

## Science-Based Diplomacy as a Strategic Imperative for Advancing Sustainable Palm Oil Implementation in Indonesia

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### ABSTRACT

Indonesia, as the world's largest palm oil producer, faces mounting international pressures to demonstrate sustainability credentials while navigating discriminatory trade barriers disguised as environmental protection. This qualitative literature review examines the critical role of science-based diplomacy in supporting sustainable palm oil implementation in Indonesia. Drawing on 118 sources published primarily between 2020 and 2025, this study synthesizes evidence on three interconnected dimensions: global challenges in palm oil diplomacy, Indonesia's position in international sustainability discourse, and strategies for constructing credible scientific narratives. Findings reveal that asymmetric power relations in standard-setting processes, contested scientific evidence, and implementation gaps between policy and practice undermine Indonesia's diplomatic effectiveness. However, demonstrated progress—including an 82% reduction in deforestation and successful WTO dispute resolutions—provides a foundation for repositioning Indonesia from a defensive actor to a proactive sustainability leader. The three-dimensional framework of science diplomacy (science IN diplomacy, diplomacy FOR science, science FOR diplomacy) offers strategic pathways for evidence-based engagement. This study recommends establishing dedicated science diplomacy units, accelerating ISPO certification to achieve 100% coverage, prioritizing smallholder inclusion through jurisdictional approaches, developing unified evidence-based narratives, and building South-South coalitions

## INTRODUCTION

### 1. Background: Palm Oil at the Nexus of Development and Sustainability

Palm oil occupies a distinctive position in contemporary debates on sustainable development, representing both economic opportunity and environmental challenge for tropical producing nations. Indonesia, accounting for 54-60% of global palm oil production, exemplifies this paradox. The sector contributes approximately 3.5% to Indonesia's GDP and supports livelihoods for 4.3-16 million people, positioning palm oil as a strategic commodity essential for national economic development and poverty alleviation. Beyond domestic significance, palm oil serves critical functions in global food security and industrial applications, utilized in approximately 50% of supermarket products and increasingly in bioenergy sectors (Hamid, 2023).

However, this economic importance is counterbalanced by environmental controversies that have positioned palm oil at the center of international sustainability debates. Historical expansion of oil palm plantations has been associated with significant deforestation, with studies indicating that one-third of old-growth forest loss in Indonesia—approximately 3 million hectares—occurred in areas subsequently converted to palm oil production. These environmental impacts have generated intense international scrutiny and criticism, particularly from European consumers, environmental organizations, and policymakers. The resulting discourse often portrays palm oil as inherently unsustainable, overlooking both the complexity of production systems and the substantial progress achieved in recent years (Benedict & Heilmayr, 2024b).

This oversimplified narrative creates significant diplomatic challenges for Indonesia. International regulatory measures, most notably the European Union Deforestation Regulation (EUDR) and the classification of palm oil as a "high indirect land-use change (ILUC) risk" commodity under the Renewable Energy Directive, function as de facto trade barriers that disproportionately affect Indonesian exports. These measures reflect what Indonesia and Malaysia characterize as discriminatory protectionism—regulatory actions ostensibly motivated by environmental concerns but serving to protect competing vegetable oil producers in temperate regions. Indonesia's successful WTO dispute against the EU in January 2025, which ruled that the EU's differential treatment of palm oil violated international trade obligations, validates Indonesian claims of discrimination while simultaneously affirming the legitimacy of environmental objectives when applied in a non-discriminatory manner (Mai, 2024).

The emergence of science-based diplomacy as an imperative stems from the growing recognition that traditional diplomatic approaches prove insufficient for navigating complex sustainability challenges involving contested scientific evidence, asymmetric power relations, and divergent stakeholder interests. A widening gap exists between technical achievements in sustainable palm oil production—including dramatic reductions in deforestation rates and expansion of certification coverage—and persistent negative perceptions in international markets. This disconnect undermines Indonesia's economic interests, limits market access for millions of smallholder farmers, and perpetuates inequitable global governance structures that marginalize developing country perspectives (Nurshadrina et al., 2023).

## 2. Urgency: Critical Junctures Demand Strategic Responses

Several converging factors elevate the urgency of developing robust science-based diplomatic approaches to sustainable palm oil. First, Indonesia faces critical junctures in global palm oil governance that will shape market dynamics and regulatory landscapes for decades. The EUDR, scheduled for phased implementation with recent delays extending compliance deadlines, establishes unprecedented traceability and due diligence requirements that threaten to exclude significant portions of Indonesian production, particularly from smallholder farmers who manage approximately 40% of national palm oil area but predominantly lack certification and formal registration. Simultaneously, the WTO ruling in Indonesia's favor creates both opportunity and responsibility – opportunity to challenge discriminatory measures through established legal mechanisms and responsibility to demonstrate genuine sustainability progress that justifies international market access (Hamid-Walker, 2025).

Second, shifting market dynamics introduce new variables into Indonesia's strategic calculations. China has emerged as the largest importer of Indonesian palm oil, surpassing traditional European and Indian markets and offering potential alternatives that reduce dependence on European buyers. This market diversification provides Indonesia with enhanced negotiating leverage but simultaneously raises questions about sustainability governance in alternative markets where environmental standards may be less stringent. The World Economic Forum's recent analysis of Indonesia-China palm oil trade emphasizes the importance of maintaining sustainability standards even in markets with lower regulatory pressure, recognizing that long-term competitiveness depends on credible sustainability credentials across all markets (Benedict & Heilmayr, 2024a).

Third, Indonesia confronts a fundamental credibility challenge that undermines its diplomatic positioning. Despite establishing the Indonesian Sustainable Palm Oil (ISPO) certification system and declaring it mandatory through Presidential Regulation 44/2020, certification rates remain disappointingly low – approximately 32% of plantation area as of 2020, far short of the government's 100% target for 2025. This implementation gap between ambitious policy pronouncements and ground-level realities provides ammunition for critics who characterize Indonesian sustainability commitments as rhetorical rather than substantive. Furthermore, systematic exclusion of independent smallholders from certification schemes – with only 0.21-7% of smallholder area achieving ISPO or RSPO certification – contradicts official narratives of inclusive sustainability and raises fundamental questions of social equity (Prasetyo, 2025).

The consequences of inadequate scientific communication extend beyond immediate market access concerns. Trade protectionism disguised as environmental policy sets dangerous precedents for other tropical commodities and developing country exports, potentially undermining the rules-based international trading system. Excluding smallholder farmers from sustainable supply chains threatens to reverse poverty-reduction gains and exacerbate rural

inequality, contradicting Sustainable Development Goal commitments to leave no one behind. Most fundamentally, Indonesia risks losing competitive advantage despite genuine sustainability improvements—a scenario in which real environmental progress goes unrecognized while competitors gain market share through superior communication strategies rather than superior performance(Solidaridad, 2022).

### **3. Objectives: Toward Evidence-Based Strategic Engagement**

This study pursues four interconnected objectives designed to advance both theoretical understanding and practical application of science-based diplomacy for sustainable palm oil. First, it analyzes the conceptual and theoretical foundations of science diplomacy, adapting frameworks developed primarily for traditional domains such as climate change, public health, and space exploration to the specific context of commodity sustainability governance. This adaptation recognizes distinctive features of palm oil diplomacy – including the central role of private certification schemes, the prominence of non-state actors in norm-setting, and the integration of trade, environment, and development dimensions—that differentiate it from conventional science diplomacy domains(Cuellar-Ramirez, 2021).

Second, the study systematically identifies key challenges and opportunities in Indonesia's palm oil diplomatic engagement, synthesizing evidence on power asymmetries in global governance, scientific controversies regarding sustainability metrics, implementation deficits in domestic policy, and emerging pathways for strategic repositioning. This comprehensive mapping provides the foundation for evidence-based strategy development, moving beyond reactive responses to proactive leadership grounded in scientific credibility(Suradiredja et al., 2025).

Third, this research examines strategies for constructing credible and consistent scientific narratives on sustainable palm oil implementation in Indonesia. Drawing on communication theory and empirical studies of sustainability discourse, it analyzes principles of evidence-based communication, narrative framing techniques, multi-stakeholder engagement platforms, and strategic use of digital ecosystems. Particular attention focuses on balancing technical accuracy with public accessibility, acknowledging challenges while highlighting progress, and positioning Indonesia as solution provider rather than problem source(Commetric, 2019).

Fourth, the study provides evidence-based policy recommendations for strengthening Indonesia's science-based palm oil diplomacy across institutional, implementation, communication, and international engagement dimensions. These recommendations are grounded in best practices from comparative contexts, informed by stakeholder perspectives, and designed for practical applicability within Indonesian institutional and political contexts(Balme, 2025).

## LITERATURE REVIEW

### 1. Conceptual and Theoretical Foundations of Science-Based Diplomacy

Science diplomacy has emerged as a critical framework for addressing complex transnational challenges that require integration of scientific knowledge with diplomatic practice. The Royal Society and American Association for the Advancement of Science established foundational conceptual architecture in 2010, delineating three dimensions that remain influential: science *IN* diplomacy (applying scientific knowledge to inform foreign policy objectives), diplomacy *FOR* science (facilitating international scientific collaboration), and science *FOR* diplomacy (using scientific cooperation to improve international relations). This tri-dimensional framework recognizes that science and diplomacy intersect in multiple ways, each requiring distinct skills, institutional arrangements, and strategic approaches (Cuellar-Ramirez, 2021).

Recent developments have expanded and refined this foundational framework. The European Science Diplomacy Alliance, launched in 2021, emphasizes the particular challenges of science diplomacy in an era characterized by post-truth movements, populist skepticism toward expertise, and geopolitical fragmentation. Cuellar-Ramirez and colleagues demonstrate how science diplomacy proves essential for climate action and sustainable development, arguing that the complexity and urgency of environmental challenges necessitate unprecedented integration of scientific evidence into diplomatic processes. Their analysis highlights asymmetries between developed and developing countries in scientific capacity, knowledge production, and participation in international standard-setting— asymmetries with direct relevance to palm oil governance (Balme, 2025).

Application of science diplomacy to environmental governance reveals both opportunities and limitations. The Intergovernmental Panel on Climate Change (IPCC) exemplifies successful institutionalization of science-policy interfaces, establishing procedures for synthesizing scientific evidence, managing uncertainty, and informing international negotiations while maintaining scientific integrity. However, the IPCC model also illustrates challenges including lengthy assessment cycles that lag behind policy needs, political interference in summary documents, and ongoing debates regarding the appropriate boundary between scientific assessment and policy prescription. These challenges intensify in domains such as palm oil sustainability, where private governance mechanisms operate alongside state regulations, commercial interests shape research agendas, and scientific evidence remains contested across multiple dimensions (Choiruzzad et al., 2021).

Critical perspectives on science diplomacy emphasize power asymmetries in whose science counts and how scientific authority is constructed. Developing countries often lack resources to produce authoritative scientific evidence, participate effectively in international scientific networks, and translate scientific findings into diplomatic leverage. When European institutions dominate research on tropical commodities, producer countries find themselves responding to externally generated narratives rather than shaping knowledge production agendas. This structural disadvantage underscores the importance of

building indigenous scientific capacity and asserting developing country agency in global knowledge systems (Tyson et al., 2018).

## **2. Global Challenges in Palm Oil Diplomacy**

International palm oil diplomacy unfolds within contested terrain characterized by trade barriers, scientific controversies, and geopolitical tensions. The European Union's regulatory interventions exemplify how sustainability governance can function as non-tariff trade barriers with discriminatory impacts. The EUDR, establishing strict traceability requirements and due diligence obligations for palm oil and other forest-risk commodities, imposes compliance costs that disproportionately affect smallholder producers and developing country exporters. More fundamentally, the classification of palm oil as "high ILUC risk" under the Renewable Energy Directive effectively excludes it from biofuel markets while exempting competing oils such as rapeseed and sunflower, which occupy substantial agricultural land in Europe (Hicks, 2025).

Indonesia's WTO challenge against these measures culminated in a landmark ruling in January 2025 that found the EU's differential treatment violated international trade obligations by discriminating against palm oil relative to other vegetable oils with comparable sustainability profiles. The panel report represents a significant diplomatic victory for Indonesia, validating claims that EU measures constituted protectionism disguised as environmental policy and establishing legal precedent for challenging discriminatory sustainability regulations. However, the ruling's practical impact remains limited – it affirms Indonesia's legal position without compelling the EU to modify its policies immediately – and implementation will require ongoing diplomatic engagement and potential retaliatory measures (Costa, 2025).

Scientific controversies permeate palm oil sustainability debates, with contested evidence on greenhouse gas emissions, biodiversity impacts, and land-use efficiency enabling competing narratives. Malaysia claims that palm biodiesel achieves 60-74% greenhouse gas savings compared to fossil fuels, while EU methodologies calculate only 17-19% savings when accounting for indirect land-use change. These methodological divergences reflect genuine scientific uncertainties regarding attribution of deforestation to palm oil expansion, appropriate counterfactuals for emissions calculations, and temporal boundaries for historical carbon debt. However, they also reflect underlying political economy – European rapeseed producers benefit from methodologies that disadvantage palm oil, while palm oil exporters favor approaches emphasizing direct rather than indirect effects (Alhaji et al., 2024).

The efficiency argument represents a core element of Indonesia's scientific counter-narrative. Palm oil produces approximately 9 times more oil per hectare than sunflower and 4-6 times more than rapeseed, making it the most land-efficient vegetable oil globally. Proponents argue that replacing palm oil with alternatives would require vast additional land, potentially generating greater environmental impacts than sustainable palm oil production. Critics counter that this efficiency argument ignores historical deforestation associated with palm oil expansion and the particular conservation value of tropical forests converted to plantations. The scientific debate thus centers on contested framings – whether

to emphasize present efficiency or historical impacts, direct effects or system-wide consequences, technical potential or actual practice(Hurst, 2019).

Geopolitical dimensions further complicate scientific discourse. Indonesia and Malaysia characterize international criticism as reflecting "trade war narratives" and "black campaigns" orchestrated by competing oil producers seeking to protect market share through non-tariff barriers. Industry associations point to organized campaigns by European agricultural interests and their environmental allies to delegitimize palm oil while exempting comparable impacts from temperate oilseeds. While some claims of conspiracy lack substantive evidence, the political economy analysis correctly identifies that regulatory measures favoring domestic products over imports serve protectionist functions regardless of stated environmental motivations. The WTO ruling substantiates this analysis, finding that EU measures discriminated against imports while protecting domestic production(Sugihartono, 2024).

### **3. Indonesia's Position in International Sustainability Discourse**

Indonesia's engagement with international palm oil sustainability discourse has evolved from defensive reaction to more strategic positioning, though significant challenges persist. The establishment of ISPO certification through Presidential Regulation 44/2020 represents the most significant policy intervention, creating a mandatory national standard applicable to all plantation companies and smallholders. ISPO encompasses environmental criteria (deforestation prohibition, peatland protection, biodiversity conservation), social requirements (labor rights, community consultation, land tenure recognition), and economic standards (productivity, traceability, legality). The mandatory nature distinguishes ISPO from voluntary schemes like RSPO, theoretically ensuring universal coverage rather than self-selection by better-performing actors(Suwarganda, 2024).

However, implementation has lagged substantially behind policy ambitions. As of 2020, only 32% of plantation area achieved ISPO certification, far short of the government's 100% target originally set for 2025. Multiple factors explain slow uptake including administrative complexity, cost burdens particularly for smallholders, limited awareness of requirements, insufficient government extension support, and weak enforcement of mandatory provisions. More fundamentally, ISPO faces an international recognition challenge—European buyers and consumers remain skeptical of a government-controlled standard that lacks independent third-party verification comparable to RSPO. This credibility deficit limits ISPO's value in international markets, reducing incentives for certification and perpetuating reliance on RSPO for export-oriented producers(Madani, 2024).

The National Action Plan for Sustainable Palm Oil (RAN-KSB), established through Presidential Instruction 6/2019, provides a broader policy framework encompassing five priority areas: integrated data systems, smallholder capacity building, environmental management, governance improvement, and ISPO acceleration. By 2023, regional action plans (RAD-KSB) had been developed in 8 provinces and 15 regencies, demonstrating subnational engagement and multi-level governance approaches. The RAN-KSB framework

integrates with Indonesia's Low Carbon Development Initiative and circular economy strategies, positioning sustainable palm oil within broader green economy transitions. Policy modeling tools such as SIPOS (Sistem Informasi Palm Oil Sustainability) support evidence-based planning and monitoring (EFI, 2025).

Despite policy frameworks, governance challenges undermine the effectiveness of implementation. Approximately 3.37 million hectares of oil palm plantations are located within state forest estate boundaries, creating legal ambiguities and conflicts between forestry and agricultural regulations. Land tenure disputes affect an estimated 2+ million hectares, and smallholders often lack formal land rights despite cultivating these areas for decades. Weak inter-agency coordination between forestry, agriculture, environment, and land agencies perpetuates policy incoherence and regulatory gaps. Enforcement capacity remains limited, with insufficient inspectors, inadequate penalties for violations, and political pressures that constrain regulatory action against powerful plantation companies (Kirana, 2013).

The smallholder inclusion challenge represents perhaps the most significant implementation deficit. Independent smallholders—those unaffiliated with plantation companies—manage approximately 40% of Indonesia's palm oil area but remain largely excluded from certification schemes and formal supply chains. Only 0.21-7% of smallholder area has achieved ISPO or RSPO certification, compared to 32% overall certification rates that predominantly reflect large plantation company participation. Barriers include high certification costs (averaging \$100-300 per smallholder), complex documentation requirements, lack of technical knowledge, limited organizational capacity, and weak extension services. Traceability systems designed for industrial plantations prove incompatible with smallholder realities of small plots, mixed landscapes, and informal marketing arrangements (Purnomo et al., 2024).

Indonesia's diplomatic responses have combined defensive posturing with more strategic engagement. The WTO disputes against the EU exemplify assertive use of international legal mechanisms to challenge discriminatory measures. The joint Indonesia-Malaysia task force on palm oil demonstrates producer country coordination, though cooperation has been episodic rather than systematic. Recent initiatives show evolution toward proactive positioning, including jurisdictional certification pilots that address traceability challenges at landscape scale, engagement with Chinese buyers on sustainable supply chain development, and participation in multi-stakeholder dialogues with European stakeholders (Ostfeld & Reiner, 2024).

#### **4. Constructing Credible and Consistent Scientific Narratives**

Effective science-based diplomacy requires not only robust evidence but also strategic communication that translates complex technical information into compelling narratives accessible to diverse audiences. Communication scholarship identifies multiple dimensions of credibility essential for persuasive sustainability discourse. Scientific rigor and methodological transparency establish technical credibility among expert audiences, requiring peer-reviewed

research, reproducible methods, and acknowledgment of uncertainties. Independence from vested interests and perceived objectivity enhance trustworthiness, creating challenges for government and industry sources that may face skepticism regardless of evidence quality. Cultural sensitivity and stakeholder inclusivity affect legitimacy, with top-down narratives lacking participatory development often rejected by affected communities and civil society organizations (Kiger & Varpio, 2020).

Balancing complexity with accessibility represents a persistent tension in scientific communication. Technical accuracy demands nuanced discussion of uncertainties, methodological limitations, and contextual contingencies—complexity that risks losing non-specialist audiences. Conversely, oversimplification to enhance public comprehension may distort scientific understanding and provide ammunition for critics who identify gaps between simplified messages and technical realities. Recent controversies illustrate this dilemma—Indonesian President Prabowo Subianto's statement that "oil palms have leaves" so expansion would not constitute deforestation generated international ridicule for conflating forest canopy with forest ecosystems, undermining more sophisticated Indonesian scientific arguments. Effective communication requires calibrating message complexity to audience knowledge while maintaining scientific integrity (Judijanto, 2025).

Narrative framing significantly influences how audiences interpret identical evidence. Research on palm oil media discourse reveals that negative framings emphasizing deforestation, biodiversity loss, and corporate malfeasance dominated international coverage, while positive framings highlighting efficiency, economic benefits, and sustainability progress remained marginalized. This asymmetry partly reflects algorithmic and editorial biases favoring conflict and crisis over incremental progress. However, it also indicates Indonesian communication failures—reactive rather than proactive engagement, defensive rhetoric that reinforces negative framings, and insufficient investment in systematic media relations and digital communication strategies (Choiruzzad, 2025).

Recent analysis suggests the potential to reframe palm oil discourse from "defending a controversial commodity" to "advancing sustainable tropical development." This reframing acknowledges genuine environmental challenges while emphasizing tangible progress, positions palm oil within broader development imperatives, including poverty reduction and food security, and asserts developing country agency in defining sustainability pathways appropriate to national contexts. Comparative narratives that are particularly effective include land-use efficiency relative to alternative oils, progress in reducing deforestation rates from historical peaks, and contributions to the Sustainable Development Goals through rural employment and economic opportunity (RSPO & MSPO, 2024).

Multi-stakeholder communication platforms enhance credibility through diverse participation and transparent processes. Government-industry-civil society partnerships can co-create narratives that integrate multiple perspectives, though power imbalances within such partnerships require active management

to ensure meaningful participation by marginalized stakeholders, including smallholders and indigenous communities. Scientific community engagement in policy processes strengthens evidence foundations while maintaining analytical independence. International collaborations demonstrate openness to external scrutiny and a willingness to engage constructively with critical perspectives (Suradiredja et al., 2025).

Strategic use of digital ecosystems enables more sophisticated communication approaches. Real-time data dashboards and geospatial monitoring platforms enhance transparency while providing visual, accessible representations of complex information. Social media and influencer partnerships extend reach beyond traditional media gatekeepers, though require careful attention to platform-specific communication norms and risks of misinformation amplification. Measuring communication effectiveness through sentiment analysis, media tracking, and market research enables adaptive strategies responsive to audience reception (Prasetyo, 2025).

## **METHODOLOGY**

This study employs a qualitative literature review methodology designed to synthesize existing knowledge, identify patterns across diverse sources, and generate conceptual insights regarding science-based diplomacy for sustainable palm oil. The qualitative approach is distinguished from systematic review methodologies by greater flexibility in scope, interpretive rather than aggregative analytical orientation, and emphasis on theoretical development alongside empirical synthesis. This methodological choice reflects research objectives focused on conceptual understanding and strategic implications rather than quantitative effect estimation (Susanto et al., 2024).

### **1. Literature Search and Selection**

Literature identification utilized multiple complementary strategies to ensure comprehensive coverage. Academic databases including Scopus, Web of Science, and Google Scholar were systematically searched using keyword combinations encompassing "palm oil," "sustainable palm oil," "Indonesia," "science diplomacy," "ISPO," "RSPO," "deforestation," "certification," "trade," "EUDR," "sustainability narrative," and "scientific communication." The temporal focus emphasized sources published 2020-2025 to capture current developments, while selectively incorporating earlier seminal works that established conceptual foundations (Cuellar-Ramirez, 2021).

Grey literature from policy documents, international organization reports, and reputable NGO analyses complements academic sources, recognizing that palm oil sustainability discourse unfolds across multiple knowledge production venues beyond peer-reviewed journals. News media and industry publications provided insights into public discourse and stakeholder positioning. Forward and backward citation tracking from key sources identified additional relevant literature, employing snowball sampling techniques until theoretical saturation (CIFOR-ICRAF, 2024).

Inclusion criteria prioritized sources with clear authorship, transparent methodology, or evidence-based, and substantive engagement with research questions. Exclusion applied to purely promotional materials lacking analytical

content, sources without verifiable provenance, and literature predating 2015, except for foundational theoretical works. Language limitations restricted the primary focus to English sources, acknowledged as a constraint that may underrepresent Indonesian-language scholarship and domestic policy debates (Tyson et al., 2018).

## **2. Thematic Analysis Framework**

Analysis followed the six-phase thematic analysis approach articulated by Braun and Clarke and subsequently refined for policy research contexts. Phase one involved intensive familiarization with the literature corpus through repeated reading and preliminary note-taking. Phase two generated initial codes capturing discrete elements of meaning relevant to research questions, including both descriptive codes (e.g., "ISPO certification rates") and interpretive codes (e.g., "credibility deficit"). Phase three organized codes into candidate themes representing patterned meanings across sources, distinguishing between descriptive themes summarizing content and analytical themes offering interpretive insights (Qualtrics, 2023).

Phase four involved iterative theme review, assessing internal homogeneity within themes and external heterogeneity between themes to ensure coherent and distinctive analytical categories. Phase five refined theme definitions and generated narrative descriptions capturing the essence and boundaries of each theme. Phase six produced the synthesis presented in the Results and Discussion sections, integrating themes into a coherent argument that addresses the research objectives (Naeem et al., 2023).

The analytical approach combined inductive and deductive elements. Inductive analysis remained open to emergent patterns in evidence, identifying themes not predetermined by existing theoretical frameworks. Deductive analysis applied the three-dimensional science diplomacy framework as sensitizing concepts guiding attention to particular dimensions of evidence. This hybrid approach balanced theoretical grounding with empirical openness, enabling both the application and refinement of the framework through empirical engagement (Christou, 2022).

## **3. Quality and Limitations**

Trustworthiness criteria, adapted from Lincoln and Guba, guided the quality assurance process. Credibility was enhanced through triangulation across multiple sources and perspectives, comparing government documents, academic research, industry positions, and NGO analyses to identify convergences and divergences. Dependability required transparent documentation of analytical decisions, maintained through detailed research notes explicating coding choices and theme development. Confirmability demanded reflexivity regarding the researcher's positionality—as a scholar examining Indonesian palm oil policy, awareness of potential biases toward national perspectives informed interpretation (Kiger & Varpio, 2020).

Transferability—the qualitative analog to generalizability—is supported through thick description of contexts, enabling readers to assess applicability to other settings. While findings specifically address Indonesian palm oil diplomacy, conceptual insights regarding science diplomacy for contested

commodities may inform analysis of analogous cases, including Colombian palm oil, Brazilian soy, or Ghanaian cocoa (Qualtrics, 2023).

Significant limitations warrant acknowledgment. Language constraints predominantly emphasizing English sources may underrepresent Indonesian scholarship and policy debates conducted in Bahasa Indonesia. Publication bias in international literature likely overrepresents critical perspectives on palm oil relative to supportive views, potentially skewing evidence base toward negative framings. The qualitative methodology precludes quantitative effect estimation or causal inference—findings illuminate patterns and relationships but cannot establish causation or precise magnitudes. Rapid policy evolution means some analyses may be overtaken by events, and there are inherent limitations in researching dynamic policy domains (Lim, 2024).

## RESULTS

Thematic analysis identified ten major themes organized across three overarching dimensions: challenges constraining effective science-based diplomacy, opportunities for strategic repositioning, and elements of credible narrative construction. These themes synthesize evidence from 118 sources spanning academic literature, policy documents, and institutional reports.

### 1. Challenges in Palm Oil Science Diplomacy

#### Theme 1: Asymmetric power relations in global sustainability governance

Evidence consistently reveals that international sustainability standard-setting processes systematically favor Global North perspectives and institutional arrangements. The RSPO, established in 2004, exemplifies this pattern—European consumer goods companies and environmental NGOs occupied central roles in governance structures from inception, while Indonesian smallholder organizations and government agencies participated marginally or not at all during foundational stages. The EU's unilateral establishment of ILUC criteria and deforestation regulations without meaningful consultation with producer countries further demonstrates asymmetric power. Indonesia's characterization as a "defensive internal actor" unable to influence norm formation reflects structural disadvantages in knowledge production capacity, diplomatic resources, and access to transnational advocacy networks dominated by Northern organizations (Mai, 2024).

The WTO dispute ruling, while legally vindicating Indonesian positions, simultaneously illustrates both potential and limitations of international legal mechanisms as countervailing power. Indonesia required substantial technical and legal resources to mount successful challenges, resources unavailable to smaller developing countries facing comparable discriminatory measures. Moreover, even successful rulings leave fundamental power asymmetries unchanged—the EU retains the capacity to redesign regulations in ways that achieve similar restrictive effects while avoiding specific legal vulnerabilities identified in panel reports (Hamid-Walker, 2025).

## **Theme 2: Science-policy translation gaps and contested evidence**

Scientific controversies regarding palm oil sustainability reflect both genuine uncertainties and politicized interpretations of ambiguous evidence. Greenhouse gas emission calculations exemplify this dynamic – methodological choices regarding system boundaries, counterfactual scenarios, time horizons, and attribution of indirect effects generate dramatically different results. Malaysia's claim of 60-74% emissions savings, versus the EU's calculation of 17-19% savings, both derive from peer-reviewed methodologies applied to similar data, with the divergence primarily reflecting different treatment of indirect land-use change (Hamid, 2023).

Biodiversity impact assessments similarly reflect methodological pluralism. Studies demonstrating severe biodiversity losses from forest conversion to oil palm plantations provide robust evidence of negative impacts. Concurrently, research highlighting greater biodiversity in oil palm landscapes compared to other agricultural monocultures supports comparative efficiency arguments. Both sets of findings are scientifically valid, with the apparent contradiction arising from different comparison baselines – primary forest versus alternative crops. However, political actors selectively cite evidence to support predetermined positions rather than engage with the full complexity, transforming scientific uncertainty into a political weapon (Jong, 2020).

Indonesian scientific capacity to generate authoritative counter-evidence remains constrained. While the Indonesian Palm Oil Research Institute (IOPRI) and university researchers produce relevant studies, publications predominantly occur in regional journals with limited international visibility and impact factors. Indonesian research receives fewer citations and less weight in international policy processes compared to studies from European or North American institutions, regardless of methodological quality. This citation and credibility asymmetry perpetuates dependent knowledge production, in which Indonesia responds to externally generated evidence rather than shaping research agendas (Hamid, 2023).

## **Theme 3: Implementation-rhetoric disconnect undermining credibility.**

Perhaps the most significant challenge to Indonesian science-based diplomacy is the gap between policy pronouncements and on-the-ground implementation. The mandatory ISPO certification system, despite Presidential Regulation declaring universal applicability from 2020, has achieved only 32% plantation coverage as of the most recent assessments. Government targets of 100% certification by 2025 appear increasingly unrealistic given slow certification rates and persistent barriers, particularly affecting smallholders. This implementation deficit provides critics with evidence that Indonesian sustainability commitments remain rhetorical rather than substantive (Suwarganda, 2024).

Smallholder exclusion from certification represents a particularly damaging credibility gap. Official narratives emphasize inclusive sustainability and smallholder empowerment, yet only 0.21-7% of smallholder plantation area has achieved certification under any scheme. This exclusion contradicts equity principles while perpetuating unverified supply chains that undermine

traceability claims. European buyers increasingly demand plot-level traceability, which is incompatible with smallholder realities, creating pressure for supply chain consolidation that further marginalizes small producers (Ekaputri et al., 2025).

Enforcement gaps between regulation and practice compound implementation challenges. Environmental and social regulations exist on paper but are inconsistently enforced due to limited inspector capacity, inadequate penalties, political interference protecting influential companies, and corruption. The presence of 3.37 million hectares of plantations in the state forest estate, technically illegal under forestry law, illustrates regulatory gaps and governance dysfunction. These implementation deficits undermine Indonesia's diplomatic positioning regardless of policy quality, as international audiences assess credibility based on observed practice rather than stated intentions (Irawan et al., 2024).

## **2. Opportunities for Strategic Repositioning**

### **Theme 4: Leveraging demonstrated progress as an evidence foundation**

Despite persistent challenges, Indonesia has achieved measurable sustainability progress, providing a foundation for more positive narratives. Deforestation associated with palm oil expansion has declined 82% from peak rates in 2012 to 2022, representing a substantial improvement even as challenges persist. Recent data shows that 93% of EU palm oil imports were RSPO-certified in 2022, demonstrating a significant transformation of the supply chain. ISPO certification coverage, while below target levels, has expanded continuously since the implementation of the mandatory policy (Benedict & Heilmayr, 2024b). Most significantly, the January 2025 WTO ruling validated Indonesian legal and technical arguments, establishing important precedent for challenging discriminatory sustainability regulations. The panel's finding that EU measures violated international trade obligations while affirming legitimate environmental objectives when applied non-discriminatorily creates a framework for distinguishing genuine sustainability governance from protectionist measures. This ruling demonstrates Indonesia's capacity for effective, evidence-based engagement in international legal forums (Costa, 2025).

These achievements remain underutilized in Indonesian communication strategies, which continue to emphasize defensive rhetoric rather than proactively highlight progress. Reframing discourse to foreground demonstrated improvements while acknowledging ongoing challenges could shift international perceptions and strengthen diplomatic positioning (Solidaridad, 2022).

### **Theme 5: Multi-level governance innovations creating pathways forward**

Emerging governance innovations offer potential solutions to persistent implementation challenges. Jurisdictional certification approaches, piloted in Indonesian districts and Malaysian states, address traceability barriers by certifying entire administrative units rather than individual farms. This landscape-level approach is more compatible with smallholder participation, as individual documentation requirements are replaced by jurisdictional compliance systems (Tisna, 2025).

Regional Action Plans under the RAN-KSB framework demonstrate subnational engagement and multi-level governance. By 2023, eight provinces and 15 regencies had developed context-specific implementation strategies, enabling adaptation to diverse local conditions. Public-private partnerships, such as collaborations among governments, companies, and NGOs that support smallholder certification in specific regions, have the potential to drive inclusive sustainability when adequately resourced (Musim Mas, 2025).

Digital traceability platforms utilizing satellite monitoring, blockchain verification, and mobile technologies enhance transparency while reducing documentation burdens. The Indonesia-China collaboration on sustainable supply chain development includes digital infrastructure investments that could support smallholder inclusion if designed appropriately. These technological and institutional innovations, while nascent, provide tangible pathways to address implementation gaps that currently undermine credibility (Prasetyo, 2025).

**Theme 6: South-South cooperation, potential for strengthening negotiating position.**

While episodic, coordination between Indonesia and Malaysia demonstrates potential for producer-country collective action. Joint representation in trade negotiations, coordinated WTO disputes, and shared research on sustainability metrics strengthen positions relative to individual engagement. The Malaysia-Indonesia joint task force on EU relations, though progress has been slow, establishes an institutional framework for ongoing cooperation (Nurshadrina et al., 2023).

Beyond bilateral coordination, broader South-South engagement offers strategic opportunities. China's emergence as the largest palm oil importer fundamentally alters market dynamics and reduces Indonesian dependence on European markets. While sustainability standards in Chinese markets currently lag behind European requirements, the World Economic Forum analysis emphasizes China's growing environmental consciousness and its potential to develop alternative sustainability governance frameworks better suited to developing-country contexts. Engagement with other tropical commodity producers facing comparable discrimination—including Colombian palm oil, Ivorian cocoa, and Brazilian coffee—could build G77 solidarity in WTO and multilateral environmental negotiations (Benedict & Heilmayr, 2024a).

**3. Elements of Credible Scientific Narratives**

**Theme 7: Evidence-based reframing from defense to leadership.**

Effective narratives require fundamental reframing from a defensive posture to a proactive leadership positioning. Rather than "defending palm oil" against criticism, Indonesian communication should emphasize "advancing sustainable tropical development" as a positive contribution to global sustainability goals. This reframing acknowledges genuine environmental challenges while foregrounding demonstrated progress, positions sustainability within broader development imperatives, including poverty reduction, and asserts developing country agency in defining context-appropriate pathways (Solidaridad, 2022).

Comparative efficiency narratives prove particularly persuasive – palm oil's 4-9 times greater land productivity compared to alternative vegetable oils means that replacing palm oil with rapeseed or sunflower would require vast additional agricultural land, potentially generating greater environmental impacts. Progress-oriented framing that shows continuous improvement – 82% reduction in deforestation, expanding certification coverage, and innovative governance mechanisms – demonstrates a trajectory toward sustainability goals rather than static conditions. Contextualized impacts acknowledge challenges while highlighting solutions, avoid defensive denialism, and maintain a constructive tone (Hanafiah et al., 2022).

**Theme 8: Multi-dimensional sustainability communication integrating economic, environmental, and social dimensions**

Credible narratives require integration across sustainability dimensions rather than a narrow environmental focus. Economic contributions, including poverty reduction affecting millions of smallholder families, rural employment generation, and foreign exchange earnings, position palm oil within legitimate development objectives. Environmental stewardship efforts, including forest conservation initiatives, greenhouse gas emissions reduction through methane capture and renewable energy, and biodiversity protection programs, demonstrate environmental commitment. Social equity dimensions encompassing smallholder empowerment programs, labor rights improvements, and community benefit mechanisms address social sustainability (Lai et al., 2022). Integration with global frameworks, including the Sustainable Development Goals, Paris Agreement commitments, and circular economy transitions, positions Indonesian palm oil within, rather than against, international sustainability agendas. This integrative approach counters oversimplified framings that treat palm oil solely as an environmental problem, while ignoring its economic and social dimensions (PAGE, 2024).

**Theme 9: Stakeholder co-creation enhancing legitimacy and credibility**

Narratives co-created through multi-stakeholder processes possess greater legitimacy than top-down government communications. Government-industry-civil society partnerships in narrative development ensure diverse perspectives are integrated, though power balances require active management to prevent corporate dominance or token participation by critical voices. Scientific community engagement in policy processes and communication strategies enhances the credibility of evidence while maintaining analytical independence (Purnomo et al., 2024).

Most critically, smallholder voice and representation in narratives address equity concerns while demonstrating an inclusive approach. Participatory storytelling featuring smallholder experiences, challenges, and achievements humanizes abstract sustainability discourse while validating inclusive claims. International collaboration and knowledge exchange with scientific institutions, progressive NGOs, and responsible businesses build coalitions and demonstrate openness to external engagement (Judijanto, 2025).

**Theme 10: Strategic multi-platform communication maximizing reach and impact.**

Effective communication requires strategic deployment across multiple platforms, targeting distinct audiences with appropriate formats. Peer-reviewed research publications in high-impact international journals establish scientific authority and credibility with expert audiences. Policy briefs and synthesis reports accessible to decision-makers translate technical evidence into policy-relevant formats. Digital dashboards and transparency tools provide real-time data with visual, accessible interfaces enabling public verification. Media engagement through proactive press relations, rapid response protocols, and strategic journalist partnerships shapes public discourse and counters misinformation(Shigetomi et al., 2020).

Social media strategies extending beyond traditional gatekeepers require platform-specific approaches, recognizing distinct communication norms on Twitter, Instagram, YouTube, and emerging platforms. Measuring communication effectiveness through sentiment analysis, media monitoring, and market research enables adaptive strategies responsive to audience reception and evolving discourse(Judijanto, 2025).

## **DISCUSSION**

### **1 Integrating Science-Based Diplomacy Framework**

The three-dimensional science diplomacy framework offers strategic pathways to enhance Indonesian engagement in sustainable palm oil. Science IN diplomacy requires systematically embedding scientific evidence in all international negotiations and diplomatic communications. This includes strengthening technical capacity within the Ministry of Foreign Affairs and trade delegations through dedicated science advisor positions, routine science briefings for diplomatic staff, and institutionalized consultation with research communities prior to international negotiations. The successful WTO disputes demonstrate the value of robust scientific evidence in legal contexts—panel reports extensively referenced technical studies on palm oil sustainability, emissions calculations, and comparative assessments of different vegetable oils. Extending this evidence-based approach to bilateral trade negotiations, multilateral environmental forums, and international standard-setting processes would strengthen Indonesia's negotiating position systematically(Hamid-Walker, 2025).

Diplomacy FOR science involves facilitating international research collaboration to harmonize methodologies, generate mutually accepted evidence, and build trust through joint knowledge production. Indonesia could propose collaborative research programs with European and Chinese institutions on contested issues such as emissions accounting methodologies, biodiversity impact metrics, and smallholder inclusion strategies. Harmonizing monitoring systems and data standards across major producer countries would enhance comparability and reduce methodological disputes that enable selective evidence citation. The European Science Diplomacy Alliance model, adapted to palm oil

contexts, could establish formal mechanisms for scientist-diplomat-policymaker interaction to address sustainability governance challenges (Balme, 2025).

Science FOR diplomacy leverages sustainability achievements to enhance Indonesia's international standing and soft power. Positioning Indonesia as a leader in tropical-commodity sustainability transitions demonstrates the country's capacity to balance conservation and development. Contributing Indonesian knowledge to global science-policy platforms, including IPCC, IPBES, and FAO, positions Indonesia as a knowledge provider rather than a passive recipient of externally generated norms. Successful jurisdictional certification pilots could be showcased as Indonesian innovations offering models for other producer countries and commodities (Ostfeld & Reiner, 2024).

## **2. From Defensive Reaction to Proactive Scientific Leadership**

Transitioning from defensive rhetoric to proactive leadership requires both substantive action and strategic communication. Substantively, addressing credibility gaps through accelerated implementation proves essential. Achieving near-universal ISPO certification through streamlined procedures, enhanced support for smallholders, and meaningful enforcement would validate policy commitments with verifiable results. Expanding smallholder inclusion through jurisdictional approaches, group certification schemes, and investments in digital traceability would demonstrate inclusive sustainability rather than merely claim it. Enhancing transparency through public data platforms, third-party monitoring, and grievance mechanisms would counter skepticism about government-controlled certification (Liu et al., 2020).

Communicatively, proactive leadership involves setting agendas rather than responding to external criticisms. Indonesia could propose international research collaborations to address knowledge gaps, host scientific conferences that bring diverse perspectives into dialogue, and actively contribute to peer-reviewed literature rather than primarily consume externally generated research. Presenting Indonesia as a solution provider—showcasing innovations in jurisdictional certification, smallholder inclusion mechanisms, and the integration of traditional livelihoods with sustainability—offers constructive alternatives to binary defend-or-condemn framings (Suradiredja et al., 2025). Building coalitions with progressive elements of international scientific and NGO communities strengthens positioning. Not all European or North American scientists and environmental organizations accept discriminatory narratives—identifying and amplifying sympathetic voices creates insider allies who can challenge protectionist measures more credibly than Indonesian government sources. Supporting independent research, including studies that may identify shortcomings, paradoxically enhances credibility by demonstrating openness to external scrutiny rather than defensive resistance (Commetric, 2019).

### 3. Addressing Persistent Tensions

Science-based diplomacy cannot eliminate fundamental tensions between development rights and environmental protection, economic efficiency and social inclusion, or national sovereignty and international cooperation. However, it can reframe these tensions as productive rather than zero-sum contradictions. Indonesia's legitimate development aspirations and poverty reduction imperatives constitute moral claims with equal standing to environmental protection objectives, particularly given the historical responsibility of developed countries for cumulative emissions and biodiversity loss. The principle of "common but differentiated responsibilities," enshrined in the climate and biodiversity conventions, affirms that developing countries should not bear disproportionate costs for global environmental problems (Sugihartono, 2024). Simultaneously, environmental limits constitute biophysical realities that constrain development pathways regardless of moral arguments. Science-based approaches seek win-win solutions through sustainable intensification that increases palm oil productivity on existing plantations rather than expanding area, high-value downstreaming that generates greater economic returns per unit of environmental impact, and landscape approaches that integrate conservation and production zones. Recent research demonstrates the potential to reduce deforestation through better spatial planning, protecting remaining high-conservation-value forests while allowing sustainable development on degraded lands (Lestari et al., 2025).

The tension between economic efficiency, favoring large-scale operations, and social equity, prioritizing smallholder inclusion, requires innovative governance rather than binary choices. Jurisdictional certification, group schemes that pool smallholder resources, and digital technologies that reduce transaction costs offer pathways to combine efficiency and inclusion. Framing smallholder inclusion as a business opportunity – accessing fragmented supply, securing social license, demonstrating sustainability credentials – rather than purely as a cost or constraint, aligns equity objectives with commercial incentives (Lai et al., 2022).

Balancing national sovereignty with international cooperation demands strategic engagement in standard-setting processes to shape rules rather than merely complying with externally imposed requirements. ISPO's mandatory national standard asserts Indonesian sovereignty over sustainability definitions while creating a basis for international mutual recognition negotiations. Active participation in RSPO governance, ISO standard development, and UN processes enables influence over evolving norms. The WTO provides mechanisms for challenging discriminatory measures while respecting legitimate environmental regulations when applied equitably (SGS, 2024).

### 4. Implications for Policy and Practice

This analysis generates several policy implications for Indonesian sustainable palm oil governance. First, science-based diplomacy should be elevated from ad hoc responses to systematic strategy, requiring institutional investments in science diplomacy units within relevant ministries, sustained funding for policy-relevant research, and training programs developing science

communication competencies among diplomatic and policy personnel. Second, accelerating domestic implementation to close gaps between policy and practice is essential for credibility, necessitating streamlined ISPO procedures, targeted smallholder support programs, digital infrastructure investments, and enhanced enforcement capacity (CIFOR-ICRAF, 2024).

Third, narrative development should shift from defensive rhetoric to evidence-based leadership positioning, emphasizing demonstrated progress, comparative efficiency, multidimensional sustainability, and Indonesian innovations that offer models for other contexts. Fourth, coalition-building through South-South cooperation with producer countries, engagement with progressive Northern partners, and participation in multi-stakeholder initiatives strengthens positioning relative to isolated approaches. Fifth, diversifying markets while maintaining sustainability standards across all destinations prevents race-to-the-bottom dynamics and enhances long-term competitiveness (Commetric, 2019).

For broader sustainable commodity governance, this analysis illustrates the importance of inclusive standard-setting processes that meaningfully incorporate producer country perspectives rather than imposing Northern preferences. It demonstrates the value of rigorous scientific evidence and methodological transparency in reducing the politicization of technical issues. It highlights the need for differentiated approaches that recognize smallholder realities rather than applying industrial models universally. Finally, it reveals the potential of digital technologies to enhance traceability and trust when deployed inclusively (Liu et al., 2020).

## **CONCLUSIONS AND RECOMMENDATIONS**

This qualitative literature review demonstrates that science-based diplomacy represents a strategic imperative for Indonesia's sustainable palm oil sector, offering pathways to navigate discriminatory international pressures while advancing genuine sustainability progress. Three key conclusions emerge from this analysis. First, current challenges—asymmetric power relations in global governance, contested scientific evidence, and implementation gaps between policy and practice—significantly constrain Indonesian diplomatic effectiveness, positioning the country as a defensive reactor rather than a proactive leader. Second, demonstrated achievements, including 82% deforestation reduction and successful WTO dispute resolution, provide a foundation for more positive narratives, while innovations in jurisdictional certification and digital traceability offer practical solutions to persistent implementation barriers. Third, the three-dimensional science diplomacy framework—science IN diplomacy, diplomacy FOR science, science FOR diplomacy—provides actionable pathways for integrating scientific evidence into diplomatic practice, facilitating international research collaboration, and leveraging sustainability achievements to enhance Indonesia's international standing.

Policy recommendations address institutional capacity-building, accelerated implementation, strategic communication, and international engagement. Establishing dedicated science diplomacy units within relevant ministries would coordinate research, evidence synthesis, diplomatic training, and international engagement strategy. Accelerating ISPO certification toward universal coverage through streamlined procedures, enhanced support for smallholders, and meaningful enforcement would validate policy commitments with verifiable results. Prioritizing smallholder inclusion through jurisdictional approaches, digital traceability platforms, and targeted capacity building would demonstrate inclusive sustainability while addressing equity concerns. Developing unified, evidence-based narratives that emphasize "Indonesia: Leading Sustainable Tropical Development" would reframe the discourse from a defensive posture to proactive leadership. Building coalitions through South-South coordination with Malaysia and other producer countries, engaging progressive Northern partners, and participating in multi-stakeholder initiatives would strengthen negotiating positions.

This study's limitations—qualitative methodology precluding quantitative generalization, language constraints emphasizing English sources, publication bias in international literature—suggest directions for future research including longitudinal impact evaluation of science diplomacy interventions, comparative analysis across different commodity sectors and producer countries, mixed-methods integration combining qualitative policy analysis with quantitative sustainability assessments, and participatory action research engaging smallholder communities and Indonesian policymakers directly.

The transformation of palm oil from contested commodity to model for sustainable tropical development remains achievable but not inevitable. It requires genuine progress in reducing environmental impacts and including smallholder farmers, not merely rhetorical commitments. It demands credible communication of achievements and challenges, not defensive denialism or propagandistic exaggeration. It necessitates that developing country agencies shape global sustainability governance, not passively accept discriminatory Northern standards. Science-based diplomacy, properly resourced and strategically deployed, offers Indonesia pathways to achieve these objectives—balancing economic imperatives with environmental stewardship, asserting legitimate development rights while demonstrating environmental responsibility, and contributing Indonesian knowledge and innovation to global sustainability governance. The future of Indonesia's palm oil sector, the livelihoods of millions who depend upon it, and the fate of tropical landscapes will be substantially shaped by success or failure in embracing this science-based diplomatic approach.

#### **FURTHER STUDY**

This research still has limitations so that further research is needed on the topic of Science-Based Diplomacy as a Strategic Imperative for Advancing Sustainable Palm Oil Implementation to perfect this research and increase insight for readers and writers.

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