and generated USD 25.6 billion in export revenues, making it the most significant contributor to Indonesia's agricultural trade surplus. This economic centrality occurs within a complex socio-environmental context in which approximately 40% of the national palm oil area (6.7 million hectares) is managed by smallholder farmers, whose productivity levels (2-3.5 tons CPO/ha/year) lag significantly behind those of estate operations (4-5 tons/ha)(IPOSS, 2026; Saleh et al., 2021).

Sustainability governance frameworks increasingly shape the contemporary palm oil discourse. The mandatory Indonesian Sustainable Palm Oil (ISPO) certification, effective for all producers by 2025, and the European Union Deforestation Regulation (EUDR), implemented in December 2024 with enforcement beginning in 2025, represent paradigmatic shifts toward traceability-intensive, deforestation-free supply chains. Simultaneously, Indonesia's aggressive bioenergy mandates—progressing from B30 (2019) to B40 (2025) and targeting B50 by mid-2026—are fundamentally restructuring domestic consumption patterns, with non-food utilization projected to reach 39% of total palm oil allocation by 2026(Halimatussadiah et al., 2021).

1.2 RESEARCH URGENCY

Three interconnected developments underscore the urgency of examining the 2026 palm oil outlook through a welfare-centered lens. First, the biodiesel mandate escalation creates unprecedented domestic absorption pressures. The B40 implementation in 2025

already consumed an additional 2 million tons of CPO; the projected B50 transition in 2026 will require a further 2.2 million tons, collectively absorbing approximately 15-17% of national production. While this policy achieves energy security objectives—reducing diesel imports and supporting Indonesia's Nationally Determined Contributions (NDC) climate commitments—it simultaneously constrains export volumes. It intensifies competition between food and fuel applications, with direct implications for global markets and domestic price dynamics(Sahara et al., 2022).

Second, smallholder farmers face mounting certification and compliance pressures that threaten their market participation. ISPO certification, while improving sustainability credentials, imposes substantial documentation, traceability, and agronomic practice requirements that many independent smallholders—who constitute 95% of smallholder farmers—struggle to meet without external support. The EUDR further compounds these challenges by mandating geolocation data and deforestation-free proof since December 2020, requirements that smallholders with unclear land tenure, fragmented plots, and limited technical capacity find particularly onerous. Early evidence suggests these regulations risk marginalizing rather than empowering smallholders, potentially excluding up to 60% from certified supply chains(Hartono, 2024, 2025).

Third, the sector confronts a looming productivity crisis rooted in aging plantations and inadequate replanting rates. Approximately 3.5 million hectares of Indonesia's palm area comprises trees exceeding 20 years of age—beyond their productive prime—yet annual replanting achievements reach only 30,000-50,000 hectares against targets of 180,000-200,000 hectares. This replanting deficit, combined with climate variability from ENSO (El Niño-Southern Oscillation) cycles, which can reduce yields by 6-10%, threatens to constrain production growth precisely when domestic and global demand intensifies. For smallholder farmers, replanting poses acute welfare challenges: the 3-5 year non-productive period during crop establishment eliminates cash flow, and capital requirements (estimated USD 2,500-3,500 per hectare) exceed most farmers' liquidity(Haniff et al., 2016).

1.3 RESEARCH OBJECTIVES

Against this backdrop, this qualitative literature review pursues three primary objectives. First, we synthesize current scholarly and practitioner knowledge on the palm oil sector outlook for 2026, integrating global supply-demand projections, price forecasts, and policy trajectory analyses to construct a comprehensive narrative of anticipated developments. Second, we systematically identify and analyze key drivers and constraints affecting sector performance, with particular attention to their differentiated impacts on

smallholder versus estate operations, and on welfare outcomes measured through Farmers Terms of Trade (NTP/FTT), income stability, and multidimensional welfare indices. Third, we formulate evidence-based policy recommendations specifically targeting the enhancement of smallholder welfare within the context of the sustainability transition and productivity imperatives(Maria et al., 2023).

This review addresses a critical gap in existing literature: while numerous studies examine discrete aspects of the palm oil sector—sustainability certification, biodiesel economics, smallholder productivity, climate impacts—few integrate these dimensions to assess their collective implications for the 2026 outlook and farmer welfare. By adopting a qualitative literature review methodology that enables thematic synthesis across diverse knowledge sources, we provide policymakers, industry stakeholders, and development practitioners with actionable intelligence for navigating the sector's complex transformation.

2 LITERATURE REVIEW

2.1 THEORETICAL FOUNDATIONS OF PALM OIL ECONOMICS

The economic dynamics of the palm oil sector are best understood through the integration of three theoretical frameworks. **Agricultural commodity market theory** posits that palm oil prices are determined by global supply and demand, with elasticities influenced by substitutability with competing vegetable oils (soybean, rapeseed, sunflower), crude petroleum prices (given biodiesel applications), and speculation in futures markets. Recent literature emphasizes the growing importance of policy-induced demand—particularly biofuel mandates—which creates relatively inelastic demand segments that stabilize floor prices but also transmit policy uncertainty into market volatility(Khatiwada et al., 2021).

Sustainable agricultural intensification (SAI) frameworks provide conceptual grounding for addressing the dual imperative of increasing productivity while minimizing environmental externalities. SAI theory advocates for closing yield gaps through improved agronomic practices, technological adoption, and institutional support rather than land expansion. In palm oil contexts, this translates to replanting with high-yielding varieties, precision fertilizer application, integrated pest management, and optimal harvesting frequencies—interventions that can potentially double smallholder yields from current 2-3 tons/ha to 6-8 tons/ha. However, as Byerlee et al. (2017) note, smallholder intensification requires simultaneous attention to market access, input affordability, technical knowledge, and risk management mechanisms that standard SAI models often overlook(Rahutomo et al., 2023, 2025b).

The **dual-sector development model, originating with Lewis (1954)** and adapted by contemporary rural development scholars, explains **the persistent productivity and welfare gaps between the** smallholder and estate sectors. Smallholders face structural disadvantages: fragmented landholdings limiting economies of scale, restricted access to credit and quality inputs, weak bargaining power in price negotiations with mills, and limited technical extension support. Information asymmetries exacerbate these constraints—smallholders often lack real-time market price data, best-practice knowledge, and certification requirements—creating power imbalances throughout the value chain (Dodson et al., 2019).

2.2 GLOBAL PALM OIL PRODUCTION AND SUPPLY CHAIN DYNAMICS

Global palm oil production exhibits extreme geographic concentration, with Indonesia and Malaysia collectively accounting for 83-85% of world output. This duopoly structure creates unique market dynamics: supply disruptions in either country disproportionately affect global availability and prices. At the same time, their production policies (land-use regulations, biodiesel mandates) effectively set global market conditions. Production forecasts for 2026 project global CPO output at 83 million metric tons, representing 2.7% growth from 2025's estimated 80.8 million tons. This modest expansion reflects slowing area growth due to moratoriums on new plantations in both Indonesia (Presidential Instruction No. 8/2018) and Malaysia, and a shifting emphasis toward productivity enhancement rather than land expansion (Zhao et al., 2023).

Climate variability, particularly ENSO cycles, has emerged as a critical determinant of production in recent literature. Historical analysis reveals that strong El Niño events (characterized by rainfall below 100mm/month for extended periods) reduce Fresh Fruit Bunch (FFB) yields by 6-10% with lag effects appearing 10-24 months post-event due to palm physiological responses (inflorescence abortion, altered sex ratios). Conversely, La Niña events with excessive rainfall (>300mm/month) also depress yields by 4-6% through waterlogging and the proliferation of root diseases. The 2023-2024 El Niño significantly impacted 2024-2025 production, but projections for 2026 indicate neutral to mild La Niña conditions, suggesting improved growing conditions and potential yield recovery(Kamil & Omar, 2016, 2017).

Technological frontiers in palm oil production increasingly center on precision agriculture, genetic improvement, and mechanization. Adoption of remote sensing for precision fertilization, drone-based pest monitoring, and digital traceability platforms offers pathways to enhance yields while meeting sustainability standards. However, technology diffusion remains highly uneven: while estates rapidly adopt innovations, smallholder uptake

is constrained by capital requirements, digital literacy, and inadequate extension services(Reich & Musshoff, 2025).

2.3 CONSUMPTION PATTERNS AND DEMAND DRIVERS

Global palm oil consumption is projected to reach 85.9 million tons in 2025, rising to approximately 87-88 million tons in 2026, driven by fundamental shifts in utilization patterns. The food-versus-non-food allocation ratio has evolved from 70:30 in 2015 to approximately 60:40 in 2026, reflecting the global expansion of bioenergy policy. Major consuming regions exhibit distinct dynamics: India remains the largest importer (8-9 million tons annually), driven by population growth and rising incomes, with palm oil preferred for its affordability relative to soybean and sunflower oils. China's consumption (7-8 million tons) is growing more slowly as domestic oilseed production intensifies, while European Union demand contracts due to EUDR restrictions and sustainability concerns(IPOSS, 2026; Mai, 2024).

Bioenergy mandates constitute the most dynamic demand component. Indonesia's B50 program will absorb 13-15 million tons of CPO domestically by 2026, compared to 8 million tons under B30 in 2020. Malaysia similarly targets biofuel expansion, while regional programs in the Philippines, Thailand, and Colombia contribute incremental demand. The Sustainable Aviation Fuel (SAF) segment, though nascent, presents longer-term demand potential, with palm-based biojet fuel certified for commercial aviation and multiple Indonesian producers investing in capacity. However, SAF adoption faces headwinds from EUDR restrictions on feedstock sourcing, which limit access to the European market (Hicks, 2025).

Emerging market demand in Africa and South Asia drives consumption growth projections. Africa's palm oil imports are forecast to reach 6-7 million tons by 2026, up from 5.2 million in 2023, fueled by rapid urbanization, changing dietary patterns, and limited domestic production capacity. Pakistan's imports are similarly projected to grow 3.4% annually through 2026 due to stagnant domestic oilseed production and widening supply-demand gaps(IPOSS, 2026; Varqa, 2025).

2.4 SUSTAINABILITY GOVERNANCE AND CERTIFICATION

The palm oil sustainability governance landscape has transformed dramatically over the past five years, transitioning from voluntary corporate commitments toward mandatory regulatory frameworks. Indonesia's ISPO certification, revised in 2020 (Presidential Regulation No. 44/2020) and mandated for all producers by 2025, encompasses seven principles: legal compliance, management systems, environmental protection, labor rights, social responsibility, business sustainability, and continuous improvement. As of 2024,

approximately 30% of Indonesia's total palm oil production is ISPO-certified, with estate certification rates near 60% but independent smallholder certification below 15%(Judijanto, 2025b).

Empirical evidence on ISPO's economic impacts is mixed. Studies report that ISPO-certified smallholders achieve 12-18% higher FFB prices and 82% higher productivity than non-certified peers, attributable to improved agronomic practices, better market access, and mill preferences for certified suppliers. However, certification costs—estimated at USD 50-150 per hectare for group certification—combined with documentation burdens, create formidable barriers for resource-constrained smallholders. Group certification models facilitated by cooperatives or NGOs show promise in reducing per-farmer costs and providing technical assistance, yet adoption remains limited(Erdi et al., 2025).

The EUDR, initially planned to take effect in December 2024, represents the most stringent market-access regulation to date, prohibiting palm oil products derived from land deforested after December 2020 from entering EU markets. Operators must provide geolocation coordinates, conduct due diligence assessments, and demonstrate compliance with the laws of the origin country. For Indonesia, where EU exports constitute 8-12% of total volumes, EUDR implications extend beyond direct market losses: they establish it precedent for other importing regions and incentivize supply chain restructuring toward larger, certified producers, at the potential expense of smallholder inclusion. Critiques emphasize EUDR's disproportionate burden on smallholders who lack GPS equipment, land title documentation, and the technical expertise to generate the required evidence, particularly in remote areas (Rochmyaningsih, 2024).

2.5 SMALLHOLDER FARMERS AND WELFARE ECONOMICS

Smallholder farmers in Indonesia's palm oil sector comprise three categories: **plasma farmers** linked to estates through government schemes (5-10% of smallholders), **independent contract farmers** with informal mill relationships (10-15%), and **independent smallholders** operating autonomously (75-80%). This heterogeneity generates significant welfare disparities. Plasma farmers benefit from technical support, input credit, and guaranteed FFB purchases at regulated prices, achieving average yields of 3.5-4 tons CPO/ha. Independent smallholders, conversely, average 2-3 tons/ha, face price discrimination from middlemen who pay 15-30% below reference prices, and bear full production risks without support systems(Sokoastri et al., 2019).

Farmers' Terms of Trade (NTP/FTT) serves as Indonesia's primary agricultural welfare indicator, calculated as the ratio of the price indices for products sold (output

prices) to the price indices for inputs purchased (input costs plus household consumption). NTP values above 100 indicate improving welfare; below 100 signals declining purchasing power. The national NTP for palm oil farmers averaged 108-112 during 2020-2024, higher than for food crop farmers (95-100) and livestock farmers (98-102), reflecting palm oil's relatively favorable price trends. However, regional variations are substantial: palm-growing provinces like Riau and Jambi recorded NTP of 115-125, while marginal areas showed NTP below 100, indicating welfare heterogeneity even within the sector(Arintoko et al., 2024).

Recent literature emphasizes multidimensional welfare measurement beyond income metrics, incorporating education access, health outcomes, food security, housing quality, and social protection. Longitudinal studies document that palm oil cultivation significantly improves household welfare compared to alternative livelihoods, with palm-growing villages showing 20-30% higher welfare indices than non-palm communities. However, these gains concentrate among farmers with sufficient land (>3 hectares), access to capital for optimal input use, and market connectivity; marginal farmers (1-2 hectares) often remain near the poverty line despite palm cultivation (Maridjo & Ignasiak-Szulc, 2023).

Income diversification emerges as a critical determinant of welfare. Farmers depending solely on palm income face acute vulnerability to price volatility and yield fluctuations; those integrating palm with rubber, livestock, or off-farm employment achieve more stable livelihoods. Intercropping during palm establishment phases (immature period) and underplanting during replanting offer pathways to maintain cash flow. Yet, adoption rates remain low due to technical complexity and limited extension guidance(Yuda & Kühner, 2023).

2.6 POLICY LANDSCAPE AND INSTITUTIONAL FRAMEWORKS

Indonesia's palm oil policy architecture reflects competing objectives: maximizing export revenues, ensuring affordable domestic supply, promoting sustainability, and enhancing farmer welfare. The **downstreaming (*hilirisasi*)** policy, intensified since 2020, prohibits raw CPO exports (with limited quotas) to incentivize domestic processing into refined products, oleochemicals, and biodiesel. This strategy aims to capture value-added margins and foster industrialization, with some success: refined palm oil product exports grew from 40% of total exports in 2015 to 65% in 2024. However, critics argue that *hilirisasi* creates artificial market distortions, limits smallholder access to international prices, and concentrates benefits among large integrated companies(Lestari et al., 2025).

Price stabilization mechanisms include reference price systems (*Harga Acuan*), export levies (*Badan Pengelola Dana Perkebunan*/BPDP), and domestic market obligations

(DMO), which require exporters to allocate portions to domestic markets. The export levy, set at USD 200/MT for CPO in 2022, funds biodiesel subsidies when CPO prices exceed diesel prices, ensuring B30-B50 implementation remains economically viable. This mechanism, while supporting biofuel programs, reduces farmer FFB prices by 8-12% as mills deduct levy costs, creating welfare tensions(Adiatma & Prasojo, 2021).

Replanting programs (PSR) receive policy priority given productivity imperatives, with government targets of 180,000 hectares annually through 2030. However, implementation lags severely: the 2020-2024 average achievement reached only 35,000 ha/year, reflecting smallholder reluctance due to income losses during 3-5-year non-productive periods, inadequate subsidy amounts (covering ~40% of total costs), and bureaucratic delays in fund disbursement. Successful PSR models involve partnerships between smallholders, cooperatives, mills, and financial institutions, providing advance payments, technical assistance, and intercropping support during replanting—yet these remain pilots rather than mainstream(Ridani et al., 2023).

International policy coordination focuses on market access negotiations and the harmonization of sustainability standards. Indonesia actively engages in WTO dispute mechanisms and bilateral dialogues to counter perceived discriminatory regulations, such as EUDR. The government advocates recognizing ISPO as equivalent to European standards and exempting smallholders from geolocation requirements, arguing that capability-building rather than exclusion better serves sustainability objectives (Jong, 2025).

3 METHODOLOGY

3.1 RESEARCH DESIGN: QUALITATIVE LITERATURE REVIEW

This study employs a **qualitative literature review** methodology, distinct from systematic reviews in its interpretive flexibility and narrative synthesis approach. While systematic reviews prioritize exhaustive searching and statistical meta-analysis of homogeneous empirical studies, qualitative reviews accommodate diverse source types—scholarly articles, policy reports, industry analyses—and enable the thematic integration of heterogeneous evidence suited to complex, multi-stakeholder phenomena like the palm oil sector outlook (IPOSS, 2026). This methodological choice aligns with our objectives to synthesize fragmented knowledge across disciplines (agricultural economics, environmental science, development studies, policy analysis) and generate actionable policy insights rather than effect-size estimates (Barisaux et al., 2024).

The review framework adapts elements of scoping review methodology, particularly its emphasis on mapping knowledge landscapes, identifying gaps, and clarifying key concepts.

We prioritize breadth of coverage across global production dynamics, consumption trends, policy drivers, sustainability governance, and welfare outcomes, ensuring comprehensive representation of factors shaping the 2026 outlook. The thematic analysis strategy guides our synthesis, involving iterative coding of sources to identify recurring patterns, conflicting evidence, and emergent themes that structure our findings (Astari et al., 2025).

3.2 DATA SOURCES AND SELECTION CRITERIA

Primary sources comprise peer-reviewed journal articles indexed in the Scopus and Web of Science databases, selected for their rigorous peer-review processes and adherence to international research standards. Inclusion criteria specify:

- Publication period: January 2020 to December 2025 (ensuring currency while capturing pre-pandemic baseline through post-pandemic recovery)
- Geographic focus: Indonesia, Malaysia, and global palm oil systems
- Topical relevance: palm oil production, consumption, pricing, sustainability, farmer welfare, biodiesel policy, certification impacts
- Methodological quality: empirical studies with transparent methods; conceptual papers from recognized scholars

We identified 68 Scopus/WoS-indexed articles through database searches, supplemented by citation tracking of seminal works(Abubakar et al., 2021).

Secondary sources include authoritative grey literature essential for policy and market analysis contexts:

- Government agencies (such as BPS Indonesia, Ministry of Agriculture, BMKG)
- International organizations (such as USDA, FAO-OECD, World Bank, IMF, IEA)
- Industry agency or associations (such as GAPKI, MPOA, MPOB)
- NGOs and research institutes (such as WRI, CIFOR, Solidaridad)
- Market intelligence firms (such as Fastmarkets, MARC Ratings)

Secondary sources provide indispensable data (production forecasts, price projections, policy announcements) unavailable in the peer-reviewed literature due to publication lags. At the same time, government reports offer official statistics and policy frameworks (Wong et al., 2025).

Exclusion criteria: purely technical agronomic studies without economic/welfare dimensions; palm oil health/nutrition debates peripheral to the sector outlook; editorials/opinion pieces lacking empirical grounding; sources in languages other than English or Indonesian; expired forecasts superseded by recent data.

3.3 SEARCH STRATEGY AND KEYWORDS

Database searches employed Boolean combinations of core terms across three thematic clusters:

Cluster 1 (Commodity/Sector): "palm oil" OR "crude palm oil" OR "CPO" OR "oil palm" OR "*Elaeis guineensis*."

Cluster 2 (Geographic): "Indonesia" OR "Malaysia" OR "Southeast Asia" OR "global" OR "international."

Cluster 3 (Thematic): "outlook" OR "forecast" OR "projection" OR "productivity" OR "yield" OR "smallholder" OR "farmers welfare" OR "biodiesel" OR "biofuel" OR "sustainability" OR "certification" OR "ISPO" OR "RSPO" OR "EUDR" OR "deforestation" OR "climate" OR "El Nino" OR "replanting" OR "rejuvenation" OR "price" OR "policy"

Searches in Scopus and Web of Science applied filters: peer-reviewed articles, English/Indonesian language, publication years 2020-2025, subject areas Agricultural & Biological Sciences, Environmental Science, Economics/Econometrics, Social Sciences. This yielded 287 initial results, reduced to 68 after abstract screening for relevance. Google Scholar was used to supplement database searches for grey literature, using simplified keyword combinations and filtering by publication type (Moeis et al., 2020).

3.4 DATA EXTRACTION AND SYNTHESIS

Thematic coding framework structured data extraction, with six primary codes corresponding to outline sections: (1) Global Supply Dynamics, (2) Demand Drivers, (3) Price Outlook, (4) Sustainability Governance, (5) Smallholder Welfare, (6) Policy Frameworks. Sub-codes captured specific concepts (e.g., replanting barriers, ISPO impacts, EUDR compliance challenges, NTP trends). Two reviewers independently coded sources, with discrepancies resolved through discussion(Bastidas-Orrego et al., 2023).

Quality assessment applied differentiated criteria by source type. Peer-reviewed articles were evaluated on: research design rigor, sample representativeness, analytical method appropriateness, and transparency of limitations. Government and international organization reports were assessed on: data source credibility, methodological documentation, and independence from vested interests. Industry analyses were triangulated with academic sources to identify potential biases (Koutsos et al., 2019).

Narrative synthesis integrated coded evidence thematically rather than through meta-analysis. For each theme, we identified consensus findings, noted divergent evidence and explained heterogeneity, and highlighted knowledge gaps. Contradictory evidence (e.g., varying ISPO impact assessments) prompted a contextual analysis of study conditions

(region, farmer type, certification model), which explained the discrepancies. Synthesis prioritized actionable insights, particularly by translating academic findings into policy-relevant recommendations (Barisaux et al., 2024).

3.5 LIMITATIONS

This review acknowledges several limitations. **Temporal scope** constraints mean forecasts for 2026 inherently contain uncertainty, subject to unforeseen events (geopolitical shocks, extreme weather, policy reversals). We mitigate this by using scenario thinking and appropriately qualifying projections. **Language and geographic bias** may underrepresent non-Anglophone research and local knowledge, though inclusion of Indonesian-language government reports partially addresses this. **Publication lag** means most peer-reviewed articles reflect data from 2023 or earlier; we compensate by prioritizing recent grey literature for current developments. **Qualitative-quantitative trade-offs** mean we forego the statistical precision of meta-analyses for broader thematic integration, which is appropriate for our exploratory, synthesis-oriented objectives. Finally, our **smallholder welfare focus** may underweight estate-sector perspectives; this reflects a deliberate prioritization of welfare concerns, but readers should recognize the incomplete representation of industry viewpoints.

4 RESULTS: THEMATIC FINDINGS ON PALM OIL OUTLOOK 2026

4.1 GLOBAL SUPPLY-DEMAND BALANCE PROJECTIONS

Global CPO production is forecast to reach **83 million metric tons in 2026**, representing 2.7% growth from 2025's 80.8 million tons. This recovery trajectory follows the 2024 production dip caused by 2023-2024 El Niño impacts, with meteorological forecasts suggesting neutral to weak La Niña conditions in 2025-2026 supporting yield normalization. Indonesia's output is projected at **48-49 million tons** (59% global share), while Malaysia targets **19-20 million tons** (24%). Other producers—Thailand (3.5 million tons), Colombia (1.8 million tons), Nigeria (1.2 million tons)—contribute marginally, constrained by infrastructure limitations, aging plantations, and climate vulnerabilities(IPOSS, 2026; Kamil & Omar, 2016, 2017).

Demand projections indicate global consumption of **87-88 million tons in 2026**, exceeding production by 4-5 million tons and necessitating stock drawdowns. This tightness reflects intensified domestic absorption in producer countries—Indonesia's B50 mandate alone consumes an incremental 2.2 million tons—and sustained import growth in India (projected 9.2 million tons, +3.5% YoY), Africa (6.8 million tons, +4.2%), and Pakistan (3.6 million tons, +3.4%). Conversely, EU imports continue to decline (2.2 million tons in 2026, -

8% from 2024) due to EUDR constraints and biodiesel policy reversals (Benedict & Heilmayr, 2024; IPOSS, 2026).

Stock-to-use ratios are projected to tighten to **6.8%** in 2026 from 7.2% in 2025, near the critical 7% threshold below which price volatility intensifies. This structural tightness underpins price support but also magnifies supply disruption risks from weather events or policy shocks(IPOSS, 2026; Varqa, 2025).

4.2 PRICE OUTLOOK AND VOLATILITY FACTORS

Baseline price scenarios for 2026 position CPO in the **USD 1,050-1,200 per metric ton** range (FOB Malaysia), reflecting balanced supply-demand fundamentals with upside risks. This represents 5-8% appreciation from 2025 average prices (USD 1,000-1,050/MT) but remains below 2022's peaks (USD 1,400-1,500/MT) driven by Ukraine war-induced vegetable oil shortages. Indonesian domestic prices (CPO Medan) are expected to track global benchmarks, with 3-5% discounts due to export levies and domestic market obligations (IPOSS, 2026; Wong et al., 2025).

Crude oil correlation remains significant, with biodiesel applications creating structural linkages. Brent crude forecasts of USD 75-85/barrel in 2026 (base case) support palm oil demand from biofuel blending programs, as palm biodiesel maintains cost competitiveness versus fossil diesel at these price ratios. However, downside oil price scenarios (USD 60-70/barrel) could weaken biodiesel economics and reduce non-food palm oil demand by 5-8%(IPOSS, 2026; Sahara et al., 2022).

Geopolitical risks constitute key uncertainties. US-China trade tensions, Middle East conflicts affecting shipping routes through the Straits of Malacca and the Suez Canal, and potential supply chain disruptions could generate 10-15% price spikes. Conversely, synchronized global economic slowdowns, reducing demand growth, represent downside risks (Varqa, 2025; Wong et al., 2025).

EUDR compliance costs—estimated at USD 30-50 per ton for certified, traceable palm oil—create two-tier pricing structures, with certified supplies commanding premiums. At the same time, non-compliant volumes face discounts or market exclusion. This fragmentation is projected to gradually reduce non-certified producers' access to premium markets, potentially depressing smallholder prices if they cannot achieve certification (Iswara et al., 2023).

4.3 INDONESIA'S PRODUCTION AND PRODUCTIVITY LANDSCAPE

Indonesia's **16.8 million-hectare** palm area has stagnated since 2019 due to the Presidential moratorium (*Inpres 8/2018*) on new permits for primary forest and peatland conversion. Production growth thus depends entirely on productivity enhancement. Yet, national average yields remain at **3.5 tons CPO/ha/year**, far below the genetic potential of 6-8 tons/ha achieved by well-managed estates. This **yield gap** disproportionately affects smallholders (2-3 tons/ha) due to suboptimal agronomic practices, aged palms, insufficient fertilization, and delayed harvesting(IPOSS, 2026; WWF, 2023).

Approximately **3.5 million hectares (21% of the total area)** comprise palms that are 25 years or older and require urgent replanting. However, 2020-2024 achievements averaged only **35,000-50,000 hectares annually** against targets of 180,000 hectares, reflecting smallholder reluctance (due to income loss during non-productive periods), inadequate subsidies (covering only 30-40% of USD 2,500-3,500/ha costs), and bureaucratic delays. This **replanting deficit** threatens production stagnation: modeling by Austin et al. (2023) demonstrates that, absent 4% annual replanting rates, Indonesian production could decline by 15-20% through 2035 despite stable area(Hutajulu, 2023; IPOSS, 2026).

Climate vulnerability compounds productivity challenges. The 2023-2024 El Niño reduced yields in 2024-2025 by 8-12% in affected regions due to water-stress-induced flower abortion. While 2026 projections assume yield recovery under neutral conditions, longer-term climate change scenarios indicate an increasing frequency of extreme ENSO events, necessitating adaptation strategies (irrigation expansion, stress-tolerant varieties, improved soil moisture management) (Fleiss et al., 2017).

4.4 DOMESTIC CONSUMPTION AND POLICY DRIVERS

Indonesia's domestic palm oil consumption is projected at **27.67 million tons in 2026**, comprising **13.5-15 million tons for biodiesel**, **11-12 million tons for food**, and **2-3 million tons for oleochemicals**. The **B50 mandate** implementation by mid-2026 drives a **2.2 million ton incremental increase** over B40 levels, absorbing approximately **30-31% of total national bioenergy production,** compared to 20% under B30 in 2020(Siregar et al., 2024).

This domestic absorption intensification creates a **fundamental structural shift**: Indonesia transitions from a net exporter focused on maximizing export volumes to a domestically-oriented consumer balancing export revenues with energy security and industrial feedstock requirements. Modeling by Dermawan et al. (2022) estimates that B30-B50 escalation would generate 10,000-15,000 direct jobs in biodiesel manufacturing and reduce diesel import bills by USD 3-4 billion annually, thereby achieving macroeconomic

objectives. However, these gains entail trade-offs: **reduced export availability** (projected at 20-21 million tons in 2026 versus 24-25 million tons under B30 scenarios) foregoes an estimated USD 2-3 billion in potential export revenues at prevailing price levels (Siregar et al., 2024).

Food security and the management of cooking oil prices remain politically sensitive. Government cooking oil price caps (HET—*Harga Eceran Tertinggi*) and bulk cooking oil programs aim to protect consumer affordability, periodically requiring subsidized domestic sales that depress farmer FFB prices by 5-10%. The food-fuel competition intensifies during global price surges, as witnessed in 2022, when cooking oil shortages prompted temporary export bans and domestic price interventions (Arumdhani, 2025).

4.5 EXPORT MARKET DYNAMICS AND TRADE POLICIES

India dominates Indonesia's export destinations, absorbing approximately **8.5-9 million tons annually** (40-42% of Indonesian exports), driven by affordability advantages over soybean and sunflower oils and regulatory preferences for palm oil in food manufacturing. Indian import demand is growing at 3-4% annually, supported by population expansion and rising per capita consumption, providing stable market access for Indonesian producers. However, India's domestic oilseed production initiatives and periodic import tariff adjustments (ranging from 0-15% on crude palm oil to 20-30% on refined products) introduce volatility (IPOSS, 2026; Varqa, 2025).

China remains a significant but mature market, importing **5.5-6 million tons** with minimal growth projected for 2026 as domestic rapeseed and soybean oil production expands. **African markets** represent the fastest-growing segment, with collective imports projected to grow 4-5% annually, reaching **6.8 million tons in 2026**. Nigeria, Egypt, and East African countries drive this expansion through urbanization, growth of the processed food sector, and limited domestic vegetable oil production capacity (IPOSS, 2026; Varqa, 2025).

European Union imports have declined sharply from 3.5 million tons (2018) to a projected **2.2 million tons in 2026**, reflecting EUDR implementation, biodiesel sustainability criteria under RED II/III directives restricting palm-based biofuels, and consumer pressure on retailers. This market contraction eliminates Indonesia's premium-priced European segment, redirecting volumes to Asian and African markets at lower average prices, contributing to **2-3% overall export price erosion**(IPOSS, 2026; Mai, 2024).

4.6 SUSTAINABILITY TRANSITION AND CERTIFICATION PROGRESS

ISPO adoption has accelerated under mandatory compliance deadlines, with **30% of national production certified by the end of 2024** and targets of **50% by 2026**. Estates demonstrate higher certification rates (**55-60%) than** smallholders (**12-15%**), reflecting resource and capability disparities. Group certification models show promise: studies document that cooperative-facilitated ISPO certification enables **50-100 smallholders** per group to achieve certification at **per-farmer costs of USD 25-40**, compared to USD 100-150 for individual certification, while also providing technical training and market linkage benefits(Hartono, 2025; Judijanto, 2025b).

Empirical evidence on **ISPO economic impacts** indicates certified smallholders receive **8-12% FFB price premiums** from mills preferring certified supply, and achieve **15-20% higher yields** through improved practices mandated by standards (optimal fertilizer application, integrated pest management, harvest frequency optimization). However, these benefits accrue primarily to plasma and organized independent smallholders; truly independent farmers without organizational links struggle to access certification pathways(Rahutomo et al., 2023, 2025a).

Deforestation-free supply chain initiatives intensify under EUDR and corporate commitments. Analysis of RSPO-certified mill supply sheds reveals **independent smallholders contributed 33% of regional palm area but only 7% of certified supply**, indicating severe exclusion from sustainability-premium markets. Traceability systems linking individual smallholder plots to final products remain technologically and institutionally challenging, requiring GPS mapping, digital record-keeping, and third-party verification that exceed most smallholder capacities(Eggen et al., 2024; Ekaputri et al., 2025).

4.7 SMALLHOLDER FARMERS WELFARE OUTLOOK

Income projections under baseline price scenarios (USD 1,050-1,200/MT CPO) translate to smallholder FFB prices of **IDR 1,800-2,200 per kilogram** (approximately USD 0.12-0.15/kg), assuming standard oil extraction rates (OER) of 20-22% and mill-farmer price transmission of 70-75%. For a typical 3-hectare smallholder farm producing 10-12 tons FFB/ha/year, this yields an annual gross income of IDR 60-80 million (USD 4,000-5,300), placing farmers at 2-2.5 times the provincial minimum wage in major palm-growing regions. However, net income after production costs (fertilizer, hired labor, transport) and household consumption needs yields disposable incomes of IDR 35-50 million (USD 2,300-3,300), barely sufficient for a lower-middle-income livelihood(Judijanto & Pamungkas, 2024).

Price volatility remains a critical welfare threat. FFB price fluctuations of 20-30% within annual cycles (due to seasonal production patterns, global market swings, and domestic policy changes) create income unpredictability, undermining consumption smoothing and investment capacity. Studies demonstrate that a **10% decline in CPO prices** reduces smallholder FFB prices by approximately **7-8%** due to asymmetric price transmission (price increases transmit faster than decreases), with **elasticity values of 0.7-0.8** indicating inelastic transmission. This asymmetry benefits mills at the farmer's expense during price downturns(Lifianthi et al., 2022).

Farmers' Terms of Trade (NTP) for palm oil farmers averaged 108-115 nationwide in 2024, indicating modest gains in purchasing power. However, regional heterogeneity is pronounced: Riau and Jambi provinces show NTP of **120-135**, while marginal areas like Aceh and West Kalimantan record **95-105**, reflecting differential market access and input cost structures. Projections for 2026 suggest NTP stability in the **110-118 range** under baseline scenarios, but downside risks (input cost inflation, CPO price weakness) could push NTP below 100, signaling welfare deterioration(Asdep Setkab, 2025; IPOSS, 2026).

Multidimensional welfare indicators from longitudinal studies confirm palm-growing households demonstrate **20-30% higher welfare scores** than non-palm counterparts on composite indices incorporating income, education, health, housing, and food security. However, these gains concentrate among farmers with **>3 hectares, organizational membership, and market access**; marginal farmers (<2 hectares, remote locations) show welfare levels **only 5-10% above non-palm households**. Off-farm income diversification correlates strongly with welfare stability: households deriving **30-40% income from non-palm sources** exhibit **15-20% lower income volatility** and better food security than palm-monocrop households(IPOSS, 2026; Roswaldy, 2025).

5 DISCUSSION AND ANALYSIS

5.1 SYNTHESIS OF SUPPLY-SIDE CONSTRAINTS

The convergence of evidence indicates that Indonesia's palm oil sector faces a productivity trilemma: constrained land expansion, inadequate replanting rates, and persistent yield gaps collectively threaten its capacity for production growth. Land availability restrictions—imposed through moratoriums and sustainability commitments—represent rational environmental policy, yet without compensatory productivity enhancements, they impose production ceilings. The replanting deficit emerges as the most acute bottleneck: at current 40,000 ha/year rates, addressing the 3.5 million-hectare backlog would take 87 years, during which aging plantations would progressively lose productivity. This pace is

fundamentally incompatible with domestic consumption growth (B50 mandate) and export commitments(Zhao et al., 2023).

Climate vulnerability compounds supply uncertainties. While the 2026 outlook appears favorable due to neutral ENSO conditions, medium-term projections (2027-2030) indicate **70% probability of at least one moderate-to-strong El Niño event**, potentially reducing production by 3-5 million tons. Adaptation strategies—drought-resistant varieties, irrigation infrastructure, soil moisture management—require **5-10 year lead times** for development and deployment, yet receive inadequate research and development funding and extension support(Kamil et al., 2024).

Smallholder productivity gaps, while widely documented, reflect multidimensional constraints: capital limitations that prevent optimal fertilization (smallholders apply 60-70% of recommended NPK rates), knowledge deficits in precision agriculture, delayed harvesting that reduces oil content by 15-20%, and suboptimal planting densities. Addressing these gaps demands integrated interventions—technical training, affordable credit, input supply assurance, and quality seedling access—rather than isolated extension programs that current systems provide (Rahman et al., 2025).

5.2 DEMAND-SIDE TRANSFORMATIONS

The biodiesel mandate's escalation from B30 to B50 within 5 years represents an unprecedented velocity of energy transition policy, absorbing **7 million additional tons of CPO annually** (equivalent to 35% of 2020 exports). While achieving energy security and climate objectives, this policy generates several unintended consequences. First, it **reduces price transmission** from global markets to domestic farmers. During periods when international CPO prices spike, Indonesian farmers benefit less because domestic mills procure volumes for subsidized biodiesel at capped prices. Second, it creates **strategic vulnerabilities**: domestic production shortfalls would require biodiesel mandate reductions (undermining energy security) or CPO imports (contradicting producer-country status), both politically unpalatable (Zafriana et al., 2021).

The food-fuel competition manifests acutely during supply disruptions. The 2022 cooking oil crisis, when the B30 mandate combined with the export surge depleted domestic stocks, necessitated emergency export bans and bulk oil subsidy programs costing **IDR 15 trillion (USD 1 billion)**. Projections suggest **B50 leaves only a 2-3 million ton buffer** above minimum domestic food requirements; weather-induced production shortfalls of 5-10% would immediately trigger similar crises(Arumdhani, 2025; IPOSS, 2026).

Demand diversification toward Africa and South Asia offers strategic market reorientation for European access contracts. However, these markets operate on narrower margins: African importers are highly price-sensitive, paying **USD 30-50/ton less** than European buyers, while credit risk and shipping costs are higher. This margin compression transfers economic benefits from producers to consumers, potentially reducing farmer welfare by 5-7% relative **to pre-EUDR market structures**(Mai, 2024).

5.3 POLICY COHERENCE AND INSTITUTIONAL CHALLENGES

Indonesia's palm oil governance is characterized by policy fragmentation across multiple ministries, with overlapping and sometimes conflicting mandates. Replanting programs exemplify coordination failures: One agency provides planting subsidies, but others may restrict land use; one institution adjudicates tenure, while financing requires coordination with banks. This institutional complexity generates **18-24 month delays** between smallholder applications and fund receipt, during which time farmers often abandon replanting plans (Judijanto, 2025a; Ridani et al., 2023).

The **downstreaming policy**, while increasing value addition, creates distortions disadvantaging farmers. Export restrictions depress domestic CPO prices **8-12% below export parity**, transferring rents from farmers to refiners and oleochemical manufacturers. Analysis suggests that **smallholders lose an estimated IDR 200-300 per kilogram of FFB (USD 0.013-0.020) due to downstream-induced price depression, aggregating to USD 400-600 million annually in foregone farmer income** (Lestari et al., 2025).

The ISPO certification policy, despite its mandatory status, lacks enforcement mechanisms and farmer support infrastructure. Only **3 of 34 provinces** have fully operationalized Provincial ISPO Commissions responsible for certifying independent smallholders; technical assistance programs reach fewer than **20% of target farmers**. Consequently, the 2025 deadline will likely result in selective enforcement against large producers while smallholders receive de facto exemptions, undermining the credibility and market recognition of ISPO (Judijanto, 2025b, 2025c).

5.4 FARMERS WELFARE ENHANCEMENT PATHWAYS

The welfare literature converges on **productivity improvement as the primary driver of welfare: a 1-ton/ha yield increase translates into approximately IDR 10-15 million (USD 650-1,000) in additional annual income** per 3-hectare farm, a **25-35% income boost**. This effect dominates price impacts—a **10% CPO price increase** generates only **a 7-8% increase in farmer income** due to price transmission inefficiencies. Therefore,

welfare strategies must prioritize yield-enhancing interventions: replanting with high-yield varieties (potential 80-100% yield gains), precision fertilization (30-40% gains), and harvest optimization (15-20% gains)(IPOSS, 2026; Varwasih et al., 2025).

Price stabilization mechanisms demonstrate mixed welfare impacts. Reference price systems provide price floors during downturns, preventing catastrophic income collapses, but also cap prices during boom periods, limiting upside income potential. Studies suggest that farmers prefer moderate price stability with upside flexibility over rigid price controls; price band systems (floor + ceiling) that balance these objectives merit exploration (Judijanto & Pamungkas, 2024).

Access to certification represents a **welfare bifurcation point**: certified smallholders earn **15-20% higher incomes** through premiums and productivity gains, while non-certified farmers face progressive market exclusion and price discounts. This creates urgency for **inclusive certification pathways**: subsidized group certification, mobile certification teams, simplified documentation requirements, and integration with existing farmer organizations (cooperatives, farmer groups)(Erdi et al., 2025; Wibowo et al., 2023).

Income diversification strategies—intercropping during immature/replanting phases, livestock integration, off-farm employment—reduce welfare volatility. Farmers pursuing **diversification strategies achieve 20-30% lower income variance** and maintain consumption during palm income shocks. However, extension services rarely promote diversification, reflecting monoculture bias in training curricula(Prayoga & Harahap, 2025).

5.5 SUSTAINABILITY-ECONOMIC GROWTH NEXUS

The sustainability transition's welfare implications exhibit a **temporal paradox**: short-term costs (certification expenses, compliance investments, market access restrictions) fall on current smallholders, while long-term benefits (market access preservation, premium prices, ecosystem services) accrue over decades and are broadly distributed. This temporal mismatch generates resistance, particularly among aging farmers (average age 50-55 years) facing 5-10-year payback periods that exceed their farming horizons(Reich & Musshoff, 2025).

EUDR's design reveals a **capacity-compliance gap**: requirements appropriate for well-resourced corporations exceed smallholder capabilities, creating de facto exclusion despite formal market access. Studies document that **fewer than 25% of independent smallholders possess land title documents**, **less than 10% can provide GPS coordinates**, and **virtually none maintain multi-year production records** that EUDR due diligence demands. Without substantial capacity-building investments and phased

implementation, EUDR will **exclude 50-70% of smallholders from EU-destined supply chains**(Ekaputri et al., 2025).

Certification's welfare impacts are **conditional on market structure**: in competitive procurement environments where multiple mills compete for supply, certified farmers capture premiums and benefits. However, in monopsony or oligopsony settings where 1-2 mills dominate local catchments, mills appropriate certification benefits through lower FFB prices, leaving farmers with certification costs but minimal gains. This underscores the necessity of **competition policy and farmer bargaining power** as complements to certification initiatives(Judijanto & Pamungkas, 2024).

5.6 CRITICAL ANALYSIS OF 2026 OUTLOOK SCENARIOS

Optimistic scenario (30% probability): Global CPO prices reach **USD 1,150-1,250/MT** due to tighter-than-expected supply (weather disruptions in Malaysia, slower production recovery), robust demand (accelerated biofuel mandates globally, Indian import surge), and geopolitical risk premiums. Indonesian production reaches 49.5 million tons, driven by favorable weather and accelerated replanting, reaching **80,000 ha** in 2025-2026. B50 implementation proceeds smoothly, biodiesel exports commence to regional markets, and ISPO certification reaches **40% coverage**, improving market access. Under this scenario, smallholder NTP reaches **115-120**, with **per capita incomes rising by 12-15%, and poverty rates in palm-growing regions declining by 2-3 percentage points** (IPOSS, 2026; Syahza et al., 2018, 2023).

Pessimistic scenario (25% probability): CPO prices fall to **USD 950-1,050/MT** due to synchronized global economic slowdown reducing demand, oversupply from unexpected production surges, and trade barriers restricting market access. Indonesian production stagnates at **47.5 million tons** due to delayed La Niña effects or pest/disease outbreaks. B50 implementation delays due to biodiesel quality issues or fiscal constraints, leaving excess CPO seeking export markets already saturated. EUDR is strictly enforced, excluding 30-40% of Indonesian exports from the EU. This scenario yields smallholder NTP of **95-100**, income declines of **10-15%**, and emergency policy interventions (export subsidies, domestic price supports) straining government budgets(IPOSS, 2026; Wong et al., 2025).

Most likely scenario (45% probability): Prices settle in **USD 1,050-1,150/MT range**, production reaches **48-48.5 million tons**, B50 implementation occurs by Q3 2026 with moderate teething problems, ISPO coverage reaches **32-35%**, and EUDR disrupts 15-20% of prior EU trade but impacts are partially offset by African market growth. Smallholder welfare remains stable with NTP of **108-112**, modest income growth of **3-5%** in nominal terms (0-2%

real growth after inflation), and persistent productivity and market access challenges. This scenario represents **muddle-through adjustment** rather than transformative change, maintaining status quo welfare levels but failing to address structural vulnerabilities(IPOSS, 2026; Maria et al., 2023).

6 CONCLUSIONS AND POLICY RECOMMENDATIONS

6.1 SUBSTANTIVE CONCLUSIONS

Indonesia's palm oil sector in 2026 will navigate a complex landscape characterized by **moderate production growth (2-3% annually), intensified domestic consumption (B50 mandate absorbing 30% of output), stable but pressured prices (USD 1,050-1,200/MT), and accelerating sustainability transitions (ISPO mandatory, EUDR enforcement)**. This outlook presents both opportunities—continued economic contributions, energy security gains, environmental standard improvements—and challenges—export capacity constraints, smallholder marginalization risks, productivity stagnation threats.

The **biodiesel policy functions as a double-edged instrument**: it achieves energy independence and climate mitigation objectives while simultaneously reducing export revenues by an estimated **USD 2-3 billion annually**, depressing domestic prices by **8-12%**, and creating food security vulnerabilities during supply disruptions. The policy's welfare impacts on smallholders are **ambiguous**: stable domestic demand provides market assurance, but price caps and levy deductions reduce income by **5-10% compared to export parity prices**.

Smallholder productivity is a critical bottleneck constraining sector growth and welfare improvement. The yield gap of **3-5 tons CPO/ha between smallholders and estates** represents the **foregone production of 12-15 million tons annually**, equivalent to Indonesia's entire biodiesel consumption. Closing even half this gap would simultaneously enable export expansion, reduce land pressure, improve farmer incomes by **30-50%**, and enhance global supply security. However, current replanting rates (**30,000-50,000 ha/year versus targets of 180,000 ha/year) and the extension service's** reach (**<20% of smallholders**) are grossly inadequate to realize this potential.

6.2 POLICY RECOMMENDATIONS RELATED TO FARMERS' WELFARE INDEX

6.2.1 Accelerate Replanting Programs (PSR) with Comprehensive Support

Target: Increase annual replanting achievements to **200,000 hectares by 2027**, prioritizing smallholder plantations exceeding 25 years of age (3.5 million hectares total).

Instruments:

- **Financial support enhancement:** Increase per-hectare subsidies from current **IDR 25 million to IDR 40 million (USD 1,650 to USD 2,650)**, covering 70-80% of establishment costs versus the current 30-40% coverage.
- **Income replacement mechanism:** Provide transitional cash transfers of **IDR 30-40 million over 4 years** (USD 2,000-2,650 annually) to offset income loss during the non-productive period, conditioned on verified replanting implementation.
- **Intercropping promotion:** Technical assistance and seedling subsidies for intercropping with short-cycle crops (cassava, pineapple, vegetables) during the immature phase, generating **IDR 15-25 million/ha/year interim income**.
- **Streamlined disbursement:** Establish one-stop-shop district-level PSR desks consolidating application, verification, and payment functions, reducing processing time from **18-24 months to 3-6 months**.

Expected Impact: Yield improvements of **2-3 tons CPO/ha on replanted areas** translate to **additional IDR 12-18 million annual income per 3-hectare farm (USD 800-1,200)**, improving Farmers Welfare Index scores by **15-25% within 6-8 years** post-replanting. Aggregate production gains of **2-3 million tons of CPO by 2030 would offset increases in biodiesel consumption** and restore export capacity.

6.2.2 Strengthen Price Floor Mechanisms and Farmer Bargaining Power

Policy Instrument: Implement **dynamic reference price systems** linking FFB prices to CPO spot prices with **transparent formulas adjusted weekly**, replacing current opaque provincial team determinations susceptible to mill capture.

Implementation:

- **Price band system:** Establish FFB price floors at **70-75% of CPO price** (adjusted for OER 20-22% and processing costs), with ceiling prices at **85-90% during supply scarcity**, balancing farmer income protection with mill viability.
- **Digital price platforms:** Deploy mobile applications providing real-time CPO prices, reference FFB calculations, and mill gate prices, empowering farmers with market information to negotiate effectively.
- **Cooperative marketing:** Support smallholder cooperative establishment for collective FFB marketing, aggregating volumes to negotiate directly with mills and eliminating middleman margins of **15-30%**.

Coordination: Local government institutions enforce reference price compliance through spot inspections and penalties (license suspensions) for mills that systematically underpay; establish farmer hotlines for reporting price violations.

Expected Impact: Eliminating middleman margins could increase farmer receipts by **IDR 150-250/kg FFB (USD 0.010-0.017)**, totaling IDR 5-8 million in **additional annual income per 3-hectare farm (USD 330-530)**. Reducing volatility by 20-30% enhances consumption smoothing and investment capacity, improving welfare index stability.

6.2.3 Facilitate ISPO Certification for Smallholders Through Inclusive Pathways

Approach: Transition from individual to **group certification models** facilitated by cooperatives, farmer groups, or NGOs, reducing per-farmer costs by **60-75%** (from USD 100-150 to USD 25-40).

Support Mechanisms:

- **Certification subsidies:** Government grants covering **50-70% of group certification costs**, with remaining costs shared among members or advanced by mills with payback through FFB price deductions over 2-3 years.
- **Technical assistance programs:** Deploy mobile certification teams conducting on-site training, documentation support, and pre-audit assistance, targeting **50,000 smallholders annually** through 2030.
- **Simplified standards:** Develop **ISPO-Smallholder** tier with proportionate requirements reflecting smallholder capacities (e.g., GPS coordinates at cooperative level rather than individual plots, simplified record-keeping formats), maintaining core sustainability principles while reducing compliance burden.

Justification: ISPO certification provides dual benefits: **8-12% FFB price premiums** from mills preferring certified supply, and **15-20% yield improvements** through mandated best practices (optimal fertilization, IPM, harvest timing), cumulatively increasing farmer incomes by **25-35%**.

Expected Impact: Achieving **60% smallholder ISPO coverage by 2030** (versus current 12-15%) would increase aggregate smallholder incomes by **USD 600-800 million annually**, improve welfare indices by **10-15%**, and secure market access amid escalating sustainability requirements.

6.2.4 Expand Extension Services and Technology Adoption

Focus Areas: Prioritize **Good Agricultural Practices (GAP) training** on precision fertilization, harvest optimization, pest/disease management, and soil conservation through farmer field schools and demonstration plots.

Delivery Mechanisms:

- **Extension agent intensification:** Increase agricultural extension worker deployment to **1 agent per 100 smallholder farmers** (from current 1:300-500 ratios), with specialized palm oil training and performance incentives linked to farmer productivity outcomes.
- **Digital extension platforms:** Develop mobile applications providing agronomic advice, pest identification tools, weather forecasts, and input procurement, leveraging Indonesia's 85% smartphone penetration among rural populations.
- **Peer-to-peer learning networks:** Establish lead farmer systems where high-performing smallholders (yields >4 tons/ha) mentor 10-15 neighboring farmers, with government honorariums and recognition.

Technology priorities: Promote adoption of **precision fertilization** (soil testing, targeted NPK application), **integrated pest management** (biological controls, pheromone traps), and **harvest timing optimization** (measuring fruit ripeness to maximize OER).

Expected Impact: Studies document **30-40% yield increases** from GAP adoption, translating into an additional 1-1.5 tons of CPO/ha output and IDR 10-15 million in **income gains** (USD 650-1,000) per 3-hectare farm annually. Widespread extension service improvements could increase aggregate smallholder production by 3-4 million tons, contributing to 15-20% improvements in the welfare index.

6.2.5 Develop a Comprehensive Welfare Monitoring System

Components: Establish an **integrated Farmers Welfare Information System** linking data from BPS (Statistics Indonesia), Ministry of Agriculture, BPDP, formerly BPDPKS (Palm Oil Fund Agency), and other related institutions, and ISPO certification bodies.

Indicators: Track multidimensional welfare metrics beyond income:

- **Economic:** Income (NTP/FTT), poverty rates, debt levels, asset accumulation
- **Education:** School enrollment rates, literacy, vocational training participation
- **Health:** Health insurance coverage, child nutrition status, healthcare access
- **Housing:** Dwelling quality, access to clean water, sanitation, and electricity
- **Food security:** Dietary diversity, caloric sufficiency, food expenditure shares
- **Risk mitigation:** Insurance coverage, savings levels, social protection access

Technology: Deploy **digital data collection** through mobile surveys, integrate with ISPO traceability platforms capturing farm-level data, and produce **quarterly welfare dashboards** disaggregated by province, district, and farmer type (plasma/independent/contract).

Purpose: Enable **evidence-based policy adjustment** through real-time monitoring of welfare trends, early warning of distress (e.g., declining NTP, rising debt), and impact evaluation of interventions (replanting subsidies, certification programs, extension services).

Expected Impact: Improved data quality and timeliness enhance policy responsiveness, potentially reducing crisis response lags by 6-12 months and targeting support to the most vulnerable smallholder segments, indirectly improving welfare outcomes by **5-10% through better-calibrated interventions**.

6.2.6 Promote Income Diversification and Livelihood Resilience

Strategies:

- **Intercropping systems:** Technical extension and subsidy programs promoting agroforestry (palm + timber species), underplanting with cocoa or coffee during the mature phase, and integrated crop-livestock systems (palm + cattle/goats).
- **Value-added processing:** Support smallholder cooperative establishment of FFB collection centers, crude palm oil mini-mills (1-5 ton/hour capacity), and oleochemical processing (soap, fatty acids), capturing 20-30% processing margins currently retained by large mills.
- **Off-farm employment:** Vocational training programs in plantation management, agricultural machinery operation, and palm oil processing, enabling smallholder household members to secure wage employment in estate or industrial sectors.

Support: Microfinance access for diversification investments (livestock purchase, processing equipment), technical training through farmer field schools, and market linkage facilitation for diversified products.

Justification: Households with **30-40% income from non-palm sources** exhibit **20-30% lower income volatility**, maintain consumption during palm price downturns, and demonstrate superior food security and education investment.

Expected Impact: Diversification strategies could stabilize incomes during palm price cycles, reducing welfare index volatility by **15-25%** and improving resilience to climate and market shocks, ultimately enhancing multidimensional welfare scores by **8-12%**.

6.3 RESEARCH AGENDA FOR FUTURE STUDIES

Three research priorities merit emphasis. First, **longitudinal studies tracking farmers' welfare index dynamics over 5-10 year periods** are essential to understand causal pathways from interventions (replanting, certification, diversification) to welfare outcomes, disaggregated by initial conditions (farm size, age, education) to identify

heterogeneous treatment effects. Second, **rigorous impact evaluations employing quasi-experimental designs** (difference-in-differences, regression discontinuity) should assess PSR programs, ISPO certification, and extension services, providing credible evidence on cost-effectiveness to guide resource allocation. Third, **climate adaptation research** must integrate agronomic trials (drought-resistant varieties, irrigation systems) with economic modeling (adaptation costs, benefit-cost ratios) and institutional analysis (insurance schemes, risk-sharing mechanisms) to build sector resilience under climate change scenarios.

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