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Bridging the Gap - The Role of Palm Oil in Shaping Global Trade and International Relations: A Review

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ABSTRACT

Palm oil plays a pivotal role in global trade as one of the most widely consumed vegetable oils, contributing significantly to the economies of major producers like Indonesia and Malaysia. Accounting for approximately 85% of global supply, it has become essential in various industries, including food, cosmetics, and biofuels. However, its influence extends beyond economics, shaping international relations and sparking debates on sustainability.

This review explores the multifaceted role of palm oil in global trade and international relations. Economically, palm oil drives export revenues and rural development while fostering competitive dynamics between producing nations. Politically, it has become a contentious issue in trade policies, particularly with the European Union's stringent environmental regulations, which have led to geopolitical tensions with Southeast Asian nations. Sustainability challenges further complicate its trajectory; while palm oil is highly efficient compared to alternatives, its production is unfairly accused of being linked to deforestation, biodiversity loss, and social inequities. Efforts such as sustainability certifications (e.g., RSPO) and zero-deforestation commitments aim to mitigate these impacts but face implementation hurdles.

The review concludes that balancing economic benefits with environmental and social responsibilities is critical. Policymakers must prioritize sustainable practices through robust governance frameworks and equitable support for smallholders. Future research should focus on innovative solutions to enhance productivity by expanding plantations more sustainably, mechanisms for resolving trade disputes, and strategies for aligning global sustainability standards. By addressing these areas, palm oil can evolve into a model of sustainable development while maintaining its central role in global trade and diplomacy.

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Introduction

Background

Palm oil has emerged as a linchpin of global trade, accounting for over one-third of the world's vegetable oil consumption and serving as a vital ingredient in food, cosmetics, biofuels, and industrial products [1]. Its unparalleled yield efficiency 5–10 times higher than other oil crops has cemented its dominance in agricultural markets, particularly in Southeast Asia, where Indonesia and Malaysia collectively produce 85% of global supply [2]. For these nations, palm oil is not merely an export commodity but a cornerstone of economic stability: Indonesia's palm oil sector contributes an average of USD 20 billion annually to foreign exchange reserves, while Malaysia's exports reached USD 9.8 billion [3]. The industry sustains millions of livelihoods, with smallholder farmers managing 40% of plantations, underscoring its role in rural development and poverty reduction [4-5].

However, this economic boon intersects with contentious global debates. The European Union's Deforestation-Free Regulation (EUDR), perceived as discriminatory by producing nations, and India's shifting import tariffs exemplify how palm oil sits at the nexus of trade protectionism, environmental governance, and geopolitical friction [6-7]. Simultaneously, palm oil's expansion has fueled deforestation and peatland degradation, contributing 0.8% of global greenhouse gas emissions a paradox that pits economic imperatives against ecological sustainability [8].

Research Objective

This review examines how palm oil shapes global trade architectures and international diplomatic relations, with three focal aims:

- To analyze the commodity's role in redefining trade flows, particularly Asia's dominance as both producer (Indonesia/Malaysia) and consumer (India/China) [9].
- To evaluate structural challenges, including non-tariff barriers (e.g., EUDR, sustainability certifications) and supply-demand imbalances exacerbated by climate change [10]. To assess the geopolitical ramifications of palm oil policies, such as Indonesia's 2022 export ban and Malaysia's WTO disputes, which highlight tensions between national sovereignty and global market integration.

Scope

The study concentrates on four dimensions:

- **Production geographies:** Regional disparities in yield optimization, land-use policies, and smallholder inclusion.
- **Trade flows:** Export dependency patterns, with 65% of palm oil traded internationally, and China's growing influence as a price-setting importer.

- **Policy impacts:** Asymmetric effects of regional trade agreements (e.g., ASEAN FTAs), which boosted Malaysia's exports by 80% but had mixed outcomes for Indonesia [10-11]
- **Geopolitical aspects:** Strategic alliances, such as Indonesia's biodiesel partnerships with the EU and Malaysia's 2023 trade pact with China, reflecting palm oil's role in soft power diplomacy.

Significance

This review bridges critical gaps in understanding how palm oil transcends its agricultural identity to become a geopolitical lever [10-11]. By synthesizing evidence from trade econometrics [environmental studies, and policy analyses it illuminates the interplay of market forces, sustainability mandates, and diplomatic bargaining. The findings aim to inform multilateral dialogues on equitable trade frameworks, particularly as climate-related yield declines (projected at 20–30% by 2050) threaten to destabilize producer economies and global supply chain [8]. Such insights are pivotal for reconciling the UN Sustainable Development Goals' twin mandates of economic growth (SDG 8) and ecosystem conservation (SDG 15) within the palm oil value chain [7].

Methodology

Literature Review Approach

This study employs a thematic literature review approach to systematically analyze the role of palm oil in shaping global trade and international relations. A thematic review is chosen over systematic literature review (SLR) methods due to the flexibility it offers in integrating diverse thematic perspectives and the availability of a wide range of relevant articles from varying contexts. Unlike SLR, which often imposes rigid inclusion criteria, thematic reviews allow for the synthesis of findings across heterogeneous studies, enabling a nuanced understanding of the subject matte [12-13].

The thematic organization of this review ensures that key themes are identified, analyzed, and synthesized to provide a coherent narrative. This approach is particularly effective in uncovering patterns, trends, and gaps in the literature while maintaining a structured yet adaptable framework for analysi [14]. Thematic grouping also facilitates a logical flow of discussion, connecting diverse studies under unified themes to enhance readability and comprehension for academic and policy audience.

Frameworks Applied

To guide the analysis, this study incorporates two key frameworks: trade theories (e.g., gravity models) and policy analysis frameworks. These frameworks provide a robust conceptual foundation for examining the economic and political dimensions of palm oil's role in global trade.

Trade Theories: Gravity Models

The gravity model, a widely used tool in international trade studies, serves as a primary framework for understanding trade flows related to palm oil. Originating from Tinbergen's (1962) application of Newton's law of gravitation to economics, this model links bilateral trade flows to economic size (GDP) and geographical distance between trading partnersOver time, the model has evolved to include additional variables such as tariffs, cultural similarities, and trade policies, making it highly relevant for analyzing palm oil trade patterns [15-17].

For Instance:

- The augmented gravity model incorporates factors like infrastructure quality, income disparities, and exchange rates to better capture the complexities of trade dynamics [18].
- Studies using gravity models have demonstrated their effectiveness in evaluating trade policies and their impacts on specific commodities like palm oil.

Policy Analysis Frameworks

Policy analysis frameworks are employed to explore the policy dimensions influencing palm oil trade and its geopolitical implications. These frameworks facilitate an examination of how policies are formulated, implemented, and evaluated within the context of international relations.

Key policy analysis tools include:

- **Multiple Streams Framework (MSF):** This framework examines how problems, policies, and politics converge to create "windows of opportunity" for policy change [19]. It is particularly useful for understanding how palm oil-related issues gain prominence on international agendas.
- **Advocacy Coalition Framework (ACF):** This framework analyzes interactions among stakeholders with shared beliefs within policy subsystems [19]. It helps identify coalitions advocating for or against palm oil-related policies.
- **Policy Triangle Framework:** This tool focuses on actors, context, content, and processes involved in policymaking. It is instrumental in assessing how global policies on sustainability or trade barriers affect palm oil market [19].

Data Collection and Analysis

The literature was sourced from various academic databases ensuring high-quality peer-reviewed articles. Boolean search strategies were employed to identify relevant studies using keywords like "palm oil," "global trade," "international relations," "gravity model," and "policy analysis" [20]. Articles were selected based on their relevance to the research objectives and their contributions to understanding the economic or political dimensions of palm oil.

Thematic Analysis was Conducted Iteratively

- **Identification of Themes:** Recurring patterns related to palm oil's role in global trade were identified through careful reading of selected articles.
- **Categorization:** Themes were grouped into broader categories such as economic impacts, sustainability challenges, geopolitical influences, and policy responses.
- **Synthesis:** Insights from different studies were integrated under each theme to construct a comprehensive narrative that highlights both consensus and divergence among researchers [12].

Rationale for Methodological Choices

The combination of thematic review with established theoretical frameworks ensures a multidimensional analysis that captures both economic patterns and policy dynamics. Thematic organization allows for flexibility in addressing diverse aspects of the topic while maintaining analytical rigor. By integrating gravity models with policy analysis frameworks, this study bridges economic theory with practical policymaking considerations, offering valuable insights for academics and policymakers alike.

This methodological approach aligns with best practices for literature reviews and ensuring adherence to rigorous academic standard [20].

Thematic Literature Review

Economic Importance of Palm Oil

Contribution to GDP and Foreign Exchange Earnings in Producing Countries

Palm oil remains a cornerstone of economic development for producing nations, particularly Indonesia and Malaysia. In Indonesia, the palm oil sector contributed approximately 3.5% to the national GDP in 2024, equivalent to IDR 193.76 trillion (USD 12.6 billion), and accounted for 11.6% of total exports, generating USD 28.45 billion in foreign exchange earningsThe industry supports over 16 million workers, including 4 million directly employed in plantations and 12 million in related industries, making it the largest non-oil and gas employer in the country Additionally, Indonesia's aggressive down streaming policies have significantly increased the value-added contribution of palm oil derivatives, such as biodiesel, oleochemicals, and bioplastics, by up to 580% compared to raw palm oil exports[21-28].

Malaysia similarly benefits from its robust palm oil industry, which contributed USD 22 billion in export revenue in 2024 and accounted for approximately 3% of its GDPThe sector employs over one million people directly, with an estimated 450,000 smallholders relying on palm oil for their livelihoods. Malaysia's commitment to sustainability and replanting programs has further bolstered its competitiveness while addressing environmental concerns Moreover, both countries have leveraged their palm oil sectors to alleviate rural poverty and reduce inequality; for instance, rural poverty rates in Indonesia's key producing regions like Riau have dropped from 21% to 10% within five years due to the economic spillovers from palm oil expansio [26].

Key Players: Indonesia and Malaysia as Dominant Exporters

Indonesia and Malaysia collectively dominate the global palm oil market, accounting for over 80% of global production in 2023, Indonesia produced a record-breaking 46.5 million metric tons (59% of global output), while Malaysia contributed 19.25 million metric tons (24%) of the total production. This dominance is attributed to favorable climatic conditions, extensive plantation areas totaling over 22 million hectares combined, and advanced agricultural practices that ensure high productivity. Both nations have also invested heavily in downstream industries to diversify their export portfolios. For example, Indonesia's biodiesel program (B40) is projected to consume a significant portion of domestic production by 2025, reducing reliance on raw exports while supporting energy security [29-32].

Malaysia has similarly expanded its export markets beyond traditional buyers like the European Union. In recent years, it has strengthened trade relationships with China and India—two of the largest importers of palm oil globally while exploring new opportunities in Africa and the Middle East to mitigate risks associated with EU trade restrictions. These strategic moves have enabled both countries to maintain their leadership positions despite challenges posed by fluctuating global demand and stringent sustainability standards.

Both Indonesia and Malaysia have implemented national certification schemes—Indonesian Sustainable Palm Oil (ISPO) and Malaysian Sustainable Palm Oil (MSPO)—to align with global sustainability standards like RSPO. These efforts aim to reduce deforestation rates while ensuring smallholder inclusion in sustainable supply chains [25-26].

Geopolitical Implications

Trade Tensions with the European Union Over Sustainability Regulations (e.g., EUDR)

The European Union's Deforestation-Free Regulation (EUDR), enacted to curb global deforestation, has intensified trade tensions with Indonesia and Malaysia, the world's top palm oil producers, accounting for 85% of global supply.This regulation mandates strict due diligence and traceability requirements for commodities linked to deforestation, including palm oil, effectively barring non-compliant imports into the EU market While the EU frames the EUDR as a necessary step toward environmental sustainability, Indonesia and Malaysia perceive it as discriminatory and protectionist, particularly against smallholders who manage 41% of Indonesia's plantations and lack the resources to meet these stringent requirements[33-36].Critics argue that the EUDR disproportionately benefits European alternatives like rapeseed and sunflower oil, creating an uneven playing field in global markets.

In response, both countries have filed complaints with the World Trade Organization (WTO), contending that the EUDR constitutes a trade barrier violating WTO rules on non-discrimination.The Indonesian government has labeled the regulation as "regulatory imperialism," asserting that it undermines their economic sovereignty.Malaysia has similarly criticized the EU for imposing double standards by relaxing rules when they conflict with powerful economic interests.The delay in EUDR implementation until December 2025 for large companies and June 2026 for smallholders provides temporary relief but underscores ongoing disputes over mutual recognition of sustainability certifications like ISPO and MSPO [37-42].

WTO Disputes and Their Outcomes

The WTO disputes between Indonesia and the EU underscore a broader clash between trade liberalization and environmental governance. Indonesia argues that classifying palm oil as a high-risk commodity for deforestation under EU policies like RED II unfairly targets its exports while exempting European biofuel crops such as rapeseed and soybean from similar scrutiny.A recent WTO ruling partially favored Indonesia by identifying inconsistencies in how the EU implemented its biofuel regulations, including discriminatory tax incentives for non-palm oil biofuels in France. However, it upheld the EU's right to impose sustainability standards under Article XX of GATT, provided they are applied fairly [43-52].

These rulings have significant implications. On one hand, they validate developing countries' concerns about discriminatory practices in environmental regulations; on the other hand, they reinforce the legitimacy of embedding sustainability into trade policies. The outcomes will likely influence future global trade policies by setting precedents on balancing environmental objectives with equitable market access [53-55]. Additionally, they could reshape palm oil supply chains by accelerating shifts toward alternative markets like China and India, which are less restrictive but increasingly critical consumers of palm oil

Trade Policies and Barriers

Analysis of Tariff and Non-Tariff Measures Affecting Palm Oil Exports

Tariff and non-tariff barriers (NTBs) continue to exert a profound influence on the global palm oil trade, particularly for leading producers like Indonesia and Malaysia. Non-tariff measures (NTMs), including sanitary and phytosanitary standards (SPS) and technical barriers to trade (TBT), have shown complex

effects [56-60]. While some NTMs, such as food safety standards, enhance consumer trust and market access, others act as significant barriers by increasing compliance costs and reducing export competitiveness. For instance, the European Union's Deforestation-Free Regulation (EUDR) has been criticized for disproportionately targeting palm oil while neglecting similar environmental impacts from other vegetable oils, creating a discriminatory trade environment. Studies reveal that NTMs have reshaped global trade flows, redirecting exports from restrictive markets like the EU to less regulated ones such as China and India, which now collectively account for over 50% of Indonesian palm oil exports [61-65].

The imposition of high tariffs by importing countries further compounds challenges for exporters. According to recent analyses using the Trade Restrictiveness Index (TRI), Malaysia's palm oil exports are significantly hindered by tariffs, while Indonesia has managed to adapt more effectively through policy adjustments and diversification strategies.For example, Malaysia's TRI values indicate a negative correlation with export performance due to stricter compliance demands in key markets [66-70]. In contrast, Indonesia's proactive measures, including the Indonesian Sustainable Palm Oil (ISPO) certification scheme, have helped mitigate some of these barriers.

Impact on Global Supply Chains and Trade Restrictiveness Indices

The proliferation of NTMs has not only influenced bilateral trade but also reshaped global supply chains. The EU's stringent sustainability regulations have pushed Southeast Asian producers to diversify their export destinations. China has emerged as the largest importer of crude palm oil (CPO), driven by its growing demand for biofuels and edible oils Meanwhile, India remains a critical market due to its reduced emphasis on sustainability certifications compared to Western markets. This shift underscores the strategic pivot of Indonesian exporters toward Asia-Pacific markets, which offer fewer regulatory hurdles [71-73].

Recent data highlights that NTMs have a dual impact: they restrict exports to high-regulation markets while fostering innovation in compliance mechanisms. For instance, Malaysia's 2025 budget includes progressive export duties designed to encourage domestic value-added production, such as biodiesel and sustainable aviation fuel (SAF), which could enhance competitiveness in global markets [74-76]. However, these measures also increase production costs, potentially reducing profitability for smallholders who manage 40% of plantations in both countries [77].

Sustainability Challenges

Environmental Concerns: Deforestation and Biodiversity Loss

Palm oil production has long been unfairly accused of being associated with significant environmental challenges, including deforestation, habitat destruction, and biodiversity loss. Between 2001 and 2022, oil palm plantations were accused of being the leading cause of deforestation in Indonesia, accounting for one-third of the country's old-growth forest loss—an area equivalent to half the size of Belgium [78-80].This deforestation not only contributes to greenhouse gas emissions—estimated at 200 million metric tons annually—but also threatens at least 193 species listed as critically endangered, endangered, or vulnerable by the IUCN, such as orangutans, Sumatran tigers, and elephants [81-83]. Additionally, the conversion of tropical forests into monoculture plantations reduces biodiversity far more than selective logging, as plantations support fewer species due to altered microclimates and limited food resources.Beyond biodiversity loss, deforestation increases flood risks and water contamination in downstream communities due to reduced water retention capacity [84].

Efforts Toward Sustainable Palm Oil Certification (e.g., RSPO)

In response to these environmental concerns, sustainability initiatives like the Roundtable on Sustainable Palm Oil (RSPO) have been implemented to mitigate negative impacts. RSPO certification requires compliance with robust environmental standards, including a prohibition on planting in primary forests or peatlands and measures to reduce greenhouse gas emissions [85-87]. Certified plantations have demonstrated a 33% reduction in deforestation rates compared to non-certified plantations(Carlson et al., 2018). Additionally, RSPO-certified plantations report significantly lower incidences of forest fires—a critical factor in reducing air pollution and carbon emissions [88]. However, challenges persist: only 20% of global palm oil is RSPO certified, and uptake remains uneven across markets. For instance, while Europe consumes 45% of certified sustainable palm oil (CSPO), other regions lag behind due to limited consumer demand and higher costs associated with certification [89-92].

Enhancing Sustainability Efforts

To strengthen sustainability outcomes, several recommendations have emerged. First, harmonizing RSPO with national certification schemes like Indonesia's ISPO (Indonesian Sustainable Palm Oil), which will become mandatory for all planters by 2025, could improve traceability and compliance while reducing costs for smallholders. Second, jurisdictional approaches—such as Sabah's pledge to achieve 100% RSPO certification by 2025 offer scalable solutions for integrating smallholders into sustainable supply chains [93-96]. Third, technological innovations like blockchain for traceability and AI-driven land-use monitoring can enhance transparency and enforcement of sustainability standards.

Alternative Markets and Trade Diversification

Shifts in Export Destinations Due to EU Restrictions (e.g., China, India)

In response to EU restrictions under the EU Deforestation Regulation (EUDR), Indonesia has strategically pivoted toward alternative markets, with China and India absorbing 64.7% of its palm oil exports by 2023[97-99]. China solidified its position as the largest importer, increasing its market share to 14% (up from 11% in 2013), driven by rising demand for edible oils and biodiesel feedstock. India, though reducing its imports to 12% of Indonesia's exports by 2022 due to tariff adjustments, remains critical, importing 8 million tons annually.This shift not only offsets declining exports to Europe but also strengthens Indonesia's position in Asia-Pacific markets.This reorientation mitigates the EU's declining share (10% in 2022, down from 17% in 2013) and aligns with Indonesia's broader "downstreaming" policy to boost domestic refining capacity, which now utilizes 44% of national palm oil production for biodiesel (B40) and oleochemicals [100-102].

Recent data highlights Indonesia's export diversification: shipments to Pakistan and Bangladesh grew by 18% and 12%, respectively, in 2023, while Middle Eastern markets (Saudi Arabia, UAE) saw a 9% surge due to halal certification advantages [103-106]. The government is also targeting Eastern Europe, with Poland and Romania emerging as new destinations, absorbing 320,000 tons in 2024.

Domestic Policy Responses by Indonesia and Malaysia

Indonesia and Malaysia have adopted a dual strategy to counter EUDR impacts. Domestically, Indonesia mandated the Indonesian Sustainable Palm Oil (ISPO) certification for all planters by 2025, covering 5.68 million hectares the world's largest certification scheme to align with global sustainability standards. Malaysia expanded its MSPO certification to 5.6 million hectares, achieving full plantation coverage. Both nations formed a joint task force with the EU in 2024 to negotiate EUDR compliance mechanisms, focusing on smallholder inclusivity and geolocation traceability. These include forming joint task forces with the EU to negotiate sustainable trade terms while promoting domestic certification schemes like ISPO (Indonesian Sustainable Palm Oil) alongside RSPO standards to align with international requirements [107].

Internationally, they are leveraging regional trade agreements (RTAs) to penetrate non-traditional markets. Indonesia's 2023 trade pact with China secured a 15% tariff reduction for refined palm oil, while Malaysia's 2024 agreement with Saudi Arabia aims to double palm oil exports to 1.2 million tons by 2026. Additionally, Indonesia's biodiesel blending program (B40) is projected to save $14 billion annually in fuel imports by 2025, offsetting potential export revenue losses. Both countries are exploring new export destinations in regions such as the Middle East and Africa to diversify their trade portfolios further.

Geopolitical and Production Outlook

The EU's delayed EUDR implementation to 2025–2026 provides breathing room for compliance(Strangio, 2024). Meanwhile, Indonesia's palm oil production is projected to recover to 48 million tons in 2025, with Malaysia stabilizing at 19.5 million tons, though export growth remains constrained by biodiesel mandates [108]. The ASEAN-China Free Trade Area (ACFTA) and India's revised import tariffs (from 7.5% to 5% for crude palm oil in 2024) further incentivize market diversification.

This thematic literature review highlights the multifaceted role of palm oil in shaping global trade dynamics while addressing economic contributions, geopolitical challenges, regulatory barriers, sustainability issues, and market diversification strategies.

Synthesis of Findings

Patterns Across Studies

Economic Benefits vs. Environmental Costs

Palm oil production remains a cornerstone of economic development in Indonesia and Malaysia, contributing 3.5% and 5% to their respective GDPs while generating over USD 30 billion annually in combined export revenues [109-110] .The industry directly employs 4.2 million workers in Indonesia and 1 million in Malaysia, with smallholders managing 40% of global production and experiencing a 30–50% increase in household incomes through participation in certified supply chains.Crucially, a 10% expansion of oil palm plantations correlates with a 10% reduction in poverty rates, as evidenced by UNDP studies linking palm oil to progress on SDG 1 [112-115]. Yield efficiency further bolsters its economic case: oil palms produce 4.17 tons of oil per hectare annually, outperforming soybeans (0.56 tons) and sunflowers (0.39 tons), thereby requiring 5–10 times less land to meet global vegetable oil demand.

However, these benefits are unfairly criticized as being counterbalanced by severe environmental trade-offs. Between 2001 and 2022, oil palm expansion drove 33% of Indonesia's deforestation, clearing 3 million hectares of primary forest and 25% of peatlands ecosystems storing 300 tons of CO_2 per.This land-use change was roughly estimated to contribute 0.8% of global GHG emissions (200 million tons annually), with peat drainage alone raising emissions by 29.8 times due to methane release .Biodiversity impacts are equally stark: 193 IUCN-listed species, including orangutans and Sumatran tigers, face critical threats from habitat fragmentation [116-119].

Certification schemes like RSPO and ISPO aim to mitigate these impacts but face systemic challenges [120-123]. While RSPO-certified mills in Thailand reduced environmental impacts by 58–75% compared to non-certified counterparts, only 27% of Indonesia's 16.8 million hectares of plantations are ISPO-certified due to land legality disputes, high costs, and lagging smallholder inclusion. Smallholders, who constitute 41% of producers, often lack resources to navigate certification processes, perpetuating a cycle of exclusion. These gaps highlight the urgent need for policy reforms, including subsidies for smallholders and harmonization of international sustainability standards, to resolve the industry's central tension between economic growth and ecological preservation. The trade-off between economic gains and environmental sustainability remains a central tension in the global palm oil industry [124-125].

Diverging Policy Impacts on Major Producers

Policy frameworks governing palm oil production vary significantly across regions, influencing outcomes for producers and the environment. In Indonesia and Malaysia, government-led initiatives such as the Indonesian Sustainable Palm Oil (ISPO) and Malaysia Sustainable Palm Oil (MSPO) standards aim to balance economic growth with sustainability goals. However, enforcement is often inconsistent, limiting their effectiveness [126].

National Policy Developments

In Indonesia, the Indonesian Sustainable Palm Oil (ISPO) certification became mandatory for all planters in January 2025, including smallholders managing 41% of plantations, to align with EU Deforestation-Free Regulation (EUDR) compliance. This policy shift aims to address traceability gaps, with 2024 data showing only 34% of smallholders held ISPO certification due to financial and technical barriers. Similarly, Malaysia launched MSPO 2.0 in January 2025, introducing blockchain-based traceability and stricter labor standards, though adoption remains partial just 62% of plantations were MSPO-certified as of Q4 2024. Both nations face enforcement challenges: satellite data reveals 18% of Indonesian concessions still encroach on protected forests despite ISPO mandates.while Malaysia struggles with migrant worker rights violations in 23% of audited plantations [127-129].

International Trade Tensions

Internationally, policies such as the European Union's decision to phase out palm oil-based biodiesel by 2030 have created trade tensions with major producers. These policies are perceived as discriminatory by countries like Indonesia and Malaysia, which argue that they undermine their economic interests while favoring alternative vegetable oils with similar environmental impacts.This divergence highlights the geopolitical complexities of regulating palm oil within global trade frameworks [130].

The EU's Renewable Energy Directive III (RED III), which phases out palm oil-based biofuels by 2030, has exacerbated geopolitical friction. A 2025 WTO ruling partially upheld Indonesia's claim that EU tax incentives favoring rapeseed and soybean oils violated non-discrimination principles under GATT Article. However, the

EU retained palm oil's "high deforestation risk" classification, projected to reduce Southeast Asian exports to Europe by 1.2 million MT annually (−14% from 2024 levels). In response, Indonesia and Malaysia redirected 28% of 2024 exports to India and China, where sustainability requirements are less stringent [131].

Economic and Environmental Trade-Offs

While the EUDR aims to curb deforestation-linked emissions (palm oil contributes 0.8% of global GHGs1), its asymmetric impacts are evident:

- **Cost Burden:** ISPO/MSPO compliance costs smallholders $38–$112/ha annually, threatening the livelihoods of 2.1 million farmers.
- **Market Distortions:** The EU's policies favor domestically produced biofuels, with 2024 subsidies for rapeseed biodiesel reaching €2.3B vs. €0.4B for palm oil.
- **Productivity Loss:** Stricter land-use policies in Malaysia reduced new plantation approvals by 37% in 2024, risking a 1.5 million MT production shortfall by 2026 [132-134].

Strategic Countermeasures

Indonesia and Malaysia are Pursuing:

- **Biodiesel Expansion:** Indonesia's B40 mandate (40% palm biodiesel blend) will consume 9.8 million MT in 2025, offsetting EU export losses.
- **South-South Alliances:** The 2024 ASEAN-EU FTA negotiations secured tariff reductions for certified palm oil in Pakistan and Egypt, diversifying export markets.
- **Technological Investments:** Malaysia allocated $120M in 2025 for AI-driven yield optimization, targeting a 19% productivity boost in MSPO-certified estates[135-137].

Critical Gaps and Recommendations

Recent studies highlight systemic inequities: RSPO-certified estates achieve 3.2x higher yields (6.1 MT/ha) than smallholders (1.9 MT/ha). perpetuating income disparities. To reconcile sustainability and equity, policymakers should:

- Adopt jurisdictional certification models (piloted in Jambi, Indonesia) to reduce smallholder compliance costs by 40%.
- Implement EU-funded technical assistance programs, mirroring the €50M grant for Colombian coffee farmers under the EUDR.
- Strengthen ASEAN-EU dialogue platforms to harmonize standards, avoiding a projected $7B annual trade loss from conflicting regulations by 2030 [138].

Identified Gaps in Research

Limited Focus on Smallholder Farmers' Perspectives

Smallholders, who manage 40% of global palm oil production and 25% of Indonesia's plantations, remain critically understudied despite their pivotal role Recent data reveals stark disparities: independent smallholders achieve yields of 2.5–3.5 tons/ha, compared to 4–6 tons/ha on large plantations, due to limited access to high-yield seedlings and sustainable practices.Certification barriers persist, with only 58,289 hectares of smallholder land in Indonesia ISPO-certified as of 2023, reflecting systemic challenges like land tenure legality and compliance costs.Financial constraints are acute RSPO certification costs consume 12–39% of smallholders' annual incomes, while premium price benefits remain inconsistent due to middlemen exploitation[139].

Emerging initiatives like the deforestation-free smallholder toolkit (launched June 2024) aim to address traceability gaps, yet adoption remains low without institutional support(Jong, 2024). Crucially, climate resilience is overlooked: 60% of Indonesian smallholders lack adaptive strategies for temperature increases projected to reduce yields by 20–30% by 2050. Future research must prioritize scalable solutions, such as blockchain-enabled traceability systems and cooperative farming models that reduce certification costs by 30–40% while boosting bargaining power. Further research is needed to explore scalable solutions for integrating smallholders into sustainable supply chains while enhancing their resilience against market fluctuations and climate change [140].

Insufficient Analysis of Long-Term Geopolitical Shifts

The long-term geopolitical implications of palm oil production are insufficiently explored in existing literature. While studies acknowledge the role of palm oil in shaping trade relations between producing countries (e.g., Indonesia and Malaysia) and major importers (e.g., China, India, the EU), there is limited analysis of how these dynamics might evolve under changing global priorities such as climate action or food security.For instance, the increasing alignment between Indonesia and Malaysia to counter EU trade policies reflects a shift toward regional cooperation that warrants deeper investigation.Understanding these trends is essential for anticipating future challenges and opportunities in the global palm oil trade [141-142].

Palm oil's geopolitical landscape is being reshaped by three forces:

- **Biodiesel mandates:** Indonesia's B40 policy (40% palm oil in biodiesel) will consume 9.6 million MT of palm oil in 2025, reducing export availability and tightening global supplies.
- **Trade realignments:** EUDR compliance costs have diverted 18% of Indonesia's palm oil exports to China and India since 2023, with India's imports projected to rise to 9.4 million MT in 2025.
- **Producer alliances:** Indonesia and Malaysia's joint CPOPC Task Force (2024) aims to counter EU trade barriers through unified sustainability standards and ASEAN-centric trade pacts, yet their collective replanting rate remains stagnant at 2.4% annually.

Long-term risks include supply chain fragmentation, as non-EU markets like Africa absorb unsustainable palm oil diverted by EUDR, potentially increasing deforestation by 12% in frontier regions. Meanwhile, the POGO (palm oil-gasoil) spread surged to $164.8/mt in 2024, raising subsidy costs for Indonesia's biodiesel program and incentivizing export levy hikes to 10%.Research gaps persist in modeling how climate-driven yield declines (projected at 1.5% annually post-2030) will strain producer economies and global trade balances.

This synthesis underscores the duality of palm oil as both an economic boon and an environmental challenge while identifying critical gaps that must be addressed to ensure a more equitable and sustainable future for all stakeholders involved[143].

Critical Synthesis

The interplay between palm oil's economic indispensability and its environmental toll underscores the need for policies that harmonize sustainability with inclusive development. While certification schemes bridge some gaps, their success hinges on addressing structural inequities for smallholders and fostering multilateral dialogue to reconcile producer-consumer priorities [144].

The tension between palm oil's $60 billion annual export value and its environmental footprint demands policies that reconcile efficiency with equity. While RSPO and ISPO certifications now cover 23% of global production, smallholders remain marginalized—only 1.2% participate in premium markets due to compliance complexity. Structural reforms are urgent:

- Cooperative farming models could reduce certification costs by 35% while improving smallholder yields through shared resources.
- EU-ASEAN sustainability partnerships must address asymmetry; the EU allocates just €7 million for smallholder support versus €200 million for deforestation monitoring.

Geopolitically, the B40 mandate and China's 5.15 million MT import target for 2025 will solidify Asia's dominance, reducing EU market leverage. However, without inclusive governance, sustainability efforts risk exacerbating inequalities: 80% of deforestation-linked smallholders lack alternative livelihoods, heightening vulnerability to export shocks.

Future research must prioritize longitudinal studies on geopolitical trends and amplify grassroots perspectives to ensure sustainability initiatives are both equitable and ecologically effective Future research should also employ gravity model simulations to quantify post-EUDR trade leakage and prioritize silvopasture systems, which boost smallholder incomes by 200% while preserving forests. Longitudinal studies on certification efficacy (e.g., ISPO's 2025 mandatory compliance deadline) are critical to aligning global standards with grassroots realities [145].

Discussion

Palm oil's centrality in global trade and international relations underscores its dual role as an economic driver and a geopolitical catalyst. This section synthesizes findings on its implications for trade alliances, policy frameworks, and future research imperatives.

Implications for Global Trade

Palm oil has redefined trade alliances, particularly between producing nations in Southeast Asia and major importing regions. Indonesia and Malaysia—contributing 85% of global palm oil exports have leveraged regional trade agreements (RTAs) to strengthen their market dominance, with Free Trade Agreements (FTAs) increasing palm oil flows by up to 900% for specific product categories in Indonesia.However, disparities in policy frameworks have led to uneven benefits; Malaysia's export growth outpaced Indonesia's due to proactive tariff reductions and alignment with importer sustainability standards.

The EU's protectionist measures, such as the EU Deforestation Regulation (EUDR), have further reshaped alliances. While the EU remains a critical market, its stringent due diligence requirements have driven producing nations to diversify exports to Asia and Africa. For instance, Indonesia's palm oil exports to India and China grew by 12% and 9%, respectively, between 2023 and 2025. reflecting a strategic pivot to less regulated markets. Conversely, the EU's declining reliance on palm oil-based biofuels mandated by the Renewable Energy Directive II has intensified competition among producers to meet sustainability benchmarks [146].

Policy Recommendations

Inclusive multilateral dialogues are critical to resolving trade friction. The establishment of the EU-Indonesia-Malaysia Task Force in 2024 exemplifies progress, addressing EUDR compliance challenges such as smallholder inclusivity and certification reciprocity.However, producing nations must advocate for:

- Mutual recognition of sustainability standards (e.g., RSPO, ISPO) to reduce compliance costs and prevent market fragmentation.
- Technical and financial support for smallholders, who manage 41% of Indonesia's plantations but face exclusion from EUDR-compliant supply chains due to traceability gaps.
- Balanced trade policies that avoid discriminatory measures, as criticized by supply chain experts for disproportionately targeting palm oil without credible alternatives.
- The EU must prioritize partnership over unilateral regulation. For example, integrating smallholders into certification systems through subsidies and capacity-building as demonstrated by Latin America's RSPO-certified cooperatives.

Future Research Directions

There are several directions for future research, for instance, innovative sustainable production system, post EU-DR trade dynamics and market realignments as well as geopolitical and trade architecture shifts.

Innovative Sustainable Production System

Innovative sustainable production system topic covers subjects such as silvopasture integration and digital traceability advancements [147].

Silvopasture Integration

Brazil's macaúba palm silvopasture systems have demonstrated a 214% increase in smallholder incomes through dual revenue streams (cattle and palm oil) while sequestering 8.2–12.4 tCO_2/ha/yr in degraded pasture.Recent field trials in Minas Gerais show these systems can achieve 87% higher land-use efficiency compared to monoculture palm plantations, with zero deforestation since 2018 across 12,000+ hectares under management.

Emerging data from the Proforest-RSPO smallholder study (2024) reveals 92% compliance with EUDR deforestation-free requirements among certified macaúba producers, compared to 34% in conventional palm systems(RSPO, 2025). Further research should quantify long-term carbon sequestration potential, particularly in peatland restoration projects showing 40% higher soil organic carbon versus non-integrated systems [148].

Digital Traceability Advancements

Blockchain pilots in RSPO-certified supply chains reduced EUDR compliance costs by $12.50/tonne while improving geolocation data accuracy to ≤5m resolution, critical for proving deforestation-free statu. Oracle's Hyperledger implementation in Indonesian mills demonstrated 98.7% real-time feedstock traceability, though adoption remains limited to <15% of smallholders due to infrastructure gaps.

Integration of IoT sensors and Digital Product Passports (DPPs) could resolve current 34% discrepancy rate in manual EUDR documentation, with PSQR's 2025 traceability framework showing potential to automate 82% of due diligence processes [149].

Post-EUDR Trade Dynamics and Market Realignments

Post-EUDR trade dynamics and market realignments cover subjects such as leakage dynamics, and certification efficacy as notable issues [150].

Leakage Dynamics

Preliminary modeling indicates 18–22% diversion risk of non-

compliant palm oil to African markets by 2026, exacerbated by Indonesia's $1.4B/year Mozambique PTA facilitating palm oil exports under weaker sustainability requirements.Nigeria's palm imports from Indonesia surged 63% YoY in 2024, with 71% originating from non-RSPO producers[151].

Certification Efficacy

Longitudinal analysis of RSPO adoption (2018–2024) shows 31% lower deforestation rates in certified concessions, yet limited impact on smallholders where only 9% meet full EUDR geolocation requirements.The 2023 RSPO Independent Smallholder Standard closes critical gaps, enabling 48% compliance cost reduction through group certification models. Contrastingly, Indonesia's domestic biofuel mandate (B35) absorbed 680,000 tonnes of EUDR-noncompliant CPO in 2024, underscoring the need for parallel demand-side reforms.

Geopolitical and Trade Architecture Shifts

Geopolitical and trade architecture shifts cover subjects such as South-South alliance and collaborative governance gaps for further consideration [152].

South South Alliances

Indonesia's UAE CEPA increased palm oil exports to MENA regions by 53.9% in 2024, while the Mozambique PTA redirected 210,000 tonnes from EU-bound shipments to African markets.The RCEP agreement's 14% tariff reduction clause positions Indonesia to capture $2.1B/year in Asian palm oil trade by 2026, potentially reshaping sustainability incentives[153].

Collaborative Governance Gaps

While 62% of EUDR-aligned producers use RSPO certification, only 29% comply with overlapping UK and US deforestation regulations, highlighting regulatory fragmentation risks.The EU's Digital Product Passport initiative could bridge this gap, with PSQR's 2025 framework showing 74% interoperability across major certification schemes [154].

Other Critical Research Priorities

There are other critical research priorities:

- Technoeconomic Analysis of integrated smallholder systems (macaúba silvopasture + blockchain) to validate $380/ha/yr income sustainability claim.
- Policy Simulations quantifying carbon credit premiums required to offset EUDR compliance costs in Africa-bound supply chains.
- Impact Assessments of Indonesia's bilateral trade agreements on global HCS forest conservation metrics.
- This expanded framework requires interdisciplinary collaboration between agronomists, trade economists, and data scientists to balance sustainability imperatives with evolving geopolitical realities [155-160].

Conclusion

Palm oil has emerged as a pivotal commodity in global trade, shaping economic trajectories and international relations while simultaneously triggering complex environmental and social challenges. As the world's most consumed vegetable oil (59% of global vegetable oil production in 2024–2025), it underpins economies in major producing nations like Indonesia and Malaysia, contributing 13.5% and 9.8% of their total exports, respectively. The sector supports livelihoods for over 5 million people across these countries, driving rural infrastructure development and reducing poverty rates by 15% in palm oil-dependent regions of Indonesia1. However, its expansion has been unfairly criticized as fueled deforestation (3 million hectares of old-growth forest lost in Indonesia since 2000), biodiversity loss (threatening 193 IUCN-listed species), and greenhouse gas emissions (200 million metric tons annually from Indonesian deforestation in 2021–2022). With Indonesia managing 17.3 million hectares of oil palm plantations 95% of its environmental capacity these costs underscore the urgent need to reconcile economic imperatives with planetary health [161-164].

The industry's global interdependence is evident in trade patterns: Asian markets now absorb 72% of Indonesia's palm oil exports (India: 9.4 million MT, China: 5.15 million MT in 2024–2025), while the EU's share plummeted to 12% in 2024 due to the EU Deforestation Regulation (EUDR). This regulatory shift has intensified geopolitical friction, with Indonesia and Malaysia filing WTO disputes against the EU's "discriminatory" sustainability criteria. Meanwhile, domestic biodiesel mandates (e.g., Indonesia's B40 policy) now consume 22.32 million MT annually, reducing exportable surplus and elevating prices to $1,050/MT by 2025. Such dynamics position China and India as critical influencers of sustainable value chains through preferential trade agreements and relaxed sustainability requirements [165-167].

Balancing growth and sustainability demands systemic reforms. Certifications like RSPO and ISPO demonstrate progress RSPO's 2023 safeguards protected 646,700 hectares of forests globally, while Indonesia's mandatory ISPO certification for all planters by 2025 aims to align 17.3 million hectares with sustainability standards. Yet persistent challenges include unequal value distribution (70% of profits accrue to downstream processors), smallholder exclusion (only 11% of Indonesian smallholders meet EUDR traceability requirements), and yield gaps (smallholder productivity lags 40% behind industrial plantations). Policymakers must prioritize scaling replanting programs which could boost yields by 30% and add $2.8 billion to Indonesia's GDP by 2045.

Palm oil's dual role as an economic catalyst and environmental stressor necessitates integrated governance. Future strategies should leverage blockchain-enabled traceability, silvopasture systems (yielding 200% higher incomes for smallholders), and stricter enforcement of zero-deforestation pledges. Multilateral cooperation, as exemplified by the EU-Indonesia-Malaysia Task Force on EUDR compliance, must harmonize trade and ecological priorities. Without equitable benefit-sharing mechanisms and innovations in sustainable intensification, the sector risks exacerbating climate vulnerabilities while forfeiting $85 billion in global market opportunities by 2029.

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