








**POLICY BRIDGE**

# Smallholder participation in zero-deforestation supply chain initiatives in the Indonesian palm oil sector: Challenges, opportunities, and limitations

Michael Eggen<sup>1</sup>, Robert Heilmayr<sup>2</sup> , Patrick Anderson<sup>3</sup>, Rebecca Armson<sup>4,5</sup>, Kernen Austin<sup>6</sup> , Reza Azmi<sup>7</sup>, Peter Bayliss<sup>8</sup>, David Burns<sup>9,10</sup>, J. T. Erbaugh<sup>11,12</sup> , Andini Desita Ekaputri<sup>13,14</sup> , David L. A. Gaveau<sup>15,16</sup> , Janina Grabs<sup>17</sup> , Aida Greenbury<sup>18,19</sup>, Ibrahim Gulagnar<sup>19,20</sup>, Mansuetus Alsy Hanu<sup>19</sup>, Tony Hill<sup>21</sup>, Marieke Leegwater<sup>22</sup>, Godwin Limberg<sup>23</sup>, Charlotte Opal<sup>24</sup>, Violace Putri<sup>25,26</sup>, Judy Rodrigues<sup>18</sup>, Grant Rosoman<sup>27</sup>, Musnanda Satar<sup>28</sup>, Su Sin Sheun<sup>18</sup>, Rukaiyah Rafik<sup>29</sup>, Sarah Walen<sup>30</sup>, and Kimberly M. Carlson<sup>13,31,\*</sup> 

As actors in tropical agricultural commodity supply chains implement commitments to end deforestation, they risk exacerbating social inequities by excluding smallholder farmers, who are important producers of many tropical commodity crops. Here, we explore the potential for independent oil palm smallholders in Indonesia to participate in zero-deforestation supply chains. We find that these smallholders are underrepresented in the share of zero-deforestation compliant oil palm production. We then synthesize perspectives from key actors in the oil palm industry including smallholders and their representatives, palm oil producing and consulting companies, nongovernmental organizations, and academic researchers. Based on these perspectives, we find that challenges to smallholder supply chain participation include limitations in knowledge (e.g., smallholders may not know the location of protected forests), institutional issues (e.g., absence of trust between oil palm growing companies and smallholder farmers), and financial constraints (e.g., the opportunity cost of not clearing forest). To address these shortcomings, we encourage oil palm growing and milling companies to take the lead on incentivizing, supporting, and facilitating smallholder participation in zero-deforestation

<sup>1</sup> Science for Nature and People Partnership, National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, Santa Barbara, CA, USA

<sup>2</sup> Environmental Studies Program and Bren School of Environmental Science & Management, UC Santa Barbara, Bren Hall, Santa Barbara, CA, USA

<sup>3</sup> Forest Peoples Programme, Moreton-in-Marsh, UK

<sup>4</sup> Goodhope, Jakarta, Indonesia

<sup>5</sup> PT Evans Indonesia, Jakarta, Indonesia

<sup>6</sup> Wildlife Conservation Society, Forest and Climate Program, Bronx, NY, USA

<sup>7</sup> Wild Asia, Kuala Lumpur, Malaysia

<sup>8</sup> PT REA Kaltim Plantations, East Kalimantan, Indonesia

<sup>9</sup> International Wildlife Conservation, National Wildlife Federation, Washington, DC, USA

<sup>10</sup> Climate Program, World Resources Institute, Washington, DC, USA

<sup>11</sup> Department of Environmental Studies, Dartmouth College, Dartmouth, NH, USA

<sup>12</sup> The Nature Conservancy, Global Science Division, Montpelier, VT, USA

<sup>13</sup> Department of Natural Resources and Environmental Management, University of Hawai'i at Mānoa, Honolulu, HI, USA

<sup>14</sup> National Research and Innovation Agency (BRIN), Jakarta Pusat, Jakarta, Indonesia

<sup>15</sup> TheTreeMap, Montpellier, France

<sup>16</sup> Jeffrey Sachs Center on Sustainable Development, Sunway University, Petaling Jaya, Selangor, Malaysia

<sup>17</sup> Department of Society, Politics and Sustainability, ESADE Business School, Universitat Ramon Llull, Barcelona, Spain

<sup>18</sup> High Carbon Stock Approach Foundation, Kuala Lumpur, Malaysia

<sup>19</sup> Serikat Petani Kelapa Sawit, Bogor, Indonesia

<sup>20</sup> Proforest Indonesia, Jakarta, Indonesia

<sup>21</sup> Proforest, Oxford, UK

<sup>22</sup> Solidaridad Utrecht, Utrecht, The Netherlands

<sup>23</sup> Daemeter Consulting, Samarinda, Indonesia

<sup>24</sup> Earthworm Foundation, Nyon, Switzerland

<sup>25</sup> Solidaridad Indonesia, Jakarta, Indonesia

<sup>26</sup> Daemeter Consulting, Bogor, Indonesia

<sup>27</sup> Global Forest Solutions, Greenpeace International, Christchurch, New Zealand

<sup>28</sup> Yayasan Konservasi Alam Nusantara, Jakarta, Indonesia

<sup>29</sup> FORTASBI, Kota Bogor, Jawa Barat, Indonesia

<sup>30</sup> Meridian Institute, Silver Plume, CO, USA

<sup>31</sup> Department of Environmental Studies, New York University, New York, NY, USA

\* Corresponding author:  
Email: [kimcarlson@gmail.com](mailto:kimcarlson@gmail.com)

initiatives. Specifically, these companies could build and use their technical and political resources to identify and map all forests in their entire supply shed and ensure small producers have land rights that enable participation in zero-deforestation supply chains. These policy levers would need to be combined with economic incentives such as access to improved inputs or price premia for their products. However, we caution that smallholder integration into existing zero-deforestation supply chains alone is unlikely to result in significant additional forest conservation at scale in Indonesia due to selection bias, leakage, and existing land tenure norms. Community-led and jurisdictional or landscape-scale supply chain initiatives that acknowledge multi-commodity production are more likely to provide equitable and just avenues for Indonesian smallholder farmers to steward forest resources.

---

**Keywords:** Private sustainability governance, Social responsibility, Tropical commodity crops, Leakage, Land tenure, Selection bias

---

## 1. Introduction

Production of agricultural commodities including beef, soy, palm oil, and cocoa is driving rapid loss of the world's tropical forests (Curtis et al., 2018; Pendrill et al., 2022). This loss threatens biodiversity (Alroy, 2017) and accelerates climate change (Mitchard, 2018). Over time, across commodities and regions, various actors—ranging from small farmers to capitalized corporations—have undertaken such tropical deforestation for agriculture (Rudel et al., 2009; Godar et al., 2014; Austin et al., 2019). Achievement of thus-far elusive global forest conservation goals (United Nations Development Program, 2014; NYDF Assessment Partners, 2019) therefore requires that policies and programs intended to reduce forest loss address the diversity of agricultural producers across tropical forest frontiers.

Recent corporate “zero-” or “no-” deforestation commitments by commodity traders, producers, and retailers to end forest loss associated with the products that they handle represent one set of private policies that aspire to reduce deforestation (Garrett et al., 2019; Rothrock et al., 2019; Lambin and Furumo, 2023). To help firms act upon their commitments, diverse implementation mechanisms that map and monitor forests, verify deforestation, and enforce sanctions have been developed (Lambin et al., 2018; Accountability Framework, 2023; Bager and Lambin, 2022). For example, companies operating in Brazil's soy sector have implemented their commitments through a single sectoral standard and associated monitoring system with sanctions for producers who planted soy on lands deforested after a predetermined cutoff date (Austin et al., 2021). In contrast, many companies in the palm oil sector have executed their pledges through individualized mixes of forest identification, monitoring, and enforcement systems (Lyons-White and Knight, 2018). In aggregate, these varied implementation mechanisms represent a complex set of internal corporate policies, sectoral standards, and reporting practices that contribute to policy mixes attempting to govern the sustainability of supply chains (Lambin et al., 2018; Lambin and Furumo, 2023).

Such corporate implementation of zero-deforestation commitments imposes new requirements on local production networks, including smallholder farmers (McCarthy,

2012; McCarthy et al., 2012; Grabs et al., 2021; Grabs and Garrett, 2023). Smallholder farms of <2 hectares comprise about one-third of global agricultural land (Ricciardi et al., 2018). Smallholders are especially important in the production of tropical forest-risk commodity crops (Pendrill et al., 2019) including cocoa (70% of global production) (Voora et al., 2019a), oil palm (40% of global production) (Voora et al., 2019c), rubber (>70% of global production) (Carr, 2012), and coffee (67%–80% of farms in developing countries) (Voora et al., 2019b).

In some contexts (e.g., cocoa in West Africa), smallholder farmers are also the primary agents of deforestation (Ordway et al., 2017; Carodenuto, 2019). Because smallholders contribute to deforestation, including them in zero-deforestation supply chains is important for arresting forest loss (Austin et al., 2017; Schoneveld et al., 2018; Gaveau et al., 2022; Grabs et al., 2021; Grabs and Garrett, 2023). In addition, corporate pledges to end deforestation and the tools used to implement them typically include social goals, reflecting a recognition that socioeconomic well-being and human rights are an integral part of sustainability (Accountability Framework, 2023). However, requirements of zero-deforestation supply chains may not align with the knowledge, skills, financial capital, land tenure, and/or human resources held by smallholder producers (Lee et al., 2012; Brandi et al., 2015; Garrett et al., 2016). As a result, zero-deforestation commitment implementation may limit smallholder participation in zero-deforestation compliant markets (Jopke and Schoneveld, 2018; Zhunusova et al., 2022).

Indeed, companies claim that tracing purchases back to thousands of smallholders poses a major logistical and financial obstacle to realizing zero-deforestation commitments (Kuala Lumpur Kepong Berhad, 2018; Lyons-White and Knight, 2018). Moreover, as a company sources from more producers, each of whom might be participating in deforestation, it potentially incurs greater reputational risk (Harland et al., 2003). Some companies have chosen to modify their approaches in response to this tension between their environmental and social goals (Grabs and Garrett, 2023). For example, in the palm oil sector, Nestlé argued that delaying its zero-deforestation commitment implementation target from 2020 to 2022 was necessary to retain smallholder producers within its supply chain

(Chandrasekhar, 2019). In contrast, Mars has chosen to restrict purchases to a smaller number of large suppliers to demonstrate progress toward its zero-deforestation commitment (Cosgrove, 2020; MARS, 2022), likely shifting its purchases away from smallholders. Indeed, an analysis of dozens of zero-deforestation commitments suggests that companies rarely seek to maintain prior sourcing relationships with smallholders when implementing their pledges (Jopke and Schoneveld, 2018). Although prior research indicates that smallholder producers remain underrepresented in sustainably certified supply chains (Bush et al., 2013; Garrett et al., 2016), empirical evaluations of rates and determinants of smallholder participation in zero-deforestation compliant supply chains remain limited (Newton and Benzeev, 2018; Grabs et al., 2021).

A failure to integrate smallholders into supply chains covered by zero-deforestation commitments may negatively affect rural livelihoods, consolidate market power among companies, and displace deforestation from industrial to smallholder actors (Alix-Garcia and Gibbs, 2017; Austin et al., 2017; Newton and Benzeev, 2018; Heilmayr et al., 2020). Conversely, smallholder inclusion in these initiatives may benefit both livelihood and conservation outcomes (Garrett et al., 2021). For instance, companies seeking to reduce nearby smallholder expansion into forests might be more likely to carry out training or incentive programs to increase yields (Anggraini and Grundmann, 2013; Brandi et al., 2015; Piñeiro et al., 2020). Smallholders may also reap direct financial benefits in the form of price premia from selling products that comply with zero-deforestation commitments (Schouten and Glasbergen, 2011).

To ensure more equitable implementation of zero-deforestation commitments, new assessments of the barriers preventing smallholder participation in zero-deforestation initiatives, as well as policy recommendations to overcome those barriers, are needed. Such information is especially important considering government-imposed due diligence requirements for companies to demonstrate compliance with zero deforestation, such as the European Union regulation on deforestation-free products (European Parliament and Council of the European Union, 2023). Here, we undertake such an assessment, using independent smallholders in the Indonesian palm oil sector as our focus. In the following sections, we first explain the policy context of smallholder oil palm production and corporate zero-deforestation commitments in Indonesia. We then synthesize the information generated from a 2019 workshop in Indonesia in which most coauthors participated to detail the challenges faced by independent oil palm smallholders in zero-deforestation supply chains. We conclude with a set of policy recommendations that would address these challenges to achieve more expansive, equitable, and just zero-deforestation production landscapes.

## 2. Policy context

### 2.1. Palm oil producers in Indonesia

Palm oil is the world's most prevalent vegetable oil, and Indonesia is the leading producer of palm oil globally

(Meijaard et al., 2018), with about 12.1–16.2 million hectares cultivated in 2019 (Descals et al., 2021; General Directorate of Estate Crops, 2021; Gaveau et al., 2022). In Indonesia, oil palm is either grown on large-scale plantations controlled by private or state corporations (around 59%–67% of Indonesian oil palm area in 2019) or on private noncorporate holdings, including those managed by smallholder farmers (33%–41% of Indonesian oil palm area in 2019) (Descals et al., 2021; General Directorate of Estate Crops, 2021; Gaveau et al., 2022). Fresh fruit bunches are harvested from palms throughout the year and are transported to palm oil mills owned by the corporations that control large-scale plantations. Because fruits must be processed within 24–48 h of harvest (Heinimann, 2020), oil palms must be located near palm oil mills. Oil palm producers without mills therefore require nearby mills to provide a market for their fruits, and some mills also depend on fruit supply from noncorporate holdings.

Noncorporate oil palm producers are diverse (Jelsma et al., 2017; Meijaard et al., 2018). They include “tied” or “scheme” oil palm farmers who have binding contracts or credit arrangements with palm oil mills, and “independent” producers who undertake oil palm cultivation independent from a corporate grower or mill. For tied producers, land management activities, including site selection, land development, fertilizer application, and fruit harvest are often undertaken by the company, not the farmer (Cramb and McCarthy, 2016). Any zero-deforestation commitment implementation activities carried out by a company should be applied to their tied producer lands. Therefore, zero-deforestation initiative implementation is unlikely to lead directly to exclusion of tied producers from supply chains and may also be associated with fewer additional benefits to these producers. Here, we focus attention on independent producers, noting that some individuals manage both tied and independent oil palm plantings.

Independent producers are not obligated to sell their produce to any single buyer but often sell to intermediaries who aggregate fresh fruit bunches and transport and sell them to a mill (Bakhtary et al., 2021; zu Ermgassen et al., 2022). Such transportation systems benefit farmers who do not have access to vehicles or time to transport their product to a mill. Producers in this independent category range from smallholder farmers with limited landholdings and substantial dependence on oil palm for their rural livelihoods to well-capitalized city-dwelling absentee landlords and local elites who have operations similar to corporations (Jelsma et al., 2019; Li, 2024). Given our focus on identifying pathways that would enable zero-deforestation supply chains to support poverty reduction, we focus on independent smallholder farmers, rather than these wealthier, noncorporate independent oil palm producers.

In Indonesia, various organizations have attempted to distinguish between such independent smallholders and other actors based on the size of their landholdings and other characteristics. Both the Indonesian Oil Palm Farmers' Union and the High Carbon Stock Approach (HCSA)

smallholder toolkit consider independent smallholders in Indonesia to be those who farm <10 hectares of oil palm and who live near and work their land (Serikat Petani Kelapa Sawit, 2020; HCSA, 2023). The Indonesia interpretation of Roundtable on Sustainable Palm Oil's (RSPO) standard for independent smallholders only applies to farmers with <20 hectares of agricultural land, in accordance with Indonesian law (RSPO, 2022a). The RSPO's 2018 Principles and Criteria define smallholders as farmers with up to 50 hectares if the family provides most of the labor and the farm is the principal source of income (RSPO, 2018). Rather than adopt a single definition of an independent smallholder oil palm farmer, we recognize that conservation and socioeconomic implications of including or excluding independent producers in zero-deforestation supply chains are likely to vary depending on the characteristics of the producer. For example, it is possible that ensuring that producers who control substantial land areas (e.g., >25 hectares) are compliant with expectations of zero-deforestation programs may provide the most benefit for conservation because these producers are more likely to clear larger areas of forest. However, given that these larger properties are often controlled by urban investors and local elites (Jelsma et al., 2019; Li, 2024), integrating these producers into zero-deforestation supply chains might do less to alleviate poverty.

Independent oil palm smallholder lands in Indonesia are characterized by diverse tenurial claims (Simarmata et al., 2021), including nationally recognized certificates and usufruct or inheritance rights recognized by local communities but not by governments. In many cases, these land claims conflict with national regulations. In 2019, interpretation of satellite remote sensing data suggests that about 26% of smallholder oil palm was located in area designated as State Forest or *Kawasan Hutan* (1.56 million hectares smallholder palm in State Forest/5.92 million hectares smallholder palm in Indonesia) (Greenpeace, 2021; Gaveau et al., 2022), where farmers cannot get title for their land so do not meet typical zero-deforestation supply chain legality standards (Jelsma et al., 2017; Larsen et al., 2018). There are multiple reasons for the existence of smallholder oil palm in State Forest, including encroachment into protected areas by local businesspeople (Rainforest Action Network, 2022), displacement of smallholders dispossessed of their land by oil palm companies (Li, 2019), and designation of customary community land by the Indonesian government as State Forest (Peluso and Vandergeest, 2001; Siscawati et al., 2017). Regardless of the cause, the overlap between State Forest and smallholder oil palm means that many independent smallholders lack the land rights required for direct engagement with certain zero-deforestation supply chains due to legality requirements (Bakhtary et al., 2021).

## **2.2. Zero-deforestation commitment implementation mechanisms in Indonesia's palm oil sector**

In Indonesia, from 2000 to 2019, remote sensing suggests that around 29% of all deforestation (2.8 million hectares)

was due to oil palm expansion (Gaveau et al., 2022). Around 76% of all oil palm associated deforestation (22% of all deforestation) was related to expansion of industrial oil palm, while 24% (7% of all deforestation) was from expansion of smallholdings (Gaveau et al., 2022). Due to the critical role of industrial oil palm in driving deforestation in Indonesia, in the early 2010s, several civil society organizations pressured oil palm companies to develop no-deforestation pledges (Grabs and Garrett, 2023). By 2020, around 80% of Indonesian palm oil exports were covered by zero-deforestation commitments (Trase, 2020).

Circa 2020, companies in the Indonesian palm oil sector used several mechanisms to implement their zero-deforestation commitments. Implementation mechanisms are the systems and processes that an organization applies to carry out its zero-deforestation commitment. These mechanisms are sometimes defined by the corporate commitment itself. For instance, Musim Mas (2021) pledged that “mills [...] are fully [No Deforestation no Peat no Exploitation—NDPE] compliant through POIG [Palm Oil Innovation Group] and/or RSPO assurance procedures and adherence to HCSA requirements.” In other cases, generic commitment language allows a firm to determine how to best act on its pledge, such as the promise by L'ORÉAL (2014) that “100% of palm supply will be free from deforestation.” Here, we separate these implementation mechanisms into 3 broad categories—forest identification methodologies, verification systems, and grievance systems to report and rectify noncompliances (Table 1).

*Forest identification methodologies* map the location of forests that need to be avoided for a producer to comply with a zero-deforestation commitment. The primary examples in the palm oil sector are High Carbon Stock (HCS) Approach assessments, the High Conservation Value (HCV) method, and their integrated methodology (HCS–HCV). Around 90% of zero-deforestation commitments for companies with high-deforestation risk across all sectors rely on the HCV approach, while about two-thirds apply the HCS Approach methodology to identify forests (Garrett et al., 2019). Companies may also use custom approaches offered by private parties.

*Verification systems* proactively demonstrate a company's compliance with a zero-deforestation commitment. This may occur through audits conducted by the company (“first-party verification”), independent consultants hired by the company (“second-party verification”), or accredited third-party organizations (“third-party verification”). Downstream buyers can, in turn, meet their own zero-deforestation commitments by restricting their sourcing to these verified producers or doing their own audits of supplier operations. Companies with oil palm-specific zero-deforestation commitments often state that they will use RSPO certification, a form of third-party verification, as their implementation mechanism (Garrett et al., 2019), while others have chosen to demonstrate compliance via the HCSA and HCV Network quality assurance processes (Soetjiadi et al., 2023). Still others use a custom approach to verification, which may include following the HCS

**Table 1. Implementation mechanisms widely used by companies with zero-deforestation commitments in the Indonesian palm oil sector**

Type	Name	Description	Independent Smallholder Engagement
Forest identification methodologies	High Carbon Stock (HCS) approach	Used to identify forested areas for protection using a combination of satellite remote sensing and fieldwork. Has been mainly implemented by large-scale oil palm and pulp and paper growers in Indonesia (High Carbon Stock Approach [HCSA], 2017).	Requires that companies undertaking the approach complete a land-use study to identify community lands including those held by independent smallholders. Any lands used by the company for commodity production should be acquired via free, prior, and informed consent. In 2023, a simplified HCS–HCV Approach for smallholders was published for Indonesia (HCSA, 2023).
	High Conservation Value (HCV) method	Used to identify and protect areas of high conservation value including certain forested areas, using a field-based approach (High Conservation Value Resource Network, 2021).	Requires conservation of certain lands used by local community residents, including lands that provide ecosystem services (e.g., flood control) and those that are critical to meet basic needs and support cultural identities (e.g., graveyards). HCV identification must be undertaken with free, prior, and informed consent from communities.
	Custom methodologies	Commonly used approaches include Starling satellite technology (Earthworm Foundation, 2019), Global Forest Watch Pro (pro.globalforestwatch.org), Nusantara Atlas (nusantara-atlas.org), Maphubs (www.maphubs.com), and Satelligence (satelligence.com).	Depends on company and methodology applied.
Verification systems	RSPO Certification	A comprehensive certification system that applies annual third-party audits to ensure that producers comply with a set of social, environmental, and economic criteria. The system has always required identification and protection of HCVs, with a clearance cutoff date of 2005 (RSPO, 2015). In 2018, the RSPO incorporated the HCS approach into its certification standard (RSPO, 2018); in 2019, it adopted an independent smallholder standard (RSPO, 2019).	Offers a system for group certification of FFB production, which is applicable to independent smallholders (RSPO, 2022c). Requires the free, prior, and informed consent of affected communities for land acquisition by companies and fair and transparent dealings with independent smallholders by certified companies. Information on the location, ownership status, and operating license of lands producing oil palm fruit, including those managed by smallholders, must be available from certified mills. A simplified HCV approach for smallholders is available and a risk-based approach has been adopted to identify low-risk lands (i.e., those unlikely to contain forest or HCVs) that can be cleared (RSPO, 2022b).
	HCSA and HCV quality assurance process	The HCSA offers a quality assurance process that applies external review to HCSA or HCV–HCSA assessments to evaluate whether they meet the standards of HCV and HCSA methods. This process involves review of the assessment either by peer reviewers who provide recommendations but do not pass or fail the assessment or by the HCV Resource Network Assessor Licensing Scheme, which is a pass/fail system. The HCSA uses a 2015 cutoff date for HCS forest clearance (HCSA, 2022) and has been recognized by the Accountability Framework as a tool for implementing zero-deforestation commitments (Accountability Framework, 2019).	Does not specifically engage with independent smallholders except to evaluate whether the assessment has met the requirements of the HCSA (and in some cases HCV) methods.

(continued)

**Table 1.** (continued)

Type	Name	Description	Independent Smallholder Engagement
	Custom verification systems	Forest monitoring and deforestation verification are undertaken by commodity companies, often in collaboration with consultants and advocacy organizations. Commonly used systems include Starling satellite technology (Earthworm Foundation, 2019), Global Forest Watch Pro (pro.globalforestwatch.org), Nusantara Atlas (nusantara-atlas.org), Maphubs (www.maphubs.com), and Satelligence (satelligence.com). Assessments are rarely made publicly available.	Depends on company and methodology applied.
Grievance Systems		Systems that allow for stakeholder-led monitoring of commitments through a combination of sourcing transparency and grievance reporting mechanisms (e.g., Wilmar's grievance procedure for the implementation of its No Deforestation, No Peat, No Exploitation Policy; Wilmar International, 2015). Grievance systems have been adopted by the RSPO and HCSA (2021), as well as oil palm growers and palm oil buyers, with variable thoroughness in subsequent grievance resolution. These systems typically rely upon well-resourced advocacy organizations (e.g., Mighty Earth) to monitor land-use changes and submit claims.	Given the need to decisively link deforestation events to perpetrators and, subsequently, to buyers' supply chains, grievances raised as of 2023 have almost exclusively focused on deforestation or human rights issues on corporate concessions, rather than independent smallholders. Rare reports (e.g., Eyes on the Forest, 2018) have raised grievances about mills, rather than concessions, which could affect independent smallholders' market access.

Not all companies that use these approaches necessarily have zero-deforestation commitments. For instance, many oil palm mills certified by the Roundtable on Sustainable Palm Oil (RSPO) have no zero-deforestation commitment.

and/or HCV methodologies or undertaking verification through partnerships with a consultant or advocacy organization.

*Grievance systems* invite external scrutiny of commitments through publicly transparent sourcing and a “grievance” mechanism through which external groups can report deforestation or other corporate policy violations. If a claim is found valid upon review, the company should adjust its behavior or engage with the supplier in question to enforce stop work orders and deforestation moratoria for their plantation concession areas. If a supplier refuses to change their behavior, a downstream company may “close” the grievance by excluding the noncompliant company from their supply chain (Grabs et al., 2021).

### **2.3. Smallholder integration into zero-deforestation supply chains**

Despite the widespread adoption of zero-deforestation pledges in the Indonesian palm oil sector, independent smallholders are rarely integrated into zero-deforestation supply chains. We consider independent smallholders to be “integrated” or “included” in zero-deforestation supply chains when: (1) they produce a product (in this case, oil palm fresh fruit bunches) that is fully compliant with one or more zero-deforestation initiatives; and (2) the physical good (e.g., fresh fruit bunches) or the attributes of the good (e.g., via sale of certificates or traceability evidence) are recognized or verified as being compliant with the initiative upon sale to the purchaser.

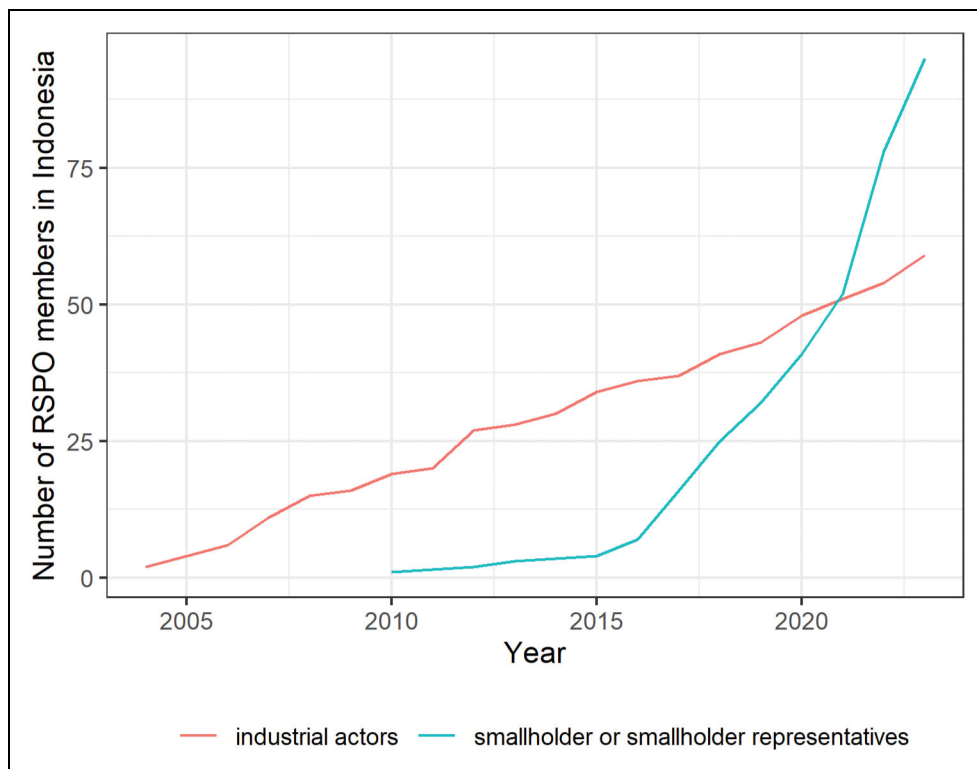
The rate of independent smallholder certification by the RSPO verification system continues to lag far behind the large-scale grower company certification rate (Hutabarat et al., 2019; Apriani et al., 2020). About 1% of RSPO certified oil palm area in Indonesia was managed by independent smallholders in 2021 (26,839/2,307,057 hectares total certified) (RSPO, 2020b). As of December 2023, the HCSA standard for independent smallholders has only been applied to 27,000 hectares in 7 villages of West Kalimantan (HCSA, 2023). In contrast, 109 HCSA or HCV–HCSA assessments had been completed for concessions or tied smallholder groups supported by oil palm companies in Indonesia (HCSA, 2024). We have no information on the degree to which smallholders are included in custom verification systems. Since corporate procurement strategies often ignore indirect sourcing (zu Ermgassen et al., 2022), widespread extension of verification systems to independent smallholders in oil palm supply chains is currently unlikely. However, this may change with the implementation of mandatory due diligence requirements adopted by importing regions, such as the European Union regulation on deforestation-free products. Such regulations compel companies to take responsibility for their supply chains (Zhunusova et al., 2022) and may move smallholders themselves to achieve compliance with such regulations (Serikat Petani Kelapa Sawit, 2022).

The low degree of smallholder integration into *verified* zero-deforestation supply chains does not mean that smallholders cannot sell their product to oil palm mills covered by zero-deforestation commitments, or that they

are excluded from oil palm supply chains (zu Ermgassen et al., 2022). Many mills with RSPO certification, mills associated with concessions that have undergone HCSA assessments, and those covered by zero-deforestation commitments that are implemented through grievance mechanisms purchase fresh fruit bunches from independent smallholders. Indeed, given the need to convincingly link deforestation events to producers in a committed company’s supply chain for grievances to be deemed as valid, thus far grievance-based systems have focused mostly on deforestation within concessions. They have largely ignored land-use changes outside of concessions with exceptions for oil palm encroachment into protected areas (e.g., Greenpeace, 2021). This allows independent smallholders to remain in zero-deforestation supply chains without being subject to HCV or HCSA assessments or other similar initiatives. However, as companies and stakeholders increasingly turn their attention to deforestation outside of concessions, as evidenced by the Palm Oil Collaboration Group’s “Production and Protection Beyond Concessions Working Group” (Palm Oil Collaboration Group, 2021), smallholders might be at a disadvantage if they cannot provide assurance that they do not deforest.

### **2.4. Smallholder inclusion in zero-deforestation initiative governance**

These low rates of smallholder integration into zero-deforestation supply chains persist despite ongoing efforts to include smallholders in the governance of zero-deforestation implementation bodies such as the RSPO and HCSA. These efforts reflect a recognition that the presence of smallholders within governance processes can affect the extent to which such producers can shape system standard setting and implementation in ways that yield tangible benefits for them (Cheyns, 2011; Bush et al., 2013; Pichler, 2013; Rietberg and Slingerland, 2016; Larson et al., 2021). In the RSPO, voting members approve implementation standards. In 2023, based on our analysis of RSPO membership data (RSPO, 2023a), about 62% of voting Indonesian RSPO members ( $n = 155$  members) represented smallholder organizations or their interests. Although smallholders were not well-represented in the first 10 years of the RSPO, by 2021 smallholder and smallholder advocacy organization representation in Indonesia’s RSPO membership had surpassed that of industrial grower representation (**Figure 1**). Nevertheless, just one position on the 16-member RSPO Board of Governors is reserved for a smallholder representative (6% of positions) (RSPO, 2023b), and independent smallholders are rarely part of working groups and committees that develop the RSPO standard. The HCSA is governed by an executive committee that includes a spot for a representative from smallholder/farmer groups or their support organizations. We were not able to directly evaluate the contribution of smallholders to the governance of custom approaches to zero-deforestation verification. Since smallholder producers have little influence over the decisions of palm oil mills or downstream corporations, it is unlikely that they participate in program governance.



**Figure 1. The prevalence of smallholders and their advocates or industrial oil palm growers from 2004 to 2023 in Roundtable on Sustainable Palm Oil (RSPO) voting membership from Indonesia.** The number of smallholder members surpassed industrial grower members in 2021. Data represent all “ordinary” Indonesian RSPO members in the sectors of “Oil Palm Growers” categorized as smallholders or industrial actors based on information in the member profile and “NGO” categorized as smallholder advocates based on the NGO name downloaded from RSPO (2023a) in June 2023. Members in other parts of the supply chain—including traders and processors, consumer goods manufacturers, and banks—as well as members based in countries outside of Indonesia but with operations in Indonesia, are not included here.

### 2.5. Smallholder-specific sustainability programs

All verification systems have also, to some degree, foregrounded smallholder oil palm farmers through development of smallholder-specific programs, standards, processes, and direct financial support. In 2006, the RSPO set up a task force designed to encourage smallholder participation (RSPO, 2006). By 2009, the RSPO had launched a standard that allowed independent smallholders to form groups and gain certification (RSPO, 2010). In 2019, the RSPO developed a certification standard specifically designed for independent smallholders (RSPO, 2019). This standard is intended to reduce the need for laborious and technically demanding field assessments required of larger companies by allowing independent smallholder groups to use a risk-based approach. A combined, simplified HCS–HCV approach is being drafted to further streamline this process (RSPO, 2020c), and the RSPO has provided trainings to improve smallholders’ capacity to meet sustainability standards via their Smallholder Training Academy. In addition, the RSPO’s smallholder support fund has provided financial assistance to independent smallholders undertaking certification activities.

The HCSA developed a simplified HCS–HCV approach for smallholders based on trials in the province of West Kalimantan, Indonesia (HCSA, 2023). This approach aims

to integrate smallholders into zero-deforestation supply chains by supporting them to implement the HCV and HCS forest identification methodologies.

Custom zero-deforestation supply chain initiatives have also aided smallholders. In Kotawaringin Barat district, Central Kalimantan province, Unilever has supported activities to help oil palm smallholders while protecting forests across several villages (Unilever, 2017). Activities included RSPO certification of oil palm smallholders and helping smallholders obtain the documentation needed to ensure legality (e.g., land titles). In Aceh Tamiang district, a coalition that includes oil palm producing companies has supported extension officer training, clarified land titles, and conducted HCV and HCS assessments, among other activities (Demopoulos and Indrarto, 2021). A comprehensive review of such activities across oil palm companies and regions would be a welcome contribution and might highlight regional and corporate gaps in such outreach activities.

### 3. Transdisciplinary perspectives on smallholder integration in zero-deforestation supply chains

Above, we established that in Indonesia, independent oil palm smallholders are increasingly represented in the governance of major zero-deforestation commitment



verification initiatives, and that zero-deforestation commitment implementation mechanisms originally created for large-scale growers are now being adapted for smallholder producers. Yet, we found that smallholders remain underrepresented in the share of compliant verified production coming from these initiatives in the palm oil sector. In the next sections, we (1) develop greater understanding of the linked challenges of independent smallholder inclusion in zero-deforestation supply chains and reduced deforestation from oil palm expansion and (2) present policy recommendations to address both challenges. To do so, we draw from information collected during an April 2019, 2-day expert workshop focused on zero-deforestation supply chains and independent oil palm smallholders in Yogyakarta, Indonesia, coupled with development of arguments and understandings via collective iterative writing by all manuscript coauthors.

### 3.1. Expert workshop

Coauthors KMC, ME, and RH organized and facilitated the workshop with the understanding that research into transdisciplinary environmental and sustainability challenges benefits from the perspectives and diverse expertise and experiences of those living and working within impacted landscapes (Lang et al., 2012). Specifically, merging science and society in the research process helps with complex problem identification, enhances information exchange, and supports buy-in for potential solutions (Ravnborg and Westermann, 2002; Leventon et al., 2016). Moreover, integration of different types of expertise in these complex problems ensures that research outcomes are not only robust but also relevant and responsive to the concerns of those directly impacted by environmental problems (Phillipson et al., 2012; Bracken et al., 2015). Finally, to address smallholder integration into upgraded supply chains, coproduction of appropriate mechanisms is important to enhance the legitimacy of these procedures among both companies and smallholder farmers (Dawson et al., 2021; Grabs et al., 2021).

The workshop organizers sought participants based on their prior experience implementing zero-deforestation commitments, advocating on behalf of or working as independent oil palm smallholders, and/or researching social and environmental sustainability initiatives in the Indonesian palm oil sector. Facilitators aimed to assemble a group with a variety of perspectives, prioritizing diversity in participant gender and profession. Organizers identified participants by using internet searches, inquiries via personal networks, and review of relevant publications. The professional affiliations of the workshop participants included representatives from an Indonesian oil palm smallholder cooperative ( $n = 1$  person), smallholder farmers' union ( $n = 2$ ), oil palm growing corporations ( $n = 2$ ), environmental and/or social sustainability advocacy organizations ( $n = 8$ ), sustainability consulting firms ( $n = 2$ ), standard-setting bodies ( $n = 3$ ), and academic institutions ( $n = 4$ ). At least 11 participants had extensive field experience in Indonesian oil palm plantations and/or working with smallholders, and at the time of the workshop, 9 were living in Indonesia. Most workshop participants are

coauthors (participants who did not provide input on the manuscript when invited were not included as coauthors), but not all coauthors were workshop participants (ADE, JG, and DLAG did not attend the workshop).

As described earlier, oil palm farmers in Indonesia are highly diverse, and there was only one smallholder oil palm farmer in attendance. Yet, since at least 9 of the other participants worked directly with smallholders or managed programs designed to support smallholders, and because few zero-deforestation supply chain initiatives beyond RSPO certification had been implemented among smallholders as of 2019, we believe that the workshop captured the breadth of major independent smallholder perspectives on zero-deforestation supply chains in Indonesia available at the time.

Workshop organizers facilitated a set of presentations by some participant coauthors, followed by full-group and small-group discussions around research questions with all participant coauthors. The meeting was simultaneously translated in Indonesian and English. Before the meeting, participants prepared presentations with responses to the following questions. Oil palm smallholders ( $n = 1$  presentation), a smallholder farmers' union ( $n = 1$ ), and consulting companies that work closely with smallholders ( $n = 1$ ) were asked: "What barriers have smallholder growers experienced as a result of zero-deforestation commitment implementation?" and "What new opportunities have emerged for smallholder growers as a result of corporate sustainability commitments?" Oil palm growers ( $n = 2$  presentations) and civil society organizations that work with growers ( $n = 2$ ) were asked: "How have companies sought to support smallholders during their implementation of sustainability standards?" and "What challenges do companies face as they try to integrate smallholders into their zero deforestation and/or sustainably certified operations?" Civil society organizations that work with smallholders ( $n = 4$  presentations) were asked: "What specific challenges prevent smallholder inclusion in zero-deforestation supply chains?" and "What solutions are you pursuing to ensure just, inclusive and sustainable supply chains?" After these presentations, all participants developed responses to the following questions: "How can small producers and local communities protect forests outside of [oil palm] concessions?" "What does it mean to be a zero-deforestation smallholder?" "What kinds of incentives would be most effective at encouraging forest conservation outside of industrial concessions, and why?" and "How can landscape scale HCS forest maps support smallholder inclusion?"

### 3.2. Development of arguments from workshop content

Throughout the workshop, the facilitators collected and compiled written products produced by small groups and took comprehensive notes on presentations, deliberation, and responses. After the workshop, they drew from these materials to develop the initial manuscript draft. First, facilitators compiled the "barriers" and "challenges" as well as the "opportunities" and "solutions" identified by participants who gave presentations in response to initial

**Table 2. Challenges and opportunities for smallholders in the face of zero-deforestation commitment implementation in the Indonesian palm oil sector**

Type	Category	Description
Challenges	Knowledge	Smallholders have limited awareness of how markets are organizing around zero deforestation The location of lands considered biophysical forest under zero-deforestation programs and State Forest by the Indonesian government is unclear Requirements of certification systems used to implement zero-deforestation commitments do not always align with smallholder management approaches The large number of smallholders and high degree of indirect sourcing prevents effective transmission of information between smallholders and companies
	Institutional	Smallholder oil palm production may be illegal, rendering it noncompliant with zero-deforestation initiatives that require legality Independent smallholders are rarely organized as cooperative groups, limiting smallholder participation in zero-deforestation initiatives Low levels of trust between companies and communities enhance other barriers to smallholder inclusion
	Financial	Costs may outweigh benefits of smallholder participation in zero-deforestation supply chains Smallholders and companies face risks that may disincentivize companies from sourcing from smallholders, or smallholders from pursuing compliance with zero-deforestation initiatives
Opportunities		Map and monitor palm oil mill supply shed lands Improve smallholder farmer and community land rights security and land legality Enable zero-deforestation initiative compliant fresh fruit bunch sales by smallholders Offer incentives to encourage smallholder compliance with zero-deforestation initiatives

questions. Then, facilitators grouped similar challenges and opportunities under general themes.

Because of the large number of challenges, workshop organizers grouped them into 3 overarching categories (i.e., knowledge, institutional, and financial challenges). Organizers chose these categories because they play an important role in adoption of voluntary sustainability standards by independent smallholders, including in the palm oil sector (Lee et al., 2011; Brandi et al., 2015). *Knowledge* challenges include limitations with respect to the quality and type of information and skills that smallholders or companies possess. Such knowledge may be gained through experience (e.g., work at an oil palm company) or education (e.g., extension programs offered by the government; peer-to-peer learning). *Institutional* challenges relate to obstacles presented by the systems, including legal, economic, and sociocultural systems, within which smallholders operate. Each smallholder faces a unique set of institutional constraints mediated by the interaction of their own assets and attributes, and the corporations, governments, nongovernmental organizations, and communities around them. Finally, *financial* challenges are associated with the costs, benefits, and risks of integration into a zero-deforestation supply chain. We acknowledge that there is some overlap between these categories (e.g., economies of scale may fall into both the institutional and financial groupings) but still find them useful as tools to organize the information garnered from the workshop.

Organizers then read through notes from workshop discussions and breakout groups to generate additional material under each theme or category. Next, they summarized information within each theme or category and supplemented this with information gathered via a search of the relevant academic literature. They reframed the opportunities as policy recommendations for change by oil palm growing and milling companies. Finally, all coauthors iteratively developed arguments within categories through multiple rounds of manuscript revision. In some cases, we added or expanded categories based on emerging understandings that developed while writing the manuscript. The challenges are presented in Section 4, and the policy recommendations are presented in Section 5.1. Because meeting participants adopted Chatham House Rules, the source of specific quotes and ideas is not provided here.

## 4. Challenges to smallholder integration into zero-deforestation supply chains

### 4.1. Knowledge

Several knowledge challenges prevent or deter independent oil palm smallholders in Indonesia from participating in zero-deforestation supply chains. These relate to market demands, lands considered forested or illegal, managerial knowledge, and supply chains (Table 2). In general, these constraints are in the realm of smallholder knowledge, although companies also face some knowledge limitations.

#### 4.1.1. Smallholders have limited awareness of how markets are organizing around zero deforestation

“How many would-be smallholders [...] are aware of the implications [of acquiring a piece of recently deforested land] for marketing their FFB in 4–5 years’ time?” asked one workshop participant. Lack of market knowledge—including how the market is reorganizing around sustainable production, as well as requirements of specific initiatives—may prevent independent smallholders from planning to meet market demands. Zero-deforestation initiatives often include cutoff dates, after which deforestation is not acceptable or is only acceptable after a fine, offset, or other compensation mechanism. Smallholders who are unaware of program requirements may unknowingly clear forest after the cutoff date, making it difficult to sell their product into supply chains with increasingly stringent conservation constraints. This is particularly relevant for oil palm, which is a perennial crop that takes 3 or 4 years until first harvest and is typically harvested for 20 to 30 years (Corley and Tinker, 2016).

Smallholders must also operate under the uncertainty of potential future demand for products that comply with zero-deforestation agreements and price premia/benefits of compliance (Lee et al., 2011; Hidayat et al., 2018). This uncertainty is greater for smallholders (compared to oil palm growing companies) because these smallholders have little direct influence on the requirements of such programs or their adoption (Pichler, 2013; Rietberg and Slingerland, 2016). Some workshop participants argued that this lack of knowledge is due to poor communication between downstream supply actors and smallholders, so smallholders have had limited ability to plan strategically with respect to zero-deforestation initiatives.

#### 4.1.2. The location of lands considered biophysical forest under zero-deforestation programs and State Forest by the Indonesian government is unclear

“There is no clarity regarding forest boundaries,” according to another participant in our workshop. Even when smallholders recognize that mills supplying zero-deforestation supply chains may not purchase oil palm grown on recently deforested land, they may be underinformed regarding which areas should not be cleared if they wish to meet supply chain requirements. Moreover, smallholders may not be aware of the deforestation history of already-developed land that they acquire through purchase or inheritance (Martens et al., 2020). Smallholders rarely have the training and equipment needed to map forests and land cover change history on their land (Rietberg and Slingerland, 2016), and high-resolution maps identifying areas for conservation may not be readily available for the lands that they wish to cultivate (e.g., lands outside of large-scale concessions). Similarly, smallholders may be unaware of government land designations, especially State Forest, where agricultural development is largely illegal according to Indonesian law (Heilmayr et al., 2020) and therefore may be unacceptable under zero-deforestation programs that require legality. Further, the fact that zero-deforestation initiative definitions of forest that are based on the biophysical characteristics of

vegetation do not fully align with government zoning of forests (e.g., State Forest contains substantial non-forest land covers) can create confusion for small producers (Murdiyarso et al., 2011; Austin et al., 2021).

#### 4.1.3. Requirements of certification systems used to implement zero-deforestation commitments do not always align with smallholder management approaches

When zero-deforestation supply chains are implemented through comprehensive certification systems, participation may require knowledge of management practices and recordkeeping that is uncommon in traditional smallholder production systems. Several presentations identified this as a major barrier for smallholders. This constraint has been well documented in research regarding barriers to smallholder sustainability certification (Lee et al., 2011; Brandi et al., 2015). For example, certification under the RSPO requires that independent smallholders keep records to document their compliance with the RSPO standard (RSPO, 2019). Although civil society organizations and companies assist with independent smallholder training (Apriani et al., 2020; Martens et al., 2020), these support services are available to few independent smallholders (Brandi et al., 2015) because of limitations in funding and, in the case of companies, interest.

#### 4.1.4. The large number of smallholders and high degree of indirect sourcing prevents effective transmission of information between smallholders and companies

The sheer number of individual smallholders poses a major challenge in transmission of information between oil palm mills and smallholder farmers, a challenge identified by 4 presentations. Because many smallholders sell their produce to intermediaries rather than directly to palm oil mills, the origins of smallholder fresh fruit bunches are often obscure in the absence of substantial investment in traceability mechanisms by companies (Lyons-White and Knight, 2018; zu Ermgassen et al., 2020; Bakhtary et al., 2021). Companies with zero-deforestation commitments, or those that sell into supply chains with downstream actors that have zero-deforestation commitments, are struggling to gain sufficient visibility over their supply chain (zu Ermgassen et al., 2022). Moreover, companies may need to communicate information about requirements related to zero-deforestation initiatives to hundreds of farmers with diverse preferences, educational backgrounds, risk profiles, landholdings, and financial resources. Furthermore, companies may differ in their ability and interest in addressing independent smallholder knowledge limitations, although prior research indicates that agricultural extension led by for profit companies can be successful even with smallholders (Gómez et al., 2016; International Finance Corporation, 2016).

### 4.2. Institutional

Workshop participants identified diverse institutional constraints that currently limit smallholder integration into zero-deforestation supply chains, including land status and cover, smallholder organization, and relationships between companies and nearby residents (**Table 2**).

#### 4.2.1. Smallholder oil palm production may be illegal, rendering it noncompliant with zero-deforestation initiatives that require legality

Multiple presentations identified constraints for independent smallholders created by land tenure institutions in Indonesia. First, villages where smallholders reside may be partially or fully located within State Forest (Greenpeace, 2021) making some or all oil palm production by the community illicit and therefore noncompliant with zero-deforestation initiatives that require legality. Unless farmers find and cultivate lands outside of the State Forest, they cannot sell their fresh fruit bunches into zero-deforestation supply chains with strict legality requirements even if these lands meet other zero-deforestation criteria (e.g., not recently deforested) (Azevedo et al., 2015). In many other cases, the Indonesian government has issued long-term (approximately 35 years) concession leases (*Hak Guna Usaha*) to corporations on lands already managed by community members. Even if the concession holding company wishes to respect these community land claims, until the Indonesian government acts to resolve such issues (Ilmar and Assidiq, 2020), farmers cannot acquire title to lands within such concessions.

Scholars have hypothesized that oil palm companies may comply with zero-deforestation initiatives by acquiring and developing “compliant” lands that are considered non-forest under zero-deforestation initiatives (e.g., cleared before a cutoff date), leaving only forested land available to smallholders (Heilmayr et al., 2020). In this case, community members who wish to develop oil palm plantations may only be able to do so on lands that are forested, making their future oil palm production unlikely to be acceptable under zero-deforestation initiatives.

Even when smallholder farmers have secure, customary claims to their land and are eligible to obtain title to this land, the costs associated with land titling can be steep (Apriani et al., 2020). Smallholders are also required to hold a *Surat Tanda Daftar Budidaya* (cultivation registration letter) which states farm boundaries, size, and other attributes. Although local government officials are responsible for issuing these letters, they are often not well-equipped to do so, and consequently in some regions very few smallholders have a cultivation registration letter (Dharmawan et al., 2021). This may also act as a barrier to selling into zero-deforestation supply chains with legality requirements.

#### 4.2.2. Independent smallholders are rarely organized as cooperative groups, limiting smallholder participation in zero-deforestation initiatives

In Indonesia, independent oil palm smallholders are rarely organized as cooperative groups. According to a workshop participant, companies “may see strong [independent smallholder] groups as a threat” because of the greater bargaining power these groups have, and therefore may not wish to help build smallholder organizational capacity. Independent smallholders who are not part of cooperatives are unlikely to be able to participate in zero-deforestation initiatives. First, because the RSPO typically certifies independent smallholders when they are

organized as a group. Second, because smallholder cooperatives are more likely than individuals to deliver oil palm fruits directly to mills, avoiding the traceability problems that arise when using intermediary traders (described in Section 4.1.4). In the rare cases where smallholders are organized into groups, these groups might be inclined to exclude peers with forests on their land because of the extra documentation and oversight it could trigger or prohibitions on the whole group if the forests are cleared.

#### 4.2.3. Low levels of trust between companies and communities enhance other barriers to smallholder inclusion

Other institutional barriers were related to relationships between companies and communities with oil palm smallholders. Due to frequent company–community conflicts in the palm oil sector (Levang et al., 2016; Naylor et al., 2019), communities and companies often have low levels of trust in one another. One workshop attendee stated that there was “[m]istrust over [the] role/objectives of [the] company in collecting data, providing support, [and] promoting sustainability/zero-deforestation . . .” largely generated from unrelated conflicts between the company and residents. Another participant mentioned that mills had low commitment to support smallholder capacity building. Limited trust may prevent communication between companies and communities, exacerbating other barriers identified here.

### 4.3. Financial

Many workshop participants emphasized that independent smallholder integration into zero-deforestation supply chains must be cost-effective. Addressing financial constraints to smallholder inclusion includes balancing the costs and benefits of integration and attending to the risks such integration poses to farmers and corporations (**Table 2**).

#### 4.3.1. Costs may outweigh benefits of smallholder participation in zero-deforestation supply chains

In the workshop presentations, the most salient challenge (i.e., mentioned in the most presentations) was the low net benefit of smallholder integration into zero-deforestation supply chains. Several presenters pointed out that there were few financial benefits and considerable costs to compliance with zero-deforestation requirements.

Ensuring smallholder compliance with zero-deforestation initiatives typically involves substantial resources. These include time to conduct land surveys and organize and maintain documentation, and funds needed to acquire land title and pay auditors or consultants (Hidayat et al., 2016; Rietberg and Slingerland, 2016). Because smallholders often have limited access to capital and credit (Krishna et al., 2017), companies, smallholder advocates, and/or governments typically provide up-front financial resources needed to support these activities (e.g., Apriani et al., 2020). Companies may prefer to exclude smallholders from supply chains rather than pay these up-front and ongoing costs (Brandi, 2017). Over time,

benefits of integration into upgraded supply chains may exceed costs if smallholders are rewarded for compliance through benefit streams such as price premia for their fruit (Hidayat et al., 2016), although workshop participants emphasized that even for sustainably certified palm oil, such price premia are not guaranteed. Smallholders who wish to take advantage of zero-deforestation markets may not be located near mills who either have their own zero-deforestation commitments or sell to traders with such commitments (Trase, 2020), making the transport cost of integration into zero-deforestation supply chains prohibitively high.

Smallholders also face the opportunity cost of not converting forested lands to oil palm (Lee et al., 2011). According to a workshop presentation, “development looks more economically attractive than leaving the forest standing” in parts of Indonesia where demand for oil palm fruit exceeds supply. Moreover, in rural areas, acquiring more land is one way a farmer can increase their income without migrating to another location. More land also offers smallholders the ability to diversify their income sources by planting both subsistence and commodity crops (Netting, 1993).

The cost of smallholder compliance with and integration into zero-deforestation supply chains likely depends on the implementation mechanism used to meet zero-deforestation commitments. Higher costs are likely for a comprehensive certification system like the one offered by the RSPO, and lower costs may occur in cases where companies simply require legality and traceability coupled with large-scale monitoring to ensure that production is not associated with deforestation.

#### 4.3.2. Smallholders and companies face risks that may disincentivize companies from sourcing from smallholders or smallholders from pursuing compliance with zero-deforestation initiatives

Although it was not often discussed during the workshop, coauthors later agreed that risk is another financial concern for both companies and independent smallholders. Companies that choose to integrate smallholders into their zero-deforestation supply chains risk accidentally including illicit products (e.g., fresh fruit bunches grown on land out of compliance with zero-deforestation initiatives) into these product streams. In landscapes with more forest, companies selling to supply chains with zero-deforestation commitments may manage this risk by discouraging independent oil palm expansion (e.g., by never purchasing fresh fruit bunches from outside suppliers). Smallholders who choose to comply with zero-deforestation initiatives may not benefit from their decision due to actions by the company (e.g., a company reneges on their zero-deforestation commitment or decides to stop sourcing from independent smallholders altogether) (Lee et al., 2011).

Smallholders and companies may also have different planning time horizons (Hettig et al., 2016). Smallholders living in precarity may value income generated soon after oil palm development more highly than income in the future, when markets for deforestation-free products may

be better established. Oil palm companies, on the other hand, may apply a lower discount rate to future production and thus more highly value the option of selling their product to deforestation-free markets.

## 5. Recommendations for more equitable and effective zero-deforestation policies

Independent smallholders stand to benefit from integration into zero-deforestation supply chains if the terms of incorporation carefully address the constraints detailed above (**Table 2**). In this section, we outline policy recommendations to address these constraints.

We recognize that oil palm mills and growers perceive that they bear an unjust proportion of the burdens, while accruing few of the benefits, of supply chain sustainability programs (Lambin et al., 2018). In our workshop, some participants expressed that smallholders would prefer that conservation incentives and programs be routed through governments or community groups rather than oil palm companies. Others stated that companies often lack support from local governments, making such routes of support difficult at best. Considering the need for the long-term (e.g., more than decadal) presence of a committed party to ensure continuity across political changes (e.g., elections) (Seymour et al., 2020), and assuming dedication of the oil palm grower or mill to meeting its environmental pledges over such time scales, we argue that oil palm growing and milling companies in partnership with communities should play a central role in facilitating and sustaining conservation efforts implemented through supply chains. Moreover, since oil palm grower and miller company representatives and civil society organizations that work with these companies attended our workshop, but government representatives and other corporate supply chain actors (e.g., palm oil traders) did not, we are best positioned to make suggestions about grower and miller policies. Finally, the European Union regulation on deforestation-free products, which requires importing companies to eliminate deforestation from their supply chains, asks that companies support smallholders through capacity building and investment (European Parliament and Council of the European Union, 2023). Our policy recommendations therefore center oil palm grower and miller companies as central actors in integrating smallholders into zero-deforestation supply chains. We emphasize that other supply chain actors and governments—both domestic and foreign—should also make policy changes to support smallholders.

### 5.1. Opportunities to enable smallholder participation

#### 5.1.1. Map and monitor palm oil mill supply shed lands

Oil palm growing and milling companies can undertake land mapping and monitoring within supply sheds (i.e., the geographic regions from which mills source oil palm fruit), including outside of their concessions, with the participation of independent smallholders. First, these companies can appoint personnel to conduct detailed ground and/or remote sensing studies to identify biophysical forests and the history of land cover change in extra-

concession lands in a way that aligns with expectations of zero-deforestation commitment implementation mechanism requirements. Second, they can provide resources to help independent smallholder farmers delineate the boundaries of their landholdings to clarify the location of smallholder claimed and managed areas. Third, through remote sensing or field visits, they can monitor forest persistence in these lands and share monitoring updates with farmers so that they know if deforestation may have been detected on their lands.

Taken together, these actions would address one potential barrier to zero-deforestation market entry by interested smallholders—that is, demonstration of no deforestation beyond a given cutoff date on their land. If a company buys from independent smallholders, it might also reduce the company's reputational risk while ensuring continued access to markets with increasingly stringent requirements. Delineating independent smallholder land parcels would allow companies to establish dialogue with nearby communities regarding supply chain requirements from the global market, providing community residents with market information that may inform their land-use decisions. Workshop participants felt that mapping may help resolve conflicting claims among communities and companies, addressing issues around trust. Companies may wish to build upon smallholder-focused mapping already underway. For instance, the RSPO has developed an approach to confirm, via data collected by smartphone, the absence of forests and HCVs in areas proposed for expansion by smallholders (RSPO, 2020a). We recognize, however, that mapping may not always be desirable to smallholders: if forest considered off-limits according to definitions of deforestation is found and mapped on farmer property, it could limit farmer ability to use that land for growing oil palm fruits acceptable at any mill.

#### 5.1.2. Improve smallholder farmer and community land rights security and land legality

Growers and millers can use their often-considerable political and economic resources to help clarify and strengthen land rights security and land legality for smallholder farmers within supply sheds. For farmers with customary claim to land outside of State Forest, companies can facilitate the land titling process, so that smallholder ownership of these lands is fully recognized by the national government. Companies can also ensure that their State-recognized concession boundaries accurately encompass industrial plantation areas so that they do not encumber de facto smallholder lands. To address legality for smallholder land within the State Forest that is not part of a protected area, companies can work with the Indonesian government to rezone cultivated areas to *Areal Penggunaan Lain* (areas outside the State Forest where oil palm cultivation is allowed) through Indonesia's amnesty program (Jong, 2023). Finally, companies may help communities with smallholders who wish to protect forests to gain formal authority to manage such forested lands, potentially under Indonesia's varied social forestry and customary forest (*Hutan Adat*) programs that formalize rights of

forest users (Fisher et al., 2018; Erbaugh, 2019; Li, 2024). Such approaches focused on land rights have been suggested in other high-deforestation countries including Brazil (Moutinho et al., 2016). To accommodate smallholders who cannot gain legal title to their land over the short term, companies and civil society organizations may explore the possibility of offering flexibility on supply chain legality requirements if smallholders meet standards with respect to biophysical forest protection.

Greater farmer land rights security and legality would support smallholders in achieving compliance with laws and regulations, thus addressing legal barriers to smallholder integration into zero-deforestation supply chains. Because changing land rights security can influence farmer decision-making around investment in land, such changes may also alter land productivity and land cover, as well as agricultural expansion, although such changes might not always benefit forest conservation (Ostrom, 2007; Robinson et al., 2014). We also recognize that improving smallholder land rights security is a major challenge given complex politics that include elite capture (Palmer and Engel, 2007; Persha and Andersson, 2014), as well as the overlapping, informal, and ambiguous land claims that often characterize Indonesian landscapes (Gaveau et al., 2017; Kunz et al., 2017; Naylor et al., 2019). However, if companies or supporting civil society organizations follow techniques developed by participatory mapping practitioners and scholars to unravel and represent the multiplicity of land claims and uses, this may increase the likelihood that communities and marginalized groups are given a voice in the process (Chapin et al., 2005; Norris, 2014; Young and Gilmore, 2017).

#### 5.1.3. Enable zero-deforestation compliant fresh fruit bunch sales by smallholders

Companies in zero-deforestation supply chains can improve transparency around their smallholder sourcing practices, helping smallholders to sell fresh fruit bunches that are recognized as compliant with zero-deforestation initiatives. First, milling companies can invest in emerging traceability systems that have been designed to track commodity flows through intermediary transactions (e.g., OPTTEL, 2019; KOLTIVA, 2021). This may address both market and supply chain knowledge barriers outlined above, even with no change in supply chain structure. Grower and miller companies can also help smallholders form cooperatives, which are better positioned than individual farmers to sell directly to mills. If formation of cooperatives leads to a reduction in the use of intermediaries, this could improve traceability and potentially allow smallholders to capture more of any price premium garnered from participation in a zero-deforestation supply chain. As an alternative to traceability, we recommend wider dissemination of credit trading systems. In these systems, smallholders engage with zero-deforestation supply chains only by selling credits, rather than physical product (e.g., RSPO's book and claim supply chain model with specific credits for smallholders). This could enable smallholders far from mills covered by

zero-deforestation commitments, or who cannot avoid intermediaries, to participate in zero-deforestation supply chains. Because there is a lack of information on smallholder integration into custom zero-deforestation initiatives, supply chain companies and their partners should also increase their transparency regarding smallholder support and sourcing.

#### 5.1.4. Offer incentives to encourage smallholder compliance with zero-deforestation initiatives

Oil palm companies should offer incentives that encourage smallholder compliance with zero-deforestation requirements. Such incentives could be linked to forest conservation or persistence on individual private smallholder lands, or within broader jurisdictions (e.g., villages), and could be delivered through existing mechanisms (e.g., the Farmer for Forest Protection Foundation, which provides support for smallholders). To encourage a diversity of independent smallholder farmers, “a package of benefits will likely work best” according to one workshop participant. Price premia for compliant products are one option (Hidayat et al., 2016; Saadun et al., 2018; Apriani et al., 2020). Education and training in best management practices (e.g., those related to land preparation, planting practices, fertilizer management, input management, soil conservation, or harvesting practices), in-kind support in the form of fertilizer and other inputs to agriculture, improved infrastructure such as road maintenance, and mentorship of producer groups could all improve profits for smallholders by enhancing yields and/or fresh fruit bunch quality. Companies might also offer smallholders expanded access to low- or no-interest credit, either directly or via local credit unions. Access to credit would enable smallholders to make upfront investments (e.g., high-quality planting material and appropriate fertilizer application) in their oil palm lands to improve long-term yields and profit. Critically, such access to credit should ensure that the funds cannot be used—directly or indirectly—to finance deforestation. Companies could help smallholders protect forests on their lands from fires and other land users. Other potential benefits mentioned by workshop participants included skipping the queue at the mill, helping communities develop diverse income streams, and supporting smallholders to achieve sustainability certification. At the workshop, such incentives were the most salient “opportunity” identified by attendees, because they were seen to jointly promote smallholder integration into and benefits from zero-deforestation supply chains. Indeed, we expect that a diverse package of benefits could be tailored to address many of the barriers identified above.

#### 5.2. Limited conservation benefits from improved smallholder integration

If revisions to zero-deforestation initiatives succeed in integrating more independent smallholder producers into verified supply chains, this would address concerns around equity and justice in supply chain governance. Nevertheless, workshop participants suggested that such initiatives may struggle to achieve their underlying goal of

forest protection for several reasons. These include selection and leakage effects, and the degree to which individual smallholders can influence land-use change in forested areas.

Selection effects occur when program participants are not representative of the whole population (Ferraro, 2009). In the case of zero-deforestation commitments, corporate adopters need to manage the deforestation risk associated with sourcing fresh fruit bunches from many farmers, which could push adoption toward supply chains or locations with lower risk (e.g., fewer smallholders and/or less forest). Indeed, provisional RSPO guidance on HCS–HCV implementation for independent smallholders explicitly states that, until more detailed guidance can be developed, the only farmers that can achieve certification are those located in “low-risk areas” (RSPO, 2019). Under such practices, zero-deforestation commitments would preferentially integrate smallholder farmers from landscapes with relatively few forests, undermining conservation gains.

In addition, zero-deforestation commitments can lead to leakage, a displacement of forest loss to another time, location, or actor (Heilmayr et al., 2020; Villoria et al., 2022). Hence, when zero-deforestation initiatives do reach smallholders operating in landscapes with forests, the single commodity focus of these initiatives may weaken conservation benefits. For example, the RSPO limits the application of their draft independent smallholder standard to smallholder plots that are planted with or planned to be oil palm (RSPO, 2019). Smallholders can sell production from RSPO-compliant land to zero-deforestation supply chains but clear forests in other locations, for other uses (e.g., cocoa, rubber, or rice). The focus on the land used to produce a specific commodity, rather than on the aggregate actions of the farmer, can enable a reallocation of resources by smallholders that does little to protect forests.

Finally, individual Indonesian smallholders rarely have exclusive claim to lands with standing intact or logged forests, which limits their ability to actively protect forests from deforestation. This is partly because many customary law systems in Indonesia allow an individual rights only over lands that they—or an ancestor—cleared and developed. Instead, remaining intact and logged forests typically fall under the control of other actors (Siscawati et al., 2017) including the Ministry of Environment and Forestry, which manages most lands in the State Forest; companies, which are legally responsible for any remaining forests inside their concessions; community customary institutions, where customary collectives control forested lands; or local governments that were standardized under Suharto’s New Order regime, often at the expense of indigenous and customary autonomy (McWilliam, 2006). As a result, conservation of these forests will likely require more holistic action across institutions, rather than commitments by individual smallholders.

## 6. Conclusion

Efforts to end deforestation associated with tropical commodity production can draw attention to the social

conditions under which these commodities are grown. In theory, this attention could be harnessed to benefit independent smallholder producers in these landscapes (Garrett et al., 2021; Grabs et al., 2021). However, we find that in practice within Indonesia's palm oil sector, zero-deforestation initiatives have failed to effectively integrate independent smallholders into verified supply chains, creating tension between environmental and social sustainability. For zero-deforestation commitments to deliver on their environmental promises in a just and equitable manner, our findings suggest that in the Indonesian palm oil sector, these programs require dramatic transformation. Based on the knowledge of multiple experts representing diverse actors in Indonesian oil palm producing landscapes, we argue that policies initially designed for large plantations present knowledge, institutional, and financial barriers to smallholder participation in verified zero-deforestation supply chains. To overcome these barriers, initiatives must be shaped to directly benefit independent farmers to empower them to contribute to forest conservation. Oil palm growing and milling companies can play an important role in surmounting these challenges by undertaking land-use mapping and monitoring, facilitating improvements to smallholder land tenure security, tracing smallholder oil palm fruits, and offering incentives to encourage smallholder compliance with zero-deforestation initiatives. Existing guidance such as the Accountability Framework (2023) and the High Carbon Stock Approach Smallholder toolkit (HCSA, 2023) may be useful to help companies, smallholders, and others implement this vision.

Mitigating constraints to farmer participation in zero-deforestation supply chains may provide social and economic benefits for smallholder farmers (Garrett et al., 2021). For instance, if smallholders conform with a company-led zero-deforestation initiative, the barriers to entering other sustainability programs may be lower, providing outsized value of compliance to farmers. Smallholders may be closer to meeting the Indonesian Sustainable Palm Oil certification standard (Hidayat et al., 2018) or conforming with the European Union regulation on deforestation-free products (Zhunusova et al., 2022). Yet, the supply chain approach does not give all members of communities in the supply sheds of oil palm plantations a stake in the maintenance of carbon rich, biodiverse, intact forest. Other policies and programs, including those at the jurisdictional or landscape scale that consider multiple commodities and land uses, are needed to ensure that both companies and the communities where they operate hold a mutually beneficial commitment to conserving forests and supporting local livelihoods.

#### Data accessibility statement

Workshop presentation slides and notes are available on request from authors. The workshop used Chatham House Rules, so requests will be honored but information will be deidentified before provision.

#### Acknowledgments

This work resulted from the Science for Nature and People Partnership (SNAPP) Zero Deforestation Landscapes Working Group. SNAPP is a partnership of The Nature Conservancy and the Wildlife Conservation Society. NCEAS is an independent research affiliate of the University of California, Santa Barbara.

#### Funding

Funding was provided by the Science for Nature and People Partnership (SNAPP). KMC was supported by the U.S. Department of Agriculture National Institute of Food and Agriculture Hatch Project HAW01136-H managed by the College of Tropical Agriculture and Human Resources.

#### Competing interests

None.

#### Author contributions

- Contributed to conception and design: ME, RH, KMC
- Contributed to acquisition of data: ME, RH, KMC.
- Contributed to analysis and interpretation of data: ME, RH, KMC.
- Drafting the article or revising it critically for important intellectual content: All authors.
- Final approval of the version to be published: All authors.

#### References

- Accountability Framework.** 2019. Terms and definitions. Available at <https://accountability-framework.org/wp-content/uploads/2019/07/Definitions.pdf>. Accessed June 30, 2022.
- Accountability Framework.** 2023. Core principles. Available at [https://accountability-framework.org/fileadmin/uploads/afi/Documents/Core\\_Principles/AFi\\_Core\\_Principles\\_\\_April\\_2023\\_-\\_English\\_\\_04-04-24\\_Amend\\_.pdf](https://accountability-framework.org/fileadmin/uploads/afi/Documents/Core_Principles/AFi_Core_Principles__April_2023_-_English__04-04-24_Amend_.pdf). Accessed May 10, 2024.
- Alix-Garcia, J, Gibbs, HK.** 2017. Forest conservation effects of Brazil's zero deforestation cattle agreements undermined by leakage. *Global Environmental Change* **47**: 201–217.
- Alroy, J.** 2017. Effects of habitat disturbance on tropical forest biodiversity. *Proceedings of the National Academy of Sciences* **114**(23): 6056–6061.
- Anggraini, E, Grundmann, P.** 2013. Transactions in the supply chain of oil palm fruits and their relevance for land conversion in smallholdings in Indonesia. *The Journal of Environment & Development* **22**(4): 391–410.
- Apriani, E, Kim, Y-S, Fisher, LA, Baral, H.** 2020. Non-state certification of smallholders for sustainable palm oil in Sumatra, Indonesia. *Land Use Policy* **99**: 105112.
- Austin, KG, Heilmayr, R, Benedict, JJ, Burns, DN, Eggen, M, Grantham, H, Greenbury, A, Hill, JK, Jenkins, CN, Luskin, MS, Manurung, T, Rasmussen, LV, Rosoman, G, Rudorff, B, Satar, M, Smith, C, Carlson, KM.** 2021. Mapping and



- monitoring zero-deforestation commitments. *BioScience*. DOI: <http://dx.doi.org/10.1093/biosci/abiab082>.
- Austin, KG, Mosnier, A, Pirker, J, McCallum, I, Fritz, S, Kasibhatla, PS.** 2017. Shifting patterns of oil palm driven deforestation in Indonesia and implications for zero-deforestation commitments. *Land Use Policy* **69**: 41–48. DOI: <http://dx.doi.org/10.1016/j.landusepol.2017.08.036>.
- Austin, KG, Schwantes, A, Gu, Y, Kasibhatla, PS.** 2019. What causes deforestation in Indonesia? *Environmental Research Letters* **14**(2): 024007.
- Azevedo, AA, Stabile, MC, Reis, TN.** 2015. Commodity production in Brazil: Combining zero deforestation and zero illegality. *Elementa: Science of the Anthropocene* **3**: 000076.
- Bager, SL, Lambin, EF.** 2022. How do companies implement their zero-deforestation commitments. *Journal of Cleaner Production* **375**: 134056.
- Bakhtary, H, Haupt, F, Luttrell, C, Landholm, D, Jelsma, I.** 2021. Promoting sustainable oil palm production by independent smallholders in Indonesia: Perspectives from non-state actors. Germany: GIZ. Available at [https://climatefocus.com/wp-content/uploads/2022/06/Indonesian-Palm-Oil-Smallholders\\_Briefing-Paper.pdf](https://climatefocus.com/wp-content/uploads/2022/06/Indonesian-Palm-Oil-Smallholders_Briefing-Paper.pdf). Accessed January 10, 2022.
- Bracken, LJ, Bulkeley, HA, Whitman, G.** 2015. Transdisciplinary research: Understanding the stakeholder perspective. *Journal of Environmental Planning and Management* **58**(7): 1291–1308.
- Brandi, C, Cabani, T, Hosang, C, Schirmbeck, S, Westermann, L, Wiese, H.** 2015. Sustainability standards for palm oil: Challenges for smallholder certification under the RSPO. *The Journal of Environment & Development* **24**(3): 292–314. DOI: <http://dx.doi.org/10.1177/1070496515593775>.
- Brandi, CA.** 2017. Sustainability standards and sustainable development—Synergies and trade-offs of transnational governance. *Sustainable Development* **25**(1): 25–34.
- Bush, SR, Belton, B, Hall, D, Vandergeest, P, Murray, FJ, Ponte, S, Oosterveer, P, Islam, MS, Mol, AP, Hatanaka, M, Kruijssen, F, Ha, TTT, Little, DC, Kusumawati, R.** 2013. Certify sustainable aquaculture? *Science* **341**(6150): 1067–1068.
- Carodenuto, S.** 2019. Governance of zero deforestation cocoa in West Africa: New forms of public–private interaction. *Environmental Policy and Governance* **29**(1): 55–66.
- Carr, M.** 2012. The water relations of rubber (*Hevea brasiliensis*): A review. *Experimental Agriculture* **48**(2): 176–193.
- Chandrasekhar, A.** 2019 Nov 4. Why Nestlé won't meet its zero-deforestation pledge. *SWI*. Available at [https://www.swissinfo.ch/eng/business/smallholders-over-strategy\\_why-nestle%20won-t-meet-its-zero-deforestation-pledge/45334830](https://www.swissinfo.ch/eng/business/smallholders-over-strategy_why-nestle%20won-t-meet-its-zero-deforestation-pledge/45334830). Accessed January 10, 2022.
- Chapin, M, Lamb, Z, Threlkeld, B.** 2005. Mapping indigenous lands. *Annual Review of Anthropology* **34**: 619–638.
- Cheyens, E.** 2011. Multi-stakeholder initiatives for sustainable agriculture: Limits of the “inclusiveness” paradigm, in Ponte, S, Gibbon, P, Vestergaard, J eds., *Governing through standards: Origins, drivers and limits*. Houndmills, Basingstoke, Hampshire: England; New York, NY: Palgrave Macmillan: 318–354. (International Political Economy Series).
- Corley, RHV, Tinker, PB.** 2016. *The oil palm*. 5th ed. Oxford, UK; Hoboken, NJ: Wiley. (World agriculture series).
- Cosgrove, E.** 2020. Breaking down Mars' maverick move for a more sustainable palm oil supply chain. Supply Chain Dive. Available at <https://www.supplychaindive.com/news/mars-sustainable-palm-oil-supply-chain/591953/>. Accessed January 10, 2022.
- Cramb, R, McCarthy, JF.** 2016. *The oil palm complex: Smallholders, agribusiness and the state in Indonesia and Malaysia*. Singapore: NUS Press.
- Curtis, PG, Slay, CM, Harris, NL, Tyukavina, A, Hansen, MC.** 2018. Classifying drivers of global forest loss. *Science* **361**(6407): 1108–1111.
- Dawson, N, Coolsaet, B, Sterling, E, Loveridge, R, Gross-Camp, N, Wongbusarakum, S, Sangha, K, Scherl, L, Phan, H, Zafra-Calvo, N, Lavey, W, Byakagaba, P, Idrobo, CJ, Chenet, A, Bennett, N, Mansourian, S, Rosado, F, Dawson, N, Coolsaet, B, Sterling, EJ, Sangha, KK, Scherl, LM, Phan, HP, Zafra-Calvo, N, Lavey, WG, Byakagaba, P, Idrobo, CJ, Chenet, A, Bennett, NJ, Mansourian, S, Rosado-May, F.** 2021. The role of Indigenous peoples and local communities in effective and equitable conservation. *Ecology and Society* **26**(3): 19.
- Demopoulos, K, Indrarto, G.** 2021. *Jurisdictional approach to sustainability: Lessons learnt from private sector action in Aceh Tamiang, Indonesia*. Indonesia: Tropical Forest Alliance.
- Descals, A, Wich, S, Meijaard, E, Gaveau, DL, Peedell, S, Szantoi, Z.** 2021. High-resolution global map of smallholder and industrial closed-canopy oil palm plantations. *Earth System Science Data* **13**(3): 1211–1231.
- Dharmawan, AH, Mardiyarningsih, DI, Rahmadian, F, Yulian, BE, Komarudin, H, Pacheco, P, Ghazoul, J, Amalia, R.** 2021. The agrarian, structural and cultural constraints of smallholders' readiness for sustainability standards implementation: The case of Indonesian sustainable palm oil in East Kalimantan. *Sustainability-Basel* **13**(5): 2611.
- Earthworm Foundation.** 2019 Jun 25. Leading multinationals adopt starling satellite technology to monitor and verify their palm oil supply chain. Available at <https://www.earthworm.org/id/news-stories/pz-cussons-and-reckitt-benckiser-use-starling-satellite-technology-to-monitor-100-of-their-supply-chain>. Accessed January 10, 2022.
- Erbaugh, JT.** 2019. Responsibilization and social forestry in Indonesia. *Forest Policy Economics* **109**: 102019.

- European Parliament and Council of the European Union.** 2023. Regulation (EU) 2023/1115 of the European parliament and of the Council. Available at <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32023R1115>. Accessed January 16, 2024.
- Eyes on the Forest.** 2018. Enough is enough: Time for the palm oil market to start the real work to stop driving deforestation. Available at [https://www.eyesontheforest.or.id/uploads/default/report/EoF\\_\(08Jun18\)\\_Enough\\_is\\_Enough.pdf](https://www.eyesontheforest.or.id/uploads/default/report/EoF_(08Jun18)_Enough_is_Enough.pdf). Accessed January 10, 2022.
- Ferraro, PJ.** 2009. Counterfactual thinking and impact evaluation in environmental policy. *New Directions for Evaluation* **2009**(122): 75–84. DOI: <http://dx.doi.org/10.1002/ev.297>.
- Fisher, MR, Moeliono, M, Mulyana, A, Yuliani, EL, Adriadi, A, Kamaluddin, J, Sahide, MAK.** 2018. Assessing the new social forestry project in Indonesia: Recognition, livelihood and conservation? *International Forestry Review* **20**(3): 346–361.
- Garrett, R, Levy, S, Carlson, KM, Gardner, T, Godar, J, Clapp, J, Peter, D, Heilmeyr, RL, Polain de Waroux, Y, Ayre, B, Barr, R, Døvre, B, Gibbs, H, Hall, S, Lake, S, Milder, J, Rausch, L, Rivero, R, Rueda, X, Sarsfield, R, Soares-Filho, B, Villoria, N.** 2019. Criteria for effective zero-deforestation commitments. *Global Environmental Change* **54**: 135–147.
- Garrett, RD, Carlson, KM, Rueda, X, Noojipady, P.** 2016. Assessing the potential additionality of certification by the Round table on Responsible Soybeans and the Roundtable on Sustainable Palm Oil. *Environmental Research Letters* **11**(4): 045003. DOI: <http://dx.doi.org/10.1088/1748-9326/11/4/045003>.
- Garrett, RD, Levy, S, Gollnow, F, Hodel, L, Rueda, X.** 2021. Have food supply chain policies improved forest conservation and rural livelihoods? A systematic review. *Environmental Research Letters* **16**: 033002.
- Gaveau, DL, Locatelli, B, Salim, MA, Manurung, T, Descales, A, Angelsen, A, Meijaard, E, Sheil, D.** 2022. Slowing deforestation in Indonesia follows declining oil palm expansion and lower oil prices. *PLoS One* **17**(3): e0266178.
- Gaveau, DL, Pirard, R, Salim, MA, Tonoto, P, Yaen, H, Msi, H, Parks, SA, Carmenta, R.** 2017. Overlapping land claims limit the use of satellites to monitor no-deforestation commitments and no-burning compliance. *Conservation Letters* **10**(2): 257–264.
- General Directorate of Estate Crops MoA, Republic of Indonesia.** 2021. *Statistik Perkebunan Unggulan Nasional, 2019–2021*. Jakarta, Indonesia: Sekretariat Direktorat Jenderal Perkebunan.
- Godar, J, Gardner, TA, Tizado, EJ, Pacheco, P.** 2014. Actor-specific contributions to the deforestation slowdown in the Brazilian Amazon. *Proceedings of the National Academy of Sciences* **111**(43): 15591–15596.
- Gómez, M, Mueller, B, Wheeler, MK.** 2016. Private sector extension activities targeting small farmers in developing countries. MEAS Report USAID, USA. Available at <https://meas.illinois.edu/wp-content/uploads/2016/01/MEAS-Report-2016-Private-Section-Extension-Activities-Small-Farmers-Gomez-Mueller-Wheeler.pdf>. Accessed January 10, 2022.
- Grabs, J, Cammelli, F, Levy, SA, Garrett, RD.** 2021. Designing effective and equitable zero-deforestation supply chain policies. *Global Environmental Change* **70**: 102357.
- Grabs, J, Garrett, RD.** 2023. Goal-based private sustainability governance and its paradoxes in the Indonesian palm oil sector. *Journal of Business Ethics* **188**(3): 1–41.
- Greenpeace.** 2021. Deceased estate: Illegal palm oil wiping out Indonesia's national forest. Available at [https://www.greenpeace.org/static/planet4-south-eastasia-stateless/2021/10/85efa777-illegal\\_palm\\_oil\\_in\\_forest\\_estate.pdf](https://www.greenpeace.org/static/planet4-south-eastasia-stateless/2021/10/85efa777-illegal_palm_oil_in_forest_estate.pdf). Accessed June 30, 2022.
- Harland, C, Brenchley, R, Walker, H.** 2003. Risk in supply networks. *Journal of Purchasing and Supply Management* **9**(2): 51–62.
- Heilmayr, R, Carlson, KM, Benedict, JJ.** 2020. Deforestation spillovers from oil palm sustainability certification. *Environmental Research Letters* **15**(7): 075002.
- Heinimann, A.** 2020. Hungry palm oil mills in Central Kalimantan, Indonesia: Key players for moving towards sustainability in the palm oil supply chain [Master thesis]. Bern, Switzerland: University of Bern, Institute of Geography.
- Hettig, E, Lay, J, Sipangule, K.** 2016. Drivers of households' land-use decisions: A critical review of micro-level studies in tropical regions. *Land* **5**(4): 32.
- Hidayat, NK, Offermans, A, Glasbergen, P.** 2016. On the profitability of sustainability certification: An analysis among Indonesian palm oil smallholders. *Journal of Economics and Sustainable Development* **7**(18): 45–62.
- Hidayat, NK, Offermans, A, Glasbergen, P.** 2018. Sustainable palm oil as a public responsibility? On the governance capacity of Indonesian Standard for Sustainable Palm Oil (ISPO). *Agriculture and Human Values* **35**(1): 223–242.
- High Carbon Stock Approach.** 2017. The HCS approach toolkit version 2.0: Putting no deforestation into practice. Available at <http://highcarbonstock.org/the-hcs-approach-toolkit/>. Accessed January 10, 2022.
- High Carbon Stock Approach.** 2021. HCSA grievance mechanism. Available at <https://highcarbonstock.org/wp-content/uploads/2022/02/HCSA-Grievance-Mechanism-FINAL-WEB-English.pdf>. Accessed January 10, 2022.
- High Carbon Stock Approach.** 2022. Restoration and remediation guidance version 1. Available at [https://highcarbonstock.org/wp-content/uploads/2022/04/HCSA-Restoration-Remediation-Guidance\\_V1-approved-1-Mar-2022\\_Copy-Edited-1.pdf](https://highcarbonstock.org/wp-content/uploads/2022/04/HCSA-Restoration-Remediation-Guidance_V1-approved-1-Mar-2022_Copy-Edited-1.pdf). Accessed June 30, 2022.

- High Carbon Stock Approach.** 2023. HCS-HCV simplified smallholder approach for Indonesia. Available at <https://highcarbonstock.org/toolkit/simplified-smallholder-toolkit/>. Accessed January 16, 2024.
- High Carbon Stock Approach.** 2024. HCSA assessments. Available at <https://highcarbonstock.org/forest-conservation-monitoring/assessment-reports/>. Accessed February 28, 2024.
- High Conservation Value Resource Network.** 2021. Available at [www.hcvnetwork.org](http://www.hcvnetwork.org). Accessed January 10, 2022.
- Hutabarat, S, Slingerland, M, Dries, L.** 2019. Explaining the “certification gap” for different types of oil palm smallholders in Riau province, Indonesia. *The Journal of Environment & Development* **28**(3): 253–281.
- Ilmar, A, Assidiq, H.** 2020. Synchronization of Indonesian regulation in sustainable palm oil management to reduce greenhouse gas emissions. *IOP Conference Series: Earth and Environmental Science* **423**(1): 012006.
- International Finance Corporation.** 2016. *Working with smallholders: A handbook for firms building sustainable supply chains*. Washington, DC: World Bank.
- Jelsma, I, Schoneveld, GC, Zoomers, A, van Westen, AC.** 2017. Unpacking Indonesia’s independent oil palm smallholders: An actor-disaggregated approach to identifying environmental and social performance challenges. *Land Use Policy* **69**: 281–297.
- Jelsma, I, Woittiez, LS, Ollivier, J, Dharmawan, AH.** 2019. Do wealthy farmers implement better agricultural practices? An assessment of implementation of good agricultural practices among different types of independent oil palm smallholders in Riau, Indonesia. *Agricultural Systems* **170**: 63–76.
- Jong, HN.** 2023 May 4. Indonesia legalizes illicit oil palm farms in program slammed as opaque. *Mongabay*. Available at <https://news.mongabay.com/2023/05/indonesia-legalizes-illicit-oil-palm-farms-in-program-slammed-as-opaque/>. Accessed January 16, 2024.
- Jopke, P, Schoneveld, GC.** 2018. Corporate commitments to zero deforestation: An evaluation of externality problems and implementation gaps. Occasional Paper 181. Bogor, Indonesia: CIFOR.
- KOLTIVA.** 2021. Available at <https://koltiva.com/>. Accessed January 10, 2022.
- Krishna, V, Euler, M, Siregar, H, Qaim, M.** 2017. Differential livelihood impacts of oil palm expansion in Indonesia. *Agricultural Economics, Blackwell* **48**(5): 639–653.
- Kuala Lumpur Kepong Berhad.** 2018. Traceability & smallholders/small growers. Available at [www.klk.com.my/sustainability/traceability-smallholders/](http://www.klk.com.my/sustainability/traceability-smallholders/). Accessed January 15, 2018.
- Kunz, Y, Steinebach, S, Dittrich, C, Hauser-Schäublin, B, Rosyani, I, Soetarto, E, Faust, H.** 2017. “The fridge in the forest”: Historical trajectories of land tenure regulations fostering landscape transformation in Jambi province, Sumatra, Indonesia. *Forest Policy Economics* **81**:1–9.
- L’ORÉAL.** 2014. “Zero deforestation” commitment. Available at <https://www.loreal.com/-/media/project/loreal/brand-sites/corp/master/lcorp/documents-media/publications/sbwa/2014-loreal-zero-deforestation-commitment.pdf>. Accessed June 30, 2022.
- Lambin, EF, Furumo, PR.** 2023. Deforestation-free commodity supply chains: Myth or reality? *Annual Review of Environment and Resources* **48**(1): 237–261.
- Lambin, EF, Gibbs, HK, Heilmayr, R, Carlson, KM, Fleck, LC, Garrett, R, Le Polain de Waroux, Y, Mcdermott, C, McLaughlin, D, Newton, P, Nolte, C, Pacheco, P, Rausch, L, Streck, C, Thorlakson, T, Nathalie, F.** 2018. The role of supply-chain initiatives in reducing deforestation. *Nature Climate Change* **8**(2): 109–116.
- Lang, DJ, Wiek, A, Bergmann, M, Stauffacher, M, Martens, P, Moll, P, Swilling, M.** 2012. Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science* **7**(Suppl 1): 25–43.
- Larsen, RK, Osbeck, M, Dawkins, E, Tuhkanen, H, Nguyen, H, Nugroho, A, Gardner, TA, EcoNusantara, Z, Wolvekamp, P.** 2018. Hybrid governance in agricultural commodity chains: Insights from implementation of ‘No Deforestation, No Peat, No Exploitation’ (NDPE) policies in the oil palm industry. *Journal of Cleaner Production* **183**: 544–554.
- Larson, AM, Mausch, K, Bourne, M, Luttrell, C, Schoneveld, G, Cronkleton, P, Locatelli, B, Catacutan, D, Cerutti, P, Chomba, S, Houria, D, Ihalainen, M, Lawry, S, Minang, P, Monterroso, I, Myers, R, Naito, D, Thuy, P, Reed, J, Barletti, JPS, Sola, P, Stoian, D.** 2021. Hot topics in governance for forests and trees: Towards a (just) transformative research agenda. *Forest Policy Economics* **131**: 102567.
- Lee, J, Gereffi, G, Beauvais, J.** 2012. Global value chains and agrifood standards: Challenges and possibilities for smallholders in developing countries. *Proceedings of the National Academy of Sciences* **109**(31): 12326–12331.
- Lee, JSH, Rist, L, Obidzinski, K, Ghazoul, J, Koh, LP.** 2011. No farmer left behind in sustainable biofuel production. *Biological Conservation* **144**(10): 2512–2516.
- Levang, P, Riva, WF, Orth, MG.** 2016. Oil palm plantations and conflict in Indonesia: Evidence from West Kalimantan, in Cramb, R, McCarthy, JF eds., *The oil palm complex: Smallholders, agribusiness and the State in Indonesia and Malaysia*. Singapore: NUS Press: 283–300.
- Leventon, J, Fleskens, L, Claringbould, H, Schwilch, G, Hessel, R.** 2016. An applied methodology for stakeholder identification in transdisciplinary research. *Sustainability Science* **11**: 763–775.
- Li, TM.** 2019. Intergenerational displacement in Indonesia’s oil palm plantation zone. *The Journal of Peasant Studies* **44**(6): 1158–1176.

- Li, TM.** 2024. Securing oil palm smallholder livelihoods without more deforestation in Indonesia [Online]. *Nature Sustainability*: 1–7.
- Lyons-White, J, Knight, AT.** 2018. Palm oil supply chain complexity impedes implementation of corporate no-deforestation commitments. *Global Environmental Change* **50**: 303–313.
- MARS.** 2022. Deforestation & land use change position. Available at <https://www.mars.com/about/policies-and-practices/deforestation-policy>. Accessed June 30, 2022.
- Martens, K, Kunz, Y, Rosyani, I, Faust, H.** 2020. Environmental governance meets reality: A micro-scale perspective on sustainability certification schemes for oil palm smallholders in Jambi, Sumatra. *Society & Natural Resources* **33**(5): 634–650.
- McCarthy, JF.** 2012. Certifying in contested spaces: Private regulation in Indonesian forestry and palm oil. *Third World Quarterly* **33**(10): 1871–1888.
- McCarthy, JF, Gillespie, P, Zen, Z.** 2012. Swimming upstream: Local Indonesian production networks in “globalized” palm oil production. *World Development* **40**(3): 555–569. DOI: <http://dx.doi.org/10.1016/j.worlddev.2011.07.012>.
- McWilliam, A.** 2006. Historical reflections on customary land rights in Indonesia. *The Asia Pacific Journal of Anthropology* **7**(1): 45–64.
- Meijaard, E, Garcia-Ulloa, J, Sheil, D, Wich, S, Carlson, KM, Diego, J-B, Thomas, MB** eds. 2018. *Oil palm and biodiversity: A situation analysis by the IUCN Oil Palm Task Force*. IUCN Oil Palm Task Force Gland, Switzerland: IUCN: xiii–116.
- Mitchard, ET.** 2018. The tropical forest carbon cycle and climate change. *Nature* **559**(7715): 527–534.
- Moutinho, P, Guerra, R, Azevedo-Ramos, C.** 2016. Achieving zero deforestation in the Brazilian Amazon: What is missing? *Elementa: Science of the Anthropocene* **4**: 000125.
- Murdiyarmo, D, Dewi, S, Lawrence, D, Seymour, F.** 2011. Indonesia’s forest moratorium: A stepping stone to better forest governance? Working Paper 76. Bogor, Indonesia: CIFOR.
- Musim Mas.** 2021. No Deforestation, No Peat (NDP) risk management framework report. Available at <https://www.musimmas.com/wp-content/uploads/2021/09/Risk-Management-Framework-Report-2021.pdf>. Accessed June 30, 2022.
- Naylor, RL, Higgins, MM, Edwards, RB, Falcon, WP.** 2019. Decentralization and the environment: Assessing smallholder oil palm development in Indonesia. *Ambio* **48**(10): 1195–1208.
- Netting, RMC.** 1993. *Smallholders, householders: Farm families and the ecology of intensive, sustainable agriculture*. Stanford, CA: Stanford University Press.
- Newton, P, Benzeev, R.** 2018. The role of zero-deforestation commitments in protecting and enhancing rural livelihoods. *Current Opinion in Environmental Sustainability* **32**: 126–133.
- Norris, TB.** 2014. Bridging the great divide: State, civil society, and “participatory” conservation mapping in a resource extraction zone. *Applied Geography* **54**: 262–274.
- NYDF Assessment Partners.** 2019. Protecting and restoring forests: A story of large commitments yet limited progress. Climate Focus (coordinator and editor). New York Declaration on Forests Five-Year Assessment Report. Available at <https://forestdeclaration.org>. Accessed January 10, 2022.
- OPTEL.** 2019. GeoTraceability platform for palm oil. Available at <https://www.optelgroup.com/en/blog/accurate-mapping-for-the-palm-oil-industry-due-to-traceability-technologies/>. Accessed January 16, 2024.
- Ordway, EM, Asner, GP, Lambin, EF.** 2017. Deforestation risk due to commodity crop expansion in sub-Saharan Africa. *Environmental Research Letters* **12**(4): 044015. DOI: <http://dx.doi.org/10.1088/1748-9326/aa6509>.
- Ostrom, E.** 2007. A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences* **104**(39): 15181–15187.
- Palm Oil Collaboration Group.** 2021. Working group: Production and protection beyond concessions. Available at <https://palmoilcollaborationgroup.net/ppbc>. Accessed January 10, 2022.
- Palmer, C, Engel, S.** 2007. For better or for worse? Local impacts of the decentralization of Indonesia’s forest sector. *World Development* **35**(12): 2131–2149.
- Peluso, NL, Vandergeest, P.** 2001. Genealogies of the political forest and customary rights in Indonesia, Malaysia, and Thailand. *The Journal of Asian Studies* **60**(3): 761–812.
- Pendrill, F, Gardner, TA, Meyfroidt, P, Persson, UM, Adams, J, Azevedo, T, Bastos Lima, MG, Baumann, M, Curtis, PG, De Sy, V, Garrett, R, Godar, J, Goldman, ED, Hansen, MC, Heilmayr, R, Herold, M, Kuemmerle, T, Lathuilière, MJ, Ribeiro, V, Tyukavina, A, Weisse, MJ, West, C.** 2022. Disentangling the numbers behind agriculture-driven tropical deforestation. *Science* **377**(6611): eabm9267.
- Pendrill, F, Persson, UM, Godar, J, Kastner, T, Moran, D, Schmidt, S, Wood, R.** 2019. Agricultural and forestry trade drives large share of tropical deforestation emissions. *Global Environmental Change* **56**: 1–10.
- Persha, L, Andersson, K.** 2014. Elite capture risk and mitigation in decentralized forest governance regimes. *Global Environmental Change* **24**: 265–276.
- Phillipson, J, Lowe, P, Proctor, A, Ruto, E.** 2012. Stakeholder engagement and knowledge exchange in environmental research. *Journal of Environmental Management* **95**(1): 56–65.
- Pichler, M.** 2013. “People, planet & profit”: Consumer-oriented hegemony and power relations in palm oil and agrofuel certification. *The Journal of Environment & Development* **22**(4): 370–390. DOI: <http://dx.doi.org/10.1177/1070496513502967>.

- Piñeiro, V, Arias, J, Dürr, J, Elverdin, P, Ibáñez, AM, Kinengyere, A, Opazo, CM, Owoo, N, Page, JR, Prager, SD, Torero, M.** 2020. A scoping review on incentives for adoption of sustainable agricultural practices and their outcomes. *Nature Sustainability* 3(10): 809–820.
- Rainforest Action Network.** 2022. *Carbon bomb scandals: Big brands driving climate disaster for palm oil*. San Francisco, CA: RAN. Available at <https://www.ran.org/wp-content/uploads/2022/09/Rainforest-Action-Network-Leuser-Report-FINAL-WEB.pdf>. Accessed January 16, 2024.
- Ravnborg, HM, Westermann, O.** 2002. Understanding interdependencies: Stakeholder identification and negotiation for collective natural resource management. *Agricultural Systems* 73(1): 41–56.
- Ricciardi, V, Ramankutty, N, Mehrabi, Z, Jarvis, L, Chookolingo, B.** 2018. How much of the world's food do smallholders produce? *Global Food Security* 17: 64–72.
- Rietberg, P, Slingerland, M.** 2016. *Barriers to smallholder RSPO certification: A science-for-policy paper by the SENSOR programme*. Wageningen, the Netherlands: Wageningen University.
- Robinson, BE, Holland, MB, Naughton-Treves, L.** 2014. Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical deforestation. *Global Environmental Change* 29: 281–293.
- Rothrock, P, Weatherer, L, Zwick, S.** 2019. Targeting zero deforestation: Company progress on commitments that count, 2019. *Forest Trends*. Available at <https://www.forest-trends.org/publications/targeting-zero-deforestation>. Accessed January 10, 2022.
- Roundtable on Sustainable Palm Oil.** 2006. Smallholder task force minutes of first meeting.
- Roundtable on Sustainable Palm Oil.** 2010. RSPO standard for group certification.
- Roundtable on Sustainable Palm Oil.** 2015. Remediation and compensation procedure (RaCP) related to land clearance without prior High Conservation Value (HCV) assessment. Available at <https://rspo.org/certification/remediation-and-compensation>. Accessed June 30, 2022.
- Roundtable on Sustainable Palm Oil.** 2018. Principles and criteria for the production of sustainable palm oil. Available at <https://rspo.org/wp-content/uploads/rspo-principles-criteria-for-production-of-sustainable-palm-oil-2018revised-01-february-2020-with-updated-supply-chain-requirements-for-mills.pdf>. Accessed January 10, 2022.
- Roundtable on Sustainable Palm Oil.** 2019. RSPO Independent smallholder standard. Kuala Lumpur, Malaysia: RSPO. Available at [https://rspo.org/wp-content/uploads/RSPO\\_ISH\\_Standard\\_2019-English.pdf](https://rspo.org/wp-content/uploads/RSPO_ISH_Standard_2019-English.pdf). Accessed January 10, 2022.
- Roundtable on Sustainable Palm Oil.** 2020a. Guidance for ISH group manager independent smallholder—Land use risk identification (IS-LURI). Available at <https://www.rspo.org/resources/smallholders-documents/smallholders-key-documents/is-luri>. Accessed January 10, 2022.
- Roundtable on Sustainable Palm Oil.** 2020b. Indonesian independent smallholder membership up 167%. Available at <https://rspo.org/indonesian-independent-smallholder-membership-up-167/>. Accessed January 16, 2024.
- Roundtable on Sustainable Palm Oil.** 2020c. Interim measure for the simplified combined HCV-HCS approach in accordance with the ISH Standard 2019. Available at <https://rspo.org/interim-measure-for-the-simplified-combined-hcvhcs-approach-in-accordance-with-the-ish-standard-2019/>. Accessed January 10, 2022.
- Roundtable on Sustainable Palm Oil.** 2022a. Endorsement of RSPO independent smallholder standard Indonesia national interpretation 2022. Available at <https://rspo.org/endorsement-of-rspo-independent-smallholder-standard-indonesia-national-interpretation-2022/>. Accessed January 16, 2024.
- Roundtable on Sustainable Palm Oil.** 2022b. Guidance document on the simplified High Conservation Value (HCV) approach for smallholders in the RSPO—Introduction document (Phases 1 and 2). Available at [https://rspo.org/wp-content/uploads/01\\_hcv-guidance\\_introduction\\_eng\\_2022.pdf?\\_rt=MTYwfDE2fHNIYXJjaF90ZXJtX3N0cmluZ3wxNjc0OTQ5MTk0&\\_rt\\_nonce=d57b929491](https://rspo.org/wp-content/uploads/01_hcv-guidance_introduction_eng_2022.pdf?_rt=MTYwfDE2fHNIYXJjaF90ZXJtX3N0cmluZ3wxNjc0OTQ5MTk0&_rt_nonce=d57b929491). Accessed January 16, 2024.
- Roundtable on Sustainable Palm Oil.** 2022c. RSPO management system requirement for group certification of FFB production 2022. Available at [https://rspo.org/wp-content/uploads/RSPO-Group-Certification\\_2022\\_ENG.pdf](https://rspo.org/wp-content/uploads/RSPO-Group-Certification_2022_ENG.pdf). Accessed January 16, 2024.
- Roundtable on Sustainable Palm Oil.** 2023a. Search members. Available at <https://rspo.org/search-members/>. Accessed June 12, 2023.
- Roundtable on Sustainable Palm Oil.** 2023b. Who we are: Board of governors. Available at <https://rspo.org/who-we-are/governance/board-of-governors/>. Accessed June 12, 2023.
- Rudel, TK, Defries, R, Asner, GP, Laurance, WF.** 2009. Changing drivers of deforestation and new opportunities for conservation. *Conservation Biology* 23(6): 1396–1405. DOI: <http://dx.doi.org/10.1111/j.1523-1739.2009.01332.x>.
- Saadun, N, Lim, EAL, Esa, SM, Ngu, F, Awang, F, Gimin, A, Johari, IH, Firdaus, MA, Wagimin, NI, Azhar, B.** 2018. Socio-ecological perspectives of engaging smallholders in environmental-friendly palm oil certification schemes. *Land Use Policy* 72: 333–340.
- Schoneveld, GC, Ekowati, D, Andrianto, A, van der Haar, S.** 2018. Modeling peat- and forestland conversion by oil palm smallholders in Indonesian Borneo. *Environmental Research Letters* 14: 014006.
- Schouten, G, Glasbergen, P.** 2011. Creating legitimacy in global private governance: The case of the roundtable on sustainable palm oil. *Ecological Economics* 70(11): 1891–1899.

- Serikat Petani Kelapa Sawit.** 2020. SPKS: Definisi petani sawit luas lahan kurang 4 hektar. Available at <https://spks.or.id/detail-berita-spks-definisi-petani-sawit-luas-lahan-kurang-4-hektar>. Accessed January 10, 2022.
- Serikat Petani Kelapa Sawit.** 2022. Palm oil farmers believe that the EU regulations on products and commodities related to deforestation can become an opportunity and can contribute benefits for palm oil farmers in Indonesia. Jakarta, Indonesia: SPKS. Available at <https://spks.or.id/detail-sikap-palm-oil-farmers-believe-that-the-eu-regulations-on-products-and-commodities-related-to-deforestation-can-become-an-opportunity-and-can-contribute-benefits-for-palm-oil-farmers-in-indonesia>. Accessed January 16, 2024.
- Seymour, FJ, Aurora, L, Arif, J.** 2020. The jurisdictional approach in Indonesia: Incentives, actions, and facilitating connections. *Frontiers in Forests and Global Change* **3**: 124.
- Simarmata, R, Dewi, SN, Sasmita, T.** 2021. Tenure options: Toward the recognition of customary and local community rights to land and forest. Forest Peoples Programme. Available at [https://www.forestpeoples.org/sites/default/files/documents/Policy%20Brief\\_English.pdf](https://www.forestpeoples.org/sites/default/files/documents/Policy%20Brief_English.pdf). Accessed January 10, 2022.
- Siscawati, M, Banjade, MR, Liswanti, N, Herawati, T, Mwangi, E, Wulandari, C, Tjoa, M, Silaya, T.** 2017. Overview of forest tenure reforms in Indonesia. Working Paper 223. Bogor, Indonesia: CIFOR.
- Soetjiadi, A, Silva, R, Frojan, J, Lasmana, F, Dewanto, H, Aldina, R, Wulffraat, S.** 2023. HCV-HCSA Assessment manual. HCV Network Ltd. Available at <https://www.hcvnetwork.org/library/hcv-hcsa-assessment-manual-english-2023>. Accessed January 16, 2024.
- Trase.** 2020. Trase yearbook 2020 executive summary: The state of forest-risk supply chains. Available at [http://resources.trase.earth/documents/Trase\\_Yearbook\\_Executive\\_Summary\\_2\\_July\\_2020.pdf](http://resources.trase.earth/documents/Trase_Yearbook_Executive_Summary_2_July_2020.pdf). Accessed January 10, 2022.
- Unilever.** 2017. Driving a new approach to sustainable palm oil. Available at <https://www.unilever.com/news/news-and-features/Feature-article/2017/We-are-driving-a-new-approach-to-sustainable-palm-oil.html>. Accessed January 10, 2022.
- United Nations Development Program.** 2014. New York declaration on forests—Action statements and action plans. Available at [https://unfccc.int/media/514893/new-york-declaration-on-forests\\_26-nov-2015.pdf](https://unfccc.int/media/514893/new-york-declaration-on-forests_26-nov-2015.pdf). Accessed January 16, 2024.
- Villoria, N, Garrett, R, Gollnow, F, Carlson, KM.** 2022. Leakage does not fully offset soy supply-chain efforts to reduce deforestation in Brazil. *Nature Communications* **13**(1): 1–10.
- Voora, V, Bermúdez, S, Larrea, C.** 2019a. *Global market report: Cocoa*. Manitoba, Canada: IISD. (Sustainable Commodities Marketplace Series 2019).
- Voora, V, Bermúdez, S, Larrea, C, Baliño, S.** 2019b. *Global market report: Coffee*. Manitoba, Canada: IISD. (Sustainable Commodities Marketplace Series 2019).
- Voora, V, Larrea, C, Bermúdez, S, Baliño, S.** 2019c. *Global market report: Palm oil*. Manitoba, Canada: IISD. (Sustainable Commodities Marketplace Series 2019).
- Wilmar International.** 2015. Grievance procedure for the implementation of Wilmar's no deforestation, no peat, no exploitation policy. Available at <https://www.wilmar-international.com/wp-content/uploads/2015/01/Grievance-Procedure-27-Jan-2015.pdf>. Accessed January 10, 2022.
- Young, J, Gilmore, M.** 2017. Participatory uses of geospatial technologies to leverage multiple knowledge systems within development contexts: A case study from the Peruvian Amazon. *World Development* **93**: 389–401.
- Zhunusova, E, Ahimbisibwe, V, Sadeghi, A, Toledo-Aceves, T, Kabwe, G, Günter, S.** 2022. Potential impacts of the proposed EU regulation on deforestation-free supply chains on smallholders, indigenous peoples, and local communities in producer countries outside the EU. *Forest Policy Economics* **143**: 102817.
- zu Ermgassen, EK, Ayre, B, Godar, J, Lima, MGB, Bauch, S, Garrett, R, Green, J, Lathuilliere, M, Löfgren, P, Macfarquhar, C, Meyfroidt, P, Suavet, C, West, C, Gardner, T.** 2020. Using supply chain data to monitor zero deforestation commitments: An assessment of progress in the Brazilian soy sector. *Environmental Research Letters* **15**(3): 035003.
- zu Ermgassen, EK, Lima, MGB, Bellfield, H, Dontenville, A, Gardner, T, Godar, J, Heilmayr, R, Indenbaum, R, Dos Reis, TNP, Ribeiro, V, Abu, IO, Szantoi, Z, Meyfroidt, P.** 2022. Addressing indirect sourcing in zero deforestation commodity supply chains. *Science Advances* **8**(17): eabn3132.

**How to cite this article:** Eggen, M, Heilmayr, R, Anderson, P, Armson, R, Austin, K, Azmi, R, Bayliss, P, Burns, D, Erbaugh, JT, Ekaputri, AD, Gaveau, DLA, Grabs, J, Greenbury, A, Gulagnar, I, Hanu, MA, Hill, T, Leegwater, M, Limberg, G, Opal, C, Putri, V, Rodrigues, J, Rosoman, G, Satar, M, Sheun, SS, Rafik, R, Walen, S, Carlson, KM. 2024. Smallholder participation in zero-deforestation supply chain initiatives in the Indonesian palm oil sector: Challenges, opportunities, and limitations. *Elementa: Science of the Anthropocene* 12(1). DOI: <https://doi.org/10.1525/elementa.2023.00099>

**Domain Editor-in-Chief:** Alastair Iles, University of California Berkeley, Berkeley, CA, USA

**Associate Editor:** Kevin Dooley, Department of Supply Chain Management, Arizona State University, Tempe, AZ, USA

**Knowledge Domain:** Sustainability Transitions

**Part of an Elementa Special Forum:** Multi-Stakeholder Initiatives for Sustainable Supply Networks

**Published:** May 16, 2024    **Accepted:** March 29, 2024    **Submitted:** July 06, 2023

**Copyright:** © 2024 The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC-BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. See <http://creativecommons.org/licenses/by/4.0/>.



*Elem Sci Anth* is a peer-reviewed open access journal published by University of California Press.

OPEN ACCESS The Open Access logo, consisting of the words "OPEN ACCESS" followed by a circular icon containing a stylized 'A'.