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REPORT

Traceability and transparency in supply chains for agricultural and forest commodities

A review of success factors and enabling conditions to improve resource use and reduce forest loss

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With the technical support of:

Food and Agriculture Organization of the United Nations

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ACKNOWLEDGMENTS

This report was prepared by World Resources Institute, Efeca, and Kanopi Consulting with the technical support of the Food and Agriculture Organization of the United Nations (FAO).

The authors would like to thank everyone who supported this work, including the following people who were interviewed and provided information used in the report or served as reviewers:

Jean Bakouma, Mairon Bastos-Lima, Leandro Baumgarten, Helen Bellfield, Grace Blackham, Ethan Budiansky, Pedro Burnier, Andre Campos, Caroline Duhesme, Luca Fischer, Toby Gardner, David Gehl, Adrian Gires, Adrian Hagitas, Maddie Harris, Alastair Herd, Lisandro Inakake de Souza, Vincent Istace, Simon Kartar, Marcel Koubemba, Godwin Limberg, Daniela Mariuzzo, Rob Maslin, Serge Moukouri, Sengbee Ng, Saskia Ozinga, Naven Pankhania, Gary Paoli, Oswaldo Pereira, Elizabeth Petykowski, Florian Reimer, Luke Ryder, Anna Sands, Jade Saunders, Daniel Silva, Jack Simpson, Lucie Smith, Tim Steinweg, Olivier Tichit, Nanne Tolsma, Sebastiaan van der Hoek, Laura Waisbich, Jon Walker, Nathalie Walker, Victoria Wiafe, Mark Wong, a number of contributors who wish to remain anonymous, and FACT Dialogue members of the Traceability and Transparency Action Group.

Thank you also to the following FAO colleagues for their support: Bruno Cammaert, Rémi D'Annunzio, Serena Fortuna, Julian Fox, Buyung Hadi, Tomislav Ivančić, Thaís Linhares-Juvenal, Caroline Merle, Anne Mottet, Cristiana Orlandi, Tiina Vähänen, and Erik van Ingen.

Finally, the authors would like to thank the following current and former WRI staff and consultants for serving as reviewers, for providing technical inputs, for guiding the publication and peer review process, for supporting the dissemination of the findings, and for designing and copyediting the report: Ruth Nogueron, Wan Jian, Zhe Liu, Achille Djeagou, Bukti Bagja, Hidayah Hamzah, Mikaela Weisse, Luiz Calado, Caroline Winchester, Fred Stolle, Sarah Carter, Charles Barber, Marie Vallée, Elizabeth Goldman, Anne Rosenbarger, Bo Li, Tobias Stäuble, Chloe Shauck, Jun Geng, Stephanie Tan, Ekin Birol, Laura Malaguzzi Valeri, Gregory Taff, Renee Pineda, Emilia Suarez, Romain Warnault, Sarah DeLucia, Sara Staedicke, Shannon Collins, and Emily Vail.

Funding for this independent piece of research was provided by the UK Department for Environment, Food and Rural Affairs. Funding for the Forest Data Partnership was provided by the United States Agency for International Development (USAID).

SUGGESTED CITATION

Fripp, E., J. Gorman, T. Schneider, S. Smith, J. Paul, T. Neeff, F. Marietti, L. Vary, A. Zosel-Harper. 2023. "Traceability and transparency in supply chains for agricultural and forest commodities: A review of success factors and enabling conditions to improve resource use and reduce forest loss." Report. Washington, DC: World Resources Institute. Available online at doi.org/10.46830/wrirpt.22.00156.

VERSION 1
October 2023

CONTENTS

Foreword

Close to 90 percent of forest loss is associated with the expansion of agriculture. Yet, even though we know agriculture is the leading cause of deforestation, it is difficult to know where change needs to start.

Complex and opaque supply chains are covering the path to progress. To understand where and how production is associated with forest loss, we need to better monitor the journey of products from harvest to sale. This information and level of transparency is critical to begin sustainably managing the supply chains that are responsible for forest loss today.

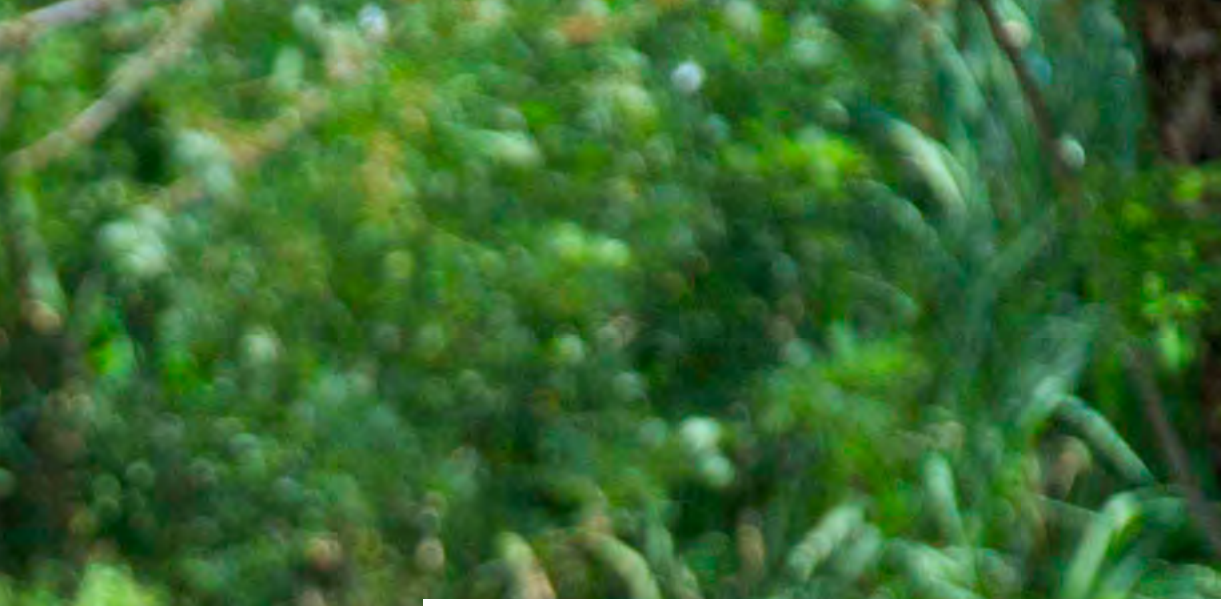
The global community has recognized the urgent need to halt deforestation—and the role of agricultural production in driving it. Several markets are now developing policies to restrict the import or sale of commodities grown on recently deforested land. Countries are enacting requirements for traceability and corporate reporting from point of production to export. They are also working to align commodity production with international agreements such as the Sustainable Development Goals or Nationally Determined Contributions in formal UN climate procedures. But, achieving traceability and transparency requires not only policy interventions; technical solutions and significant investment of time and resources are also needed.

To ensure these policies succeed, we need the right tools and initiatives to provide decision-makers with accurate information. For example, we must be able to monitor where forest loss is happening to identify the supply chains responsible. This report identifies gaps and proposes a set of priority actions on traceability and transparency for supply chains for seven commodities — cattle, palm, soy, cocoa, timber, coffee and rubber. Governments, companies and civil society will only be able to design effective interventions on traded products if they understand their impact.

Supply chains are complex by nature. Existing supply chains can only be effectively transformed with inclusive collective action, which must start now. Collaboration is needed to align approaches, avoid duplication of efforts, and ensure benefits for all actors across the system. Shifts must account for the needs and interests of producers, particularly smallholder farmers. While there are certainly still gaps in the data landscape, supply chain actors have enough information to start proactively assessing and managing risks associated with forest loss. More and better data is not a pre-requisite for effective action, and should not be an excuse to delay progress.

Building up traceability and transparency can underpin the ambitious objectives set out by the public and private sectors to address forest loss. Policymakers should invest in collaborative solutions that identify opportunities for scaling and replicating approaches to advance traceability and transparency in every aspect of supply chain management. We can only understand and tackle the challenge ahead by working together to build a new system. By doing so, we can turn the tide on forest loss and secure a nature-positive world for all.

ANI DASGUPTA
President & CEO
World Resources Institute



Executive summary

Without halting forest loss, the global community will not be able to meet climate targets. While the overall rate of tree cover loss has declined since its peak in 2016, primary forest is still being lost at an alarming rate. Close to 90 percent of forest loss is associated with the expansion of agriculture. Traceability and transparency in supply chains for these products are therefore necessary to understand the impact of commodities on forests, and to support the design, implementation, monitoring of effective solutions to address forest loss, and help make agricultural production and food systems more sustainable.

HIGHLIGHTS

- Decoupling production and consumption of commodities such as soy, palm oil, cattle, cocoa, timber, coffee, and rubber from forest loss is imperative for meeting climate targets. Although the causal link between forest loss and traceability and transparency is complex, forest loss cannot be addressed without understanding where and how commodities are produced and how sustainability of agricultural value chains could be strengthened.
- This report assesses traceability and transparency tools and initiatives based on a literature review and interviews. It draws out enabling conditions and success factors that inform priority actions for expanding traceability and transparency.
- Independent verification is necessary for systems to be credible. Definitions need to be applied consistently.
- Traceability and transparency in commodity supply chains are achievable, though additional investment is required.
- Governments should provide an adequately resourced policy environment that facilitates traceability and transparency within the challenges of complex supply chains. Investments are rarely one-off since continued funding is usually needed. Approaches to traceability and transparency must consider the needs of smallholders to be effective.
- Data gaps remain, especially where there is a large smallholder component, but equally important is ensuring that data are accessible and usable. Investments are needed to help close these gaps.

BACKGROUND

Traceability and transparency are increasingly called on to help halt and reverse forest loss. In November 2021, 145 countries restated their commitments to conserve, protect, sustainably manage, and restore forests and to work toward halting forest loss and land degradation in the Glasgow Leaders' Declaration on Forests and Land Use (COP26 2021). Close to 90 percent of forest loss is associated with expansion of agriculture, resulting in increasing calls for better solutions to identify and help manage the risk of forest loss associated with commodity supply chains. The role of traceability and transparency has been widely recognized in the application and enforcement of laws that underpin sustainable production, efforts by companies to ensure sustainable sourcing of agricultural commodities, and efforts by stakeholders and civil society to enhance accountability. There is growing momentum of government commitments at the national, regional, and international levels; private sector commitments and pledges; and requirements for disclosure, monitoring, and reporting. Delivering on these commitments requires robust traceability and transparency systems.

OBJECTIVE AND METHODS

This independent research project, undertaken by World Resources Institute with technical support of the Food and Agriculture Organization of the United Nations (FAO) and a team of consultants on behalf of the Forest Data Partnership, seeks to provide an updated evidence base on traceability and transparency in commodity value chains. The report aims to inform collaborative action among governments, the private sector, and civil society organizations that are working toward enhancing traceability and transparency. It focuses on seven commodities: cattle, palm oil, soy, cocoa, timber, coffee, and rubber, but also offers insights applicable to other commodities.

Traceability and transparency can have different meanings to different stakeholders in different circumstances. This report uses the following working definitions:

- *Traceability* refers to the ability of an actor to link a product or unit of material with information about its history of locations, owners, and transformations between points in the supply chain, such as from production site

to end user. The information associated with commodities also includes sustainability aspects at the production site, notably forest loss.

- *Transparency* refers to the making available of information by any stakeholder. The information that is made available will often relate to the traceability of commodities, but can include broader information that is relevant and useful in the context of halting and reversing forest loss such as sustainability policies and practices, commitments, land use information, monitoring, or outstanding grievances. There can be different levels of transparency, ranging from information sharing within an organization or peer companies, to sharing with specific stakeholders, to sharing publicly.

Traceability and transparency tools and initiatives, while providing much needed information, do not alone lead to reduced forest loss. Traceability and transparency are not solutions in themselves but are necessary to support decisions by supply chain actors that affect forest cover. While the causal link between traceability and transparency on one side and forest conversion on the other is complex, increased access to information is a precondition for producing commodities without inducing forest loss.

This report's research draws on three sources of information collected and analyzed between October and December 2022. First, we surveyed 94 tools and initiatives that generate, collect, process, and distribute relevant information about agricultural and forest commodities through a global mapping exercise. Second, we conducted over 70 interviews with representatives from government, the private sector, civil society, and academia. Third, we undertook case studies to delve into more detail, covering regions and commodities of global importance. The case studies are on palm oil in Southeast Asia, cocoa and timber in West and Central Africa, soy in Brazil, and cattle in Latin America.

CONCLUSIONS

This report draws out three categories of findings based on these information sources:

- An overview of enabling conditions and success factors for traceability and transparency
- An assessment of how traceability and transparency can underpin the ambitious objectives to address forest loss in the public and private sectors and identify key gaps
- Priority actions to improve traceability and transparency

ENABLING CONDITIONS AND SUCCESS FACTORS

Enabling conditions can be critical for the success of traceability and transparency.

- **Public funding and civil society involvement in design and management** lead to higher levels of disclosure in traceability and transparency tools and initiatives, highlighting the importance of ownership structure and funding sources.
- The **regulatory environment** requires transparency on commodity production (e.g., including due diligence requirements and mandatory national or jurisdictional standards, reporting standards, or assurance mechanisms) and governance structures set up to successfully implement and enforce legal frameworks.
- **Reporting standards, definitions, and methodologies** are consistently applied across a whole sector and within initiatives.
- Governments make **data available and accessible**, supporting traceability and transparency within supply chains and facilitating agreement on standards for data disclosure and publication.

Traceability and transparency are not solutions in themselves but are necessary to support decisions by supply chain actors that affect forest cover.

- **Shared goals and trust** among actors enable data sharing and avoid duplication of efforts, building on and expanding the reach of individual supply chain solutions.
- **Collective action relies on agreement among companies, governments, financial institutions, and civil society** on the demands for data.
- **Equitable cost sharing** to set up and maintain data collection and traceability systems enables broad participation.
- **Continued investment in technical innovation** creates the conditions for better data quality and usability, which are important for tools and initiatives to be effective.

In addition to the enabling conditions, there are also common success factors associated with specific tools and initiatives, which the report lays out with examples.

- **Clear scope and corresponding metrics of success** enable targeted initiatives that can be evaluated.
- **Internal or external verification and audit processes** assess the validity of reported data and build data credibility.
- **Aligned or consistent** definitions, metrics, scopes, and reporting mechanisms and alignment on what constitutes credible evidence make it possible to compare disclosed results from several sources. Safeguards for sharing data effectively are needed to protect sensitive information, reduce duplication of efforts, and enhance transparency.
- **Clear frameworks and rules** for consistent data collection and reporting across sectors, commodities, and geographies enable broad uptake and reduce cost.
- **When datasets are user-friendly and well-documented, and data and methods are accessible** (published and easy to find) **and interoperable** (different datasets can be used together), target audiences are able to act upon information.

Existing and future traceability and transparency tools and initiatives can support policy objectives to halt and reverse forest loss by building on existing efforts and closing gaps.

Current traceability and transparency tools and initiatives have developed rapidly to meet evolving needs. This report lays out a list of successful examples across several geographies and commodities that illustrate that enhancing traceability and transparency is achievable and can be part of efforts to address forest loss. In many cases, changing voluntary and regulatory requirements have encouraged innovation and the development of solutions to meet these requirements. Governments should continue to raise the level of ambition reflected in systems, requirements, and pledges, while providing the necessary guidance and support to help private sector actors navigate these changes.

Despite the rapid progress seen to date in developing traceability and transparency solutions, more concerted and aligned action from all groups is necessary in the near term to address forest loss in agricultural and forest supply chains. Individual companies and collaboration platforms have adopted pledges to remove deforestation from supply chains, but to date only 36 percent of the largest companies have commitments and many of these companies are not systematically monitoring their progress toward meeting them. Much of the effort to date has been focused on individual supply chains and small pilots. Similarly, governments have signed commitments to halt and reverse forest loss, but in many cases more funding and staff are needed to meet these commitments, and to expand government-owned traceability and transparency tools and initiatives. There needs to be a shift both in the pace and scope of action taken to apply traceability and transparency to achieve sector-wide transformation.

The ability to achieve full traceability back to the point of origin depends on various factors, including geographic complexity, the number of tiers of a supply chain, whether the supply is from only direct or also indirect sources, and the proportion of smallholders in the supply chain. There are examples where full traceability has been achieved, but traceability of indirect supply and for smallholder producers remains challenging, requiring investments of time, financial resources, and effort. For some commodities, individual units of products are easier to trace, but for others (e.g., soy, coffee, cocoa, palm oil), raw materials and derived products are blended in the supply chains.

Governments play a key role in collecting and sharing data and should make more data available to help fill remaining gaps. Traceability and transparency tools and initiatives in many cases rely on public sector information, such as farm legality and licensing data, as well as forest monitoring systems. Traceability and transparency can be advanced more rapidly when private sector traceability data can be

integrated with data from government forest monitoring systems and sources of information on land tenure, including on legality and other contextual information. Further improvements can also be made in terms of the accessibility and usability of public sector data. For example, even when government data are available, systems could be further improved to allow integration of relevant datasets and information flows across state and federal agencies. Government action is needed at the jurisdictional, country, and international levels to expand the data and information available for use, which is a key component of a conducive enabling environment for achieving transparency and traceability on commodity production. However, in many cases, providing additional data will depend on the provision of adequate capacity development support.

While gaps remain, in most instances enough data and information exist for supply chain actors to take meaningful steps toward assessing the risk of forest loss in supply chains, and to prioritize areas for action. Data gaps remain such as in data availability for individual commodities (some commodities have been prioritized, and interest in others is now rising), for certain producer groups (primarily related to smallholder farmers), and for specific types of data (some kinds of geospatial data are difficult or expensive to obtain, and a lot of contextual data, such as around land tenure, are often not available). While continued investments are needed to improve data availability, quality, usability, and interoperability, data gaps should not be used to delay action. Solutions should start from the problem, not the available technology, to avoid limiting ambition to what is already common practice and avoid bias in selecting tools and resources.

Individual supply chain projects and pilot approaches have been a useful source of experimentation and learning, but to address forest loss in supply chains, a sector-wide transformation is needed. Solutions developed by individual actors or small consortia remain limited in reach in part because data remain siloed or are not shared across actors, or because of a lack of adoption by peer companies. Private sector–led approaches will cover only a portion of markets, typically the activities of the largest enterprises, which are subject to international investor and buyer pressure. The largest private sector actors engaged in the "visible" economy, such as major meatpackers, soy traders, and palm oil traders, have taken voluntary measures to set up traceability systems. However, in all these cases their market shares, while meaningful, do not cover all production. More emphasis can be placed on recruiting more private sector actors, including small and midsize enterprises, to join collaborative efforts aimed at sector transformation. Enhanced collaboration within and among supply chains, collective action approaches, and scaling up successful strategies are all essential building blocks. However, these approaches all rely on funding and time to build trust among actors and align on definitions and can be harder to fund than new tools and initiatives. Rather than creating new systems, a necessary focus is on strengthening the linkages of existing systems, protocols, and datasets, and the certifications across both the public and private sectors.

For a sector-wide transformation, governments in producing and consuming countries need to continue raising the bar with respect to traceability, reporting, and disclosure requirements as well as supporting information flows across public and private sectors. Relying on private sector financing and innovation limits the ability of traceability systems to reach full market saturation. Even if these systems are strong and fully implemented in these supply chains, private sector efforts cannot on their own fully transform sectors. The lack of efficient information flows and exchange across multiple private sector actors limits effective policy design and interventions. Government efforts, regulations, and systems, in collaboration with private sector efforts, are necessary to ensure that traceability systems cover the entire marketplace. Furthermore, the public sector can help facilitate information flows and accessibility by and for market actors.

Producing countries need support in developing, implementing, and maintaining sector-wide traceability and transparency tools and initiatives. Government approaches to achieving market-wide uptake of tools and initiatives through required standards, certification, or disclosure mechanisms are needed to "raise the floor." However, this may not occur unless there is investment from consuming countries, philanthropies, and private sector sources to accompany changing market requirements. Such investments enable producing countries to pursue traceability and transparency tools and initiatives—both for public sector purposes, such as improving governance, enhancing revenue collection, and meeting national-level commitments and climate targets, and to improve market access for producers. Improved market access is particularly important in supporting vulnerable

actors that may otherwise be excluded from markets and supply chains. The interests and needs of vulnerable actors such as smallholders need to be considered in traceability and transparency tools and initiatives starting in the design phase.

Broad uptake of transparency and traceability initiatives rests on collaborative approaches that manage to ensure that all supply chain actors participate and that collected information is of a high quality. The credibility of tools and initiatives will derive from their broad uptake, as long as strong mechanisms are in place for systematic quality control and data verification. Such quality management is essential to achieving public trust in systems that self-reported data will not always enjoy.

International dialogue can advance traceability and transparency by setting expectations and creating guidance. International fora such as the Forest, Agriculture and Commodity Trade (FACT) Dialogue; the Amsterdam Declarations Partnership; and the Forest and Climate Leaders' Partnership can advance discussions around topics that require government participation or support. This includes finding an equitable cost-sharing mechanism to avoid the burden of traceability and transparency being placed on smallholders or other upstream actors. International alignment would also be useful in agreeing on best practices for data gathering undertaken in an inclusive manner, considering current power imbalances in supply chains, and safeguarding privacy concerns and ownership of data collected, especially when it concerns data collected about individual producers. These fora could agree on best practices for funding traceability and transparency tools and initiatives, which should include a requirement for robust impact evaluation and a mandate to learn from and build on existing experiences. Government dialogue could also serve as a useful avenue for sharing lessons about efforts to implement traceability and transparency at the national or jurisdictional level. Further, governments can assess existing and planned initiatives in-country based on the key elements and success factors identified in this report and apply the lessons from collaborative approaches presented in this report. Government dialogue can help align on methods for data gathering and reporting, and on what constitutes credible evidence based on existing initiatives such as the Accountability Framework initiative and the Science-Based Targets Network.

Government, the private sector, and civil society need to expand the ambition and scale of action now to improve and increase traceability and transparency while engagement and dialogue continue. Making progress on some issues, such as definitions and specific data requirements, may take time and should not distract from the urgency of the forest loss crisis. There needs to be a dual approach to simultaneously pursuing better alignment on standards, reporting requirements, and datasets, while putting into place traceability systems. Today's existing solutions can be used more fully while work progresses in parallel to define and establish tomorrow's approach to traceability and transparency among the public and private sectors and civil society.

This report draws out the following priority actions by category of actor to improve traceability and transparency.

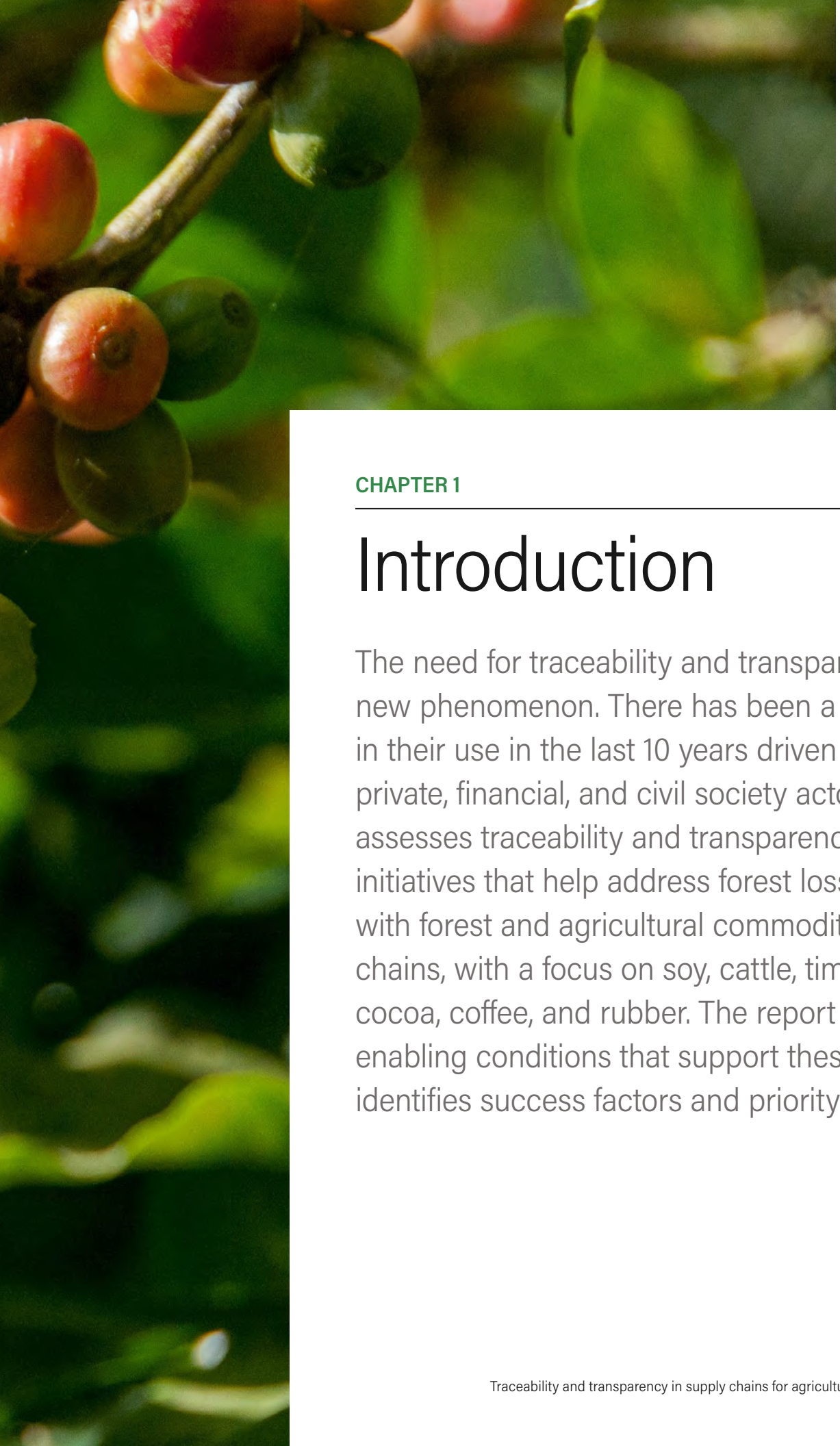
Private sector actors in supply chains should make the necessary effort to collect information, build up traceability systems, and disclose information where appropriate. Private sector actors should, jointly with other stakeholders, pursue an equitable solution to the additional costs created by increasing demands for traceability and transparency; collaborate with other actors to find ways to ensure that cost does

not cut out vulnerable upstream producers from markets; and put in place safeguards to protect privacy. They should, jointly with other stakeholders, work toward aligned standards for data disclosure and publication. They should support greater consistency within the objectives and reporting standards set in policy measures. They should work toward coherent and aligned commitments and take measures to address specific challenges facing smallholders and small and medium-sized enterprises in supply chains.

Governments of consuming countries should closely work together with those of producing countries. This will often include a range of activities, from providing technical and financial support to setting up and rolling out approaches to traceability and transparency. They should prioritize funding coordinated and integrated approaches and initiatives that build on and expand existing successful projects. They should carefully work with producers and supply-chain actors toward meeting consistent objectives and reporting standards.

Governments of producing countries should "raise the floor" by setting up assurance systems for commodity production and create market signals by setting national standards for traceability and transparency. They should provide the necessary data to create effective traceability and transparency systems. They should, jointly with other stakeholders, work toward consistent objectives and reporting standards set in policy measures. Where they provide tools and platforms, governments should ensure that cost does not limit access to tools and platforms, especially among vulnerable upstream producers, and put in place safeguards to protect privacy. They should also set up support mechanisms to prevent smallholders from being excluded from markets.

Civil society organizations should continue developing technical solutions to integrating datasets, tools, and systems. They should ensure that cost does not limit access to tools and platforms, especially among vulnerable upstream producers, and put in place safeguards to protect privacy. They should leverage innovation and learn from other sectors to facilitate data sharing. They should support consistent objectives and reporting standards set in policy measures. They should bolster efforts to collaborate with existing initiatives, and support smallholders and other vulnerable actors in targeted projects.



CHAPTER 1

Introduction

The need for traceability and transparency is not a new phenomenon. There has been a step change in their use in the last 10 years driven by public, private, financial, and civil society actors. This report assesses traceability and transparency tools and initiatives that help address forest loss associated with forest and agricultural commodity supply chains, with a focus on soy, cattle, timber, palm oil, cocoa, coffee, and rubber. The report draws out the enabling conditions that support these systems and identifies success factors and priority actions.

The Glasgow Leaders' Declaration on Forests and Land Use restates the commitment of 145 countries to conserve, protect, sustainably manage, and restore forests and to work toward halting forest loss and land degradation for climate, development, and other targets (COP26 2021). Close to 90 percent of forest loss is associated with the expansion of agriculture (FAO 2022b; Pendrill et al. 2022), resulting in increasing calls for better traceability and transparency solutions to identify and help manage the risk of forest loss in these commodity supply chains (Goldman et al. 2020; Pendrill et al. 2022). The role of traceability and transparency in the application and enforcement of laws that underpin sustainable production, efforts by companies to ensure sustainable sourcing of agricultural commodities, and efforts by stakeholders and civil society to enhance accountability are also recognized in international processes, such as the Amsterdam Declaration Partnership and the Forest, Agriculture and Commodity Trade (FACT) Dialogue.[1] The FACT Dialogue, launched in 2021, aims to promote sustainable development and trade while protecting forests and other critical ecosystems.

This independent research project, undertaken by World Resources Institute (WRI) with support from the Food and Agriculture Organization of the United Nations (FAO) and a team of consultants on behalf of the Forest Data Partnership, seeks to provide an updated evidence base that can inform and advance collaborative actions on traceability and transparency.

TRACEABILITY AND TRANSPARENCY: RESEARCH OBJECTIVES

The aim of this research was **to assess traceability and transparency tools and initiatives that help address forest loss associated with forest and agricultural commodity supply chains to draw out the enabling conditions that support these systems** and identify success factors and priority actions. The research focused on soy, cattle, timber, palm oil, cocoa, coffee, and rubber as the commodities identified as those most closely linked to forest loss.

Traceability and transparency can have different meanings to different stakeholders in different circumstances. They are often considered critical, and designed specifically for meeting and monitoring compliance with market requirements and commitments made at company, national, regional, and international levels to halt and reverse forest loss associated with forest and agricultural commodity supply chains, and to support increasing requirements for disclosure, monitoring, and reporting. However, the terms *traceability* and *transparency* are not used consistently. The ambiguity in terminology is explored further in "Results from a global mapping of traceability and transparency tools and initiatives." For the purposes of this report, the working definitions for traceability and transparency are the following:

- **Traceability** refers to the ability of an actor to link a product or unit of material with information about its history of locations, owners, and transformations between points in the supply chain such as from production site to end user. The information associated with commodities also includes sustainability aspects at the production site, notably forest loss.
- **Transparency** refers to the making available of information by any stakeholder. The information that is made available often relates to the traceability of commodities, but can include broader information that is relevant and useful in the context of halting and reversing forest loss such as sustainability policies and practices, commitments, land use information, monitoring, or outstanding grievances. There can be different levels of transparency, ranging from information sharing within an organization or among peer companies, to sharing with specific stakeholders, to sharing publicly.

Thus, even when applying these working definitions, a specific action of generating or sharing information may be accurately described as contributing to either traceability or transparency (or both) depending on what information is being shared, by whom and to whom.

Traceability and transparency systems can provide information to stakeholders on the origin of a commodity, along with other attributes that link to forest loss. A wide array of traceability and transparency tools and initiatives exist, from earth observation; use of information technology to trace product-related information from source to end user; and methods for data verification to provide assurance of credibility using internal processes, voluntary and/or mandatory certification, or systems of compliance and disclosure.

These systems support efforts by the following:

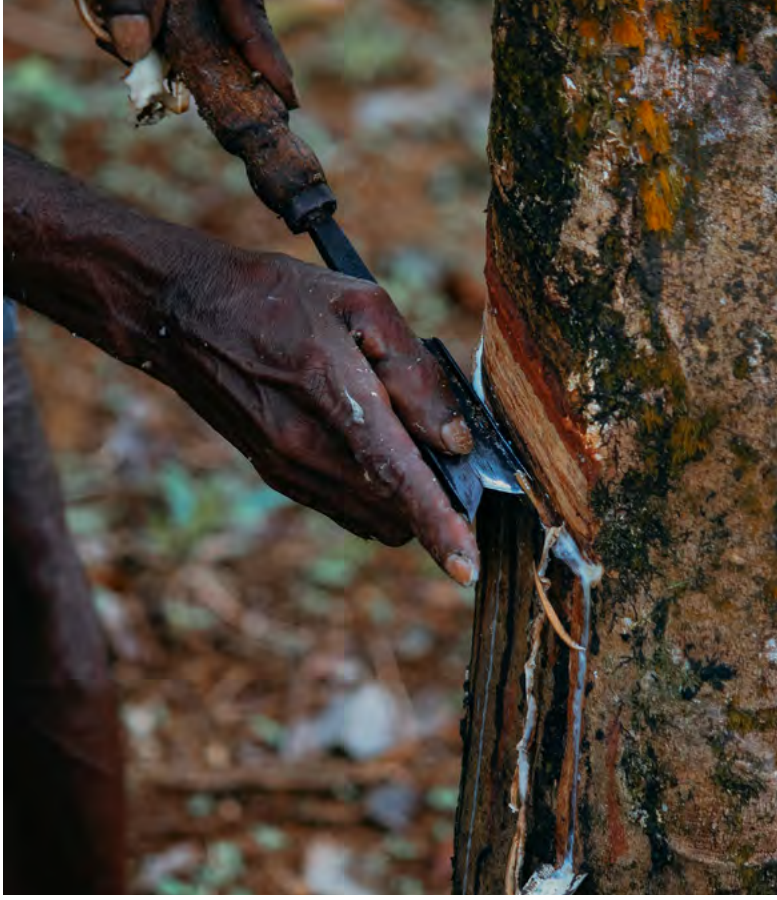
- Producing and consuming governments to develop, apply, and enforce laws that underpin sustainable production based on information about the links among commodity supply chains and forest loss
- Private sector actors (companies and financial institutions) involved in supply chains to monitor production and manage the supply base, including to ensure and demonstrate sourcing of sustainably and legally produced agricultural and forest commodities
- Civil society to enhance accountability
- Donors and philanthropies interested in addressing forest loss

In addition, the following are factors relevant to traceability and transparency that are not always directly referred to:

Enabling conditions and *interdependencies* are terms often used to describe certain underlying factors that can influence the likelihood that any given traceability or transparency system or initiative will achieve its objective(s).

- **Enabling conditions** are often broad external factors relating to the policy, regulatory, or cultural context within which the traceability or transparency system is operating. These factors both motivate and facilitate the emergence and use of traceability and transparency systems, as well as translate information provided by these systems into impacts on the ground.
- **Within the enabling environment, interdependencies** often exist among stakeholders within a shared process; for example, one stakeholder may be dependent on data provided by another stakeholder to make progress, but these data may not be publicly available or published in a format that is usable. In addition, decisions that affect one part of the supply chain (such as changes to legal frameworks) can affect supply chain actors in other geographies.

Enabling conditions and interdependencies are critical for the effective implementation of traceability and transparency systems and are drawn out throughout the report and reviewed in "Summary of findings."



EVOLVING GLOBAL CONDITIONS DRIVING TRACEABILITY AND TRANSPARENCY

The need for traceability and transparency is not a new phenomenon. For more than 20 years, traceability and transparency have been applied in the forest and other sectors, from which other forest risk commodity actors can learn. There are also useful lessons in the development and implementation of government-mandated systems that institute broad market requirements in the forest sector, complementing and building on voluntary initiatives, sometimes led by the private sector, to improve timber supply chain governance.

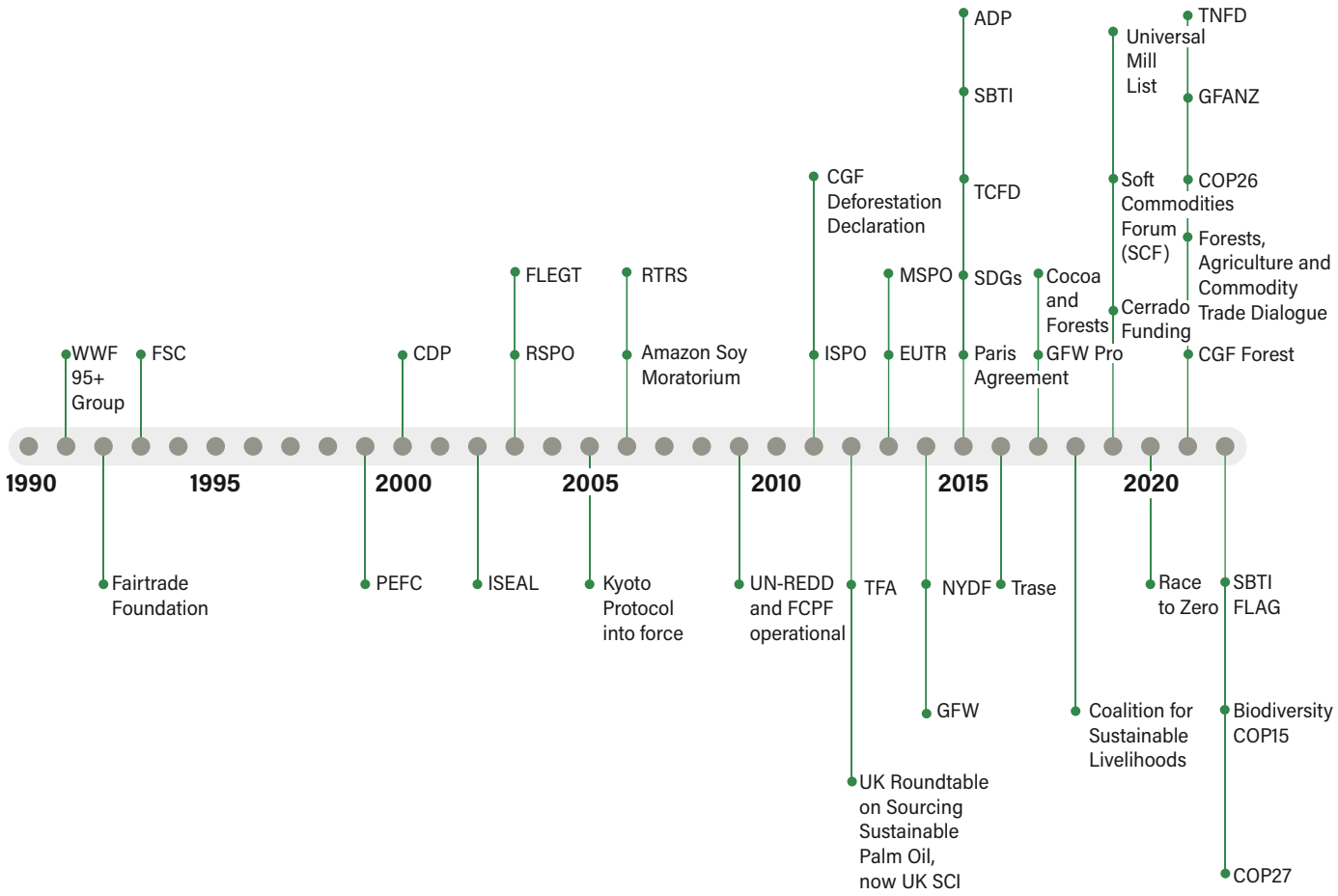
There has, however, been a step change in the last 10 years with the recognition of the role that some agricultural commodities play in driving forest loss—contributing to the 11.1 million hectares (ha) of tree cover loss in the tropics in 2021 (Weisse and Goldman 2022). This is in turn increasing demand for traceability and transparency tools and initiatives, an expansion of their coverage in both commodities and users, and continuous evolution in technology. For

example, over the past two decades, there has been a shift from paper-based traceability systems to digitalized processes for mapping, monitoring, verification, and sharing of information as in the case of timber (discussed further in Appendix F).

Figure 1 depicts this evolving landscape through examples of corporate and international commitments, development of certification standards, and industry initiatives.

Alongside these developments, means of providing assurance have evolved from voluntary-based, private sector–led certification to an increased role of national government–led systems. For example, a Timber Legality Assurance System (TLAS) (see "Traceability and transparency through the supply chain," Box 6) is a core component of the bilateral Voluntary Partnership Agreements (VPAs) under the European Union (EU) Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan.[2] These government-led

FIGURE 1 | Illustration of the evolving and increasingly crowded space addressing forest loss and related issues



Note: WWF = World Wildlife Fund; FSC = Forest Stewardship Council; PEFC = Programme for the Endorsement of Forest Certification; CDP = Carbon Disclosure Project; ISEAL = International Social and Environmental Accreditation and Labelling Alliance; FLEGT = Forest Law Enforcement, Governance and Trade; RSPO = Roundtable on Sustainable Palm Oil; RTRS = Round Table on Responsible Soy; UN-REDD = United Nations–Reducing Emissions from Deforestation and forest Degradation; FCPF = Forest Carbon Partnership Facility; ISPO = Indonesia Sustainable Palm Oil; UK SCI = United Kingdom Soft Commodities Initiative; TFA = Tropical Forest Alliance; EUTR = European Union Timber Regulation; MSPO = Malaysian Sustainable Palm Oil; NYDF = New York Declaration on Forests; GFW = Global Forest Watch; ADP = Amsterdam Declarations Partnership; SBTi = Science Based Targets initiative; TCFD = Task Force on Climate-related Financial Disclosures; SDGs = Sustainable Development Goals; AFi = Accountability Framework initiative; SBTi FLAG = Science Based Targets initiative Forest, Land and Agriculture; COP15 = 15th Conference of the Parties; TNFD = Taskforce on Nature-related Financial Disclosures; GFANZ = Glasgow Financial Alliance for Net Zero.

Source: Compilation by authors.

traceability and transparency systems emerged to meet timber market requirements in the EU, United Kingdom (UK), and United States but more importantly were developed to improve sector-wide forest enforcement in VPA countries.[3]

Government commitments and actions

Traceability and transparency systems are components of government-led actions in both producing and consuming countries, although the distinction is not always binary, given the important role of domestic markets and the fact that some countries are engaged primarily in processing and transshipment. At the national and subnational levels, governments are working to strengthen the enabling conditions to provide greater traceability and transparency from production and processing to end user markets.

Producing countries, through processes such as designing and implementing a TLAS, have increasingly seen the benefits of traceability and transparency tools and initiatives as part of improved natural resource management and governance. Traceability, transparency, and monitoring approaches for forest resources are also being used, for example, increasingly as part of compliance with climate commitments and supporting efforts to access climate finance. They may also be used in managing resources through greater collaboration among actors, as shown in the collaboration between the Ghana Forestry Commission and the Cocoa Board (see Appendix D).

At the same time, consuming countries and markets are taking responsibility for the footprints of their consumption of forest risk commodities and forest products (in the context of this report, forest products include timber, wood products, and pulp and paper, but not non-timber forest products). They are also building on the experiences with timber regulations: For example, the United States, UK, and EU have developed or are discussing regulations on agricultural commodities and forest products to ensure that consumption of these commodities does not drive forest loss and supports the production of commodities in compliance with the laws of the country of origin. In addition, the joint declaration from Brazil and China on cooperation on climate change expressed an intention to collaborate toward eliminating illegal deforestation, which highlights the broad interest in the topic even among consuming countries that are not pursuing regulatory options at this time (MMA 2023).

Traceability and transparency tools and initiatives will be important in meeting due diligence requirements at least in some import markets, along with supporting frameworks, guidance, and other resources, as shown in Box 1.

Private and financial sector commitments and actions

In addition to government commitments to combat climate change, there has been a plethora of private sector commitments and pledges to reduce the impact of agricultural production on forests and forest loss, all of which require greater levels of traceability and transparency (see Figure 2).

Most major private sector companies, including producers, traders, and manufacturers of key commodities, and many consumer-facing brands have committed to addressing forest loss (often articulated as commitments to "deforestation- and conversion-free" supply chains) and developed programs of work to deliver on this. Ambitions on traceability and transparency vary—Table 8 in "Traceability and transparency through the supply chain" describes a range of approaches. Coupled with this are climate change commitments, such as the Race to Zero Campaign supported by the United Nations Framework Convention on Climate Change (UNFCCC).[4] However, as shown in the 2022 Forest 500 annual report, three out of four companies do not have a deforestation commitment for all the forest-risk commodities in their supply chains (Forest 500 2022a). Thus, private sector actors are responding to increasing demand for information about products and their associated supply chains through traceability tools and disclosing information through varying levels of transparency.

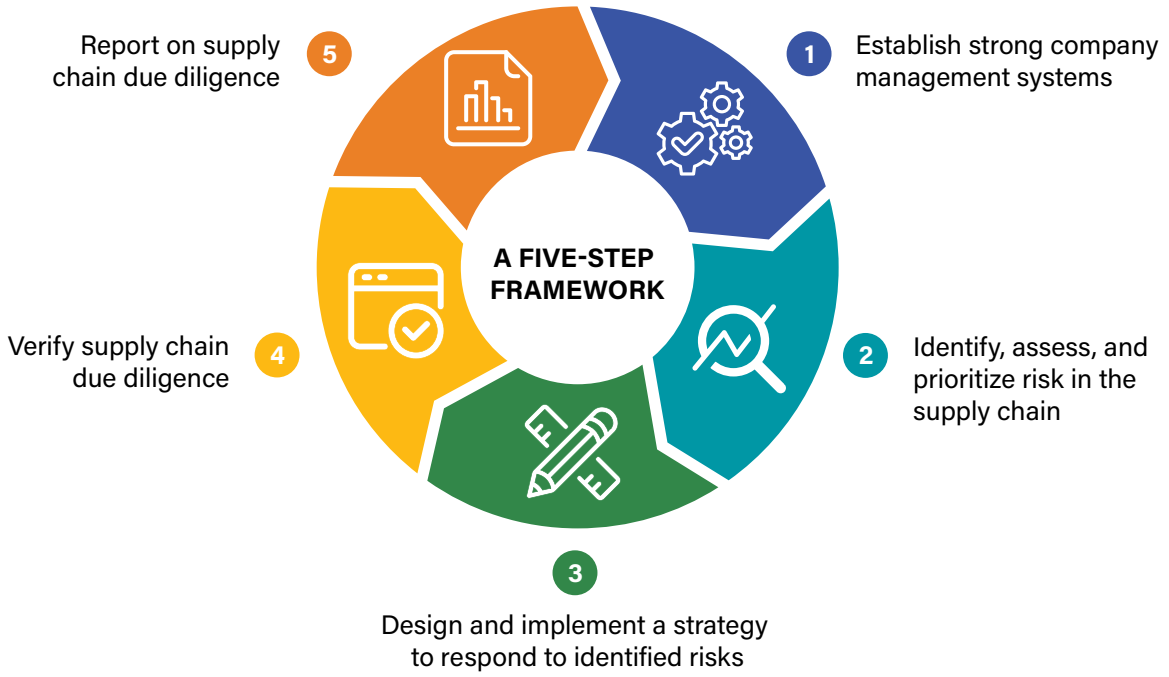
Notwithstanding this increasing move toward company pledges driven primarily by large corporations, companies working alone cannot achieve the scale and pace of change required. Therefore, collective action is needed, such as through the Consumer Goods Forum Forest Positive Coalition, which has developed commodity-specific roadmaps and reporting requirements for four commodities: palm oil; soy; pulp, paper, and fiber-based packaging; and beef.[5] The Coalition of Action has 20 members among the leading retailers and manufacturers that aim to leverage their influence to catalyze wider transformation in commodity supply chains, production landscapes, and jurisdictions globally (CGF 2021). Further examples of collaborative action are discussed

BOX 1 | A five-step framework for risk-based due diligence using traceability to link information with sustainability characteristics

There are a growing number of tools, approaches, and guidance documents to meet evolving market requirements. One such tool is the Organisation for Economic Co-operation and Development and Food and Agriculture Organization (OECD-FAO) *Guidance for Responsible Agricultural Supply Chains*. It introduces a five-step framework for risk-based due diligence that helps companies observe and meet evolving sustainability standards linked to global trade, risk management, and traceability (see Figure B1-1).[a,b]

Based on their guidance and due diligence framework, the OECD and FAO have also launched a deforestation-focused handbook to help companies embed considerations on deforestation and forest degradation into their responsible sourcing and corporate due diligence efforts. The *OECD-FAO Business Handbook on Deforestation and Due Diligence in Agricultural Supply Chains* shows how traceability can complement due diligence across contexts, considering both large and small companies and upstream and downstream supply chains.[c]

FIGURE B1-1 | OECD-FAO five-step framework for risk-based due diligence



Note: OECD = Organisation for Economic Co-operation and Development; FAO = Food and Agriculture Organization of the United Nations.

Sources: a. FAO 2022b, Box 3.2, 59; b. OECD and FAO 2016; c. OECD and FAO Forthcoming.

in "Collaboration beyond individual supply chains" and in Appendix H. Further, to achieve market-wide uptake of tools and initiatives, other types of companies, including small and medium-size enterprises, need to be part of the process. The role of other supply chain actors is described in more detail in "Traceability and transparency through the supply chain."

Financial institutions (FIs) are increasingly making commitments to act on deforestation. Examples of this include the Glasgow Financial Alliance for Net Zero,[6] a commitment made at the 26th UNFCCC Climate Conference (COP26) by 30 FIs with more than US$8.7 trillion in assets to tackle agricultural commodity-driven deforestation (Global Canopy 2021); the Task Force on Climate-Related Financial Disclosures,[7] which is now mandatory in the UK; and the Taskforce on Nature-related Financial Disclosures.[8] However, the majority of FIs to date have not taken steps to actively assess or manage deforestation risks within their portfolios. In fact, according to the 2022 Forest 500 annual report, two-thirds (93) of the 150 FIs providing $2.6 trillion in finance to the companies with the highest exposure to deforestation risk do not have deforestation policies covering their investments but are lending to companies in key forest-risk commodity supply chains (Forest 500 2022a).

Recognizing the importance of the finance sector in creating change, both the UK government and the European Commission are considering options for mandatory due diligence obligations for financial institutions, potentially in line with those under development for private sector corporations, such as the EU Corporate Sustainability Due Diligence Duty (EC 2022; GRI Taskforce 2020; 2022).

Transparency and the role of civil society

Civil society continues to play an important role in monitoring action, ensuring that credible and verifiable data are used, shared, and reported on, and in holding actors accountable to commitments.

Alongside the focus on accountability, civil society actors have supported the development of traceability and transparency tools and are often at the forefront of developing new systems and generating new data, as shown in "Innovation in technological applications for traceability and transparency," while also supporting the development of guidance, including, for example, the creation of the Accountability Framework initiative and other certification and assurance processes (see Appendix G). Civil society has also been leading efforts to monitor progress toward company commitments, such as the assessments by Forest 500, World Wildlife Fund (WWF), and SPOTT.

ADDRESSING FOREST LOSS THROUGH TRACEABILITY AND TRANSPARENCY

This report recognizes the important and increasing role of traceability and transparency in the application and enforcement of laws that underpin sustainable production, efforts by companies to ensure sustainable sourcing of agricultural commodities, and efforts by stakeholders and civil society to enhance accountability. Governments play an essential role in supporting the process, providing an enabling environment that improves consistency (e.g., what information is needed, definitions, reporting formats), while supporting the availability and usability of the data from the ground up to the end user. While global supply chains are complex and traditionally not established to provide information pertaining to forest loss, traceability and transparency tools and initiatives are constantly evolving in line with technological advancements. What is not possible today could be possible tomorrow. Thus, it is important to not limit aspirations based on what traceability can deliver today.

Civil society continues to play an important role in monitoring action, ensuring that credible and verifiable data are used, shared, and reported on, and in holding actors accountable to commitments.

Working collaboratively, governments, private sector actors, financial institutions, and civil society are increasingly supportive of consistency in data collated, transferred, and shared throughout the supply chain, and across all producer and consumer markets. Civil society is also working to create a framework of definitions and means of assurance. While progress is being made, this consistency takes time to achieve. However, alignment is an essential enabling condition for broad-scale application of traceability and transparency in commodity supply chains.

It is important to note that traceability and transparency tools and initiatives, while providing much needed information, do not alone lead to reduced forest loss. More information, more tools, and more reports do not automatically lead to changes in behavior. Traceability and transparency are not solutions in themselves but are necessary to support decisions by supply chain actors that affect forest cover.

The causal link between traceability and transparency on one side and forest conversion on the other is complex (Pendrill et al. 2022), and relates to a number of other challenges such as poverty, lack of secure land tenure, power imbalances in supply chains between upstream and downstream actors, and disconnects among actors in the supply chain. Increased access to information does not solve all these issues, but does enable better decision-making in supply chains to avoid forest loss. For instance, access to easy-to-use and consistent data on forest areas, land allocations, and crop cover can enable companies to avoid sourcing from commodity production areas that overlap with forest areas. Early warning deforestation alert systems are important tools to prioritize enforcement action to protect remaining forest areas and understand patterns of conversion pressure to inform government policy. Software designed to enable smallholders to easily map their farms with smartphones makes linking products to the impact of production on the ground easier and can be a way to collect data in a more inclusive manner.

None of these examples necessarily leads directly to reduced forest loss, but traceability and transparency underpin the shift to consistently considering forest loss risk in decisions. All these examples enable more effective monitoring of the impact of commodity supply chains on forests, which is necessary for civil society actors to hold companies accountable.

This report is not intended to be a review of the status of traceability and transparency tools and initiatives per se, nor of compliance with specific market and regulatory requirements. Due to the wide variety of traceability and transparency systems and the fact that they are often developed for a specific purpose, this report cannot define a prescriptive list of recommendations and best practices for policy development for specific contexts. Each supply chain, sector, geography, and situation requires a targeted approach. However, the report does highlight limitations, opportunities, and the core elements of traceability systems along with enabling conditions and success factors required to the extent possible.

STRUCTURE OF THE REPORT

This report considers the use of traceability and transparency through the lens of a commodity supply chain, from the point of production to end use, looking both at individual approaches and at collaborative efforts. It aims to draw out and better understand interdependencies and enabling conditions that are needed to deliver improved and more sustainable resource use on the ground.

It assesses this ecosystem through a focus on data related to forest loss: how data and information on forest and agricultural commodities are generated, passed on within and across supply chain entities, and disclosed, and how innovation is tackling data gaps and remaining challenges.

However, it does not address overarching questions related to the sustainability of land use, living incomes for farmers, and power dynamics within supply chains, and topics that do not directly relate to forest loss, including human rights and labor issues.

The information, examples, and analysis within this report are therefore intended to support decisions and actions made by a range of actors—from those in the private sector, governments, and civil society, including monitoring bodies and researchers.

The next chapter, "Research process" describes the methodology we used to map the development and application of traceability tools and initiatives, assumptions, and research questions. "Results from a global mapping of traceability and transparency tools and initiatives" (and Appendix A) summarizes the results of the global mapping of traceability and transparency tools and initiatives used across commodity supply chains globally.

The remainder of the report follows the approach of a commodity supply chain, from data availability and usability at the point of commodity production (see "Availability and usability of data at the point of origin and/or production") through the supply chain (see "Traceability and transparency through the supply chain" and "Collaboration beyond individual supply chains") to the end user, including downstream actors or wider reporting and disclosure commitments (see "The role of public reporting and disclosure"). Traceability and transparency tools and initiatives are rapidly evolving to meet changing demands and address data gaps, inconsistencies, and usability constraints (see "Innovation in technological applications for traceability and transparency"). The final chapter, "Summary of findings," reviews our findings and suggests priority areas for action.

CHAPTER 2

Research process

The findings in this report are based on a global mapping and analysis of tools and initiatives, a literature review, and interviews with key informants, providing a snapshot in time of supply chain traceability and transparency tools and initiatives.

RESEARCH SCOPE

Information contained in this report is drawn from extensive desk-based research undertaken between September and December 2022. The research provided a snapshot in time of traceability and transparency tools and initiatives, and while it can be used as a compendium of information, it is not exhaustive.

The research consisted of a global mapping and analysis of tools and initiatives, a literature review, and interviews with key informants, which provided the inputs for a whole-system assessment and case studies.

GLOBAL MAPPING OF TRACEABILITY AND TRANSPARENCY TOOLS AND INITIATIVES

Approach used

We carried out a global mapping exercise to survey how different tools and initiatives generate, process, and distribute relevant information to those involved in the global trade of agricultural commodities often linked to forest loss. Furthermore, we reviewed published evaluations of the effectiveness of different tools and initiatives in helping to reduce forest loss. The mapping sought to shed light on what tools and initiatives do; what types of data they collect, process, and publish; and how they are used by decision-makers, as shown in "Results from a global mapping of traceability and transparency tools and initiatives" and Appendix A.

We undertook the global mapping of traceability and transparency tools and initiatives through a desk-based review of literature and publicly available information, supported by stakeholder interviews and in-depth case studies. These three approaches to collecting inputs provided a means to verify and triangulate findings. One issue encountered through this process was a high level of variation in the definitions of the terms *traceability* and *transparency* used by different stakeholders and throughout the literature. This issue is discussed further in "Results from a global mapping of traceability and transparency tools and initiatives."

The desk-based mapping compiled information from over 120 reports and papers and additional web-based information, including the traceability and transparency tools and initiatives themselves. We undertook interviews with representatives from governments, the private sector, civil society, and technical experts and tool developers, selected to ensure geographic and thematic diversity as well as a variety of perspectives (see Table 1).

Semi-structured interviews included a set of questions designed to help draw out and identify the success factors (and key challenges) for effective supply chain traceability and transparency as well as enabling conditions and interdependencies. Based on the initial questions and interviewee expertise, we added additional questions.

Case studies

The global mapping highlighted that the traceability and transparency tools and initiatives we reviewed focus on regions and commodities of global importance, notably palm oil in Southeast Asia, cocoa and timber in West and Central Africa, cattle in Latin America, and soy in Brazil. Considering the different scales of approaches used for traceability and transparency—global, regional, national, jurisdictional, or landscape level, and companies—the case studies focused on specific tools and experiences within these geographies and scales. Research for the case studies considered factors such as the context or problem that is being addressed (by whom, what timescale, and funding); link to smallholders, legality, and sustainability; approaches to traceability and transparency used; and the enabling environment in which they operate. Case studies draw heavily on publicly available information, supported by discussion during interviews. They feature approaches driven by private sector actors that rely

TABLE 1 | Representation of interviews undertaken as part of this research

PUBLIC SECTOR	PRIVATE SECTOR	CIVIL SOCIETY	OTHER (TECHNICAL EXPERTS)
20	20	23	8

Source: Interviews conducted by authors.

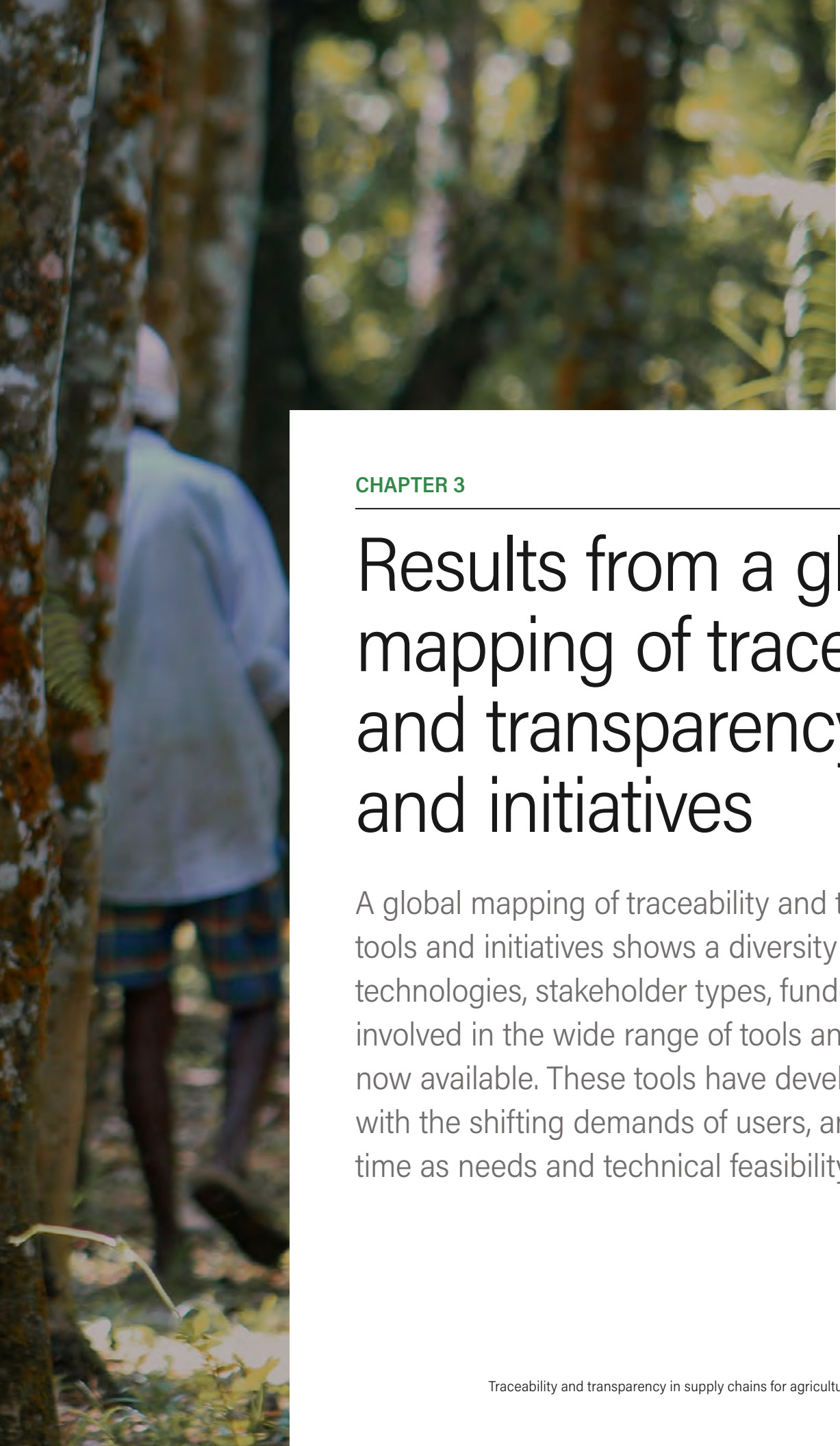
heavily on self-reported resources and data, not all of which has been independently verified. Lessons and examples are drawn from the appendices and used throughout the report. The results are presented within Appendices B to F.

ASSUMPTIONS USED

When using the information compiled in this report, the following assumptions should be taken into consideration:

- All information was compiled from publicly available sources at the time of research and complemented with interviews. While comprehensive, the research was not an exhaustive census of all relevant tools and initiatives. Written information was collected in English; interviews were conducted in a range of languages with interpretation.
- Due to the limited timeframe for this analysis and collation of information, we did not undertake country-focused case studies. To do justice to a country-level approach, on-the-ground and national-level data collation would have been required. Instead, the analysis focused on key commodities and the geographical regions where these commodities are dominant.
- We took a whole-system approach, using a commodity supply chain lens from point of production to end user, as the focus for the analysis. This helped capture the interconnectivity among actors on a global scale beyond individual countries.
- Some of the initiatives captured in this report fall under the mantle of assurance systems, in which supply chain actors are provided with a clear set of requirements for compliance including a verification and oversight mechanism, a complaints mechanism, and transparency within the assurance system. But there are many other types of tools and initiatives captured in this report that contain only some of these elements yet still provide useful lessons.
- No weighting is applied to the aggregation of the tools and initiatives, in terms of financial backing, number of users, or volume of data handled.
- The analysis distinguishes between "raw" and "processed" data, and whether an activity is generating raw data or handling existing data. Raw data are taken to mean newly generated data on location of production, sustainability characteristics at origin, and flows of commodities (e.g., chain-of-custody data, customs data). In this report, we treated land use information derived from satellite imagery as raw data. We treated information and ratings about company policies and progress as processed data.

- Validating the accuracy of information provided by sources via tools and initiatives and in public reporting, including self-reported data by private sector actors, was beyond the scope of this report.
- The focus of the report is traceability and transparency relevant for halting and reversing forest loss. Detailed consideration of important topics such as land tenure, access, and rights was beyond the scope of this report. Their importance is reflected in the discussion, for example, when talking about data requirements for legality and engagement with smallholders.
- Of the commodities considered, a subset (cocoa, palm oil, soy, cattle, and timber) are those recognized as most important in terms of potential impact on forest loss. The other two commodities included in the scope (coffee and rubber) are covered in less detail. This is because they have more recently been the focus of discussions and efforts to halt forest loss, and there are fewer initiatives, tools, and experiences to draw on.
- The capacity of all actors to collate, interpret, and use data is an important enabling condition for the uptake and use of traceability and transparency systems. This report considers the capacity needs of actors as part of the enabling conditions, but does not include an in-depth analysis.



CHAPTER 3

Results from a global mapping of traceability and transparency tools and initiatives

A global mapping of traceability and transparency tools and initiatives shows a diversity of technologies, stakeholder types, funders, and users involved in the wide range of tools and systems now available. These tools have developed in line with the shifting demands of users, and evolve over time as needs and technical feasibility change.

STOCK-TAKE OF TRACEABILITY AND TRANSPARENCY TOOLS AND INITIATIVES: KEY FINDINGS

We carried out a mapping survey of 94 tools and initiatives focused on the six commodities most associated with forest loss: palm oil, soy, timber, cattle, cocoa, and coffee. Rubber was not in scope at the time of the mapping survey, but we have provided examples in the rest of the report. Additionally, we carried out a survey of published evaluations on the effectiveness of these tools and initiatives, which is discussed in "Operational and funding models."

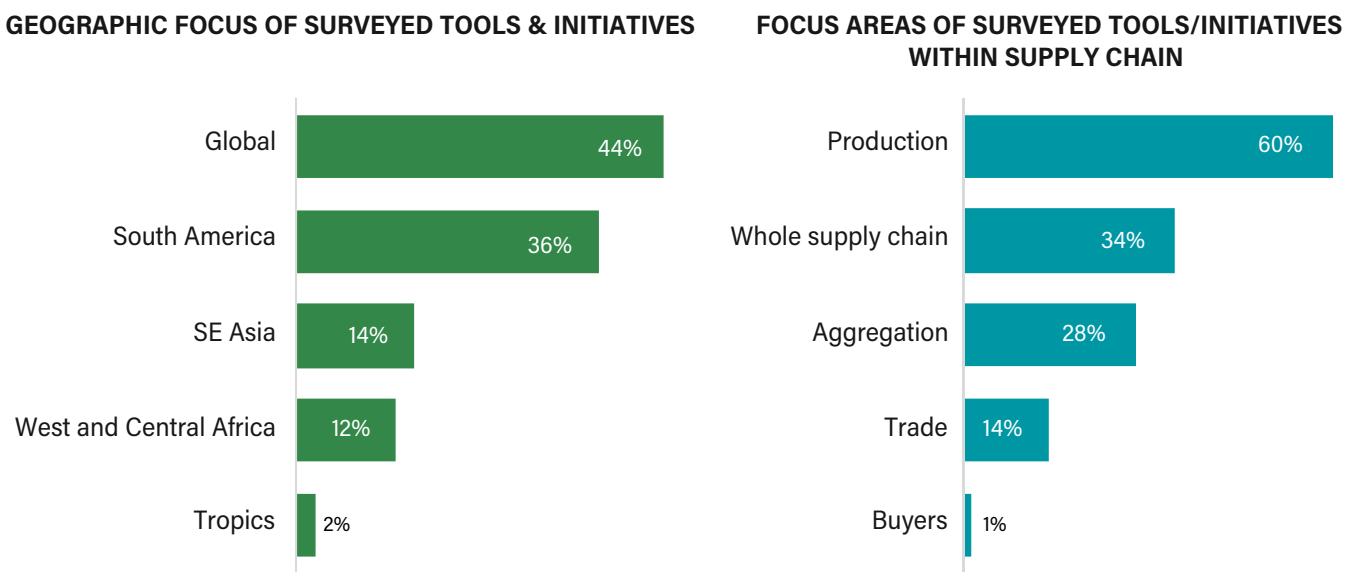
The tools and initiatives reviewed focused on palm oil, soy, cattle, timber, and cocoa, with less coverage of coffee and rubber. Tools and initiatives exist in country, regional, and global applications, recognizing the global nature of these commodity supply chains, but may focus on different sections of supply chains.

Definitions of traceability and transparency

We carried out the mapping to help identify the interdependencies and enabling conditions that affect the usage and potential impact of traceability and transparency tools and initiatives. To do so, we examined the approaches taken in traceability and transparency tools and initiatives. However, during the literature review, no consistent, precise definitions of the terms *traceability* and *transparency* were seen to be universally used.

In fact, there was much overlap in the usage of the two key terms. For example, transparency may refer to the ultimate aim of being able to see through a whole supply chain—for

FIGURE 2 | Coverage of global mapping survey: Geographic focus, in terms of regions of production of surveyed tools and initiatives (left), and focus areas of surveyed tools/initiatives within supply chains



Source: Authors.

all required information about a supply chain to be available and to be shared externally and internally (Bateman and Bonanni 2019). Under this definition, traceability, related to the preservation of information about a commodity as it moves through a supply chain, is required to meet full transparency. However, a simple definition of transparency is also sometimes used, referring to the simple act of disclosing information (i.e., being able to see into the operations of one stakeholder) (AFi 2020a). Under this definition, a stakeholder could be fully transparent about its operations by disclosing that it has little information on traceability in its supply chain and no targets or policy to change this, so under this definition transparency and traceability could be wholly distinct concepts. However, an upstream company being transparent and disclosing such information may aid in the traceability of a downstream company and therefore help its decision-making in terms of choosing whom to do business with.

Thus, in the process of generating information and placing it in the hands of decisions-makers, the choice of how to define exactly which parts of this process count as traceability or transparency is not consistent across the sector. Unfortunately, this can slow efforts to align, coordinate, and amplify the work of stakeholders working in different contexts related to commodity-driven forest loss. This inconsistency, or lack of clarity and understanding, has been recognized, and Table 2 gives sources that outline workable definitions of traceability and transparency.

The broad working definitions for this report, detailed in "Traceability and transparency: Research objectives," were chosen to balance the work that has gone into scoping more rigorous definitions, presented in Table 2, with the common uses that are seen in the literature, and to provide some level of distinction between transparency and traceability.

Furthermore, Table 3 gives core elements of traceability systems that we identified during the research process. Not all systems include all elements, depending on the scope and purpose.

This report treats transparency not so much as a system with components but the process of sharing data and information under certain conditions, which applies to both traceability systems and other contexts for collecting and sharing data.

TABLE 2 | Examples of definitions of traceability and transparency

TERM	SOURCES	SUMMARY AND DEFINITIONS GIVEN
Supply chain transparency	Gardner et al. 2019.	This report defines supply chain transparency with the aim of improving sustainability aspects on the ground as being composed of six information types relating to traceability, transactions, impacts, policy and commitments, activities, and effectiveness. It also identifies 10 gaps in information availability, and gives guidance on how transparency efforts can make positive impacts.
Traceability	IDH et al. 2021c.	This paper gives an overview of traceability definitions and evaluations relevant to cocoa in West Africa. It proposes a new traceability definition as consisting of three parts—the origin, the steps cocoa takes through a supply chain, and links to sustainability characteristics. In this report, "cocoa traceability systems provide a foundation for improving transparency along value chains" (p. 5).
Transparency	Mol 2015.	This paper discusses the role of supply chain transparency in the wider context of sustainability and democracy. Four levels of transparency are defined relative to where an organization is sharing information: management transparency (upstream actors sharing with downstream actors), regulatory transparency (sharing with regulators or inspectors), consumer transparency (sharing with certification bodies and consumers), and public transparency (open disclosure).
Transparency	AFi 2020a.	In the context of making a credible process of monitoring and verification for a supply chain, transparency is defined as stakeholder engagement and public disclosure of information including policies and methodologies related to traceability and grievances.
Transparency	Bateman and Bonanni 2019.	This paper defines the level of transparency of an organization along two axes: One axis relates to the level of availability of information about supply chain relationships, policies, and practices, while the other relates to the depth to which information availability extends into the supply chain.

Source: Compilation by authors.

TABLE 3 | Key elements of traceability systems for monitoring risk of forest loss associated with production of commodities

KEY ELEMENTS OF TRACEABILITY	DESCRIPTION
Objective	▪ Purpose ▪ Target users of traceability information (e.g., government, private sector, civil society)
Scope	▪ Geography ▪ Commodity ▪ Supply chain stages ▪ Specified characteristics (e.g., legality, sustainability, deforestation or forest degradation impacts, qualification as deforestation-free, presence of certification)
Governance structure	▪ Monitoring and oversight over the system, based on purpose and audience ▪ Internal or external leadership
Mechanism to control commodities through the chain of custody	▪ An approach for physical management of commodity volumes (e.g., mass balance, segregated, identity preserved)
Conformity requirements and assessment framework	▪ Defined metrics for success
Monitoring framework	▪ Defined inputs: Data needs, sources, definitions, guidelines, reporting flow, and framework ▪ Defined outputs: Characteristics of data to be shared between successive steps of the supply chain ▪ Control mechanisms
Data: Management approach, including privacy and integrity	▪ System for data collection and maintenance of data that corresponds to the purpose (see "Objective" above) ▪ Systems for quality management of data ▪ Rules for data sharing among players along the supply chain ▪ Data-sharing processes (including practical aspects and tools) ▪ Safeguards for managing commercial sensitivities and compliance with data privacy protection laws
Data: Interoperability and usability	▪ Alignment on definitions, methods, and what constitutes credible evidence ▪ Data in a format and with context that enables decision-making on the defined purpose (see "Objective" above)
Assurance and verification	▪ Monitoring accuracy of assessment ▪ Validation of data and identifying and correcting errors in the system ▪ Assurance models: First-party assurance, second-party verification, or external third-party verification, corresponding to system objective
Reporting systems	▪ Transparency of data, methods, and system components

Source: Compilation by authors.

Functions of tools and initiatives

Using the working definitions as given in "Traceability and transparency: Research objectives" for the 94 tools and initiatives covered in this mapping survey, 72 can be described as primarily to do with traceability and 22 can be described as primarily to do with transparency. However, many tools that provide traceability may also provide an element of transparency in that they may or may not provide information to stakeholders beyond the direct users of the tool. Therefore, for this initial delineation, we define transparency initiatives as those primarily developed to catalyze information sharing or make existing information more usable, while traceability tools and initiatives are those that primarily aim to help stakeholders using the tool or partaking in the initiative understand the flows of commodities and impacts of their production.

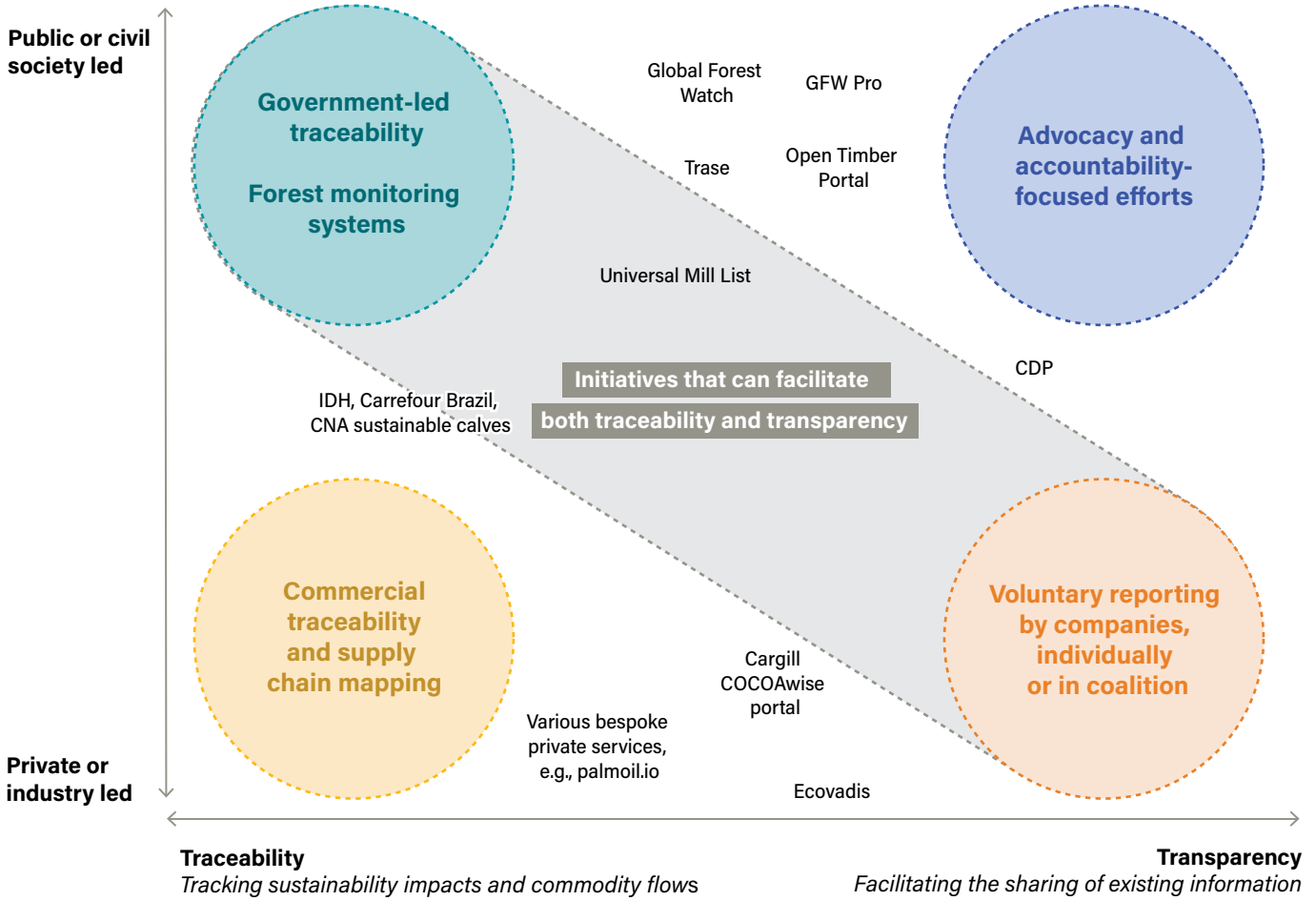
Figure 3 shows one way to categorize the tools and initiatives and highlights the area of overlap between traceability and transparency.

To further investigate the functions and use of tools and initiatives, we categorized them according to the type of information they provide and the level of transparency with which this information is accessible. The categorization used draws from the work presented in Table 4 to identify key features of traceability and transparency, but is not presented as a new definition or analytical framework that this report advocates to be universally applied. Instead, this is a way to understand what the tools and initiatives produce information about, how they help stakeholders use and share information, and who can use this information.

The four broad categories into which tools and initiatives were grouped are as follows: those that **generate** data about production circumstances or trade flows of commodities; **gather and/or process** data into more easily accessible or decision-ready information for different audiences; provide a **disclosure mechanism** for stakeholders to communicate private information; or **share** information (i.e., this tool or initiative can be used as an information source for interested stakeholders—this was further broken down into the level of transparency of this information).

Most tools and initiatives fit into more than one of the above categories. For example, Trase uses processed satellite data to generate new spatial datasets about land use for different commodities; processes existing data (e.g., producing

FIGURE 3 | Categorization of traceability and transparency tools and initiatives based on indicative examples



Source: Analysis by authors.

models of trade flows drawing on sources such as customs data); and shares information through reports and an online platform. The vast majority of tools shared information that they produced. Information was shared with varying degrees of transparency. A low proportion of tools facilitated third parties sharing information by providing disclosure mechanisms. Those that did not share data were often frameworks to guide stakeholders in generating or sharing their own information, such as the Global Reporting Initiative and Accountability Framework initiative. Likewise, some initiatives were focused on building capacity to facilitate greater traceability or transparency.

We provide a more thorough breakdown of how these categories, and further subcategories, vary with each other and with funding and governance models in Appendix A, while key findings informed by this survey are illustrated in the below sections.

Of the tools and initiatives in the sample that generate raw data, over 70 percent produce new data to track the sustainability impacts of commodities at the location of production. Of these, 66 percent draw from satellite imagery. This reflects the effort invested in building a clear idea of what may be driving forest loss, and the dominant role that remote sensing now plays in informing stakeholders of on-the-ground impacts.

However, a significant number do not generate raw data. Of the tools and initiatives that share data, about 26 percent do not generate any raw data, deriving their outputs wholly from existing datasets. Of those that both generate data and make information relevant to sustainability impacts available, 78 percent also draw on other existing datasets (e.g., publicly available data or data available for a fee) to supplement or contextualize newly generated information. Tools using information on land ownership and adding satellite-based deforestation alerts to inform estimations of company exposure to deforestation risk are a common example. In summary, tools that share on-the-ground insights focus on how to use data that already exist, as well as on the creation of new data. This reflects the value that can be drawn from reusing and combining existing, available data in innovative ways to produce or infer usable insights.

Through the supply chain—data transfer and usability

Data generated about the origins and movements of commodities are generally processed into information that improves the capability to assess risk of production upstream, including through sustainability ratings of companies or production areas, as well as more actionable information on commodity flows.

Forty percent of surveyed tools provide outputs focused on commodity flows. Given the drivers for traceability and transparency outlined in the introduction, this is not surprising. However, tracking commodity flows can be subject to commercial sensitivities, as businesses may not want to disclose details of their trade with third parties, and be technically complex. For example, and as discussed further in "Traceability and transparency through the supply chain,"

products from different origins with different sustainability characteristics can be mixed or processed into new products (e.g., palm oil derivatives, or poultry products coming from soy-fed chickens) at several points in the supply chain, while traveling through different legal jurisdictions and through the custody of various companies.

Governments in producing countries develop national traceability systems for certain commodities within their borders. However, stakeholders operating from downstream in global supply chains may also have to trace through international trade and through stages of the supply chain post-import, so by the time a product reaches them it may be hard to link the information they have about a product with data from systems based in the producing country. Tracking within a supply chain is often undertaken by companies themselves or within closed membership groups, highlighting the commercial sensitivities of data sharing.

There are a growing number of private consultancies offering supply chain mapping and risk assessments that are core components of a traceability and transparency system, often to larger corporations. These partnerships between expert consultants and private companies often see the combination of the companies' internal logistical or procurement data with data generated by the consultancy (e.g., through satellite imagery or other accessible datasets, such as customs data) to build assessments of whole supply chains and environmental impacts.

Data availability, cost, and funding

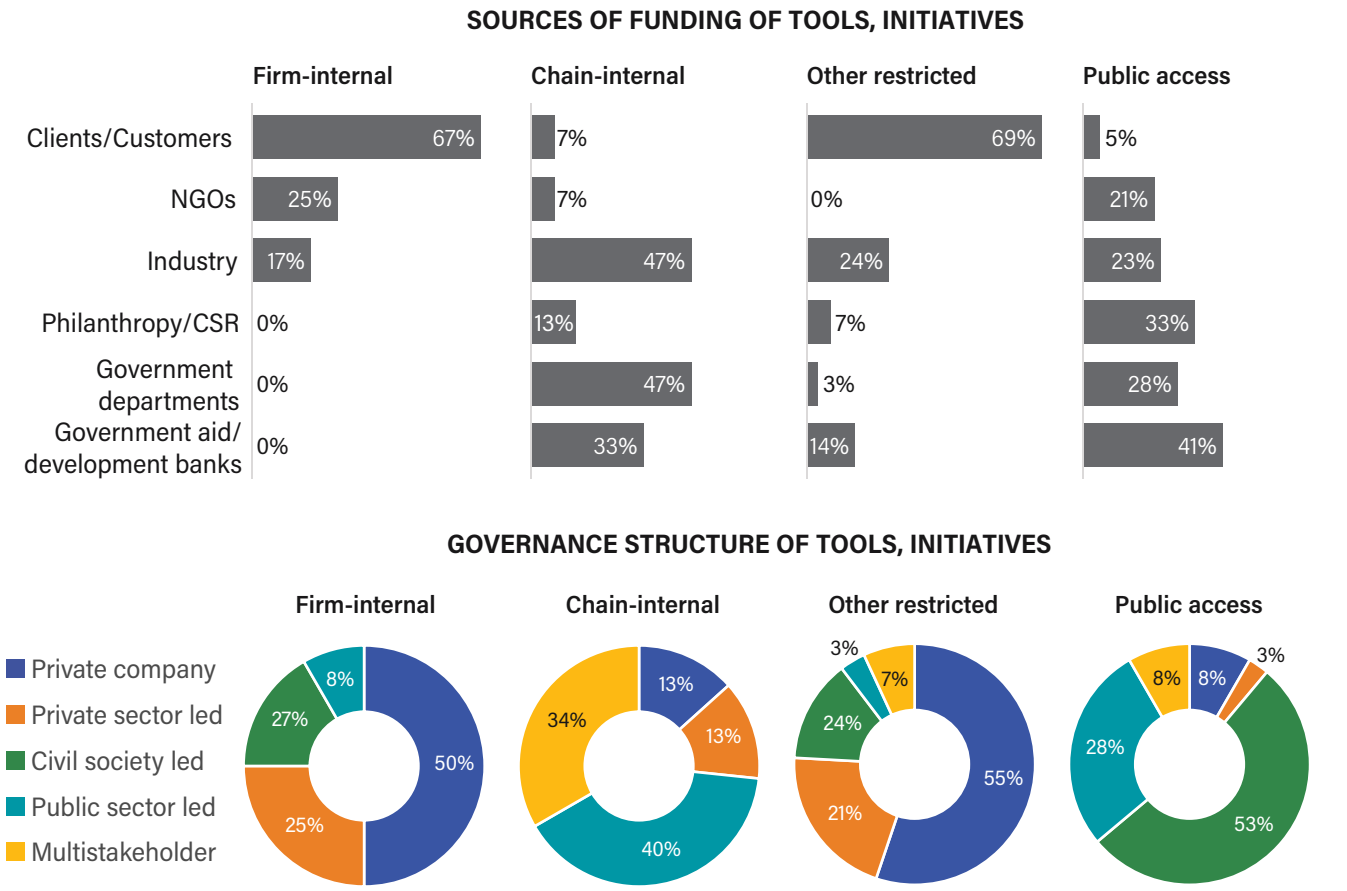
As mentioned above, almost a third of the tools that share information do not generate new data, only collate, process, and re-share existing information. There are tools and initiatives that release data or process insights for free (45 percent of surveyed tools), and there are many that share this only with initiative members or within a supply chain (17 percent) or for a fee (33 percent).

Collation and sharing of information are often services charged to users of the data, often including their own company-relevant data. This charge to users represents both the level of effort and expertise required, and the tangible financial value of such insights. There is a growing industry commercializing information generated from data that are freely available by processing data into usable forms. This could imply that many published datasets are not fully or properly used by stakeholders (see "Data ownership and access" and "The role of governments" for a discussion on data sharing and utilization). A lack of usage could, for example, be partially due to a lack of resources, technical expertise, or access to computing power among stakeholders who could best utilize existing datasets—a motivating factor behind the development of Global Forest Watch's Small Grants Fund.[9]

Tracking within a supply chain is often undertaken by companies themselves or within closed membership groups, highlighting the commercial sensitivities of data sharing.

However, the level of transparency[10] appears to correlate with the funding and governance models of the tools (see Figure 4) and with different objectives. For example, those that are most transparent or are entirely focused on transparency tend to be led by civil society, and although these tend to have diverse or mixed funding sources, almost 90 percent of them have as primary funding sources governments of the countries they operate in, government foreign aid, philanthropies, or nongovernmental organizations (NGOs). That is not to say that different stakeholders have different or opposing agendas, but it could imply that different aspects of traceability and transparency work are most effectively carried out by different stakeholder groups. Likewise, this could imply that a sustainable funding model, obtained, for example, through fees or donations, is a key factor in determining the level of transparency of tools and initiatives. This is discussed in "Evaluation and effectiveness of traceability and transparency tools." In addition, tools set up to trace products for a company have different objectives than those that assess company performance, which focus more on accountability.

FIGURE 4 | Tool/initiatives sources of funding and governance structures



Notes: The above figure shows how the level of transparency of surveyed tools/initiatives varies by funding source and governance structure. Each column shows a breakdown of funding sources (top row) and governance structures (bottom row) for a specific level of transparency. For example, most tools/initiatives that restrict access to information to a single entity or organization (termed firm-internal transparency) are funded by clients/customers, and three-quarters are either governed as a private company or private sector led; many tools/initiatives receive funding from more than one sector, and different tools and initiatives may share different levels of information with different audiences, so total percentages can sum to more than 100; CSR = corporate social responsibility.

Source: Analysis by authors.

OPERATIONAL AND FUNDING MODELS

Tools and initiatives can be set up in a range of operational and funding models, including off-the-shelf solutions or systems developed by internal or external experts. Funding sources can include external funding from donor agencies or private philanthropies, internal funding through government or other revenue allocations, or a mix of both. Depending on the scope, purpose, and complexity, cost can vary widely. In the forest sector, the upfront development of government-owned traceability systems in Latin America was found to cost as little as $300,000 and as much as several million US dollars. However, it is difficult for external analyses such as this report to assess the cost of system development since there are frequently several government agencies involved and costs are not usually published or shared (Stäuble et al. 2022).

When deciding on whether to develop a system in-house or hire external system developers, system owners should consider several factors, including the complexity of the planned system and in-house capacity, relative cost, and how long-term maintenance and upkeep of the system can

be performed and funded. In either case, the system owner needs to develop the knowledge, capacity, and commitment to maintain the system in the long run (Stäuble et al. Forthcoming).

There may also be a correlation between motivation and system sustainability. In the case of government-owned systems, agencies in charge of funding and maintaining systems set up with external financial assistance can face issues finding long-term support for system upkeep. Governments that decide to develop and implement a system with their own resources in some cases can also show more long-term ownership over the system. However, the context varies widely across system owners and countries. In either case, funding models need to be considered at the outset, including sufficient funding for maintenance and upkeep of the system over time, including potential additional development costs to respond to the evolving data landscape, whether through user fees or fines generated by the system itself, or from external sources (Stäuble et al. Forthcoming).

Box 2 summarizes considerations related to funding models for timber traceability systems developed by governments, which can provide lessons for other types of tools and initiatives, as analyzed by an upcoming WRI publication (Stäuble et al. Forthcoming).

EVALUATION AND EFFECTIVENESS OF TRACEABILITY AND TRANSPARENCY TOOLS

Much attention has been placed on ensuring the accuracy of the data available in these traceability and transparency tools through rigorous, peer-reviewed, methodological research. However, very little has focused on the impact (measurable change for forests and people) of the tools that employ these data. Without such evidence it is not possible to estab-

BOX 2 | Considerations for determining funding models for government-owned timber traceability tools and initiatives

The funding scenario of a government-owned traceability tool can have different types of implications. Donor-funded systems could face an increased risk of escalating development cost and/or an underestimation of the running cost because the availability of external funding can lead agencies to plan for more ambitious and complex systems. In some cases, a base amount of public funding can increase ownership of the implementing agency.

Systems that rely on one funding source are more vulnerable to losing funding over time as priorities shift. A mix of funding sources can help manage this risk.

Funding models include the following:

- **System-generated income**, consisting of the cost of compliance, royalties collected via the system, penalties issued for noncompliance, and the perceived risk of conviction. Systems that rely only on this type of income can be vulnerable to accusations of misuse, and can also go through budget challenges if payments are not collected in a timely manner.
- **Donor funding** frequently supports initial system development but in most cases does not cover operational costs. In some instances, donor interest may focus on supply chains leading to export markets, which could leave domestic markets behind.
- **Public funding**, which would ideally not stem from agencies that benefit from compliance or noncompliance with the system to avoid real or perceived conflict of interest, which may undermine trust in the tool. Systems relying entirely on public funding are vulnerable to budget cuts due to financial crises or other economic developments.

Since systems are never "finished," they incur development and maintenance costs over time that are required to ensure that the system remains fit for purpose. These factors should be considered in the funding plan.

Source: Stäuble et al. Forthcoming.

lish a clear causal link between the use of traceability and transparency tools and improvements in natural resource management, nor is there evidence about the effectiveness of tool features or conditions.

This leaves unanswered questions about, for example, the most useful data types, minimum standards on data quality, best tool design, most effective dissemination methods, and more. Without robust answers, this lack of knowledge has real consequences: There is a risk of wasting valuable and limited resources by duplicating efforts to analyze, combine, or deliver data and insights; there is a risk of confusing key stakeholders with competing information or creating unnecessary reporting burdens that are not useful; and a risk of delivering data in ways that will never contribute to decision-making because they are not accessible or usable, or because the necessary enabling conditions are not in place.

While our review of tool evaluations was not exhaustive, it indicates that few tools have implemented ways of measuring the impact of open data or drawing lessons about the best way to deliver such information.

Findings

Of the 94 tools and initiatives covered in the global mapping, 85 percent have not conducted, or at least have not publicly shared, evidence that their work is effective in preventing commodity-driven deforestation or supporting other environmental impacts. Though this doesn't mean these tools aren't effective or impactful—some tools indeed do offer anecdotes or user stories as examples of their potential usefulness—these few examples do not amount to a clear signal, nor are they strong evidence on which practitioners can base future projects. Our findings illuminate a missed opportunity to learn from advances in data science to create the biggest impact.

The importance of evaluating tools and initiatives

Investing in impact evaluations of traceability and transparency tools offers opportunities to gather clear evidence, allowing stakeholders to better align around fewer tools that are most effective, and therefore to provide consistent information across more users and sectors. Better information

about the most effective tools would make it possible to more efficiently allocate resources to increase adoption of data for decision-making in key user groups. Impact analysis could lead to more effective tools providing rigorous evidence that does the following:

- Demonstrates causal links between the availability of certain data and outcomes for forests, carbon sequestration, or other natural resources
- Compares data delivery mechanisms in meeting the unique needs of stakeholders in diverse geographic and social-political contexts
- Identifies key enabling conditions to increase the effectiveness of tools
- Illuminates gaps in causal chains between data availability and outcomes for forests
- Explores unintended consequences of tools

Where evaluations have been conducted, they provide valuable lessons for the future funding of tools, selection of data, and tool-dissemination strategies. Some of these valuable findings are presented in Table 4.

Challenges to be addressed

Barriers that are often cited as reasons why evaluations have not been undertaken include cost, time, expertise, and challenges in accessing information. Allocating funds for an impact evaluation could be a low priority, especially in the face of the significant costs of handling large datasets and web or app development.

Time poses a unique challenge because the generation of data on land use change can be slow and some datasets are gathered only annually, so determining impact may take years. In many cases, forest loss is due to multiple factors, and it may be difficult to isolate the impact of one factor such as a traceability and transparency system.

Expertise may also play a key role; evaluation and research of traditional sustainable development work often looks at a limited target population to determine the impact of interventions. Traceability and transparency tools, however, do not normally have such a clearly defined target audience. Many are available to anyone with an internet connection, which makes it difficult to understand who uses the tool and for what purpose, and to associate changes in the environment

TABLE 4 | Examples of impact evaluations of traceability and transparency tools

TOOL	FINDING	RESPONSE
Global Forest Watch, GLAD Alert subscriptions[a]	A 2021 evaluation found that subscriptions to GFW's freely available forest change detection led to an 18% decrease in the probability of forest loss in Central Africa and that subscriptions have a stronger deterrent effect in areas where a policy framework is present, such as protected areas and forest concessions.	This evidence supports decisions to invest in freely available alert systems, indicates a successful delivery method that could be scaled to include alerts of various types, and creates an imperative to fund work to integrate them into local policy frameworks.
SISBOV—Brazilian Service for Traceability of the Cattle and Buffalo Production Chain[b]	A 2012 evaluation found that farmers were not satisfied and would not use the SISBOV system because it posed a cost that they were unlikely to recuperate through higher prices. This held even when farmers recognized that the system provided useful information.	These findings could highlight the importance of cost-effectiveness even in technically effective systems, or instigate a rethinking of the funding structure.
World Cocoa Foundation Climate Smart Cocoa Initiative[c]	An analysis of the World Cocoa Foundation initiative to share transparent information on climate interactions of agricultural practices found that providing a cost-benefit analysis increased the likelihood that farmers and lenders would adopt practices that could mitigate climate effects and improve livelihoods.	These findings provide evidence for the future direction of farmer information systems, and in the capacity of farmers and lenders to interpret that information.

Note: GLAD Alerts = Global Land Analysis & Discovery Alerts; GFW = Global Forest Watch; SISBOV = Serviço Brasileiro de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos (Brazilian Service for Traceability of the Cattle and Buffalo Production Chain).

Sources: a. Moffette et al. 2021. See also Jamilla n.d., a case study on the lessons learned from an impact assessment of GFW; b. Furqium and Cyrillo 2012; c. Bunn et al. 2019.

with the use of the tool. The global survey of tools done in this research found almost half of tools and initiatives offered some level of access free of charge (see Appendix A). Assessing the link between access to data and outcomes for forests and people is a new and unique research challenge that may require new methodologies, which in turn require greater investment. Some projects, such as the Forest Data Partnership,[11] are addressing this need for integrated research, from tool inception and development through user application.

While these barriers are not insignificant, the lack of evidence available to support continued investment in data and tool development could limit the potential of the field to tailor and scale its impact.

LESSONS

The global mapping—drawing on interviews, case studies, literature, and a survey of tools and initiatives—has shown the enormous diversity in function, funders, and users. It highlights different priorities and barriers to meeting traceability and transparency and the needs of different stakeholders in ensuring that information in the hands of decision-makers leads to reduced forest loss. The following is a compilation of key themes identified through the mapping:

- Funding, ownership, access, and use of data: Alongside the need for more data, there are often issues around ownership and accessibility/use of data for all stakeholders (including smallholders), the question of who is funding the provision of that data, and the sustainability of the funding sources.
- Relevance and quantity versus quality of data: The mapping survey showed a wide range of tools generating or outputting data that, at face value, cover different parts of a supply chain or monitor the forest of certain regions. However, other factors identified during stakeholder interviews and in wider literature that dictate whether those data are useful include the quality of that data source—for example, the granularity and completeness of the data, frequency of publication (i.e., annually, monthly, or daily), or time lag between data generation and publication.

- Providing improved data is not sufficient to impact forest loss: Data must be usable in real-world supply chain management and decision-making, thus enabling stakeholders to implement and act upon information. Data generated, and information disclosed, must provide decision-ready information for those seeking to improve the environmental impact of commodity production and trade. This can mean, for example, that different published datasets are usable together to build a larger picture.
- Scaling up of successful projects: The mapping survey revealed effective traceability systems from many geographies and commodities. However, through stakeholder interviews it was understood that several of these successful projects have not been able to scale up to achieve significant coverage of a supply chain or be translated into systemic changes to provide improved traceability to the whole supply chain or region.
- Most (85 percent) of the tools and initiatives have not conducted, or at least have not publicly shared, rigorous evidence that their work is effective in preventing commodity-driven deforestation or supporting other environmental impacts.
- Motivations for engaging in traceability and transparency and metrics for success: Initiatives to improve transparency and traceability are very diverse in the organizations involved (from trading companies to smallholders to NGOs), in the specific reasons for their formation (e.g., to react to market pressure or to comply with legal requirements), and the metrics that are used to define and measure success.
- The enabling environment can be very influential in providing the motivation to act and determining the likely scale, depth, and durability of any initiative. Enabling conditions are often specific to geographical or sectoral circumstances. Critically, they can determine the likelihood that the intended impacts, such as reduced forest loss, are achieved. Understanding the context within which the tools or initiatives are developed (by whom, for whom, and why) as well as understanding their function (in terms of data inputs and outputs, or transparency level) can be critical in understanding the success of a particular traceability or transparency tool/initiative.

CHAPTER 4

Availability and usability of data at the point of origin and/or production

This chapter examines the traceability and transparency initiatives, tools, and platforms that make data available about the production circumstances and impacts at commodity origin, and how they are being used by public and private sector actors to avoid forest loss. It examines the roles and responsibilities of governments, the private sector, financial institutions, and civil society in making data available and usable, and draws out challenges, gaps, and opportunities that are further explored in the following chapters.

DATA REQUIREMENTS

Companies, financial institutions, and governments need data to assess, manage, and mitigate the risks and costs within their operations and investments in commodity supply chains. These risks and costs are directly related to the complexity of the supply chain and ease of access to credible information from the point of origin.

Data requirements vary by user, but there are common requirements summarized in Table 5, including meeting commitments by corporations and financial institutions; supporting civil society monitoring, disclosure, and reporting; and complying with market requirements.

TABLE 5 | Examples of types of data at commodity origin relevant to traceability and transparency systems

TOPIC	EXAMPLES OF DATA POINTS	PURPOSE
Location of production areas	▪ Location of the production areas, e.g., shapefile of concession/farm	▪ Cross-check information with other spatially explicit information related to sustainability aspects ▪ Understand risk of encroachment in protected areas ▪ Allow for independent verification of sustainability claims, such as absence of forest loss, using satellite imagery, for example
Commodity production	▪ References on average production (or authorized production, notably for timber) of the sourcing area ▪ Volumes sourced from the region	▪ Control of data coherence and identification of leakage risks
Producers	▪ Type and number of producers, producer organizations, and intermediaries (structure of the first steps of the supply chain)	▪ Map suppliers and related risks regarding the chain of custody
Environmental	▪ Rates and locations of forest loss/land conversion ▪ Locations of high natural value; for example, with High Carbon Stock or High Conservation Value	▪ Cross-check with locations of commodity production and assess environmental or carbon footprint of activities
Social	▪ Evidence of slave labor, migrant labor, child labor, occupational health and safety, complaints mechanism ▪ Livelihood incomes for farming households	▪ Identification of risk of human rights abuses and exploitation, as well as poor pay, prices, or working conditions
Legal	▪ Land registration (e.g., CAR in Brazil) ▪ Legally protected areas (e.g., Indigenous land, legal reserves) ▪ Permits (to produce commodities) ▪ Laws pertaining to production and processes of commodities ▪ Specific local laws and rights of different stakeholders (e.g., plantation owners and smallholders may have different legal permissions for different activities)	▪ Assist governments in enforcing laws that protect citizens from exploitation and environmental degradation ▪ For some commodities and contexts, legality is an important precondition and partial proxy metric to assess sustainability and is a requirement for many stakeholders
Ownership	▪ Land tenure ▪ Legal identity of landowner ▪ Evidence of Free, Prior and Informed Consent	▪ Rights to access and use the land resource

Note: CAR = Cadastro Ambiental Rural (Rural Environmental Registry).

Sources: Analysis by authors based on Transparency Pathway 2023 and IDH et al. 2021c.

TRACEABILITY AND TRANSPARENCY SYSTEMS: DATA AVAILABILITY

Table 6 provides examples of traceability and transparency systems that collate, process, and make available data from the point of origin of commodity production. These examples illustrate several key points:

- Many of the data points on commodity production related to forest loss are already covered by these tools to different extents based on the type of commodity.
- Availability of datasets for different commodities and across countries varies; gaps exist in commodity coverage (particularly for cocoa and coffee) and frequency of updates (some are not updated annually, see below examples, noting that there are many commercial platforms that provide similar services or build on these tools and initiatives).
- There are also data points for which data availability is limited (e.g., on land tenure, particularly for smallholders), land use designation, illegality (e.g., illegal forest or other land conversion), and farm/concession boundaries (especially for smallholders but also for other land holdings). In some cases, in the absence of such data, platforms rely on assumptions and/or models to link components of the supply chain.
- Data needs are constantly evolving, including for whom, by when, and for what. The traceability and transparency solutions developed to date will change in response. For example, there is a growing focus in the palm oil sector on social and human rights issues (e.g., migrant labor, living wages).
- Different commodity supply chains come with different levels of complexity for traceability and transparency. Factors to consider include presence of smallholders, number and size of farms, prevalence of indirect suppliers, number of intermediaries, resilience of supply networks and supplier relationships, and whether the type of crop can be easily distinguished using earth observation.
- The cost and resources required to achieve full traceability to the farm level depend on the specific commodity and supply chain, as well as the scale of application (specific volumes within one supply chain, an entire individual supply chain, or volumes of various suppliers). Market and regulatory requirements drive decisions on whether and how to pursue transparency and traceability, including farm-level traceability (see also "Traceability and transparency through the supply chain") and may require different levels of resources for different commodities.

DATA OWNERSHIP AND ACCESS

Open data

Collating and processing data can be time and resource intensive. Despite this, a significant amount of the data that are relevant to the commodity supply chain and forest risk is freely provided, by both the public and private sectors, such as the following:

- The United Nations (UN) Comtrade site and the Food and Agriculture Organization's FAOSTAT offer high-level production and trade statistics for various commodities
- The National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA) grant public access to data drawn from their earth observation programs
- Platforms such as Trase and Global Forest Watch are open access
- The Brazilian government makes PRODES data publicly available through the Brazilian National Institute for Space Research

In fact, the global mapping found that 45 percent of the tools and initiatives surveyed provide some data and/or process insights for free, while 41 percent publish all information they produce (see "Results from a global mapping of traceability and transparency tools and initiatives" and Figure 4).

TABLE 6 | Examples of traceability systems and tools providing information at point of commodity origin

TOOL/SYSTEM AND PROVIDER	DATA POINTS, SOURCES, FREQUENCY	COMMODITY	OPEN ACCESS/FEE BASED	USE AND USER
Global Forest Watch[a] and GFW Pro[b] WRI and partners	Tree cover and natural forest cover to support monitoring of deforestation and land use change Combined with public datasets on land ownership for selected geographies worldwide	Land use/land cover change driven by all causes including agricultural and forest commodities (logging, oil palm, wood fiber)	Open access/ launching fee-based premium service based on access to enhanced functionalities to maintain the platform (all data remain open and accessible)	Government agencies, journalists, civil society forest monitors, company users, and financial institutions can track locations or upload areas to generate more actionable insights in support of realizing responsible supply chains
MapBiomas,[k] an initiative of the Climate Observatory involving universities, NGOs, and technology companies	Annually maps changes in Brazil's land use and land cover, using satellite data to a 30-meter spatial resolution (it also operates in Chaco and Indonesia)	Land use/land cover change driven by all causes including agricultural and forest commodities	Open (public), free to access	A wide range of stakeholders including government agencies, companies, civil society, and the media to understand trends in land use change and deforestation
Trase[c] The Stockholm Environment Institute and Global Canopy	Combines existing publicly available data on global trade, supply chain facilities, and transport to produce sector-wide supply chain maps for exports For some commodities, connects supply chain maps to commodity deforestation and emissions in subnational sourcing regions to enable risk assessment	Soy, cocoa, beef, and palm oil, but expanding	Open access	Uses existing data (including per-shipment trade data such as bills of lading and supply chain facilities) to bridge the gap in the middle of the supply chain of international trade, linking consuming countries and trading companies with impacts in production landscapes
Visipec[d] National Wildlife Federation, the University of Wisconsin-Madison, the International Sustainability Institute, Amigos da Terra–Amazônia Brasileira	Draws on public datasets already in use by meatpackers in Brazil to close the gap in traceability and monitoring of indirect suppliers to the cattle sector in Brazil	Cattle	Approved users have free access—it was designed specifically for meatpackers and service providers	Meatpackers provide information on their direct suppliers (through CAR identification numbers), which is used by the Visipec tool to identify and assess their indirect suppliers against a range of environmental criteria, including official deforestation data published by the Brazilian government (PRODES) as well as official data including protected areas, Indigenous lands, embargoed properties, and properties with slave labor
RubberWay[e] A private company	Wages and working conditions Environmental/production practices of producers Information gathered via app-based questionnaire across the supply chain[f]	Rubber	Fee-based	Can be used by companies downstream in the supply chain using natural rubber to understand social and environmental impacts upstream, and their own risk exposure

TABLE 6 | Examples of traceability systems and tools providing information at point of commodity origin (cont.)

TOOL/SYSTEM AND PROVIDER	DATA POINTS, SOURCES, FREQUENCY	COMMODITY	OPEN ACCESS/FEE BASED	USE AND USER
FLEGT Watch[g] VisioTerra and the Centre for International Development and Training, with funding from the EU and Tropenbos International	Radar imagery from Sentinel 1 satellite Satellite imagery Fieldwork, with deforestation alerts checked by ground observers submitting data via an app	Timber	Open access	Used by observers and governments involved in the FLEGT Voluntary Partnership Agreement Requires "ground truthing" of data
PRODES[h] and DETER[i,j] Brazilian National Institute for Space Research	Used to monitor ecosystems in Brazil, including forest loss and fires Satellite imagery from PRODES, annual basis DETER, a newer system, can send deforestation and forest degradation alerts to forest governance actors within a day of a change in forest cover	Commodity agnostic	Open access	Publicly available Used by government and enforcement bodies, and industry, in Brazil to support the annual monitoring and analysis of the Amazon Soy Moratorium No link to land registration or other databases (i.e., cattle movements)

Note: GFW = Global Forest Watch; NGO = nongovernmental organization; CAR = Cadastro Ambiental Rural (Rural Environmental Registry); ESA = European Space Agency; FLEGT = Forest Law Enforcement, Governance and Trade; EU = European Union; PRODES = Projeto de Monitoramento do Desmatamento na Amazônia Legal por Satélite (Satellite Monitoring for Deforestation Project for the Legal Amazon); ground truthing = verifying evidence of tree cover loss.

Sources: a. See Global Forest Watch website for further information: https://www.globalforestwatch.org/; b. See Global Forest Watch Pro platform for further information: https://pro.globalforestwatch.org/; c. See Trase homepage for tools, insights, and other resources: https://www.trase.earth/; d. See Visipec website for further information and resources: https://www.visipec.com/; e. See RubberWay homepage for further information: https://rubberway.tech/; f. See RubberWay's product page to find out more about its mobile application: https://rubberway.tech/our-product/; g. See VisioTerra's FLEGT Watch page: https://visioterra.org/FlegtWatch/; h. See the PRODES web page for further information: http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes; i. See the DETER web page for further information: http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/deter/deter; j. Bourscheit 2022; k. See Mapbiomas's website for more information: https://mapbiomas.org/en.

Growing internet access, digitization of information, and access to computing power and expertise mean that the number of open datasets, and the number of people who can use them, continues to grow. The term *open data* refers to data that are available for anyone to access and use with minimal practical or legal restrictions. Accessibility does not just mean that the data can be found, but that they are easy to use.[12] This approach is captured by the FAIR principles—findable, accessible, interoperable, reusable.[13] For example, it may be much easier to input data into a program if they are provided in a spreadsheet format rather than pdf format. Ideally, a dataset should be machine-readable so that a program can interact directly with a dataset rather than requiring manual data input.

Microsoft Planetary Computer and Google Earth Engine are currently drawing from these open data sources for their own platforms, which clean and process data and make them accessible for use. The platforms are made usable by a wide range of stakeholders to maximize accessibility and catalyze innovation. The last decade has seen growth in expertise and access to cloud-based computing capacity to process large volumes of data, especially in computer models using methods such as machine learning. Access to this processing power is now widely available with the growth of cloud-based computing services such as Microsoft Azure, Amazon web services, or Google Cloud.

Publishing data and analysis based on open data builds wider trust and accountability, allowing third parties to both check and build on published data to develop more tools and insights,[14] which feeds into an "open data ecosystem" (ODH 2016; Kazmaier 2022). This in turn can support greater alignment, decreasing duplicative efforts and enabling harmonized use and impact of data at scale.

The exponential and continuing growth in digital infrastructure means the impact of open data will continue to grow across commodity supply chains. Research by McKinsey & Company estimates that jurisdictions that embrace open data principles will see significant gross domestic product growth (White et al. 2021).

"Paid for" data

Access to data may, however, incur costs. The process of validating, interpreting, hosting, and processing data, and providing new insights and actionable information from raw data (even where the raw data are publicly available), requires human expertise, computational power, and financial resources.

The global mapping showed that around 41 percent of the tools and initiatives surveyed provide access to data and/or insights either only for members or for a fee. A growing industry of private service providers offers paid access to processed data drawn from similar input data sources as used by open platforms.

The question of who owns processed data and the insights delivered is increasingly important. The commercialization of data processing and user-friendly interfaces for decision-makers to handle and interpret information has clear benefits: A market of competing service providers drives innovation that can deliver more helpful insights and thus better information to decision-makers. However, if safeguards are not put in place, commercialization of data gathering, processing, and analysis can exacerbate existing inequalities in supply chains and exclude smallholders from accessing or owning data related to their own operations (Henderson 2021).

Ensuring that ability to pay does not restrict data availability is a central factor to consider, especially when prioritizing public and philanthropic funding, along with data verification and credibility.

What data can be made publicly available and how?

The global mapping highlighted several lessons that present both challenges and opportunities for data disclosure:

- *Data disclosure must respect the need to protect individuals.* For example, although the location of both smallholders and plantations might be important to downstream actors, the implications of publishing this information will have different connotations: The smallholder often lives on or near the production area, providing direct access to information about their home to a wide number of people, which is less likely for plantations. There is not yet a universally accepted protocol for protecting the privacy of individuals in supply chains, but various solutions are being developed.
- *Data disclosure must also respect commercial and privacy concerns.* More transparency can be achieved by putting in place safeguards to manage privacy while providing data ensuring legal and sustainable production. Regulatory requirements can include such safeguards and still improve information access. Higher levels of trust among supply chain actors facilitate the sharing of more data: What might have been considered sensitive data five years ago is more routinely shared today.

- *Not all data need to be made public to make progress.* Within commodity supply chains, even if not all data (e.g., on transactions and actors along a supply chain) are available, it is in many cases still possible using publicly available data to identify priority areas for monitoring forest loss at the point of production, enabling stakeholders to take action to avoid and compensate for forest loss.
- *Data disclosure can build the credibility of traceability and transparency initiatives by enabling external verification.* For example, data layers such as the Universal Mill List (Box 3, also see Appendix C) allow third parties to track commodity flows, along with company reporting. This type of standardization is important for interoperability of data disclosure systems. Transparency of one actor to support the traceability of another is a key interdependency and thereby increases the transparency of the entire supply chain.
- *Data disclosure decisions need to consider the trade-offs* among the safeguards mentioned above and the benefits that accrue to society when data can be shared.

BOX 3 | The Universal Mill List

Private sector operators came together with civil society partners to contribute to an open data ecosystem with the Universal Mill List (UML), which publishes lists of palm oil mills that companies source from. Commercially sensitive data (e.g., on volumes and prices) are not included.

Mills are added to the UML following a standardized methodology developed by WRI and Rainforest Alliance that uses high-resolution satellite imagery to manually verify the presence and location of mills.

The UML standardizes the identifiers used by actors for different mills by assigning a universal identification (ID). This single list and ID system applied across multiple platforms and providers allows for easy cross-referencing among mill lists and enables third-party monitoring.

Source: GFW 2022.

THE ROLE OF GOVERNMENTS

Data already made available by governments

Governments collect, manage, and in many cases make datasets publicly available to support a range of public and private sector initiatives, including on land use, land cover, production systems, land tenure, and other features. Not all relevant datasets are available to the public, however.

What datasets to make available and according to what definitions can be a matter of contention and a critical dimension of land governance. For example, information on boundaries of concessions (e.g., for timber, palm oil) are available at varying levels of clarity, consistency, and usability in different countries, and disclosure of such information by actors other than government agencies has been challenged. Ensuring consistency in land use maps is difficult, especially where land use is managed by different ministries and where there are overlapping responsibilities among ministries. This is something that many countries are seeking to resolve, for example, through One Map in Indonesia.[15]

There are some data that the private sector and civil society could collect but with significant time and cost investment. In these cases, governments may be better placed to collate and share data, especially where there is a risk of duplicating efforts or there is a lack of commercial incentive to cover certain areas or sectors that may be more remote or create higher costs. These costs cannot necessarily be absorbed by government agencies without external funding. For example, in the case of concession boundaries and land use of forest and agricultural commodities—for oversight of commodity production, forest monitoring, encroachment into protected areas, and tracking production without permits—governments can make the information available more efficiently than other actors collecting the same information. Alignment among the government, the private sector, and civil society on roles and best practices for data gathering efforts could help establish more consistency and coordination and help avoid duplication of efforts.

Opportunities to improve data interoperability

Efforts to align definitions and reporting formats when publishing data on forest loss and sustainable commodity production can improve the interoperability of different data disclosures. Such alignment can also help build the credibility of data outputs and analysis derived from them, while noting that different data-gathering protocols and analysis methods among actor groups will continue to produce different results. As such, datasets from official and external sources may contradict each other.

Data formats, definitions, and metadata are essential. According to developers of open data platforms, a lot of the work that goes into generating actionable insights from public datasets lies in cleaning and transposing data to make them usable with computer models, and compatible with datasets from other sources. Ensuring that data are published using agreed formats, definitions, underlying methods, and metadata could reduce the cost of producing insights from open data and greatly increase their impact.

An agreed data framework for managing data would cover dimensions such as metadata, interoperability, quality, and architecture and make it easier to manage data. Such a data governance framework (Earley et al. 2017) presents a mechanism through which entire sectors can decide what data to collect and publish. This requires input from those who hold data, usually in the private and public sectors, and those in civil society or expert consultancies, who tend to know what data are needed and how they can be fully used.

TRACEABILITY AND TRANSPARENCY: DATA USABILITY

Maintaining the information flow across a supply chain is a precondition for establishing a traceability system. One challenge lies in linking products to origins across the supply chain, including navigating discrepancies among organizational systems for data collection and incentives. Another major challenge relates to data usability. Data are useful only when they can be shared in a format that provides users with insights supporting better decision-making. Companies driving market demand, which may be subject to regulatory obligations, are often far removed from the point of production and have limited resources and expertise to make sense of data. Data do not, by themselves, have any impact—how data are used makes the difference.

The global mapping showed that 26 percent of the tools and initiatives that share data do not generate new data but derive their outputs wholly from existing datasets. These tools and initiatives focus on collating, processing, and sharing existing information to make it more accessible and usable. One example from the Brazilian beef sector is Visipec (see Appendix B), which compiles and synthesizes existing data from various public sources to enable monitoring of cattle supply chains to expand to indirect suppliers, and analysis of property-level socio-environmental risks.[16] Another is SPOTT, which takes public information about various companies involved with palm oil and timber to produce sustainability ratings that investors can use to inform their decisions.[17]

Role of earth observation technologies to monitor land use change

The capability, accessibility, and use of earth observation to monitor land use change grew exponentially in the last decade, including optical and synthetic aperture radar. The capabilities and ongoing research and development for these technologies are discussed in more detail in "Innovation in technological applications for traceability and transparency." High-resolution images are publicly accessible with increasing periodicity from public and private sector providers. Some examples of these tools are detailed in Table 6.

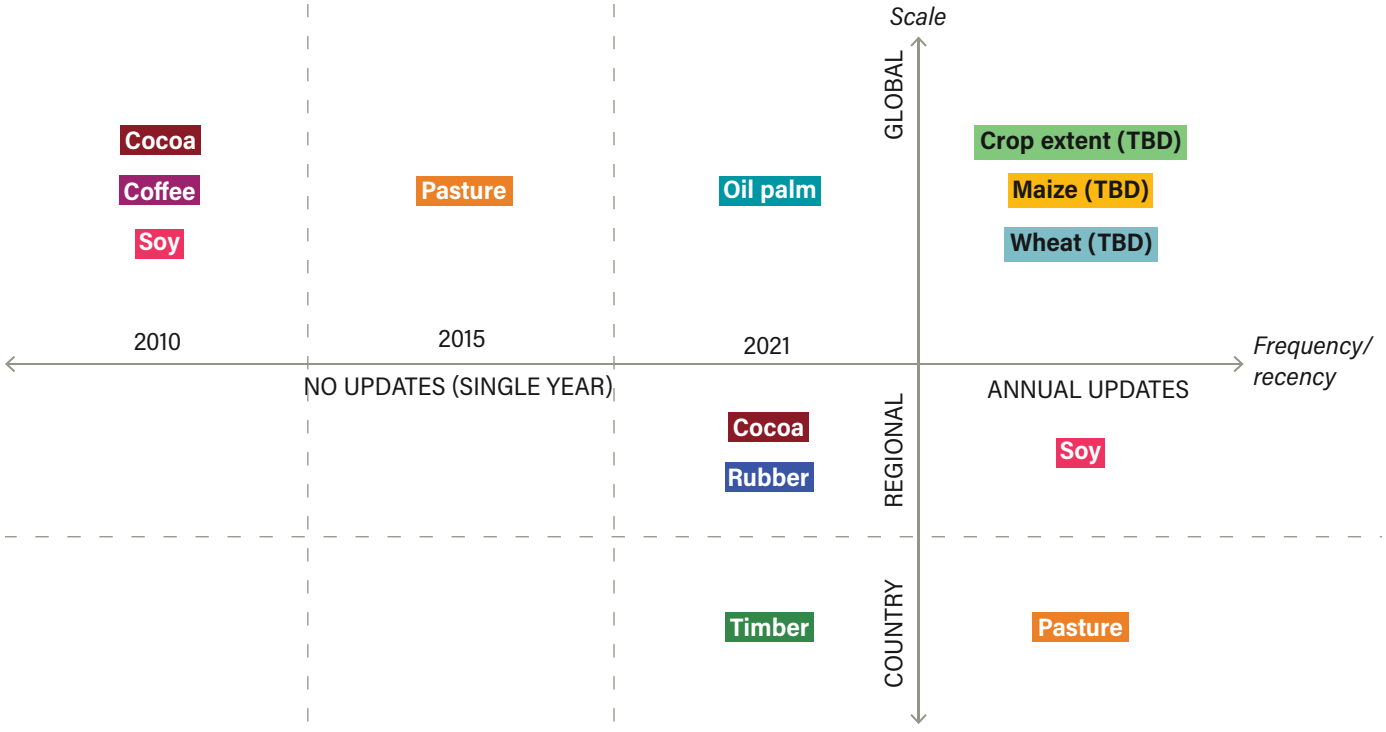
Insights from these tools can be used by companies and financial institutions to assess their supply chain risks and impacts, and inform the development of strategies to mitigate those risks and contribute to solutions on the ground. Companies use alerts to target resources and incorporate earth observation methods into their traceability and transparency systems to flag areas of concern for follow up. Civil society actors use tools based on earth observation in combination with other sources of data, such as customs data (e.g., Trase[18]) or registered production locations (e.g., the Cocoa

Accountability Map[19]), to highlight the connection between global supply chains and forest loss to hold companies to account and to call for action.

Some of these tools have systems that provide publicly accessible, near-real-time alerts of tree cover loss such as the integrated deforestation alerts available on Global Forest Watch (Weisse and Pickens 2020). These alerts provide an early indication of where tree cover loss may be occurring so that enforcement officers, local communities, and advocacy organizations can respond. See Table 7 for a list of early warning deforestation alerts offered by Global Forest Watch. In addition to these integrated alerts, complementary sources of information exist with the RADD (RAdar for Detecting Deforestation) alerts, which are based on weekly ESA Copernicus data (see Box 9 in "Innovation in technological applications for traceability and transparency").

The ability of earth observation to distinguish among land cover types is improving rapidly. Some crop-specific datasets exist (see Appendix I), but some crops are easier to map than others because of limitations of earth observation. For instance, identifying shade-grown crops such as coffee or cocoa in agroforestry systems is much more challenging than identifying oil palm plantations. Appendix I and Figure 5 provide an overview and visual summary, respectively, of the availability of datasets on crop extent and whether the datasets are one-off mapping efforts or updated annually. The public availability and coverage of spatially explicit datasets on crop extent is constantly developing. For example, a new dataset on cocoa in Ghana and Côte d'Ivoire is available in Kalischek et al. (2023); a new dataset on oil palm and pulp and paper plantations is available in Gaveau et al. (2022); and Wang et al. (2022) contains a new dataset on rubber and is currently in pre-print. "Innovation in technological applications for traceability and transparency" includes more information on ongoing research to improve crop mapping based on earth observation.

FIGURE 5 | Availability of crop data for monitoring supply chains



Source: Goldman 2022.

TABLE 7 | Overview of deforestation alerts offered on Global Forest Watch

SYSTEM	GEOGRAPHIC COVERAGE	RESOLUTION	FREQUENCY OF UPDATES	OTHER DETAILS
GLAD-L (Global Land Analysis and Discovery – Landsat)	Tropics (from 30 degrees north to 30 degrees south)	30 meters	Every 8 days	Covers a wide variety of landscapes to detect loss in any type of tree cover, including plantations
GLAD-S2 (Global Land Analysis and Discovery – Sentinel 2)	Amazon basin	10 meters	Every 5 days	Detects change in humid tropical primary forests
RADD (Radar for Detecting Deforestation)	Humid tropics	10 meters	Every 6-12 days	Penetrates cloud cover to detect change in humid tropical primary forests
Integrated deforestation alerts	Tropics (from 30 degrees north to 30 degrees south)	10 meters	Upon source systems' updates	Detects change in primary forests as well as plantations as well as younger forests

Source: Adapted from Berger et al. 2022.

Limitations of earth observation tools

While use of earth observation has clear benefits, there are technical limitations too:

- Identifying natural forest (Mazur et al. 2023b) and vegetation types (e.g., distinguishing among managed grasslands and pastureland or inter-cropping cocoa or other commodities within forests)
- Monitoring cocoa, coffee, and other shade crops that are not easily visible from space, and so are more difficult to monitor. Technological solutions have been developed that may fill in some of these gaps (again see "Innovation in technological applications for traceability and transparency").
- Interpreting the *causes* and *intended uses* of observed land use change—e.g., distinguishing between legal and illegal forest loss, between human-induced and natural tree cover loss, and between temporary tree cover loss and deforestation through land use change and determining if a commodity was eventually planted on a parcel of cleared land, which can include an expanded time horizon. As discussed above, drawing conclusions on the causes of forest loss is likely to require other information at origin, such as knowledge of land ownership and farm or concession boundaries, to identify whether encroachment into forest area observed through satellite observation complies with local laws. While data on land conflict, human rights violations, and information related to labor and legal compliance are often not geospatial, there is an urgent need to collect these types of data at a global scale.
- There is a need for "ground truthing," or verifying evidence of tree cover loss, to help interpret earth observation data and to collect sample points for training models. For example, in Guyana, drones have been used to supplement earth observation to provide a baseline mapping and monitoring of forest cover for the government of Guyana's climate commitment.
- Earth observation data on their own do not provide the information needed to trace products back to origin, which requires research and mapping on suppliers. However, earth observation data can be combined with information about commodity origin to assess sustainability and legality claims through remote sensing data.
- One limitation of commodity datasets and the myriad tools that deploy them is that these data can't be compared on different platforms, constraining users' ability to effectively apply these data to their specific needs. Within the Forest Data Partnership, partners

are currently working to increase the interoperability of existing public datasets, drawn from satellite data and other sources, and cross-check their validity with pre-competitive ground validation data to verify what the satellites show on the ground. This may be provided from a variety of sources including research establishments, civil society, and others such as the High Conservation Value Resource Network.[20]

Bringing datasets together to enhance usability for decision-makers

Data triangulation from a variety of sources into a form useful to decision-makers is a major innovation area. Examples of this (identified in Table 6) include Visipec, Selo Verde, and Trase.

Carrying information from origin downstream (through to retailers and brand owners) in a meaningful way requires further innovation to link datasets at origin into supply chain tools, and relates to challenges of traceability and transparency systems within supply chains (see "Traceability and transparency through the supply chain"). Innovation in this space will determine whether it will be possible to meet market demands for *full* traceability and transparency through supply chains to the point of origin.

LESSONS

- Technical advances including the ability to handle large datasets through cloud-based platforms will continue to improve the quality and usability of data and close current gaps (e.g., enabling better distinctions between natural and planted forests, managed grasslands, and pastures). "Innovation in technological applications for traceability and transparency" looks further at current innovations addressing these gaps.
- No one dataset can provide a full picture of the situation at origin. Different datasets need to be used together and be aligned with each other to make sense of the situation and enable better decision-making.
- Many tools and initiatives are available only after paying for access. Cost or resource constraints should not prevent actors/users, particularly smaller and vulnerable actors, from accessing tools and platforms.
- Evolving market and regulatory requirements are driving an increasing need for full traceability and transparency throughout supply chains for downstream companies to the farm level, including all smallholders.
- While there are gaps in data availability at the point of origin and limitations on earth observation data if not complemented by traceability data, another challenge of equal significance lies in carrying data through the supply chain and making them available in a way that can be used by decision-makers.
- Solutions to support making data available in a useful format will require innovations in the way datasets across supply chains can be linked, and the way data can be presented.

CHAPTER 5

Traceability and transparency through the supply chain

This chapter describes the challenges of establishing traceability and transparency systems within complex global commodity supply chains. Traceability to origin is achievable but can be time and resource intensive where supply chains include third parties or indirect suppliers and many smallholder farmers.

Moving one stage onward in the supply chain discussed in "Availability and usability of data at the point of origin and/or production," this chapter draws on the **case studies presented in Appendices B to F** to consider how data collated at the point of origin are transferred and used *within* commodity supply chains to help halt forest loss and shift to sustainable production.

This chapter considers two questions:

- What is required to achieve traceability to origin (e.g., to individual plot, plantation, or ranch) and in which cases is it necessary?
- How easily can decision-makers access and make sense of data on deforestation risk within supply chains?

COMMITMENTS TO GREATER TRACEABILITY AND TRANSPARENCY

Most major traders of key commodities and many consumer-facing brands have committed to addressing forest loss (often articulated by private sector actors as commitments to "deforestation and conversion free" supply chains) and developed programs of work to deliver on this. Ambitions on traceability and transparency vary. Table 8 summarizes examples of corporate commodity commitments from key companies and traders.

Table 8 shows that at a high level there are common commitments among some companies to achieve deforestation- and conversion-free supply chains, and that there are common ambitions to traceability and transparency in their individual supply chains.

TABLE 8 | Examples of corporate commitments across the commodities

COMMODITY	EXAMPLE OF COMMITMENT	EXAMPLES OF COMMITMENTS ON TRACEABILITY AND TRANSPARENCY
Palm oil	▪ Wilmar's "No Deforestation, No Peat, No Exploitation" policy launched in 2013 and updated in 2019[a]	▪ 100% traceability to palm oil mills by 2022 (approximately 90% as of December 2021 for CPO and PKO) and 90% traceability to oil palm plantations by 2023 (approximately 70% as of June 2022)[b] ▪ Wilmar is making information on all its 800 palm oil suppliers available through an online dashboard: 98.2% traceable to mills across its global operations and 100% traceable to plantations for all Wilmar-owned mills across its global operations[q]
Soy	▪ Bunge's commitment to reach deforestation-free value chains in 2025, including soy from the Brazilian Cerrado and the Gran Chaco of Argentina and Paraguay[c] ▪ Trader Roadmap* also sets a 2025 target date for the removal of deforestation for soy production in the Amazon, Cerrado, and Chaco[d]	▪ Bunge's monitoring of direct sources in the priority regions of the Cerrado and Gran Chaco: 2021, 100% target and 100% current status; and monitoring of indirect sources in the priority regions of the Cerrado: 2021, 35% target and 64% current status[e] ▪ Within the Trader Roadmap, traceability requirements are defined as "traceability to farm based on property boundary data for all origins within high-risk areas"[f]
Cattle	▪ Marfrig's commitment to eradicating deforestation (legal or illegal) by 2025 in the Amazon and by 2030 in the Cerrado[g] ▪ Trader Roadmap has set target dates of 2023 and 2025 (for the Amazon) for no-deforestation (legal or illegal) for direct and indirect suppliers, respectively, and 2025 (for the Cerrado) for illegal deforestation for direct and indirect suppliers[h]	▪ Marfrig progress achieved in 2021: 100% of direct supplier properties monitored; 63% of direct producers, with ranches within the Amazon reported on operations of their own suppliers (Marfrig's indirect suppliers); 67% of direct suppliers in the Cerrado shared information about their respective supply chains[i] ▪ Trader Roadmap set a target to enable the traceability of the full cattle supply chain in Brazil by the start of 2023[j]
Timber	▪ Rougier's strategic collaboration with WWF to advance sustainable forestry, developing an environmental policy based on responsible forest management and responsible trade of forest products ▪ It commits to carrying out verification on a regular basis as foreseen by regulations such as FLEGT and the Lacey Act[k]	▪ Rougier Afrique International (a subsidiary of Rougier Group) can guarantee that 100% of its products can be traded with a traceability and legality certificate[l]

TABLE 8 | Examples of corporate commitments across the commodities (cont.)

COMMODITY	EXAMPLE OF COMMITMENT	EXAMPLES OF COMMITMENTS ON TRACEABILITY AND TRANSPARENCY
Cocoa	▪ Mondelēz International's Cocoa Life aims to achieve the following goals by 2030: ▪ Increase number of farming households receiving a living income ▪ Enhance child protection systems and enable access to quality education in Cocoa Life communities ▪ Seek no deforestation on Cocoa Life farms globally[m] ▪ As of 2021, 67% (Côte d'Ivoire) and 79% (Ghana) of its directly sourced cocoa was traceable from the farm to the first purchase point[n]	▪ Mondelēz International's goal to source its cocoa volume needs through Cocoa Life (its global cocoa sustainability program launched in 2012) by 2025[m] ▪ It has also pledged to develop traceability from farm to the first purchase point for its own purchases of cocoa[n]
Coffee	▪ Starbucks commits to ensuring that 100% of its coffee is ethically sourced through C.A.F.E. Practices or another externally audited system ▪ C.A.F.E. Practices include guidelines in four key areas: quality, economic accountability and transparency, social responsibility, and environmental leadership (in partnership with Conservation International)[o]	▪ In fiscal year 2021 (FY21), due to restrictions caused by COVID-19, auditing teams were unable to complete all the necessary in-person, on-farm audits to renew its active status in the program; as a result, 94.86% of its coffee in FY21 was sourced from C.A.F.E. Practice–verified farms[o]
Natural rubber	▪ Michelin first adopted "zero deforestation" principles as part of its Natural Rubber Procurement Policy in 2015, and expanded on them in its first Sustainable Natural Rubber Policy in 2016[p]	▪ Michelin will work toward comprehensive disclosure of the provenance of natural rubber purchased from industrial plantations (estates), and for sources other than industrial plantations (including smallholders), will publish jurisdictional-level summaries of the RubberWay risk mapping[p]

Notes: * The Trader Roadmap aims to accelerate existing action by the agri-commodity sector on deforestation to align with global climate goals in a way that contributes to food security, economic development, and farmer livelihoods. Fourteen agri-commodity traders are working to develop an Agriculture Sector Roadmap to 1.5°C, which was launched at COP27 (see https://www.tropicalforestalliance.org/assets/Agriculture-Sector-Roadmap-January-2023_compressed-compressed.pdf); CPO = crude palm oil; PKO = palm kernel oil; WWF = World Wildlife Fund; FLEGT = Forest Law Enforcement, Governance and Trade.

Sources: a. Wilmar 2019; b. See Wilmar's timebound action plan 2022–2023 at the following link: https://www.wilmar-international.com/docs/default-source/default-document-library/sustainability/supply-chain/wilmar-timebound-action-plan-2022—2023.pdf?sfvrsn=377e34bb_2; c. See information on Bunge's Non-deforestation Commitment here: https://www.bunge.com/Sustainability/Non-Deforestation-Commitment; d. See the Trader Roadmap published on the Tropical Forest Alliance's website here: https://www.tropicalforestalliance.org/assets/Agriculture-Sector-Roadmap-January-2023.pdf; e. Bunge 2022; f. See the Trader Roadmap published on the Tropical Forest Alliance's website here: https://www.tropicalforestalliance.org/assets/Agriculture-Sector-Roadmap-January-2023.pdf; g. Marfrig 2020; h. See the Trader Roadmap published on the Tropical Forest Alliance's website here: https://www.tropicalforestalliance.org/assets/Agriculture-Sector-Roadmap-January-2023.pdf; i. For more information, see Marfrig's 2021 sustainability report: https://www.marfrig.com.br/en/Lists/CentralConteudo/Attachments/3/Sustainability%20Report%202021.pdf; j. See the Trader Roadmap published on the Tropical Forest Alliance's website: https://www.tropicalforestalliance.org/assets/Agriculture-Sector-Roadmap-January-2023.pdf; k. See the sustainability page on Rougier's website for more information: http://www.rougier.fr/en/groupe/482-pioneer-sustainable-development-within-african-timber-industry.html; l. See Rougier Afrique's page on products and species from the Congo Basin for more information: http://www.rougier.fr/en/rougier-afrique-international/478-wide-range-products-and-species-congo-basin.html; m. For more information, see the Cocoa Life website: https://www.cocoalife.org/; n. For more information, see the Starbucks page on the website of the Sustainable Coffee Challenge: https://www.sustaincoffee.org/partners/starbucks; o. Mondelēz 2022; p. Michelin 2021; q. For more information, see Wilmar's sustainability page: https://www.wilmar-international.com/sustainability.

Traders do make distinctions between their own operations and those of joint ventures, third parties, or indirect suppliers that supply to them, where traceability and transparency are more challenging, as explored below. The Trader Roadmap further distinguishes within the cattle sector between legal and illegal deforestation, and high risk (but not all) biomes.

Traders also have shown varying levels of ambition on traceability scope; for example, traceability to smallholder or plantation (e.g., Musim Mas, see Appendix C),[21] traceability to mill and over time to plantation (e.g., Wilmar),[22] and traceability "granularity" depending on risk (e.g., ADM, soy).[23] Taken together, there is a broad set of corporate commitments reflecting the complexity of global supply chains.

COMPLEX GLOBAL AGRICULTURAL AND FORESTRY COMMODITY SUPPLY CHAINS

Global commodity supply chains are complex and multitiered. This creates challenges for passing on information on commodity characteristics from the point of origin (the data points/indicators discussed in "Availability and usability of data at the point of origin and/or production") through each tier in the supply chain.

Commodity supply chains vary in their complexity, such as in the degree of vertical integration among tiers and in the prevalence of indirect, third-party, and smallholder suppliers.

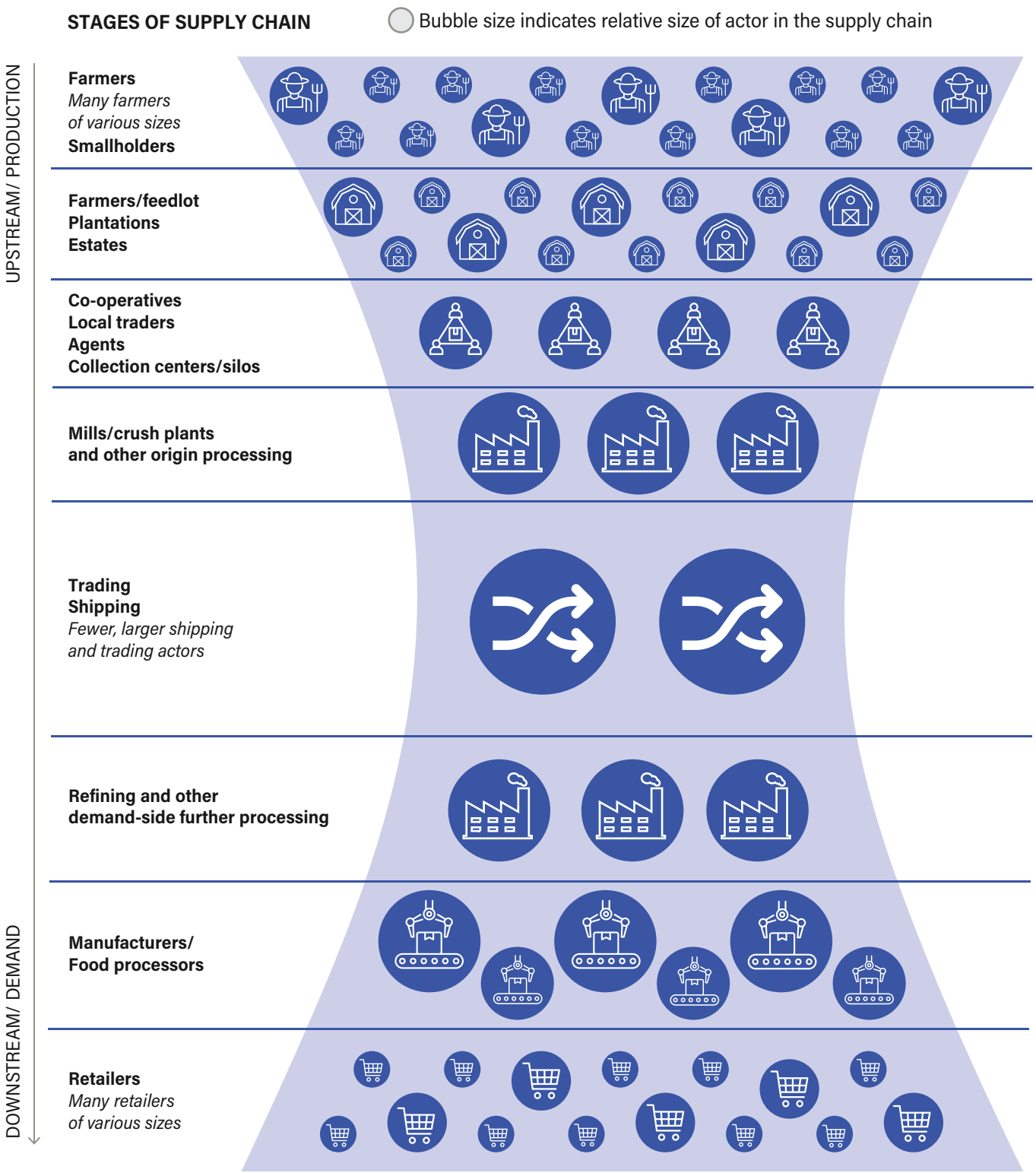
Figure 6 shows a generic model of a commodity supply chain, illustrating the common practices of mixing commodities, and changing ownership at different stages in the supply chain. The roles of key parts of the supply chain are also explained.

Traders (or shippers) are key actors in the supply chain. Figure 6 illustrates the common hourglass shape prevalent (to varying degrees) in commodity supply chains (e.g., palm oil, soy) that converge between the initial stages of production & aggregation and transportation & distribution to end use markets. While this shape does vary across commodities, commodity traders or shippers, refiners, and processors are commonly focused on this point of convergence for commodities (a point where a significant share of global commodity trade passes through), which makes their role critical in the commodity supply chain, and in any traceability and transparency system.

Some of the inherent characteristics of commodity trade present challenges for traceability and transparency, in particular the following:

- Traders can typically buy and sell commodities on the spot market, where available commodities are put up for sale for immediate delivery to manage peak demand or buy at the best value to meet customer requirements. Traceability and transparency within spot market purchases can be more difficult than where traders buy directly from suppliers with which they may have a long-term purchasing agreement with greater built-in traceability and transparency.
- Trade in commodities has historically (though not in all cases) been based on price, quality, and physical characteristics (e.g., soy to a specific protein level), not on origin and sustainability characteristics. For example, traders, global processors/refiners, or consumer goods companies may buy to a quality specification that permits pooling of commodities sourced from multiple geographies (e.g., soy meeting a specific protein content from "any origin") in which case this mixing in the supply chains inherently adds complexity in traceability of individual origins.
- Traders, refiners, and global processors may also buy from cooperatives of farmers or from other third parties (including other traders and intermediaries) that may lack the appropriate incentives (including commercial sensitivities, cost) and resources to disclose their own suppliers.
- Smallholders make up a significant share of commodity suppliers, growers, and producers in most major commodities. The related complexities and issues are discussed further below.
- Commodity trade includes not only the raw commodity (soybeans, crude palm oil) but also products derived from processing, such as dried cocoa beans, cocoa butter, processed rubber, refined coffee, and derivatives of palm oil like oleochemicals, which can include many more steps of processing. Beef products such as corned beef can be produced from trimmings from different cattle and from different farms. These examples illustrate the complexity and traceability challenges in typical commodity and commodity-derived product supply chains.
- Commodities are also embedded within transformed products (e.g., palm oil in baked goods, cocoa in chocolate, rubber in tires, soy in animal feed).

FIGURE 6 | Generic supply chain model



Source: Adapted from AAK, "AAK's Value Chain", All about better sourcing of palm, https://www.aak.com/contentassets/3a2ef8f179cd4c99a9e144a1fcdf62f7/aak-place-in-the-value-chain---palm-2021-v2.jpg and Proforest, "Soy Traceability and Supply Chain Transparency," Soy Toolkit Briefing Note 02.A, https://static1.squarespace.com/static/5b48c2572487fdd7f1f29d1c/t/6107e38471685d416f2cd05d/1627906949303/ENG+BN2A_05July2021.pdf.

Changing these supply chains—for example, by physically segregating commodity flows that meet specific criteria from "conventional" flows—can make traceability simpler but can add costs that need to be borne by someone within or shared across the supply chain.

As these points illustrate, commodity supply chains were not designed to meet traceability and transparency requirements for attributes beyond the physical product itself such as legality or safety, but for optimized cost-efficiency. The ability of commodity supply chains to adapt to requirements based either on inherent characteristics or quality or safety specifications does indicate that enhanced protocols for traceability to monitor exposure to forest loss could be pursued.

A retailer wanting to understand its supply chain will therefore need to unpack a long string of documentation about a unit of commodity, produced according to different standards, conventions, and requirements around the world, to map national and subnational origin, and from there identify a pool of potential mills, silos, cooperatives, or other aggregation points, and subsequently farmers or growers.

Changing these supply chains—for example, by physically segregating commodity flows that meet specific criteria from "conventional" flows—can make traceability simpler but can add costs that need to be borne by someone within/or shared across the supply chain. Pursuing segregated flows has also been criticized because at small scale it could undermine efforts to drive a mass market shift in commodity production, while creating "clean" segregated supply chains with the potential of leakage to other markets.

However, while traceability is challenging, it is not impossible. Global food safety and quality regulations already require a level of traceability. Also, as explored below, traceability and transparency tools and initiatives are being introduced in commodity supply chains to meet changing market demands, as highlighted in the introduction and below, within these constraints.

TRACEABILITY AND TRANSPARENCY: COMPANY-LED ACTIONS AND INITIATIVES

Traceability and transparency approaches, as shown in the introduction, are not new but are evolving to incorporate characteristics beyond physical attributes to include data on legality, sustainability, or other criteria to meet changing market requirements (commitments and regulations). Where a commitment or market requirement exists, a solution is usually developed. Evidence for this claim is found in the evolution from paper-based to more advanced tracking systems instituted in many timber supply chains in the 1990s and the introduction of cattle traceability requirements to manage bovine disease outbreaks (see Appendix B). Other examples, including high-end technical solutions, are explored in "Innovation in technological applications for traceability and transparency."

Table 9 highlights examples of traceability and transparency systems currently in use in global commodity supply chains and identifies the opportunities, limitations, and impacts of such tools. Key points from Table 9 are presented below.

- Significant progress has been claimed by early movers on traceability and transparency:
  - Traders such as Golden Agri-Resources (GAR) have achieved 95 percent traceability to palm oil mill and to plantation (GAR 2022).
  - Leading brand owners have mapped their supply chains (e.g., Nestlé in partnership with Starling) (Nestlé 2018).

- Leading meatpackers in Brazil have mapped and assessed the risks of forest loss of direct cattle suppliers (see Appendix A).
- Traceability in timber supply chains has advanced a great deal and has been incorporated into supply chain management through voluntary approaches (e.g., certification), market access requirements (e.g., EU Timber Regulation), and national systems (e.g., in Brazil, Guatemala, or Peru) (Stäuble et al. 2022).

- However, challenges remain, specifically in relation to traceability and transparency for indirect suppliers and smallholders in supply chains.

TABLE 9 | Examples of private sector–led traceability and transparency systems in commodity supply chains, based on company claims and not necessarily independently audited

TOOL OWNER/USER	COMMODITY	FUNCTION/AIM OF SYSTEM/TOOL	CHALLENGES/OPPORTUNITIES
Cargill's SoyaWise[a] traceability portal	Soy	The portal provides customers with greater transparency about their individual soy purchases, certification details, information about sourcing areas, and an understanding of deforestation risk.	Customers can follow their soy shipments back to the region and the municipality of origin. This information makes it easier for customers to answer questions from their own customers and improves transparency.
Bunge's Sustainable Partnership program[t]	Soy	Launched in 2021, the program works with direct suppliers to trace and monitor their own sourced volumes by adopting independent imaging services or using Bunge's geospatial monitoring service at no cost.	The program is voluntary, though Bunge offers commercial benefits for resellers that make progress on traceability. Bunge carried out a pilot with one direct supplier and was able to incorporate the resulting data on indirect suppliers into its annual traceability reporting.
Nestlé partnership with Starling[r]	Palm oil	The partnership monitors supply areas for deforestation risk. Nestlé improves the transparency of its supply chain by publishing this approach, and headline results, on its website.	Through this partnership, Nestlé has been able to map 97% of its palm oil to mill (2021) and receive deforestation alerts in its supply areas.[r,s] Nestlé does not itself own the mills or control where the mills are buying from, but this information informs its decisions on being involved in landscape projects.
Golden Agri-Resources (GAR)	Palm oil	GAR adopted its Forest Conservation Policy in 2011, with an ambition to trace all fresh fruit bunches purchased back to the plantation to ensure compliance with this policy.[b] GAR has worked with a series of partners to develop its traceability and verification process, including GeoTraceability (for software development) and Koltiva, a supply chain technology and field solutions provider, to assist in a boots-on-the-ground approach to engaging with smallholder farmers.	In 2021, GAR reported that it had reached 95% traceability to plantation for its global supply chain, covering its own 49 managed mills (supplied by 536,000 hectares of plantations, including smallholder farms) and supply from more than 350 third-party mills.[c] GAR publishes a map of downstream facilities (refineries, kernel crushing plants, bulking stations) and GAR-owned mills in Indonesia. GAR uses these data to identify areas of support for independent smallholder suppliers, including providing oil palm seedlings, supporting efforts for oil palm replanting, offering training in good agronomy practices, and helping them prepare for certification.
Marfrig Verde+ Plan	Cattle	In mid-2020, Marfrig, with the support of IDH, developed the Marfrig Verde+ Plan using a range of in-house systems and third-party tools (e.g., Visipec)[e] to combine data from its own suppliers with those in publicly available datasets (e.g., on forest loss, farm boundaries) to trace and monitor indirect suppliers in line with zero-deforestation commitments.[f]	There are challenges in mapping indirect suppliers and assessing compliance with Marfrig standards.

TABLE 9 | Examples of private sector–led traceability and transparency systems in commodity supply chains, based on company claims and not necessarily independently audited (cont.)

TOOL OWNER/USER	COMMODITY	FUNCTION/AIM OF SYSTEM/TOOL	CHALLENGES/OPPORTUNITIES
Cargill CocoaWise[g]	Cocoa	CocoaWise is Cargill's cocoa-specific traceability and transparency project, aiming for 100% farm-to-factory traceability by 2030. It is a digital platform that connects the whole supply chain and provides customers with access to a personalized report covering the product origins, supply chain, and financial investments.	The datasets gathered improve first-mile traceability as they map the names and locations of Cargill's cocoa sourcing network (farms, cooperative offices, and buying stations) and track the cocoa beans using bar codes to ensure that no beans from deforested areas enter its supply chain. Financial data are also collected to ensure that farmers are paid fairly. According to a Cargill-specific case study, "Cargill has reached 100% farmer-to-factory traceability (direct suppliers) through its system in Ghana [where around 25,000 farmers had registered to a fully traceable bar code and digital payment system as of 2021] and 61% in Côte d'Ivoire [where over 70,000 farmers were included in a digital Cooperative Management System tracking about 120,000 tonnes of cocoa beans in 2021]."[h,i,j]
Global Coffee Platform, collective reporting[k]	Coffee	The Global Coffee Platform launched the collective reporting program through which members of the sector's roasters and retailers report their annual sustainable coffee purchases using a standardized template, providing transparent insights on the expansion of a global market for sustainable coffee.[l]	The annual report collates data on the increasing proportion of sustainable coffee purchases, improving sector transparency by providing insights into origin and producing countries.[m] Although it demonstrates progress made among members choosing to report, scope for transformative change and complete transparency is limited without wider participation.
Agridence RubberTrace (previously HeveaConnect)[n]	Natural rubber	Agridence RubberTrace provides a digital marketplace for natural rubber that incorporates data-gathering and management tools to help trading companies understand their supply chains by mapping farms. Data on farm demographics, cultivation practices, and plot characteristics are collected to analyze land use change.[o]	A common issue with traceability in natural rubber is the high proportion of smallholders and the high number of intermediaries between production and manufacture. Agridence develops many tools and technologies to improve traceability throughout the supply chain (e.g., producing Internet of Things sensors in factories to automate data collection, or collaborating in research on ground truthing satellite imagery for rubber traceability)[p] and makes its marketplace compatible with these various data sources so users have access to useful information.
EcoVadis[q]	Various commodities covered by sustainable procurement ratings	EcoVadis is a private platform that companies pay to join. It provides assessments (based on questionnaires) on the sustainability of various aspects of member companies, including sustainable supply chains of key agricultural commodities. These assessments are available for member companies to view on the platform, by allowing companies to share information downstream, or to view the assessments of their upstream partners.	This platform increases the transparency of whole supply chains for participating companies. By using standardized assessments, it also allows comparability and benchmarking. The systematic impact on supply chains is limited by the small proportion of the market participating and the fee-dependent access to information.

Note: IDH = the Sustainable Trade Initiative.

Sources: a. For more information, see Cargill's SoyaWise page at https://www.cargill.com/sustainability/sustainable-soy/soyawise; b. GAR 2011; c. For more information, see GAR's web page "Palm Supply Chain Traceability & Transformation" at https://www.goldenagri.com.sg/sustainability/responsible-sourcing/palm-supply-chain-traceability-and-transformation/; d. GAR 2021; e. For more information, see Visipec's website at https://www.visipec.com/; f. For more information, see the page of the Verde+ program on Marfrig's website at https://marfrig.com.br/en/sustainability/marfrig-verde-mais; g. For more information, see the web page for Cargill's CocoaWise portal at https://www.cargill.com/sustainability/cocoa/cocoawise-portal; h. IDH et al. 2021b; i. For more information, see Cargill's whitepaper on CocoaWise at https://www.cargill.com/doc/1432198008895/ccc-sustainable-cocoa-cocoawise-whitepaper.pdf; j. Cargill 2020; k. For more information, see the collective reporting page on the Global Coffee Platform website at https://www.globalcoffeeplatform.org/our-work/collective-reporting/; l. For more information, see the web page for the 2021 snapshot report for the Global Coffee Platform's collective reporting: https://www.globalcoffeeplatform.org/latest/2022/snapshot-report-2021/#report-facts; m. GCP 2022; n. For more information, see the Agridence Rubber website at https://rubber.agridence.com/solution/; o. For more information, see web page "Agridence RubberTrace Farm Mapping Pilot and RubberWay Study" here: https://rubber.agridence.com/projects/agridence-rubbertrace-farm-mapping-pilot-and-rubberway-study/; p. For more information, see the Agridence Rubber website at https://rubber.agridence.com/solution/; q. For more information, see the EcoVadis website at https://ecovadis.com/; r. For more information, see Nestlé's page on responsibly sourced palm oil: https://www.nestle.com/sustainability/sustainable-sourcing/palm-oil; s. For more information, see Nestlé's page on its satellite monitoring with Starling and its palm oil transparency dashboard: https://www.nestle.com/sustainability/sustainable-sourcing/palm-oil/satellite-monitoring; t. Bunge 2021b.

TRACEABILITY AND TRANSPARENCY: INDIRECT SUPPLIERS AND SMALLHOLDERS

Where supply chains are vertically integrated, solutions for traceability and transparency are more straightforward and the influence on actors within the supply chain is greater. In contrast, traders or other major purchasers may source through a range of routes including producers they contract with directly (direct suppliers) and through third parties (e.g., other traders, agents or dealers, or cooperatives) that in turn have their own supply chains.

Indirect suppliers and third-party supply chains are one or many tiers removed from the trader or major purchaser, usually limiting influence on them. This challenge can be compounded when there are many smallholders in the supply chain.

These supply chain routes present challenges when implementing traceability and transparency systems, including posing risks associated with companies moving toward simpler supply chains by cutting out smallholders or intermediaries, or by setting up systems that create parallel data gathering structures that don't enable smallholders to access and use the proprietary information that could support risk assessment and production & quality management processes instituted by cooperatives. Examples of how these challenges have been overcome through practical applications of traceability and transparency systems are explored here, along with lessons, opportunities, and challenges.

Indirect suppliers

Indirect suppliers exist in most commodity supply chains. The Accountability Framework initiative defines suppliers as either direct suppliers (selling directly to the buyer) or indirect suppliers (selling to an intermediary that is one or more steps removed from the buyer). More than 40 percent of key forest-risk commodities are sourced indirectly via intermediaries (zu Ermgassen et al. 2022).

Within the cattle sector in Brazil, for example, an individual animal may pass through several farms over its two-plus-year life cycle before reaching the direct supplier that sells cattle for slaughter to a meat packer. Each of those farms presents a potential risk for links to forest loss.

Major meatpackers Marfrig, JBS, and Minerva have initiated programs to address these challenges with similar commitments to trace and identify their indirect cattle suppliers. Several approaches to this traceability and transparency issue have been tried. A few examples are included here and explored in more detail in Appendix B:

- **Top-down approaches** by each of the three major meatpackers utilizing a range of in-house systems and third-party tools (e.g., Visipec), combining information from their own direct suppliers and publicly available datasets (e.g., on forest loss, farm boundaries) to trace and verify indirect supplier linkages to legal or illegal forest loss. All companies have set 2030 targets to complete this task in Brazil, with targets for interim progress by 2025. While possible, progress remains slow. One of the reasons for this is because necessary data (such as animal transit data) remain siloed or are not shared across actors. In addition, direct suppliers have concerns about sharing data about their supplying farms.
- **Bottom-up approaches** such as the Sustainable Production of Calves Program, launched in 2018 in part by Carrefour Brazil Group, which aims to improve small-scale producer inclusion and encourage these cattle farmers to verify legal compliance with laws governing forest loss and land conversion and use ear tagging. In some cases, this information was carried through to point of sale with information available to the consumer via a QR (quick-response) code printed on the product label. This was a successful program and is being scaled up as of 2022 with an aim to enroll a million calves across the Mato Grosso and Pará States, though this still represents only a portion of the total heads of cattle in Brazil.

- **Collective cross-industry approaches with government support** such as the terms of adjustment of conduct in the state of Pará, an agreement not to buy cattle from recently cleared land led by the Federal Prosecution Office. The agreement includes mechanisms to identify and verify compliance of indirect suppliers using existing cattle movement data not generally publicly available in other states. This will be explored more fully in this chapter.

Cooperatives, representing groups of soy farmers, may be concerned about disclosing their upstream suppliers for commercial reasons. They may also be hesitant to share information because they prefer to use their own systems for demonstrating deforestation- and conversion-free production instead of relying on systems from other providers. It could be argued that traceability and transparency are connected to the trading activities of these cooperatives and, therefore, any data generated within internal management systems are data that the cooperatives and their members own and should benefit from, leading to more benefits for all. Institutional support may be needed to share or cover start-up costs, but "running" costs should be included in the cost of sustainable production and reflected in price. The challenge for the major trader is to ensure that the commodity it purchases can be verified as meeting its required standard while respecting these commercial confidences (see "Case study: Soft Commodities Forum" in Appendix E for one approach to working with intermediaries in the soy sector).

Within the timber sector, historically, third-party traders have acted as intermediaries for hardwood imports into European and other timber markets with very little traceability or transparency of the origin of the timber (acting as "black boxes" within the supply chain). Regulatory controls introduced starting in the late 1990s requiring evidence of legality precipitated a shift away from these intermediaries toward more direct contact with timber suppliers, reducing spot market buying.

SMALLHOLDERS/ SMALL-SCALE FARMERS AND AGGREGATION

The complexity of commodity supply chains, as described above, is higher where production is predominantly carried out by smallholders and small-scale farmers, as is typical of many of the commodity supply chains assessed in this report: palm oil, cocoa, rubber, and coffee. This is less true for soy, timber, and cattle, although the structure and composition of the sectors vary by country, and small producers are important in some geographies.

Smallholders is a broad term but in the palm oil sector, for example, refers to farmers that own up to 50 ha of land, operating either independently or as part of a smallholder scheme or cooperative.[24]

Gaining access to information about smallholders and farmers is often the first step of data gathering required for traceability and transparency systems. However, this can present numerous challenges.

- Accurate and real-time visibility over the whole supply base is not always possible using existing methods of traceability. Smallholders often sell to collectors or initial aggregators (in the case of palm oil, cocoa beans, coffee, rubber, some timber production), which then sell on to intermediaries and then to the first stage processor. Within the cocoa sector in West Africa, many smallholder farmers operate in cooperatives or sell to intermediaries, and it is often not possible to disaggregate the supply chains of cocoa smallholders to specific traders since in practice smallholders will supply to different traders at different times. Although the connections between cooperatives and traders may be known for each procurement cycle, many smallholders are not registered with a cooperative—60 percent of cocoa

The challenge for the major trader is to ensure that the commodity it purchases can be verified as meeting its required standard while respecting these commercial confidences.

BOX 4 | Smallholder participation in commodity production

At a global level, more than 1.5 billion smallholders depend on forest and farm landscapes to produce food, fuel, timber, and non-wood forest products for their livings.[a] For different commodities, smallholders make up a significant portion of the supplier base:

- More than seven million smallholders around the world make a living from oil palm.[b] In Malaysia and Indonesia alone, smallholdings represent approximately 40 percent of total palm oil production.[c,d]
- Côte d'Ivoire and Ghana account for 82 percent of the global market share for cocoa with an estimated two million smallholder farmers.[e]
- Six million smallholder farmers produce around 85 percent of the world's natural rubber.[f]
- Eighty percent of the coffee produced globally is produced by 25 million smallholders.[g]
- Various associations have come out in support of market requirements despite the additional burdens placed on supply chains, highlighting opportunities for addressing smallholder-specific concerns about market access and exclusion.[g]

Sources: a. For more information see FAO's page on micro, small, and medium-scale forest enterprises: https://www.fao.org/forestry/enterprises/99235/en/; b. For more information, see the Roundtable on Sustainable Palm Oil's page on gaining certification as a smallholder: https://rspo.org/as-a-smallholder/; c. Rahman 2020; d. Ichsan et al. 2021; Streck et al. 2020; e. GSPNR 2021; f. For more information, see Fairtrade's page on coffee: https://www.fairtrade.org.uk/Farmers-and-Workers/Coffee/; g. A number of smallholder groups published a letter in February 2022 (available via the following link) to the commission highlighting their support while noting their needs: Lettre-aux-membres-du-conseil-et-du-parlement-europeen_Finale.pdf (ongidef.org).

smallholders in Côte d'Ivoire are not registered with a cooperative, for example (IDH et al. 2021a). This makes it much harder for downstream actors to trace back to the site of production since cooperatives play a central role in coordinating engagement, sharing information, and gathering data. Where supply bases "overlap" in this way, collaborative action by buyers/processors is often advantageous and more effective, not just in helping to achieve traceability and transparency but also in pursuing other objectives related to livelihoods and productivity, among others (see example of the Cocoa & Forests Initiative in "Collaboration beyond individual supply chains").

- Smallholder mapping to enable traceability to plantation in palm oil is a static capture of what is actually a dynamic sourcing landscape. The traditional model of tracing supplies to the farm using field staff generates a snapshot of farms and farmer relationships at a particular moment in time. Data can become outdated due to land transfers, and because of the fluidity of selling and buying relationships among independent smallholders and agents or dealers, which are not wedded to selling to a specific mill.
- Even if visibility is achieved, the data required may not be available. For example, not all smallholders have documentation for legal access, rights, and tenure of the land and commodity grown on it. This documentation is, however, often essential to establishing the legality of the operation and the commodity itself.
- Access to technology may be limited. Not all smallholders have access to the internet, telecommunications, or technology to enable them to share information digitally. However, innovations in the use of mobile phone technology are advancing rapidly (as shown in "Innovation in technological applications for traceability and transparency"), which is helping to overcome these challenges.
- Understanding of international or national policy requirements and standards may be limited or lacking, necessitating training support and capacity building.
- Similarly, third-party certification to a commodity standard may be limited.

- Due to the factors above, along with the associated cost of verification and compliance, smallholder producers are often not certified. For a downstream company this will mean that alternative evidence will be required, often using a combination of remote sensing and boots-on-the-ground data gathering.

To address these challenges, individual companies are taking steps to map smallholder farmers, engage with them, and develop practical traceability systems. Two such examples are the Cargill CocoaWise program and the smallholder engagement program that Musim Mas has been undertaking with smallholders in Indonesia (see Appendix C, Box 5, and Table 10).

BOX 5 | Musim Mas's traceability program

Musim Mas uses two approaches to gather data about independent smallholders.

Individual farmer mapping. The supplying farmer data are first gathered from agents, cooperatives, farmer groups, or local traders selling to Musim Mas mills; volumes are allocated to each farmer. Musim Mas's "traceability and supplier engagement" team then goes into the field to verify submitted information and capture geocoordinates. Gathering and verifying data are both time and cost intensive and prone to inaccuracies and inconsistencies. It can take up to nine months to map the 6,000–8,000 independent smallholders supplying an individual mill. Even after data have been verified, they can become inaccurate if land rights are sold.

A risk-based "supply shed" farmer verification approach. The farmer data are organized by villages and matched to a landscape map to look for village overlap with protected areas and peatlands. Those farmers are prioritized for field verification programs and ground truthing. The risk-based approach is estimated to be three times as fast and 13 times cheaper than mapping individual farmers.

Source: For more information, see Musim Mas's web page on traceability and sustainability: https://www.musimmas.com/sustainability/traceability/.

These examples illustrate that

- it is possible to achieve traceability and transparency to smallholder suppliers in complex supply chains, even if the process can be time consuming and resource intensive; and
- there is likely to be overlap and duplication of efforts by companies where smallholders sell into shared supply chains.

Finally, governments can support company engagement with smallholders through mandatory national-level application of standards and mechanisms of assurance for commodity sectors in countries of origin (e.g., Indonesia Sustainable Palm Oil, Malaysian Sustainable Palm Oil) and in the case of timber through Timber Legality Assurance Systems, such as those developed through VPAs or in comparable government-owned information management systems for timber (see Appendix F).

Assurance systems can be helpful for companies where they are able to link commodity products within their supply chains to these systems in the country of production, enabling them to verify origin and compliance to an independently audited national standard and thereby meet changing market requirements where applicable.

Indirect suppliers and smallholders: Challenges and priorities for action

Companies have been able to work through complexities in their supply chains to increase traceability. For palm oil, traceability to mill and managed plantations and to third-party plantations has become routine. Traceability to smallholder plantation or farm is possible but can be very time and resource intensive. For companies sourcing from many thousands of smallholders, farm-level traceability is in part a logistical issue, but also creates other challenges, including the following:

- Direct suppliers may be wary of disclosing the identities of their own suppliers for commercial reasons (e.g., reducing their own competitiveness) and because of the perceived risk that they may be excluded from the market if they cannot meet the required standards. These concerns are being addressed by companies with

programs to support farmers to achieve full compliance. For example, within the Marfrig Verde+ Plan, Marfrig promotes an approach to supplier inclusion by providing technical and financial assistance.

- Direct suppliers may not have full visibility themselves of the full life cycle of the commodities they are purchasing (e.g., cattle) and may face similar disclosure concerns from their own suppliers.
- Companies with significant but not majority market share can have limited influence over a domestic market. This can complicate the implementation of traceability and transparency systems if there is a large domestic market with less stringent requirements.
- Governments can play several important enabling roles:
  - Mandating national-level application of standards and mechanisms of assurance for commodity sectors in countries of origin (e.g., Indonesia Sustainable Palm Oil, Malaysian Sustainable Palm Oil, and Timber Legality Assurance Systems)
  - Making information available to support traceability and transparency, as in these examples:
    - Timber Legality Assurance Systems were developed to improve forest resource management as part of the VPAs but also in some countries as a way to access markets, including carbon markets
    - The state of Pará has linked public data on animal movements with data for assessing forest loss with Selo Verde
    - Governments have supported collaborative action across a sector (e.g., in cocoa supply chains through the Cocoa & Forests Initiative)
  - Requiring mandatory due diligence in importing markets to drive demand for greater traceability and transparency
- While government roles are important as listed above, there are also limitations to government approaches, including the required coordination among agencies, which can cost time; lack of funding to provide sufficient staff to efforts; and divergent definitions, which can limit the ambition of government-led standard setting
- An aligned and collective approach to traceability and transparency across sectors is very important (see "Collaboration beyond individual supply chains") to agree on standards, definitions, and protocols for verification

VERIFICATION AND PROVIDING ASSURANCE OF CREDIBLE EVIDENCE

Accessing and making data available for use is a core component of any traceability and transparency system. However, the usability of data is contingent on quality, including ensuring the data are credible and trustworthy to a level accepted by market or stakeholder requirements.

Verification to provide assurance of credible evidence is predominantly done on three levels:

1. Own verification by individual companies of their own systems and data
2. Third-party verification, often relying on voluntary certification standards
3. Government-level assurance through national (mandatory) certification and in some cases information collected through conventional government oversight (e.g., pre- and post-harvest inspections in forestry, where enabling conditions are in place to collect credible data from oversight activities)

Comparability and consistency in both definitions and what constitutes credible evidence is important. The Accountability Framework initiative (AFi)[25] has sought to achieve consensus across civil society (with industry support) on definitions (e.g., for deforestation) and on expectations for monitoring and reporting. In September 2022, AFi released new guidance on aligning corporate targets, accounting, and disclosure in partnership with the Science Based Targets initiative and the Greenhouse Gas Protocol (AFi 2022).

- Alignment on definitions and reporting has been essential for providing a level playing field for companies that publicly report, giving confidence that they report progress in a similar way, and for customers and other stakeholders that use this information. Alignment has also reduced the burden for companies by simplifying the reporting process, requiring less staff time and resources. Persistent differences in approaches to reporting, however, continue to limit comparability and transparency, particularly where reporting initiatives remain voluntary, as discussed further in "The role of public reporting and disclosure."

Own verification and assurance systems

Many companies have developed their own verification systems. These systems are often developed when there are supply chain complexities and/or when voluntary or mandatory certification standards are either not available, not applicable, or too expensive. In some cases, companies work together to develop and implement such verification systems, aligning where possible on the approach, definitions and standards, and evidence. Table 10 presents examples of such approaches, and associated challenges and opportunities.

Own company verification and assurance: Lessons for traceability and transparency

- These approaches are self-verified by design, which can raise questions about the credibility of assurance they provide. This is important for downstream customers but also governments, financial investors, and civil society in holding companies to account.
- Comparison between commitments and performance remains difficult based on individual company reports where the definitions, scopes, and methods of verification vary. This variation can undermine confidence in individual companies but also entire sectors and lead to decisions to exclude markets. For example, in 2021 several European retailers decided to cease purchasing Brazilian beef (Keating 2021).
- The UK Soy Transparency Coalition[26] aims to address this lack of comparable market data on company performance by gathering more detailed information directly from traders on their policy compliance, but this is voluntary and available on a payment basis to members only.
- The Implementation Reporting Framework (IRF)[27] for palm oil uses self-reporting. The IRF is often disclosed on company dashboards. Differences in the approaches taken by companies mean that it is not always feasible to collate and use the data provided. Work is underway to strengthen the processes used for monitoring and disclosing information.

TABLE 10 | Examples of company own verification and assurance systems

COMMODITY	EXAMPLE(S)	CHALLENGES AND LIMITATIONS	OPPORTUNITIES FOR FURTHER DEVELOPMENT
Soy	Cargill maps its direct suppliers' farm boundaries using polygon mapping and draws on satellite data from external sources to monitor and identify land conversion connected to soy cultivation. It markets soy that has verified production practices as "Triple S™"—Sustainably Sourced and Supplied.[a]	Mapping indirect suppliers is a challenge, shared by other major soy traders within the Soft Commodities Forum (e.g., ADM and Bunge).[b]	▪ Mapping completed for 100% of direct suppliers in Brazil; work underway to complete this task in other South American countries[a]
Palm oil	No Deforestation, No Peat, and No Exploitation (NDPE) policies with the Implementation Reporting Framework (IRF). The IRF is a voluntary self-reporting tool looking at social and environmental issues related to NDPE commitments. It provides a common approach to understanding and monitoring progress of uncertified mills toward fully meeting NDPE requirements.[c] The NDPE IRF is developed by a working group of the Palm Oil Collaboration Group, which involves over 30 large companies from across the palm oil value chain.[c]	The framework is self-reporting and is not currently independently audited or verified, so there may be some lack of uniformity in disclosures. There is no common chain-of-custody system post export, so IRF-based claims may struggle to see wider market acceptance beyond place of production.	▪ Mechanisms for recognizing progress toward full certification/segregation ▪ Recognition of national systems (e.g., Indonesia Sustainable Palm Oil, Malaysian Sustainable Palm Oil) ▪ Extend use across industry
Cattle	JBS,[d] Minerva,[e] and Marfrig[f] have internal systems for mapping and monitoring both direct and indirect suppliers (see Table 9 for more information on Marfrig's Verde+ Plan and Appendix A for information on JBS and Minerva)	Many company systems rely on the self-reporting of upstream suppliers—different approaches are used by different meatpackers, which can make comparative assessment of progress across the sector difficult.	▪ Further alignment among meatpackers on verification criteria and standards
Timber	Timber companies use a range of tracking systems, which may be paper based, mixed with bar codes and in some cases radio-frequency identification tags, all depending on the supply chain and available technology.	These systems are often used for domestic markets.	▪ Designed to provide assurance to market, but also for internal planning purposes
Cocoa	Tony's Chocolonely used technology from ChainPoint to develop Beantracker, its traceability software.[g]	The Beantracker system generates and hosts data about the flow and trade of cocoa beans. It does not incorporate data on sustainability characteristics at the point of production. Instead, Tony's must identify cooperatives to work with through other means, then Beantracker ensures that beans from those cooperatives end up with Tony's.	▪ Managed to trace 100% of the cocoa beans it uses back to the level of the cooperative[g] ▪ Working to build partnerships with and support new cooperatives that it starts sourcing from[h] ▪ Model could be adopted by more of the industry

TABLE 10 | Examples of company own verification and assurance systems (cont.)

COMMODITY	EXAMPLE(S)	CHALLENGES AND LIMITATIONS	OPPORTUNITIES FOR FURTHER DEVELOPMENT
Coffee	In 2004, Starbucks launched C.A.F.E. Practices—Coffee And Farmer Equity Practices[i]—in collaboration with Conservation International. This was one of the first sets of ethical sourcing standards for the coffee industry, working not only toward environmental sustainability, but also ensuring that the company protects the well-being of coffee farmers and their communities.	The system works by awarding points for compliance with the standard's criteria. Those that score below 60% have to go through the time and cost of reverification every year, potentially putting smallholders at a disadvantage to larger cooperatives, despite their representing around 80% of global coffee production. It is also limited to Starbucks' direct sourcing, rather than the sector as a whole.	▪ Practices establish social, environmental, and economic criteria guidelines, achieving 99% ethically sourced coffee in 2015[j] ▪ As well as sustainable agricultural practices, criteria include economic transparency throughout the supply chain ▪ A verification system rather than a one-off certification, it requires continuous improvement
Natural rubber	ITOCHU's "Project Tree" initiative[k] works to increase traceability in the network of smallholders and intermediaries supplying two rubber processing plants in Sumatra, and helps farmers improve their livelihoods and practices. Rubber that is verified as sustainable can be segregated and traded separately.	The project involves an incentive scheme to encourage engagement with the system and runs in parallel with a sustainability scheme supporting farmers.[l] However, the platform is currently unable to track the activities of farmers, nor is it able to pay those without bank accounts, so incentives reserved for farmers are currently pooled or used in the broader sustainability support scheme.	▪ Project could establish a secure, up-to-date database of transactions among actors in the area, including smallholders and intermediaries, and guide mechanisms for providing financial incentives and support

Sources: a. Cargill 2022; b. WBCSD 2022b; c. For more information, see the web page of the NDPE IRF: https://www.ndpe-irf.net/; d. For more information, see JBS's Responsible Raw Material Procurement Policy on its JBS360 sustainability website: https://jbs360.com.br/en/responsible-procurement/; e. For more information, see Minerva's 2021 sustainability report: https://www.minervafoods.com/rs-2021/index_EN.html; f. For more information, see Marfrig's web page on the Marfrig Verde+ program: https://marfrig.com.br/en/sustainability/marfrig-verde-mais; g. For more information, see Tony's Chocolonely's statement page on traceability and its Beantracker: https://tonyschocolonely.com/nl/en/our-mission/serious-statements/tonys-beantracker; h. Tony's Chocolonely 2020; i. Starbucks 2020; j. For more information, see the page on C.A.F.E. Practices at its website Starbucks Coffee at Home: https://www.starbucksathome.com/gb/story/café-practices; k. For more information, see the website of Project TREE: https://project-tree-natural-rubber.com/; l. For more information, see the "Initiative" page on the website of Project TREE: https://project-tree-natural-rubber.com/initiative/.

Voluntary certification standards

Voluntary third-party certification standards have evolved over the past 25 years to provide market assurance on commodity supply chains, where credibility was seen as lacking. For example, in the 1990s when there was increasing concern about timber production leading to mass deforestation, a broad set of groups created the Forest Stewardship Council (FSC).

Some certification standards, such as the FSC, provide balanced representation across industry, environment, and social concerns. Most standards have common features such as governance bodies, grievance mechanisms, and reporting requirements to provide market assurance.

Certification standards have been developed for most of the commodities that are the subject of this report, with standards in development for rubber through the Global Platform for Sustainable Natural Rubber.[28] The market uptake of these standards varies considerably with higher proportions of certified palm—19 percent of total global production of crude palm oil was certified to the Roundtable on Sustainable Palm Oil (RSPO) standard in 2021 (RSPO 2022b) and a lower proportion of certification in the soy sector (1.25 percent of total soybean production globally) was certified against the Round Table on Responsible Soy (RTRS) standard in 2021.[29] Between 27 percent and 47 percent of cocoa production in 2019 complied with a voluntary sustainability standard (e.g., Fairtrade, UTZ, Rainforest Alliance) (Bermudez et al. 2022a).

Table G-1 in Appendix G provides a summary of the main certification standards along with the percentage of production that they account for where this information is available.

There are requirements related to the control of certified products along the supply chain, including flows of certified and noncertified products and associated claims. Table G-2 summarizes these models.

A common starting point for companies purchasing certified product is to purchase credits or certificate transactions. These provide evidence that the product has been audited and verified against the standard at the farm level but do not provide a traceable connection to the physical product purchased downstream.

Different levels of traceability of *physical* flows of certified product are provided by mass balance, segregated, and identity preserved (IP) chain-of-custody models (see Table 11). Only in a segregated or IP system is certified product *physically* segregated from noncertified material. Within a mass balance chain-of-custody model, certified product is monitored to ensure that only the amount that has been produced is sold, but in the supply chain it is mixed with noncertified material. In practice, this means it is not possible for a purchaser of mass balance certified product to know what proportion of the physical material they are buying is certified.

There are advantages and disadvantages to the different chain-of-custody models for traceability and transparency. Segregated products provide greater traceability within supply chains, but establishing this separation can add cost. Credits and mass balance models offer downstream companies (e.g., retailers, brand owners) a practical mechanism through which they can support more sustainable commodity production and, for example, give smallholders access to benefits, but do not provide assurance on traceability connecting this certified material to their supply chains.

Markets will likely increasingly demand greater levels of traceability both in response to emerging legislative requirements (e.g., the requirement for geolocation within the forthcoming EU Deforestation Regulation[30]) and market demands (e.g., requirements for traceability of physical soy flows by companies within the UK Soy Manifesto).[31]

Certification bodies are responding to these developments. For example, RSPO is developing proposals for improving the robustness of the mass balance chain-of-custody model, which could include the noncertified proportion meeting a minimum standard of legality and deforestation- and conversion-free (SPOC 2022; RSPO 2022a). RTRS is retrofitting its chain-of-custody standard to accommodate due diligence requirements (EC 2023).

TABLE 11 | Chain-of-custody models for sourcing commodities

CHAIN-OF-CUSTODY MODEL	DESCRIPTION	ESTABLISHES PHYSICAL TRACEABILITY TO LAND MANAGEMENT UNIT(S)?
Identity preserved	Chain-of-custody model in which the materials or products originate from a single source and their specified characteristics are maintained throughout the supply chain	**Yes**, to unique land management units (LMUs) for identity preserved materials
Segregation	Chain-of-custody model in which specified characteristics of a material or product are maintained from the initial input to the final output	**Yes**, to multiple LMUs for segregated materials
Controlled blending	Chain-of-custody model in which materials or products with a set of specified characteristics are mixed according to certain criteria with materials or products without that set of characteristics, resulting in a known proportion of the specified characteristics in the final output	**Yes**, to multiple LMUs for the known share of materials
Mass balance	Chain-of-custody model in which materials or products with a set of specified characteristics are mixed according to defined criteria with materials or products without that set of characteristics	**No**, does not ensure physical traceability to specific land management units

Source: Greenhouse Gas Protocol, "Land Sector and Removals Guidance," Draft for Pilot Testing and Review, 2022, https://ghgprotocol.org/sites/default/files/2022-12/Land-Sector-and-Removals-Guidance-Pilot-Testing-and-Review-Draft-Part-2.pdf, Chapter 16, Table 16.11.

Voluntary certification: Lessons for traceability and transparency

- Certification can help meet market demands for assurance that commodities have been produced to meet specific standards, including legal production and deforestation-free.
- Not all certification standards provide the same level of assurance of traceability to origin. This is increasingly requested by markets and emerging due diligence regulations, which owners of certification standards are beginning to respond to.
- Overall, uptake in global commodity supply chains remains limited both in terms of hectares and volume certified and market demand.
- The cost premiums of certification and how these costs should be shared across the supply chain (shared responsibility), including with farmers (to support living incomes), are active (but unresolved) discussion points for actors within commodity supply chains.

National and regional standards

National-level assurance or certification processes have evolved in recent years in response to the need to comply with national laws such as the FLEGT and related licensing[32] and through VPAs between the EU and a number of timber-producing countries (EC 2013).

For example, in 2016, Indonesia started issuing FLEGT licenses, automatically meeting the requirements of the EU Timber Regulation.[33] The EU Timber Regulation prohibits operators in the EU from placing illegally harvested timber and products derived from illegal timber on the EU market and mandates due diligence. Indonesia's FLEGT licensing scheme is based on a mandatory certification system called the Sistem Verifikasi Legalitas Kayu (Republik Indonesia 2018), a TLAS, which was developed by the government of Indonesia with input from stakeholders as a result of the VPA between Indonesia and the EU.

A number of other timber-producing countries are in the process of developing a TLAS under a VPA with the EU to verify the legality of their timber, and therefore also its traceability. In addition, other countries are pursuing traceability and transparency systems for the forest sector for other

reasons including enhancing natural resource management, formalizing economic sectors, and improving tax collection, among others (Stäuble et al. 2022).

Within the palm oil sector, the Indonesian government has developed a national mandatory standard for palm oil, Indonesia Sustainable Palm Oil (ISPO). Approximately 32 percent of oil palm plantations in Indonesia achieved ISPO certification in 2020. Malaysian Sustainable Palm Oil (MSPO) is similarly a mandatory national standard for the Malaysian palm oil sector. Over 97 percent of oil palm planted area in Malaysia had achieved MSPO certification in 2022. Both are certification standards similar to those described above but do not currently provide chain-of-custody assurance for palm oil meeting these standards once exported.

National standards, certification, or reporting schemes such as those described in the timber and palm oil sectors (see Appendices F and C, respectively) can play an important role for domestic and export markets for these commodities:

- They can raise the bar for sustainable production standards at a national level, providing impact at scale. This is important given the size of the domestic markets for these commodities: For example, almost three-quarters of beef produced in Brazil in 2020 was consumed domestically. In 2021, 37 percent of Indonesia's palm oil production was consumed domestically. They can also ensure that all exports of commodities meet a given standard regardless of the end market requirements (ISTA Mielke GmbH 2022).[34]
- As indicated in "Own verification and assurance systems," national standards could be helpful for companies if they are able to link products within their supply chains to assurance systems such as these in the country of production, enabling them to verify origin and compliance to an independently audited standard. This could reduce the need to extend traceability and transparency systems to thousands of individual smallholders.
- National systems could play an important role in supporting voluntary certification standards by, for example, providing a level of assurance on the noncertified products entering into a certified system, as is the practice for mass balance certification.

BOX 6 | What is a Timber Legality Assurance System?

A TLAS is a national system designed to verify and demonstrate that timber and forest products conform to national laws.

According to a recent report on the TLAS assessment framework study (undertaken as part of the U.S. Agency for International Development's Targeting Natural Resource Corruption project), a complete and robust TLAS tends to have the following six elements:

1. A legality definition that identifies the subset of national laws that will be assessed for compliance
2. Tools and mechanisms to ensure transparency and stakeholder involvement
3. Supply chain control and verification mechanisms whose goal is to ensure and demonstrate the legality of the timber
4. Government oversight providing monitoring on a system level
5. Enforcement actions by government if and when laws are broken
6. A policy response mechanism that uses information on the functioning and impact of the TLAS to inform executive and legislative processes

A TLAS may also produce a legality statement intended to serve as proof to international buyers and other parties that products are legal.

Source: U.S. Agency for International Development, Report on the TLAS Assessment Framework Study, Targeting Natural Resource Corruption Project, October 2022 (unpublished).

The development and implementation of national standards can also present challenges such as the following:

- Developing these standards can take time, as does reaching national-level consensus if a standard is developed in a multistakeholder process, such as a TLAS.
- Systems need to ensure that smallholders retain market access and are not excluded by costs.
- Building international market recognition and acceptance is an important enabling condition.
- The chain of custody needs to extend beyond point of export, to link to and pass assurances into international commodity supply chains.
- Market share is limited for all voluntary approaches, and mandatory national standards are mainly limited to country of production although FLEGT licenses have achieved some market acceptance in procurement and existing import regulations.

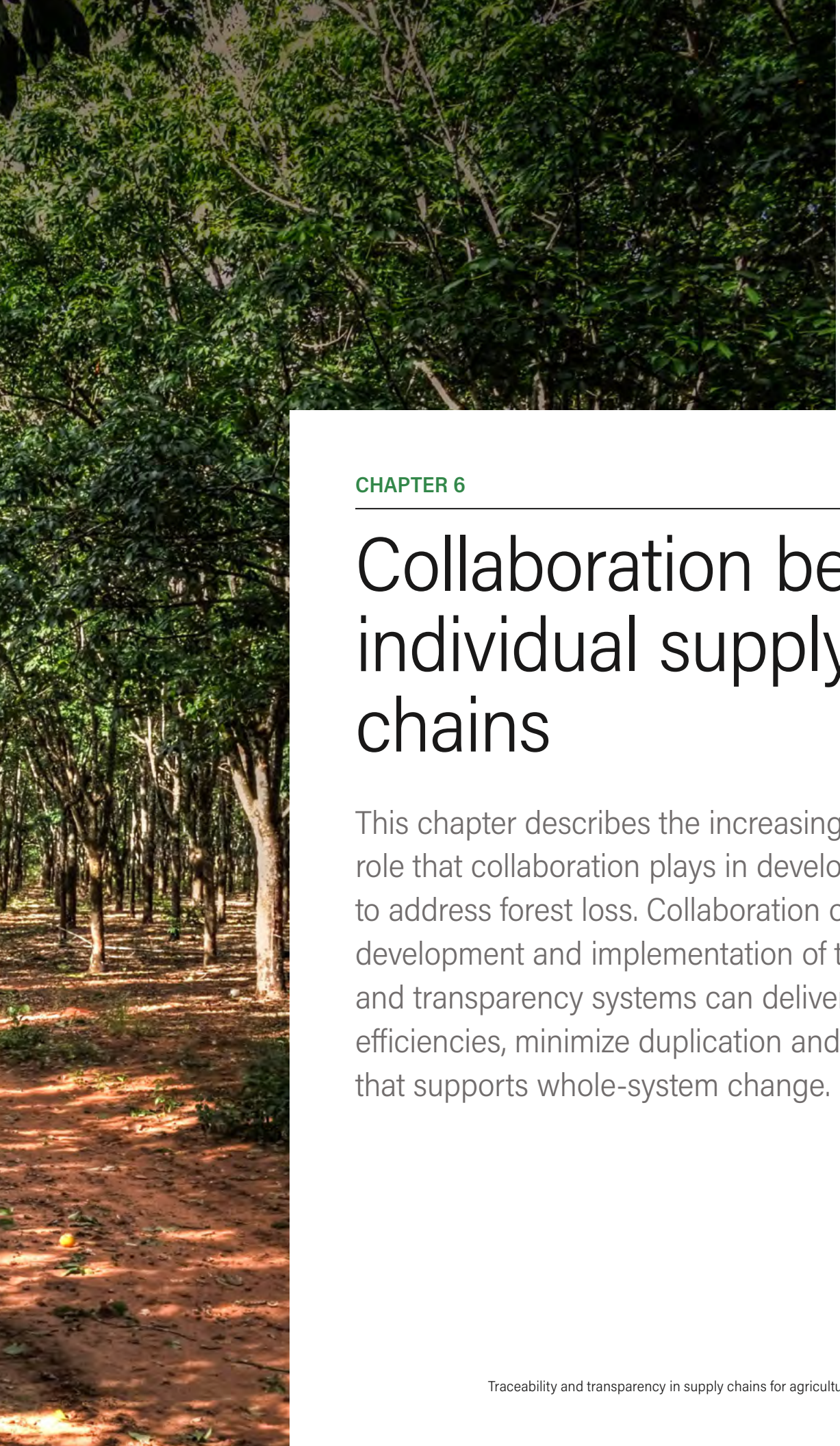
LESSONS

- Traceability and transparency are challenging in complex and multi-tiered global commodity supply chains. Purchasing commodities through a variety of routes, including direct and indirect suppliers, and mixing sources within supply chains at mills, at silos, at points of export, and during transportation create additional issues.
- Challenges for data sharing also include those related to commercial sensitivities (in opening supply bases), data confidentiality (where data exist within public systems but cannot be shared), and technology (linking databases, transitioning from paper-based to electronic systems).
- However, verification of data on commodity characteristics at origin is possible through company systems, third-party voluntary certification schemes, and collective approaches at a jurisdictional or landscape level. Voluntary certification has provided one mechanism for downstream companies to support sustainable commodity production and gain some assurance on traceability, but uptake remains limited.
- Companies increasingly self-report on progress against commitments, but comparability remains difficult because of a lack of consistency and alignment in approaches to monitoring, verification, and reporting. Self-reporting is considered less robust than independent verification. This undermines the role transparency can play as a lever for change (see "The role of public reporting and disclosure").
- Market and regulatory pressures have been increasing for greater traceability and transparency to provide assurance on legality and risk of forest loss. Increasingly, companies have been looking at ways to work together to achieve this assurance through mass market "pre-competitive" solutions. These are discussed more fully in "Collaboration beyond individual supply chains."

Enabling conditions and interdependencies

- **The costs of the transition to sustainable commodity production need to be absorbed and equitably shared through the supply chain.** The cost burden for farmers to reach a living income, achieve sustainable production, and meet the requirements of traceability systems (e.g., mapping supply chains) throughout the supply chain should be shared to ensure that they can meet these goals.

- **Data sharing needs to be encouraged and facilitated to reduce duplication of efforts and costs, and enhance transparency.** This could be achieved through greater alignment and interoperability of datasets, indicators, and definitions, supported by continued, transparent dialogue focused on solutions.
- **Data shared and disclosed must be credible, verified, and audited by third parties.** While third-party assurance alone does not guarantee credibility, external assurance bolsters trust in the validity of reported data and verification of deforestation-free claims, which is essential to building and maintaining credibility.
- **Companies further downstream need to be able to interpret publicly available data on the performance of their suppliers**, often many tiers removed, to set and monitor their own policies on deforestation.
- **Governments can set up mandatory national standards and mechanisms of assurance for commodity sectors in countries of origin.** These systems exist for timber and palm oil, and may play an increasing role in international and national markets. They can help link smallholders to international supply chains.
- **Governments can make information available to support greater traceability and transparency** to meet domestic regulatory and market requirements (e.g., compliance with national policies, assurance mechanisms) and regulate mandatory due diligence within major importing markets, both of which seek to drive demand for greater traceability and transparency. However, these market requirements need to be inclusive and designed with the needs of smallholders in mind to avoid market exclusion (Fairtrade 2022).



CHAPTER 6

Collaboration beyond individual supply chains

This chapter describes the increasingly important role that collaboration plays in developing solutions to address forest loss. Collaboration on the development and implementation of traceability and transparency systems can deliver resource efficiencies, minimize duplication and build trust that supports whole-system change.

Collaboration is essential. The previous chapters have shown that as the context and drivers for traceability and transparency evolve, and as companies, financial institutions, governments, and civil society create more initiatives, the need for collaboration increases in two areas:

- The "what": The need for alignment in market requirements, whether from individual companies, civil society, governments, or consumers. This includes consistent goals, definitions, and means of demonstrating compliance, evidence, and reporting.
- The "how": Collaborating across industry groups to work with suppliers—including smallholders, indirect suppliers, and suppliers across a landscape or jurisdiction—and across governments is essential for providing the enabling environment to support these actions.

Collaboration on the "what" and the "how" are important in the development and use of traceability and transparency tools and initiatives. Ensuring that there is a consistent approach taken across commodities, countries, and actors minimizes the potential for duplication and inconsistency in efforts undertaken by all. This chapter explores these types of collaboration in more detail, drawing out lessons from examples, including those in the case studies, and identifying the enabling conditions and interdependencies required.

COLLABORATION ON REQUESTS FOR DATA AND INFORMATION

There is a need for greater consistency in the definitions used, timelines and cutoff dates, and levels of reporting and transparency, and in what will be accepted as credible evidence as a means of assurance. A market-wide movement in both producing and consuming countries is essential for providing the right enabling environment and a level playing field. Working collaboratively supports individual actions while accelerating collective progress and building trust among companies and importantly among multiple types of stakeholders. Greater consistency leads to opportunities for disclosing data in a way that protects commercial sensitivities.

AFi has achieved significant progress in collaboration, helping provide clarity on the aligned "what" from a broad range of civil society stakeholders (see Box 7). Table 12 provides examples of collaborative efforts from supply chain actors around the "what" to support consistency in what is used as commitments, definitions, means of credible evidence, monitoring, and reporting, for example.

There are a growing number of collaborative efforts; while not mutually exclusive, these are grouped as sector-specific, national, and global, some of which are discussed below, with further examples provided in Appendix H.

Global collaboration platforms

Global platforms often include representation from private companies, trade organizations, and national or regional roundtables, alongside farmers and academia. They can consist of industry only or include other stakeholders, including civil society.

BOX 7 | Accountability Framework initiative

AFi, launched in 2016, has worked to develop a consensus-based set of norms, definitions, and guidance agreed upon by civil society, technical experts, and the private sector to achieve ethical supply chains in agriculture and forestry. It aims to provide greater clarity, consistency, effectiveness, and accountability in how companies set commitments, take action, and monitor progress toward achieving supply chains that are free from deforestation, conversion, and human rights violations.

Source: See the Accountability Framework initiative's website for more information: https://accountability-framework.org/.

TABLE 12 | Collaboration on requests for data and information

COLLABORATING ON THE "WHAT"	DESCRIPTION AND IMPACT	LESSONS FOR TRACEABILITY AND TRANSPARENCY
Soft Commodities Forum, 2018, facilitated by the World Business Council for Sustainable Development[a]	▪ A collective protocol for engaging with 19 indirect suppliers to improve monitoring of soy-driven deforestation and conversion of native vegetation in the Brazilian Cerrado through adoption of a traceability and monitoring system ▪ Six soy traders—ADM, Bunge, Cargill, COFCO International, LDC, and Viterra—collaborate with ABIOVE in Brazil	▪ Collective action has been successful in increasing transparency of soybean sourcing in 61 focus municipalities, constituting 70% of recent native vegetation conversion[b] ▪ Commercial concerns of sharing information about indirect suppliers
Consumer Goods Forum (CGF) Forest Positive Coalition[c]	▪ Roadmaps for major commodities (beef, soy, palm oil, and paper) with collaborative aims, ambitions, and means of reporting	▪ Transparency and accountability are one of the four "coalition-wide actions" within each of the roadmaps to ensure consistency in the demand for data and information for all CGF members[d]
Palm Oil Collaboration Group[e]	▪ Consists of four working groups to identify areas of opportunity and collaboration ▪ Key values are the No Deforestation, No Peat, No Exploitation policies and supporting Implementation Reporting Framework[f]	▪ Seeks to align reporting frameworks and what is meant by credible evidence of compliance, allowing for recognition of national standards and industry progress toward the end goal
Public Commitment on Cattle Ranching, 2009 ("G4 commitment")[g]	▪ To align the data/information demands of JBS, Marfrig, Minerva, and Bertin in the Amazon, working with direct suppliers	▪ While the demand for data and information has been aligned to some extent, variations in the cutoff dates and geographical scopes, for example, remain
Soy on Track platform[h]	▪ Aggregates reporting across initiatives such as the Amazon Soy Moratorium, Green Protocol of Grains of Pará, and other commitments in one place ▪ Includes data, protocols, and audits	▪ Aggregated information in one place ▪ Buyers can check information (e.g., volumes sold versus productive capacity of a farm)

TABLE 12 | Collaboration on requests for data and information (cont.)

COLLABORATING ON THE "WHAT"	DESCRIPTION AND IMPACT	LESSONS FOR TRACEABILITY AND TRANSPARENCY
UK Soy Manifesto, 2021[i]	▪ Forty-one major food companies from across the UK with a commitment to ensure all soy entering the UK will be deforestation- and conversion-free by 2025 at the latest—this represents 60+% of the UK supply chain ▪ Cross-industry joint transition plan to verified deforestation- and conversion-free (vDCF) soy by 2025	▪ Agreement on a deforestation- and conversion-free definition and accompanying forms of evidence (vDCF) ▪ Development of a vDCF soy-in-animal-feed standard to provide assurance within supply chains (to be released in 2023) ▪ Aggregated quarterly reporting by traders on the vDCF status of soy at point of import to the UK, setting out volumes, countries of origin, and the proportion carrying vDCF status
Cocoa & Forests Initiative[j, k]	▪ An agreement among the governments of Ghana and Côte d'Ivoire and 36 cocoa and chocolate companies to end deforestation and restore forest areas, including through transparent satellite-based monitoring and supply chain mapping efforts to achieve full traceability	▪ Effectiveness of public-private partnerships setting out joint objectives and commitments related to traceability and transparency ▪ Helped lay the groundwork for substantial progress on companies' mapping of the direct supply chain, and governments' enhancement of traceability systems ▪ Paved the way for an agreement among major cocoa and chocolate companies to share farm-level data in an anonymized fashion to drive forward meaningful collective action for improved and transparent deforestation monitoring

Note: LDC = Louis Dreyfus Company; ABIOVE = Associação Brasileira das Indústrias de Óleos Vegetais (Brazilian Association of Vegetable Oil Industries); UK = United Kingdom.

Sources: a. See the web page regarding the Soft Commodities Forum for further information about sustainable soy production in the Cerrado, Brazil: https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Soft-Commodities-Forum/Resources/Soft-Commodities-Forum-SCF-Sustainable-soy-production-in-the-Cerrado-Brazil; b. WBCSD 2022b; c. See the Consumer Goods Forum's website for further information: https://www.theconsumergoodsforum.com/environmental-sustainability/forest-positive/; d. See the Consumer Goods Forum's web page on commodity specific roadmaps: https://www.theconsumergoodsforum.com/environmental-sustainability/forest-positive/key-projects/commodity-specific-roadmaps-and-reporting/; e. See the Palm Oil Collaboration Group's website to find out more: https://palmoilcollaborationgroup.net/; f. See POCG's Implementation Reporting Framework working group web page: https://palmoilcollaborationgroup.net/ndpe-irf; g. Mongabay.com 2009; h. See the Soy on Track website for further information about transparency in the soy value chain: https://www.soyontrack.org/; i. See the UK Soy Manifesto website: https://www.uksoymanifesto.uk/; j. See the World Cocoa Foundation's web page on the Cocoa & Forests Initiative: https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/; k. See the Cocoa & Forests Initiative Ghana web page for more information: https://cfighana.mlnr.gov.gh/.

Examples of global-level platforms include the following:

- **Beef:** Global Roundtable for Sustainable Beef; European Roundtable for Beef Sustainability
- **Cocoa:** International Cocoa Organization; International Cocoa Initiative; World Cocoa Foundation; VOICE Network, a global network of NGOs and trade unions; supported at the European level by the European Cocoa Association
- **Coffee:** International Coffee Organization; Global Coffee Platform; International Coffee Partners; European Coffee Federation at the European level
- **Rubber:** Global Platform for Sustainable Natural Rubber; Sustainable Natural Rubber Initiative
- **Timber:** World Business Council for Sustainable Development Forest Solutions Group
- **Cross-commodity:** Africa Sustainable Commodities Initiative

National collaboration platforms

National initiatives support coalition building among companies, industry associations, and civil society to work toward sustainable production. These initiatives seek to create a collective request for data and information aligned with individual goals, traceability and transparency, and reporting.

These initiatives are growing both in ambition and in the degree of collaboration. National initiatives—such as the UK Sustainable Commodities Initiative (soy and palm oil) and

Danish Ethical Trading Initiative (palm oil, soy, and coffee)—are increasingly taking a cross-commodity approach. They create a common voice across industry and commodities, seek to share lessons, work toward consistency within individual and across markets (e.g., bilaterally in the case of the European National Soya Initiatives), and bring those messages to global dialogue platforms.

Sector-level collaboration platforms

Sector-level platforms represent the interests of different sectors within commodity supply chains (e.g., retail, manufacturer, trader groupings), providing a precompetitive space for companies that may be competitors but have common interests or challenges and are interested in developing shared solutions and providing a platform for advocacy. Greater traceability and transparency can be achieved by working together through these cross-industry commodity platforms where certain enabling conditions are in place, the following in particular:

- Cross-sector agreement on a shared goal and purpose to deliver greater consistency in communication across the supply chain and encourage greater transparency as companies are assured that others (including competitors) are reporting in the same way
- Building and ensuring trust among actors through a precompetitive space to discuss challenges that arise, including cost sharing but excluding price, which is out of scope for a precompetitive discussion
- Recognition of the need for a mass market shift with a suitable transition period to ensure that actors are not excluded, for example, with commitments by companies in a group to cascade their own commitments up the supply chain, strengthening the market signal to traders and producers more directly while putting in place safeguards to ensure that costs are equitably shared along the supply chain
- A clear baseline from which to work that provides clarity on priorities for effective action
- Opportunity to identify common "pinch points" (points of leverage) and shared areas of potential intervention (where commodity footprints overlap)

Greater traceability and transparency can be achieved by working together through these cross-industry commodity platforms.

Joint efforts to collect the production characteristics of commodities reduce costs and duplication, and can lead to sector-wide transformation when a critical mass of actors joins and the majority of the market is represented.

WORKING COLLECTIVELY WITH SMALLHOLDERS AND INDIRECT SUPPLIERS

Working collectively inherently requires an inclusive and consultative process with all parties, considering the specific needs of smallholders and indirect suppliers in particular. In complex supply chains (see "Traceability and transparency through the supply chain"), where multiple farmers are supplying to more than one company (e.g., mill, intermediaries, processor, traders), data collection can be costly and resource intensive, and replicate the efforts of other actors within the same supply chain (e.g., if producers are required to provide data individually to each buyer).

This issue surfaces in supply bases that include many smallholders or indirect suppliers. A wide array of collaborative initiatives has emerged across all actors, as shown in Table 13 (more detail can be found in Appendices B-F). These examples illustrate the following:

- Collaboration can strengthen relationships among all actors, while recognizing potential commercial sensitivities, and ensure consistent information and data requests across the supply chain.
- When dealing with a large or disparate supply base, working collaboratively can reduce the resources required, including time and funding.

TABLE 13 | Collaborations with suppliers

COLLABORATING WITH SUPPLIERS	DESCRIPTION AND IMPACT	LESSONS FOR TRACEABILITY AND TRANSPARENCY
Protocol for the Sustainable Production of Calves[a] (1 million calves registered using Blockchain)	▪ Builds on a program of support by IDH, Carrefour, and Brazilian Confederation of Agriculture and Livestock ▪ Validates field information against Ministry of Agriculture, Livestock, and Supply official information	▪ System to verify socially and environmentally responsible calf production, implemented in a blockchain ▪ Full traceability from birth through slaughter to consumer ▪ Audited by TÜV Rheinland
GAR, with GeoTraceability (software), Koltiva[b]	▪ Region-specific workshops for multiple supplying mills, field surveys[c] ▪ Customers partnered for some efforts, e.g., GAR and Nestlé mapping smallholders (25% of palm oil planted area) in Siak, Riau, Indonesia[d]	▪ Mapping of more than 120,000 smallholders via 1,600 agents[c]
GAR, Mars, Fuji Oil[d]	▪ Collaboration with customers to map mills, smallholders, and deforestation ▪ Integrate deforestation monitoring in environmentally vulnerable areas	▪ By end of 2021, worked with 1,505 smallholders, 45 agents, and 9 independent mills
Risk-Calibrated Approach Traceability to Plantation Portal[e]	▪ Documentation of risk-calibrated traceability to village data from approximately 250 mills feeding into around 50 refineries managed by a half dozen integrated or downstream actors	▪ Consistency in reporting across the supply chain, allowing downstream access to data

Note: GAR = Golden Agri-Resources; IDH = the Sustainable Trade Initiative.

Sources: a. Find out more about the Protocol for the Sustainable Production of Calves in IDH 2022a; b. GAR 2018; c. Neville and Kriswantoro 2022; d. GAR 2022, 34; e. Pers. Comm. 2022, interview with Gary Paoli, director of business and research development, Daemeter Consulting.

WORKING COLLECTIVELY ACROSS THE SUPPLY BASE: JURISDICTIONAL APPROACHES

According to the Tropical Forest Alliance, jurisdictional approaches involve "collaboration of stakeholders within a defined natural or social geography, such as a watershed, biome or company sourcing area." These approaches seek to reconcile competing social, economic, and environmental goals through integrated landscape management, "a multi-stakeholder approach that builds consensus across different sectors with or without government entities" (TFA et al. 2020).

In practice, jurisdictional approaches are a "type of landscape approach operating within sub-national or national administrative boundaries with active government involvement," but some can also cover multiple jurisdictions within a biome or region. These approaches aim to improve environmental and social sustainability at scale through a multistakeholder process. Objectives include enhancing sustainable production of commodities, reducing forest loss and degradation, and bringing social and economic co-benefits to local communities (TFA et al. 2020).

Collaboration at the jurisdictional and landscape levels is gaining momentum across commodities and geographies, recognizing that to create the impact and change required for an entire sector, working beyond individual supply chains is required. This includes the need to work collaboratively on traceability and transparency tools and initiatives. There are efforts to design verification mechanisms for deforestation-free production. Examples of such approaches are presented in Table 14.

TABLE 14 | Collaboration on jurisdictional approaches to achieving traceability and transparency

COLLABORATING ON JURISDICTIONAL APPROACHES	DESCRIPTION AND IMPACT	LESSONS FOR TRACEABILITY AND TRANSPARENCY
Siak Pelalawan Landscape Programme (SPLP), 2018, in Riau, Indonesia[a] (Public-private jurisdictional collaborations for aligning multistakeholder processes, locally led with international support)	▪ Goal is to ensure verified deforestation-free palm oil by 2025, while increasing farmer livelihoods ▪ Program covers over 2 million ha of which more than 700,000 ha are planted with oil palm, over 200 villages and independent smallholders[a] ▪ Facilitated by Proforest, Daemeter, and SPLP coalition members including Cargill, LOréal, Musim Mas, Nestlé, PepsiCo, and Unilever	▪ Outcomes: ▪ District-level monitoring and alert system for deforestation and fires ▪ Framework for claims of verified deforestation-free palm oil. ▪ Success partly due to being built on existing government green initiatives, including the Green Siak District Roadmap and the District Action Plan for Sustainable Palm Oil in Pelalawan[b]
Amazon Soy Moratorium[c] (Commitment to not trade or finance soy produced in areas in the Brazilian Amazon Biome deforested after July 22, 2008, the reference date of the Forest Code)	▪ Trade agreement signed in 2006 among the Brazilian Association of Vegetable Oil Industries, the National Grain Exporters Association, the government, and civil society	▪ Transparent MRV system including third-party verification and public data availability, with key stakeholders actively involved ▪ Multistakeholder and transparent process trusted by demand-side actors and used as part of procurement procedures/requirement
Green Protocol of Grains of Pará, launched 2014[d] (Approach to eliminating illegal deforestation for soy, rice, and maize in the state of Pará)	▪ Public prosecutor's office of Pará to ensure that soybean farms are not engaged in illegal deforestation ▪ Supported by representatives from the government of Pará, and representatives from municipalities, unions, and 30 soy trading companies ▪ The signatories' compliance with the protocol is evaluated through independent audits, which are informed by a steering committee of representatives of both public and private sector signatories	▪ Importance of protocol evaluation by independent audits, informed by a steering committee with representatives of both public and private sector signatories[e] ▪ Penalties for signatory noncompliance in the form of embargoes on buying soybeans
Africa Sustainable Commodities Initiative,[f] building on African Palm Oil Initiative	▪ Supporting sustainable commodity production, declaration signed at COP27 by Cameroon, Central African Republic, Côte d'Ivoire, Democratic Republic of Congo, Edo State (Nigeria), Gabon, Ghana, Liberia, Republic of Congo, and Sierra Leone	▪ Agreeing on a single set of principles for the responsible production of agricultural commodities such as cocoa, rubber, palm oil, coffee, and other commodities in a way that protects both livelihoods and natural resources, including forests, in Africa

Note: ha = hectare; MRV = monitoring, reporting, and verification; COP27 = 27th Conference of the Parties of the United Nations Climate Change Conference.

Sources: a. See Siak Pelalawan's website for further information about the Siak Pelalawan Landscape Programme (SPLP): https://www.siakpelalawan.net/; b. See web page for more information on SPLP's partners: https://www.siakpelalawan.net/partners; c. Inakake de Souza et al. 2016; d. Read the "Grain Protocol Commitment" via Soy on Track's website: https://www.soyontrack.org/public/media/arquivos/1634662970-008_-_19.10.2021_-_protocolo-de-graos-versao-assinada.pdf; e. De Maria et al. 2022; f. Proforest 2022.

Collaboration at the jurisdictional and landscape levels is gaining momentum across commodities and geographies, recognizing that to create the impact and change required for an entire sector, working beyond individual supply chains is required.

COLLABORATION AT THE NATIONAL AND INTERNATIONAL LEVELS

Collective action at a national level is required to create mass market change, ensuring that there is a level playing field in the application of traceability and transparency tools and initiatives, and that commitments and policies can be met.

Public sector involvement is needed to ensure that potential competition issues among stakeholders and geographical areas (e.g., landscapes, jurisdictions) are mitigated, and that all producers, including smallholders and individual farmers, maintain access to markets, both domestically and internationally. National-level traceability systems, such as TLAS, ISPO, and MSPO (as discussed in "Traceability and transparency through the supply chain"), also play a role in terms of avoiding fragmentation and duplication of private sector efforts, and making sure that more remote areas that are difficult and expensive to access are not left behind.

Moving beyond individual countries, collaboration and dialogue among countries can build on this approach, through international platforms such as the Amsterdam Declarations Partnership, where best practices and information can be more effectively shared, which in turn will support national-level action.

Multistakeholder initiatives such as the Cocoa & Forests Initiative (CFI) serve as umbrella initiatives, helping to create the enabling environment for collaboration among stakeholders that often have competing interests but shared goals within and across countries. In the case of the CFI, sustainable cocoa production is linked to protecting forests and other natural ecosystems as well as providing living incomes for farmers (see Appendix D for further details). A jurisdictional approach to forestry and cocoa in Ghana is described in Box 8.

BOX 8 | The case of cocoa and forestry in Ghana

Where a landscape produces timber but also other crops, such as palm oil, cocoa, or coffee, complex issues arise around land use and commodity production. In Ghana, forests share the same mosaic landscape with cocoa production, including through agroforestry systems.

In a complex context involving different groups with competing interests, public-private sector collaboration can address a combination of environmental and social issues. In this context, a number of initiatives have emerged at various levels, but the government of Ghana, through the Forestry Commission and the Ghana Cocoa Board, has been leading the development and implementation of traceability and transparency systems for the forest and cocoa sectors, respectively.

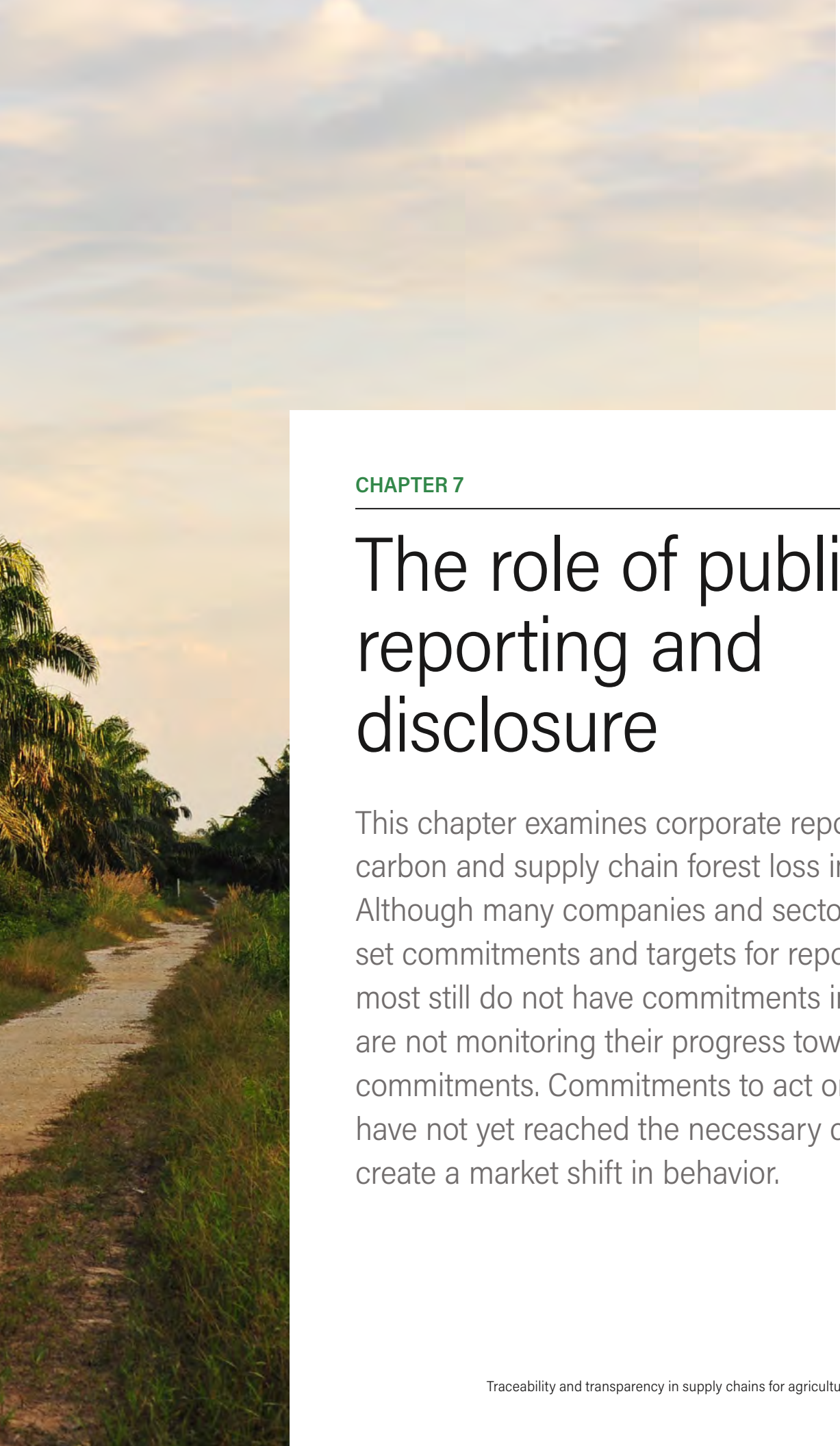
The Ghana Cocoa Board is creating a cocoa tracking system called the Cocoa Management System (CMS) in close collaboration with the Ghana Forestry Commission, which is also developing the National Forest Monitoring Systems (NFMS). The two systems build on experiences with the Ghana Wood Tracking System developed as part of the FLEGT VPA.[a] The aim is to eventually link the CMS and NFMS to be able to identify and address forest loss and its drivers, including cocoa production, and to measure, report, and verify cocoa-related emission reductions as part of the climate reporting requirements. By using identity cards and unique identification of farmers through Cocoa Cards, the system will be able to trace back to farm level, capture all farmers through a national system, and meet pending market requirements such as the EU regulation.

Source: See FLEGT VPA Facility web page on Ghana: https://flegtvpafacility.org/beyond-legality-ghana-voluntary-partnership-agreement-sustainability/.

LESSONS

Collaboration can drive improved consistency and alignment both in the requests for data and information related to traceability and transparency and frameworks to deliver on them through collective action. A number of lessons can be drawn from collaboration efforts, and associated enabling conditions, including the following:

- The most effective collaborative approach builds trust and communication across all stakeholders in the supply chain, sector, or landscape, and thereby builds momentum to shift a whole sector or market.
- Effective collaborative approaches on supply chain solutions can create efficiencies in cost, time, and knowledge in traceability and transparency efforts, especially when different companies share the same supply base. Collaboration helps avoid repetition of data provision and data collection, while improving consistency across datasets and reporting frameworks used by companies. However, collaboration can be timely and slow, and needs to be truly outcome orientated.
- When collective action reaches critical mass and the whole sector shifts, it can lead to mass market adoption with greater potential for environmental and social impact on the ground.
- Willingness to share data also depends on the framework created for sharing. Confidentiality and competition rules can often hinder data sharing along or across a supply chain, hence the need to establish precompetitive fora for collaborative discussions.



CHAPTER 7

The role of public reporting and disclosure

This chapter examines corporate reporting on carbon and supply chain forest loss impacts. Although many companies and sectors have set commitments and targets for reporting, most still do not have commitments in place, or are not monitoring their progress toward those commitments. Commitments to act on forest loss have not yet reached the necessary critical mass to create a market shift in behavior.

PUBLICLY SHARING DATA AND POLICIES

Public sharing of information through reporting and disclosure is a key aspect of transparency and often an objective of traceability systems. Private sector actors share information through voluntary disclosure to show progress against commitments; through third parties to demonstrate progress across actors or sectors; and to meet requirements be it at a national or company level. This chapter explores action across the transparency space and the potential impact on accountability and conditions on the ground.

Voluntary disclosure and reporting

Public reporting such as corporate social responsibility disclosure has been a common practice for decades. Originally it could have been seen as a way to showcase positive actions taken, often for reputational reasons, but disclosure processes have evolved. Corporate reporting on a wide range of issues and against company targets is now commonplace in annual sustainability reports, for example, with increasing expectations to show impact against commitments made.

Financial institutions are increasingly looking at environmental, social, and governance (ESG) disclosures when assessing clients and portfolios, suggesting that for some sustainability concerns are becoming more integrated within decision-making processes. Governments are requiring companies to disclose ESG-related information, too, with the Task Force on Climate-related Financial Disclosures becoming mandatory in the UK, among other examples. This creates additional incentives for companies to demonstrate and disclose their ESG credentials, in terms of both the financial risk of investments but increasingly also the material and physical risks that climate change (including risks associated with forest loss) might have on companies. For example, BlackRock head Larry Fink's 2022 letter to chief executive officers stated that a main factor in shaping BlackRock's portfolio was the sustainability strategies of companies—for purely financial reasons (Fink 2022). In addition, reputational risk and consumer preference related to environmental impacts are also having a growing material effect on companies (Rijk et al. 2019; Forest 500 2022b; Wyers 2019).

BOX 9 | Public reporting frameworks

There are many frameworks and standards for disclosing information publicly. The two leading standard-setting bodies for general sustainability are the Global Reporting Initiative and the Sustainability Accounting Standards Board, the latter of which was superseded in August 2022 by the International Sustainability Standards Board of the International Financial Reporting Standards organization.

In the context of forest loss and commodity supply chains, Carbon Disclosure Project (CDP) Forests is a leading platform that produces questionnaires as disclosure mechanisms with a rating. CDP Forests is aligned with the Accountability Framework initiative's common reporting guidelines.

Source: See Carbon Disclosure Project on forests: https://www.cdp.net/en/forests.

Consistent application of reporting standards, definitions, and methodologies will help strengthen the uptake of their use by companies and other actors. Knowing that there is consistency across industry and potential competitors will reduce the risk of being perceived as acting alone, or sharing more information than competitors. The Accountability Framework initiative, with a consortium of expert and civil society organizations, has also developed a common methodology for assessing company progress on forest loss related to commodity supply chains based on company reporting (AFi et al. 2019). Common alignment on both reporting and assessment methodologies makes it easier for third parties to understand and compare the progress of individual companies and sectors, and mitigates the risk of different assessment agencies publishing contradictory company ratings. According to AFi's 2020–2022 strategy and theory of change, the adoption of reporting frameworks and alignment on definitions lead to the emergence of a common language with which to talk about these sustainability issues (AFi 2020b). From this perspective, using the "right" language facilitates better behavior, leading to more effective policies, and positive impact.

Nevertheless, growing public scrutiny may represent a risk for some companies to report publicly, as good-quality, accessible reporting can open companies up to praise and/or criticism from civil society, consumers, and potentially investors. This is especially true where reporting/disclosure remains voluntary. Collaboration among organizations, including companies in commercial competition, civil society, and the public sector, as discussed in "Collaboration beyond individual supply chains," can help reduce any such risks that may be posed by public reporting, ensuring that pressure from third parties facilitates continuous improvement.

Third-party disclosure mechanisms and role

Third-party disclosure and reporting on private and financial sector actions plays an important role in transparency and accountability, introducing into the public domain progress against stated commitments.

For some reporting and disclosure platforms, companies are invited to submit their own data, whereas others use publicly available information to assess, and often rate, company performance. There are also initiatives that merge a combination of publicly available data with self-reported information, either by companies or third parties, such as the Open Timber Portal (OTP). Examples of such initiatives include the following:

- Global Canopy's Forest 500, now in its 10th year, with nine reports completed to date, tracks publicly available policies and performances of the 350 most influential companies and 150 financial institutions linked to deforestation in their supply chains and investments.[35]
- The OTP, developed by WRI and partners, aims to improve access to country-specific information about forest management and harvesting, and increase the effectiveness of regulations on illegal logging. The OTP compiles information from three sources: concession boundaries and the list of registered timber producers from the government; documents uploaded voluntarily by timber producers to demonstrate compliance; and observations by third-party forest monitors.[36]
- SPOTT, a free, online platform developed by the Zoological Society of London (ZSL), undertakes annual assessments of companies involved in the production and trade of palm oil, timber, pulp and paper, and natural rubber. ZSL SPOTT assesses commodity producers, processors, and traders on their public disclosures regarding their organizations, policies, and practices related to ESG issues, aiming to support primarily the financial sector and supply chain stakeholders to manage ESG risks through increased and improved transparency, and incentivize the implementation of corporate best practices.[37]
- WWF commodity scorecards provide global assessments including those on palm oil (Palm Oil Buyers Scorecard from 2009 to 2021)[38] and, more recently, soy (first Soy Traders Scorecard in 2021) (WWF 2021), in addition to country-specific assessments, including on timber (e.g., UK Timber Scorecard from 2015 to 2019).[39]

In the forest sector, companies maintaining Forest Management or Controlled Wood Certification also must comply with a public reporting requirement for audit summaries.

Reporting specific to climate and forests includes the CDP questionnaires on climate, water, and forests; the Task Force on Climate-related Financial Disclosures including recommended reporting on Scope 3 emissions (i.e., those emissions that are not directly generated by a firm's activities but that result from activities up and down its supply chain); and the early stages of the Taskforce on Nature-related Financial Disclosures. It should also be acknowledged that different reporting frameworks have been designed for different users and audiences, and this has led to a combination of definitions and metrics with overlaps and inconsistencies (GRI 2022). However, reporting and assessment frameworks such as CDP, Forest 500, and ZSL SPOTT have worked to align with the AFi standards on metrics, definitions, and reporting frameworks.

Public sector reporting

Governments and other public sector actors are also facing increasing pressure to report publicly on their own footprints (including on GHG emissions and land use due to their national consumption of commodities and products), as well as on progress achieved to date against their own targets and commitments.

For example, signatories to the Paris Agreement were expected to publish and then update their first nationally determined contributions (NDCs). According to Climate

Watch, an online platform designed to empower policymakers, researchers, media, and other stakeholders with open climate data, visualizations, and resources, 170 parties (representing 169 countries and 91.1 percent of global emissions) to date have submitted new or updated NDCs.[40]

Furthermore, to participate in REDD+ (Reducing Emissions from Deforestation and forest Degradation), countries must develop a Forest Reference Emission Level and/or a Forest Reference Level as a benchmark for REDD+ activities.[41]

Countries importing agricultural commodities are increasingly concerned about their overseas land footprints. For instance, the French government has adopted a National Strategy to Combat Imported Deforestation (Stratégie Nationale contre la Déforestation Importée; SNDI). One element of this strategy is the development of a public information system to increase transparency for risk analysis and accountability. As part of this, the Ministry of Ecological Transition has worked with Trase, EFI, and Canopée to better understand France's imported deforestation risk associated with imports of soy from Brazil and develop a new public information platform to support the implementation and monitoring of companies' zero-deforestation commitments by increasing supply chain transparency (see also "Innovation in technological applications for traceability and transparency").[42] This was developed following the 2018 publication of France's SNDI (MTOS 2018).

WWF has published two reports on the UK's overseas land footprint—*Risky Business* in 2017 (WWF-UK and RSPB 2017) and *Riskier Business* in 2020 (WWF-UK and RSPB 2020)—highlighting the issues associated with the UK's demand for agricultural and forest commodities, and related risks of forest (and other ecosystem) loss and degradation.[43] The UK is developing a due diligence regulation on forest risk commodities (as per Schedule 17 of the 2021 UK Environment Act) recommended by the Global Resource Initiative taskforce in its 2020 *Final Recommendations Report* (GRI Taskforce 2020), which built on WWF *Risky Business* data. In addition, in the UK, the Joint Nature Conservation Committee, a public body, has developed an experimental methodology to calculate the UK overseas land footprint. (Data produced with this methodology are available on the CommodityFootprints.earth platform: https://commodityfootprints.earth; further information can be found in "Innovation in technological applications for traceability and transparency.")

PUBLIC REPORTING: COMPANY COMMITMENTS AND ACTIONS

Public reporting shows that commitments to act on forest loss have not yet reached the necessary critical mass to create a market shift in behavior.

According to the 2022 Forest 500 report (Forest 500 2022a) and a joint report by CDP and AFi (AFi and CDP 2022), an insufficient number of market actors have set commitments required to deliver the changes needed to halt and reverse forest loss. The data disclosed through CDP's forests questionnaire in 2021 for companies[44] that produce or source at least one of the seven commodities responsible for most commodity-driven forest loss (namely, palm oil, forest products, cattle products, soy, natural rubber, cocoa, and coffee) show that "only 36% of companies (245/675) have public company-wide no-deforestation or no-conversion policies and only 13% of companies have commitments to no-deforestation/no-conversion that are well-aligned with good practice" (AFi and CDP 2022).

Furthermore, "only 14% of companies (95) have a traceability target related to their no-deforestation/no-conversion commitments," (AFi and CDP 2022) and while 76 percent of companies (512) report having a traceability system for at least one commodity, most companies have significant gaps in supply chain traceability:

- Only 23 percent of reporting companies (157) can trace more than 90 percent of the volumes they produce or source back to the municipality level or equivalent for at least one commodity.
- Thirty-eight percent of companies (257) report having no information about origins for at least half of their commodity volumes, and 28 percent (191) report having no traceability system for at least one commodity that they source.
- Only 26 percent of reporting companies (177) have monitoring systems in place to assess compliance with rigorous no-deforestation/no-conversion policies or commitments (AFi and CDP 2022).

These findings show that companies often prioritize certain commodities, geographies, and/or sectors, likely following a risk-based approach to identify areas of highest risk to their businesses but recognizing that the complexity of commodity supply chains (see "Collaboration beyond individual supply chains") has led to only partial progress being achieved.

JOINING EFFORTS WITH CLIMATE DISCLOSURES

A more coordinated approach between carbon disclosures on Scope 3 emissions and disclosures on the risk of forest loss within commodity supply chains could incentivize the uptake of transparency and public reporting and disclosure.

The recently launched Science Based Targets initiative (SBTi) Forest, Land and AGriculture (FLAG) sector pathway and criteria explicitly include land use change emissions and a deforestation policy requirement. This will require companies within the food, agriculture, and forest sectors to have a no-deforestation commitment, as well as enable them to set science-based targets that include land-related emissions and removals. These no-deforestation commitments also need to be aligned with the AFi, with a target date of no later than 2025 and a recommended cutoff date of 2020 (SBTi 2022c).

Additionally, all forms of land use change are included in the FLAG sector pathway model so that emissions from the conversion of other natural ecosystems and habitats (in addition to forests) must also be included and addressed as part of FLAG. Therefore, the SBTi and AFi have collaborated to ensure that the FLAG guidance builds on and is consistent with existing expectations for no deforestation and no conversion. In this way, climate and forest commitments are aligned and co-supported (SBTi 2022b).

The number of companies committing to set SBTs continues to grow (over 4,000 in December 2022), along with those that have approved SBTs (over 2,000 in December 2022).[45] The SBTi has illustrated an increased rate of emission reductions among companies that are committed within the SBTi compared with those that are not, showing the potential influence this new FLAG sector pathway model could soon have (SBTi 2022a).[46],[47]

LESSONS

- Transparency, both in terms of policies and progress, is growing across the private and public sectors. This is not only a trend in the context of forest loss, but also a broader global trend across diverse sectors, in particular climate change mitigation. There are several factors that can contribute to continued improvements in transparency and the emergence of a productive open data ecosystem.
- A central enabling condition is the setting of reporting standards. Standard-setting and disclosure bodies, such as the AFi and CDP, have taken efforts to align their frameworks and are working to improve alignment with other bodies such as SBTi and the Sustainability Accounting Standards Board. This eases the process of disclosure by reducing the burden on private sector actors to meet different requirements and allows greater comparability across reports, enabling actors, such as financial institutions or civil society, to make better informed decisions about where to apply their pressure to improve the sustainability of supply chains. However, these standards are limited in their impact by the number of actors that are reporting.
- Government-mandated disclosure is a powerful tool to increase levels of reporting. Learning from and being consistent with those used by the civil society, private, and financial sectors would support the standardization of approaches. The inclusion of Scope 3 emissions into mandatory climate disclosure obligations presents another opportunity with which to encourage data collection and reporting of actors on the impact of their value chains on forest loss.

CHAPTER 8

Innovation in technological applications for traceability and transparency

This chapter reviews innovations in three data and functionality gaps: Providing better quality information; making relevant datasets more accessible, usable, and complementary; and increasing engagement across supply chains.

This report has explored the role that traceability and transparency can play in supporting the reduction of commodity-driven forest loss. In doing so, it has examined some of the key challenges to realizing more effective traceability and traceability and where those solutions might lie, whether technological, political, social, economic, or a combination.

This chapter focuses on the three key challenge areas to more effective traceability and transparency identified throughout the report, with examples that show how innovation is developing in these areas. It is intended to illustrate the pace of innovation in this space and the capacity for innovative solutions to emerge from problems that might seem at any one point impossible or unthinkable, suggesting that the problem can also lie not in the technology but in the ambition or aspiration.

The three areas are

1. data quality within traceability systems;
2. information sharing, data "usability," and alignment; and
3. stakeholder engagement with traceability and transparency systems.

DATA QUALITY WITHIN TRACEABILITY SYSTEMS

"Availability and usability of data at the point of origin and/or production" looked at the many traceability and transparency initiatives, tools, and platforms that have developed to make available data relating to commodity production and associated forest loss at the point of commodity origin. It highlighted questions around the availability and quality of these data and how gaps in both can be a limit to stakeholders, particularly those further downstream, in making decisions on the actions they can take.

Innovation in this area of challenge includes work to fill data gaps through increases in capability of earth observation technologies (see "Increasing the capabilities of earth observation" below); efforts to strengthen data quality through greater verification on the ground (see "Innovation in approaches to harnessing smartphones and 'citizen power' toward greater traceability and transparency"); and the repurposing of existing technologies to provide alternative options for linking commodities at origin to the point of consumption (see "New methods to assess provenance").

Increasing the capabilities of earth observation

Earth observation (EO) enables near-real-time transparency of tree cover loss. Limitations remain on inferring the context for physical changes to land cover. Greater granularity of images and use of radar and laser imaging (Light Detection and Ranging; LiDAR) to overcome issues around cloud cover are some of the advances that continue to be made.

Addressing the limitations on physical information

- EO from public data sources can currently identify tree cover loss but struggles to accurately distinguish among types of forest (e.g., degraded, managed) and between natural grasslands and pastureland, for example. There are, however, commercial providers that offer proprietary data that can distinguish more successfully among these land cover types. EO satellite technology is better at identifying some commodities than others—for example, crops grown in agroforestry systems under shade trees are difficult to distinguish from other types of tree cover.
- Synthetic aperture radar is a type of active data collection whereby a sensor produces its own energy and then records the amount of that energy reflected back after interacting with the Earth, responsive to surface characteristics like structure and moisture. Unlike optical systems, it can work even where there is cloud cover.
- Efforts using artificial intelligence (AI) are underway to train AI models to distinguish natural from human-managed forest areas, including tree crops grown in monoculture plantations and mixed systems, using training data such as polygons of palm, cocoa, or coffee. Land cover and land use transitions can increasingly be tracked over time, for example, through the European Space Agency's land cover mapping[48] and Google's Dynamic World datasets.[49]

Data providers such as the University of Maryland, Land & Carbon Lab, Global Forest Watch, and individual companies providing satellite data are working on these issues to improve data quality and address limitations.

Some of these advancements are described in Box 10.

BOX 10 | Example of developing EO technology

Global Forest Watch is working to increase the spatial resolution of products available on its platform. The majority are currently available at 30 meters (m), but finer-resolution products such as RADD alerts, which are available at 10 m, allow smaller changes to tree cover to be picked up, which might have been missed in coarser products. New products such as information on natural ecosystems, a grasslands and pasturelands data layer, and a global primary forest layer (presently available only for the tropics) are in development and will strengthen the ability to answer more questions related to the conversion of natural forests/landscapes for commodity production. Currently, tree cover loss is available annually, but forest gain is available for only multiyear periods. Annual tree cover gain information (based on tree cover height) is also planned and will allow growth in tree crops and tree plantations to be captured. At the same time, developments in AI and machine learning are being explored that can fill other gaps such as producing better maps of forest type or new crop extent maps for key commodities. The aim of these data updates is to provide decision-makers with greater insights into forest change and drivers of change and to build scenarios for land use change including forecasting future forest loss.

Source: Goldman and Carter 2022.

Addressing the limitations of contextual information

- It is difficult to validate the cause of land conversion using EO, for example, whether the tree cover loss that occurred was natural or anthropogenic. In addition, forest definitions vary based on the political, social, and legal context.
- If the tree cover loss is due to human activity, in some cases it can be difficult to confirm the purpose of the land conversion using EO, or whether it was legal.
- Attribution of tree cover loss to a particular commodity is difficult because the initial conversion may be tied to one use and change over time. There may also be a time lag between conversion and planting, which takes time for EO to identify.
- EO data will in practice commonly require follow-up activities on the ground to validate findings.

These are important distinctions for decision-makers who need to rely on the data when developing appropriate solutions. Accurate information about what is driving forest loss in different regions is important for making informed responses, and can help hone forest governance in producing countries, inform legislation in consuming/importing countries, and aid companies in assessing the risk in their own supply chains. The roles of verification and ground truthing are explored in the next section.

Current research is working on obtaining greater accuracy for estimations of the drivers of deforestation, building on the ongoing monitoring of the state of global forests (FAO 2022a). For example, Pendrill et al. (2022) outline an assessment of the causes of observed forest loss in the tropics. They identify some major data gaps inhibiting the research on forest loss and commodity supply chains such as the varying quality and availability of data on deforestation over different regions in the tropics (especially in the dry tropics, and in Africa) as well as inadequate "coverage, quality, and frequency of data" (Pendrill et al. 2022, 12) on land use following deforestation.

Methods to assess legality are also under active research. For example, Transparency Pathway outlines an adaptable methodology to develop EO-based legality assessments of forest loss.[50] Filling these data gaps requires investment and involvement from various stakeholders, including governments, which are especially well-placed to contribute to data on legality and land use.

Innovation in approaches to harnessing smartphones and "citizen power" toward greater traceability and transparency

Ground truthing is a critical element of any traceability or transparency system in that it provides a reference for remote sensing–based systems and gathers additional information about the context or drivers of forest loss. This can help illuminate root causes and develop strategies to mitigate or avoid further loss. Ground truthing may, however, provide a much more immediate enforcement and transparency tool to identify, report, and act on illegality within commodity supply chains.

In the case of a platform developed by the Romanian government with charitable foundation Code4Nature,[51] innovation in the use of basic Android mobile phone technology has enabled and empowered ordinary citizens to identify and act on illegality, broadening the scale at which the traceability and transparency systems can operate, and widening the impact on illegal timber sourcing (described in more detail in Box 11). The lessons from this are now being applied elsewhere (e.g., in Gabon with timber tracing).

In another example, the University of Maryland's Global Land Analysis & Discovery Alerts (GLAD Alerts) within the Global Forest Watch (GFW) platform also enable near-real-time action to investigate potential deforestation incidences (Weisse and Pickens 2020) (see Box 12). The GFW Small Grants Fund provides financial and technical support to civil society organizations to most effectively use forest-monitoring technology, such as the GLAD Alerts, within their research, advocacy, and field work to catalyze action on the ground.[52]

The general increase in access to and use of smartphones has allowed some digital data-collection solutions to become more viable. For example, PemPem is an app-based marketplace for small-scale palm oil producers and traders that records transactions and can enhance traceability.[53] Likewise, Project TREE is a natural rubber traceability project involving app-based tracking of transactions through the network of intermediaries connecting rubber producers with processing factories.[54] Similarly, RubberWay, which can provide downstream companies with information about the impacts of the upstream supply chain, relies on web- or app-based questionnaire submissions from people at several stages of the supply chain.[55] Finally, the Cargill CocoaWise Portal creates a connection across the cocoa supply chain, sharing information such as the locations of cocoa farms; cocoa bag barcodes for traceability to origin; and weather, agronomy, and market access information to support farmers (Cargill 2020).

BOX 11 | Harnessing smartphones and citizen power to combat illegal logging in Romania

In 2016, the government of Romania, with the help of Romanian volunteers and the charitable foundation Code-4Nature, designed, built, and implemented a transparent public portal called the Forest Inspector for the country's national timber traceability system, SUMAL. The SUMAL system, in mandatory operation since 2014, requires all log and lumber transports to be registered prior to travel with an Android-based mobile application. This is Romania's first national traceability and transparency database for timber with public access.

The system also enables and encourages citizens to become part of the project through the development of a mobile phone app that makes it possible for citizens to assess the legality of timber transport vehicles in real time by checking the permits of individual logging vehicles using the vehicle registration plates. The app was downloaded by 30,000 people in the first 10 days of its launch. In the year that this public system was introduced, the number of transport permits being requested by the timber industry rose by 60 percent. The system remains in regular operation, and received a significant update in 2019 with the release of SUMAL 2.0, adding increased transparency including access to harvest permits and showing the full Global Positioning System (GPS) tracks of many timber transports.

Sources: EIA 2016; Gehl and Hagatis 2022.

The international NGO Environmental Investigation Agency (EIA) and the Code4Nature team have identified key enabling conditions that underpinned the success of this traceability and transparency system:

- The system is open to the public: This was important to activate/leverage the support and resources of citizens and enable scrutiny by civil society.
- Timing and political support: The Romanian environment minister who championed the Forest Inspector had experience working in Ghana on forest legality and so had both the experience and the impetus to act. The political support was considered critical.
- Public support: Wide-scale public concerns around the levels of illegality drove political support and citizen involvement. This is in part cultural and relating to the importance of forests to Romanian citizens.
- Publicity outside of Romania: International spotlight driven by EIA investigations preceding the inception of the Forest Inspector helped raise the profile within Romania.
- Workability: The project proved that transparency is possible.

New methods to assess provenance

Some of the challenges of traceability and transparency outlined in this report have already been a priority for other sectors. In the food industry, for example, methods such as stable isotope ratio analysis have been developed to verify claims relating to the provenance of a food product. Origin is often important because it carries characteristics that are integral to the value of the product (e.g., champagne from the Champagne region of France). This provides an opportunity to learn from and potentially repurpose some of these solutions toward the objective of halting and reversing forest loss.

In the timber industry, regulations in the EU, United States, and elsewhere in the last two decades have encouraged innovation in methods to verify origin claims to support risk assessments on the legality of timber sources. World Forest ID is an organization working to understand how these principles, and similar technology, can be applied to other commodity supply chains (e.g., soy) to support action to halt forest loss (see Box 13).

BOX 12 | Using EO to enable near-real-time action on the ground

Global Forest Watch's deforestation alerts provide information on forest disturbance in near real time. The suite of alerts[a]—integrated alerts, GLAD-L, GLAD-S2, and RADD—use imagery from NASA Landsat and ESA Copernicus satellites across the tropics, and powerful algorithms automatically identify areas where the forest canopy has been disturbed. Alerts are updated in near real time based on the revisit time of the satellites (5–12 days), although cloud cover can limit the availability of information in some cases. The purpose of the data is to alert people to potential deforestation. Natural disturbances and disturbances related to timber harvesting are also picked up by the alerts, so alerts should be checked (e.g., with high-resolution satellite images, and against contextual layers on primary forest information, or information on protected areas) to identify deforestation. This information of where new deforestation may be occurring allows law enforcement officers, local communities, advocacy organizations, and other responders to take targeted action. In the Peruvian Amazon, alerts are accessed in GFW's Forest Watcher app on smartphones by community forest monitors. Patrols are then organized using the alert locations, and on-the-ground evidence is gathered on illegal activities, such as expansion of commodity production into protected areas. Appropriate follow-up actions can then be agreed on by the communities based on this evidence. Communities that implemented this type of monitoring saw deforestation reduced by 52 percent in the first year and 21 percent in the second year.[b] This is just one example of many communities that are using the alerts and GFW's apps to protect their forests.[c]

Sources: a. Global Forest Watch, "Map," https://www.globalforestwatch.org/map. Technical information is available in the "Integrated deforestation alerts" layer; b. Shea 2023; c. Borcea 2023.

BOX 13 | New methods to strengthen assurance and identify potential fraud

World Forest ID

The methods currently used to verify where agricultural commodities come from are often vulnerable to fraud. World Forest ID is building a global geolocated collection of physical samples of forest risk commodities including timber that can be used to develop analytical reference data. It's also repurposing scientific techniques used to detect food fraud to allow for the scientific scrutiny of product origin claims. Science-based scrutiny of this sort is possible because plants have chemical, anatomical, and genetic features that change across landscapes, meaning that comparison with reference data developed at scale can be used to (in-) validate a declared location of harvest or origin, facilitating investigation and prosecution.

Further developments are underway to use the sample data collected in combination with publicly available datasets relating to climate, geology, and land use/land use change to scale the reference database and improve the level of granularity and statistical confidence that can be achieved when comparing chemical values for traded products against it.

This could provide a solution for users of products containing forest-risk commodities that require further assurance; for example, to verify a claim ("deforestation free") and/or to strengthen evidence of due diligence for market access. Enforcement authorities could also use this solution as an investigative tool. Evidence from similar initiatives within timber supply chains suggests that this approach can have a significant precautionary or deterrent effect in some market areas where reference datasets are sufficiently large.

Source: Saunders 2022.

INFORMATION SHARING, DATA USABILITY, AND ALIGNMENT

The examination of data needs and data availability supporting traceability and transparency in "Availability and usability of data at the point of origin and/or production" revealed that while gaps remain (illustrated in "Data quality within traceability systems" above, and further, below), the challenge is increasingly to ensure that data are accessible, usable (sometimes referred to colloquially as "decision-ready"), and comparable.

Innovations are developing in this area of challenge, including cloud-based data processing to make more readily available large datasets from which useful insights can be drawn for decision-makers (see "Cloud-based data compilation"); tools that aim to highlight risks of forest loss within global commodity supply chains and show the link to the point of consumption (see "Creating stronger linkages among commodity production, commodity flows, and end markets"); initiatives that use aligned data references and definitions to enable much greater transparency (see "Learning lessons from other sectors and other approaches: Trading standards"); and finally efforts to bring together and publish data at a national level necessitating solutions to core issues and sensitivities on data ownership, land ownership, tenure, and land rights (see "Transparency at a national level in consuming and producing markets").

Cloud-based data compilation

Processing ever-increasing quantities of data from various sources to produce actionable insights is both resource intensive and requires significant expertise, leading to large costs. Cost is a major barrier preventing existing data from being fully utilized. However, this barrier can be reduced by increasing access to datasets and processing power and reducing the level of expertise required to make use of them.

Work within Google Earth Engine[56] and Microsoft's Planetary Computer[57] is helping to solve this issue. By using vast computing power and coding expertise, these platforms are able to bring extremely large data together (drawn from satellite technology and other sources) and "clean up" and structure the data in a way that enables a much broader set

of stakeholders to find, access, and use them to gain insights that will help strengthen the facets of traceability and transparency discussed in this report.

These platforms can act as a catalyst to bring communities of information technology (IT)/data experts and environmentally concerned decision-makers together to develop bespoke solutions to serve their diverse needs—for example, to analyze, track, and monitor land use change, and consider new ways to combine these geospatial data with other datasets (such as Trase) to support traceability and transparency across entire supply chains—a whole systems approach.

Many commercial organizations already make use of the same datasets that feed into freely available platforms to develop proprietary software applications used by many stakeholders to inform their decisions. It is often the case that the software and processes behind proprietary applications may not be publicly available. There will need to be a balance struck between providing open data and providing the commercial incentive to use these data to develop innovative applications for the future.

Creating stronger linkages among commodity production, commodity flows, and end markets

Transparency across whole supply chains, linking together various company types and geographies, can be a powerful tool to hold stakeholders along the supply chains to account and to guide decision-making to the most appropriate points of intervention.

Trase and other platforms have created innovations in this space, compiling various datasets together that are largely already available, either publicly or for payment (e.g., customs data), and combining these data with modelling to reveal these linkages, focusing particularly on the middle part of the supply chain, from points of aggregation in producing countries to the points of import in consuming markets.

The most powerful innovation for the Trase platform going forward is likely to come from the further integration of traceability and transparency platforms, tools, and datasets, harnessing these combinations to bring more useful insights to decision-makers.

In practice, this could mean combining more powerful data from the production end of the supply chain as they become available (e.g., forest loss maps using satellite imagery with greater resolution and greater ability to discriminate among types of land cover and causes of land conversion) with more accurate spatial data maps for commodity production and expansion, and bringing these more refined insights to decision-makers in consuming markets. An additional innovation would be the integration of verifiable information disclosed by companies on their own supply chains to help users understand the connections between different actors and deforestation. In this sense, the direction of travel will come in the ability to combine these tools, platforms, and datasets in a package.

This will be made easier if supported by more aligned ways of working and facilitating data access by standardizing published data, as discussed in "Collaboration beyond individual supply chains." For example, the publication of a Universal Mill List for palm oil, using standardized naming conventions for mills, companies, and group names, has helped to more easily identify and cross-reference mills across various transparency platforms. In addition to improving compatibility and cross-referencing across platforms, the UML has resulted in many more companies adopting a common practice of publishing their supplier mill lists in the public domain—something that was not previously possible (Rainforest Alliance 2023).

The alignment of existing approaches, although perhaps technically difficult, can be more cost effective and faster than developing new collaborative systems. A study commissioned by the Global Platform for Sustainable Natural Rubber (GPSNR) (carried out by e-Audit Hong Kong) and published in 2021 (GPSNR 2021) found that technologies that existed at the time had the capabilities, when used together, to meet the traceability needs of the GPSNR. However, the study noted that collating these capabilities together into a single, central package/platform to be used by all members could potentially be too costly and time consuming to be worth pursuing for GPSNR members. Instead, the authors recommended a hybrid approach, whereby companies continue their own programs, but report certain agreed on monitoring and reporting data into a centralized data hub.

Learning lessons from other sectors and other approaches: Trading standards

Many problems faced in traceability and transparency for commodity supply chains have analogues from other sectors that can provide some inspiration on ways forward.

For example, within the global food industry, the Codex Alimentarius[58] provides a set of aligned internationally adopted minimum standards for food safety. The codex is managed by the Codex Alimentarius Commission, part of the joint FAO/World Health Organization (WHO) food standards program, which the FAO and WHO established in 1963.

The purpose of the codex is to protect consumer health, and guide and promote the elaboration and establishment of definitions and requirements for foods to assist in their harmonization, and in doing so facilitate international trade.

WWF has recently been assessing how a similar concept, the Codex Planetarius, could be applied to the trade in forest risk commodities, recognizing the same need and potential benefits that could accrue from a level playing field and aligned standards/definitions that would support, in the context of this report, greater traceability and transparency in these sectors (Taylor et al. 2021).

The principles of how this could work for pesticide and fertilizer use were explored in the December 2022 report *Core Environmental Standards for UK Imported Agri Food Products: Options for Pesticide and Fertiliser Use* (van der Ven et al. 2021).

Transparency at a national level in consuming and producing markets

For national governments, it can be a significant challenge to coordinate, compile, and integrate data on land use, using databases from local-, regional-, and national-level perspectives. Initiatives such as these can be very sensitive, going to the heart of land ownership, land tenure, and land rights, and raise issues of data ownership, both of proprietary systems and also data owned by national and other levels of local government.

The One Map initiative in Indonesia is an innovative approach that has the ambition of bringing together land use, land tenure, and other spatial data into a singular database for Indonesia, integrating data and maps from different levels of government (national, provincial, and district) as well as from the private sector.

Countries can also work to create a measure of their deforestation footprints at a national level and indicators for country-level action plans to address the need for integrated contextual data and to inform international relations in the context of their nationally determined contributions under the Paris Climate Agreement or potential. Examples of how France and the UK have approached this are explored below (see Boxes 14 and 15, respectively).

BOX 14 | Estimating a deforestation footprint to drive change in France

French Deforestation Indicator. In 2018, France adopted the National Strategy to Combat Imported Deforestation, aiming by 2030 to eliminate the import of unsustainable forest or agricultural products contributing to deforestation in the cocoa, rubber, soybean, palm oil, wood and wood-derived product, and beef and beef by-product sectors.

To support this ambition, the French government has developed a new tool, in collaboration with the Canopée association and Trase, combining soy trade data with satellite data characterizing the deforestation risk within each Brazilian municipality to provide an assessment of the risk of deforestation and conversion of Brazilian ecosystems associated with French soybean imports for each company that places soybeans on the market in France.

This provides, for the first time, an online public dashboard for soy actors (including downstream companies using soy in France) to assess the risks of deforestation linked to French soybean imports. This analysis shows that, within Brazil, 273 municipalities, representing 20 percent of soybean production, concentrate 91 percent of the risk of deforestation in imports to France. The dashboard offered by the tool is a resource available to public and private actors for analyzing the risks of deforestation in the soybean sector. It reflects an important methodological advance in the way the actors of a large supply chain can practically define a risk threshold.

This information will enable and support those companies in working together to support actions to promote sustainable soy production, for example, through the French Soy Manifesto, which is currently working with traders.

Sources: Trase 2022; Reboul et al. 2022.

BOX 15 | Estimating a deforestation footprint to drive change in the UK

UK National Consumption indicator. The UK government's own 25 Year Environment Plan was the starting point of this initiative: an ambition to reduce environmental impacts abroad from the UK's (domestic) consumption. The UK government needed an indicator framework to track progress, and out of this was developed a consumption footprint indicator and dashboard (https://commodityfootprints.earth/).

The Joint Nature Conservation Committee, Stockholm Environment Institute, and others have developed a consumption indicator for the UK (and many other consuming countries) with a dashboard that enables users to see, by commodity and country of production and consumption, a range of environmental impacts including deforestation (e.g., how much deforestation is caused by the UK's consumption of cattle-related products).

This indicator, in contrast to the French analysis in Box 13, uses MRIO (multi-regional input-output) modeling to model global trade flows representing the monetary inputs and outputs across countries/territories and their commercial sectors (e.g., oilseeds, cattle farming, paddy rice). The MRIO data used for this indicator are from EXIOBASE, although others can be used. This provides outputs on a sector basis (e.g., oilseeds), so a further step was taken to use FAO country-of-production data, which are hybridized with the MRIO data to provide datasets by commodity and by country of production and consumption.

This is innovative because it does the following:

- Provides a consumption-based dataset in a way that can be filtered by individual commodities and individual countries (of production and consumption), which is new (in the context of deforestation risk) even though the data already existed in the public domain
- Provides the data in a way that could be used by nonexperts, which means that they are accessible and interpretable

Challenges in developing the indicator and dashboard included ensuring alignment on definitions, ensuring usability given many caveats on the use of the data, and those associated with using modeling to address data gaps.

Data have been fed into the UK Biodiversity Indicators and reporting for the 25 Year Environment Plan. They have also been included in the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework as a component indicator against Target 16.

Source: Harris 2022.

INCREASING STAKEHOLDER ENGAGEMENT WITH TRACEABILITY AND TRANSPARENCY SYSTEMS

"Traceability and transparency through the supply chain" explored the complexity of global commodity supply chains and the challenges it presents to traceability. It can lead to a disconnect between commodity "users" (e.g., grocery retailers, food service companies)—which may as a consequence lack data or lack data in a usable format upon which to make decisions including on the appropriate interventions—and the commodity producers (e.g., smallholder farmers) who lack the incentives to change agricultural practices. Greater collaboration, a topic picked up in "Collaboration beyond individual supply chains," is impeded by this disconnect.

There are innovative solutions in development, such as those regarding the way data are gathered and analyzed and how insights are drawn from them that support more effective decision-making and design of interventions further down-

stream (see "Innovations to support downstream actors in complex multi-tiered supply chains") and those that enable technology to be used not only to provide traceability but also to pass on payments or other benefits that reward the efforts made by producers toward more sustainable production (see "Use of technologies by smallholders to capitalize on the demand for sustainable commodity production").

Innovations to support downstream actors in complex multi-tiered supply chains

Retailers and food service and other companies may be driving the demand for commodities such as soy and palm oil but are often far removed from their points of origin and the contexts in which they are produced. In this situation, traceability systems may currently provide some information on origin, but do not necessarily share the insights necessary to understand these complexities at source, nor to guide the development of strategies to support change, manage risk, and provide reassurance to final consumers, investors, or regulators. It is these "actionable insights" that many companies are seeking, and that may involve a range of expertise that consumer-facing organizations do not routinely employ within their organizations.

Without these more nuanced and informed views, companies may seek to manage deforestation risks within their supply chains by avoiding this risk, seeking alternative sources or alternative ingredients. This has occurred in palm oil and beef, with a growing movement to avoid the use of beef from Brazil.

Innovation that brings together a range of tools and technologies (such as product tracking and geospatial data on deforestation risk) with expert interpretation and analysis can help support companies by providing actionable, decision-ready information, and the ability to support claims on public commitments.

Use of technologies by smallholders to capitalize on the demand for sustainable commodity production

Technology is increasingly used to improve traceability in commodity supply chains, and to communicate the associated level of environmental and social risk at origin. There are innovations that take this a step further, such as Taking Root, that use this technology to pass on payments or other benefits that reward the efforts made by producers toward more sustainable production (see Box 17).

BOX 16 | ForestMind

ForestMind aims to help food retailers and manufacturers in consuming countries understand and act on products in their supply chains that may be linked to forest loss. This project will combine earth observation data with isotopic analysis to understand where company supplies come from, and the levels and risks of forest loss there.

In addition to drawing on diverse data sources, the project also relies on human expertise from a collection of backgrounds, representing industry, academia, NGOs, and agro-data and economics consultancies.

It aims to develop a set of tools to assist companies, drawing on expertise in artificial intelligence, economics, traceability, enforcement, and sustainability.

ForestMind is funded by the European Space Agency and the UK Space Agency and was initiated on the request of the UK food industry. The provision of public funds to meet a demand set by industry, and the process of co-designing it with its future users, has created an innovative forum for these technical disciplines to focus on addressing the specific needs and the role of companies in consuming countries in commodity-driven forest loss.

Sources: See the pages on the website of Satellite Applications Catapult and the ESA for more information: https://sa.catapult.org.uk/projects/forestmind/; https://business.esa.int/projects/forestmind.

BOX 17 | Taking Root's technology platform

Taking Root is an organization helping smallholders improve their access to the global carbon market. It developed a new platform that combines data generated through the use of smartphones, satellite imagery, and machine learning to monitor and verify carbon stocks and sequestration. The platform also gives participating farmers access to guidance on practices to reduce carbon emissions, which can increase carbon-based income and ensure that practices are diversified and resilient to rising temperatures.

Forest data and information on farming practices produced using this technology can be made available to downstream companies. The technology is particularly innovative as the platform does not require specialist geospatial software, and some on-the-ground elements can be completed with a smartphone without in-depth technical training. Farms are mapped using the software by walking their perimeter with a GPS-tracking smartphone, creating a polygon. Sample tree measurements are then recorded in the app, and this is extrapolated to create the total tree coverage and an estimate of carbon being stored on the farm. Data can then be used to inform the processing of satellite imagery using machine learning to track changes in vegetation, and therefore carbon stock. This combination of smartphone-based ground truthing with satellite imagery allows the automated monitoring of thousands of locations.

Sources: Sheldon 2020; Warner 2021.

Finally, there were two areas that were investigated in this research as potential gaps about which no new significant innovations were found.

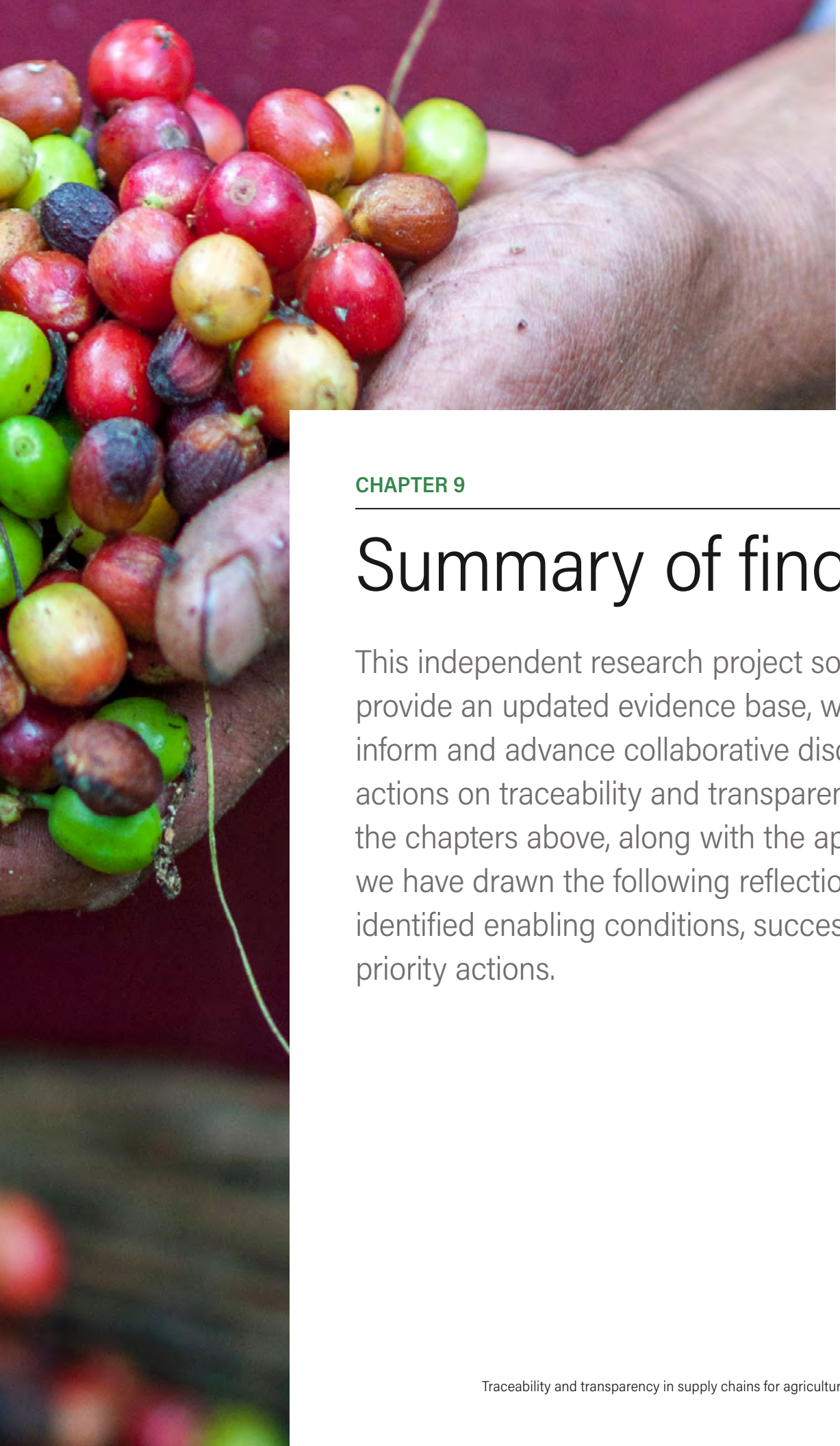
- Sensitivities around commercial data, such as information on supplier relationships, or personal data in the case of smallholders, often prevent the sharing of information by stakeholders and raise important questions about ownership and benefit sharing. These are valid concerns that are hard to overcome. There is much to learn from other sectors that have managed to reap large returns from sharing large, sensitive datasets. For example, medicine and banking invest huge amounts in anonymization, and are able to develop powerful insights from individuals' data without threatening their privacy.
- End consumers and product labeling are often spoken of as important drivers of change and promoters of sustainability in commodity markets and supply chains. This research investigated whether there were innovations in traceability connecting farmers with consumers and explored some examples (see Appendix B in relation to cattle supply chains). However, we did not find new projects with tangible, scalable impacts (beyond established certification schemes and smaller-scale projects) to empower customers to drive more sustainable action through purchasing power.

LESSONS

This research has surveyed several ongoing, innovative projects that are reducing barriers. These projects not only focus on generating new data to fill gaps, but also seek to make existing datasets more available and usable to a wider audience, as well as encourage more stakeholders to use traceability and transparency systems.

As seen in the global mapping, insights on supply chains have financial value and there is a growing industry in marketing insights. In some ways the innovations above are efforts to make insights more accessible and available to more stakeholders. Addressing these gaps so that all stakeholders can make properly informed decisions and maximize their impact in preventing forest loss requires significant, continued investment. Governments, as well as larger companies, are particularly well placed to provide that investment and/or take part in the development of standards and other systems that promote greater alignment and enable greater traceability and transparency that in turn can more effectively support actions to halt forest loss. However, in the long term, an equitable and sustainable solution to sharing the additional costs created is a key precondition to broad application of traceability and transparency.

The examples above illustrate the significant potential for innovation to deliver solutions to many of the major barriers to effective traceability and transparency, whether innovation in technology, in ways of working, or in harnessing what we already know to better effect. The limitations are often ones of aspiration and ambition.



CHAPTER 9

Summary of findings

This independent research project sought to provide an updated evidence base, which can inform and advance collaborative discussions and actions on traceability and transparency. From the chapters above, along with the appendices, we have drawn the following reflections and identified enabling conditions, success factors, and priority actions.

"Results from a global mapping of traceability and transparency tools and initiatives" illustrates the diversity of technologies, stakeholder types, funders, and users involved in traceability and transparency systems and the wealth of tools and systems now available. These tools have developed in line with the changing demands of users, prioritizing commodities of current concern, but evolve over time as technology advances.

Of those tools and initiatives that share information, almost a third do not create data, the majority combining, processing, and sharing preexisting publicly available data to generate new insights. Forty-seven percent of surveyed tools release data or process insights for free but many share this only with their members (18 percent) or for a fee (35 percent).

The level of transparency of information correlates with the funding and governance models of the tools and initiatives—in the mapping survey, tools and initiatives that disclose more information publicly tend to be led by civil society and funded by governments or philanthropy.

"Availability and usability of data at the point of origin and/or production" examines the traceability and transparency tools and initiatives developed to collate and make available data from commodity origin in an accessible and usable format. Much of these data are already available in the public domain, although the exact data landscape and ecosystem varies across countries and regions. Data availability has been the focus of a technological revolution in the development of tools, platforms, and systems that can process them and make them available in a way that can be better used by decision-makers further downstream.

Ensuring that a productive open data ecosystem develops that can reduce the burden of data collection and maximize accessibility, uptake, and use of these tools and the insights they can provide remains a challenge.

"Traceability and transparency through the supply chain" describes the challenges of establishing traceability and transparency systems within complex global commodity supply chains. Leading companies have shown that traceability to origin is achievable but that it can be time and resource intensive where supply chains include third parties or indirect suppliers and many smallholder farmers.

Systems to verify and validate the credibility of data are evolving, through companies' own systems and third-party voluntary certification systems. Increasingly, companies have been working together to develop solutions on assurance in a precompetitive space, in which trust among actors can be built to facilitate data sharing.

An equitable and feasible solution has to be found to the question of who will bear the costs of the transition to sustainable commodity production or greater traceability and transparency within supply chains. Governments are playing an important enabling role: through evolving mandated requirements for company disclosure, and through the application of mandatory national-level standards and mechanisms of assurance in countries of origin, raising the bar across whole commodity sectors.

"Collaboration beyond individual supply chains" demonstrates that to create market change, collaboration is key. Collaboration builds trust and communication across all stakeholders in the supply chain, sector, or landscape, which in turn builds momentum to shift a whole sector or market. Traceability and transparency systems can be time and resource intensive to implement, and the risk of duplication can be reduced when working together. The rapid growth in tools risks confusion among users if different tools are duplicating efforts and following different protocols.

There is a growing request for consistency and alignment from those using data (e.g., end users) and those providing data (e.g., producers). Collaboration among companies, governments, consumers, financial institutions, and civil society can, if the necessary investment is made, provide the basis for traceability and transparency solutions that go beyond individual supply chains to cover sector-wide or jurisdictional or national approaches, including aligned requirements for producers.

"The role of public reporting and disclosure" describes how reporting on carbon and supply chain forest loss impacts are increasingly shifting from a voluntary to a mandatory footing. However, most companies still do not have commitments in place, or are not monitoring their progress toward those commitments. Governments and other public sector actors are also facing pressures to report publicly on their own footprints including on the GHG emissions and land use change associated with their national consumption of commodities and products.

Aligned standards for data publication have been shown to be a key enabler to greater disclosure and greater transparency by building trust, credibility, and accountability. Government-mandated disclosure requirements will be essential to creating incentives for companies to disclose and create a level playing field when they do.

"Innovation and direction of travel of technological applications for traceability and transparency" outlines current innovations in tools and technology that are filling known data and functionality gaps that can support more effective traceability and transparency. Energies are focused on providing better *quality* information; making relevant datasets more *accessible*, *usable,* and *complementary*; and increasing *engagement* across supply chains. This is a dynamic space in which solutions, although perhaps not yet envisaged, will evolve to meet the need.

Government funding agencies and philanthropies should coordinate on funding priorities to ensure that the highest-need gaps and limitations are addressed. This includes more work on mapping and modeling commodity crop extent and responding to technical limitations, as well as investing in processes supporting alignment and collective action projects. Finding an equitable solution to absorbing the additional costs created by traceability and transparency should be a priority for government dialogue but complex and varied contexts in different countries require differentiated approaches.

ENABLING CONDITIONS AND SUCCESS FACTORS

Enabling conditions influence the operating environment for traceability and transparency initiatives and can affect their success and sustainability. These enabling conditions often reflect the local context. This report draws out the following enabling conditions for traceability and transparency:

1. **The ownership structure and funding model of tools and initiatives enable access.**

The ownership structure of tools and initiatives can determine the data architecture and therefore in many cases who has access to data and information. While some systems are internal to one actor, many tools and initiatives aiming for broad use must allow all stakeholders (including smallholders) to access, interpret, and use the data. **Funding models** affect the ownership structure and should incorporate plans for maintenance and updates of tools and initiatives to ensure sustainability.

2. **A supportive regulatory environment requires transparency on commodity production (e.g., including due diligence requirements and mandatory national or jurisdictional standards, reporting standards, and assurance mechanisms).**

The **regulatory environment** affects the demands for traceability and transparency that are placed on supply chain actors. Governments play an essential role in creating a **supportive and enabling regulatory environment**, in both the domestic markets of producing countries and in import markets. Governments can work toward formalizing commodity sectors and ensuring that producers and traders are registered. Governments should also ensure that oversight and enforcement mechanisms are adequately resourced and given the necessary competencies.

In import markets, **governments can require mandatory regulations on agricultural and forest commodities**, thereby creating demand for traceability and transparency during procurement. In producing countries, governments can create legal requirements for **national standards and assurance mechanisms** for commodity production. Multiple countries and subnational jurisdictions have already set up such systems for timber and palm oil, which can lead to broad-scale application of minimum requirements. Other countries **mandate registration of farms and other properties in rural areas**, which facilitates monitoring of compliance with standards and commitments.

Governments can also mandate disclosure and define the parameters for reporting to lead to broad uptake of consistent reporting frameworks. Governments can set up digital systems for reporting to capture information from different sources and different actors in a consistent format in one system or design approaches that allow for interoperability across existing systems.

Governments are key actors for providing data and making information available to support greater traceability and transparency. Official public sector datasets play an important role in enabling traceability and transparency on land use, land use change, rural property registration, land titling, and trade.

3. **Coordination and collaboration based on shared goals and trust among actors enable precompetitive fora for data sharing and avoid duplication of efforts.**

Coordination and collective action create efficiencies in traceability and transparency efforts, especially where companies share the same supply base. Coordination saves supply chain actors time and money and avoids duplication of efforts, leading to greater consistency across datasets.

For traceability and transparency to reach broad acceptance, **agreement across the commodity sector on shared goals and purpose** can be important. Shared goals encourage greater transparency by assuring companies that others (including competitors) are also reporting in the same way.

Trust among actors is a key precondition to sharing data and addressing challenges, including cost distribution, commercial sensitivities, data confidentiality, and technical obstacles. Confidentiality and competition rules can often hinder data sharing along or across a supply chain. **Establishing precompetitive fora** can enable collaborative discussions but requires investments of time and resources.

4. **There must be agreement upon equitable sharing of costs to set up, maintain, and verify traceability systems and data collection.**

Agreement across the sector is needed on how the **cost of transitioning to sustainable commodity production should be shared**, without creating inequities and leading to the exclusion of vulnerable actors such as smallholders. These include additional costs for farmers, and added costs to set up, maintain, and verify traceability systems and data collection.

All actors in the supply chain should be incentivized to share data through clear communication of the costs and benefits of traceability and transparency to supply chain actors. **Cost or resource constraints** should not prevent actors/users from accessing tools and platforms.

5. **Clear frameworks and rules for consistent data collection and reporting across sectors, commodities, and geographies enable broad uptake and reduce cost.**

There needs to be a **clear and agreed upon framework of the "rules"** to ensure **consistent and transparent data collection** along supply chains and at points of production, using definitions and standards that have been agreed upon.

Consistent reporting standards, including definitions and means of assurance, ensure comparability. Standard-setting and disclosure bodies, such as the AFi and CDP, are pursuing alignment to streamline requests for disclosure and enable comparability among reports.

6. **Datasets should be user friendly and interoperable, and enable target audiences to act upon information.**

Data must be usable, enabling stakeholders to implement and act upon information. Providing data is not sufficient. Users must be able to access and interpret data in a format that makes it possible to draw conclusions. This can mean, for example, that analysis and reporting functions are built for raw datasets, or that user interfaces are created to provide analysis results.

Interoperability of datasets allows different datasets to be used together. No single dataset can provide a full picture of the situation at origin. Solutions to support making data available in a useful format will require **innovations in the way datasets across supply chains can be linked, and the way data can be presented.**

7. **Continued technical innovation improves the quality and usability of information and closes data gaps.**

Technical advances improve the quality and usability of data and close data gaps, for example, by enabling better distinctions among natural and planted forests, managed grassland, and pastures.

Establishing precompetitive fora can enable collaborative discussions but requires investments of time and resources.

SUCCESS FACTORS

In addition to enabling conditions, which determine the framework within which tools and initiatives operate, the research identified specific success factors in traceability and transparency systems. Table 15 summarizes these success factors.

1. **Initiatives are built from successful pilots.** Building on pilot projects and successful approaches by expanding their scopes has been a successful strategy, for example, in Bunge's Sustainable Partnership program.
2. **Clear scope and corresponding metrics of success enable targeted initiatives that can be evaluated.** This success factor was critical, for example, for creating a tool that can undergo a rigorous evaluation, such as Global Forest Watch, as well as for achieving progress with the Amazon Soy Moratorium.
3. **Internal or external verification and audit processes** assess the validity of reported data and build data credibility. The key importance of external verification became apparent, for example, through third-party auditing in GAR's smallholder mapping via agents with Geotraceability and Koltiva, and also in the Protocol for Sustainable Production of Calves, the Amazon Soy Moratorium, Green Protocol of Grains of Pará, and the Aquaculture Dialogue on Sustainable Soy Sourcing from Brazil.
4. **Shared definitions, metrics, scopes, and reporting mechanisms** are required to make disclosures comparable and to assess progress. Shared definitions have received much attention, for example, in the UK Soy Traceability Platform, Risk-Calibrated Approach Traceability to Plantation (RCA-TTP) Portal, Implementation Reporting Framework, AFi, and CDP.
5. **Safeguards for sharing data effectively protect sensitive information.** Where sensitivities restrict actors' willingness to disclose data, personal and commercially sensitive data can be protected while the information required to support compliance monitoring can still be shared. Such safeguards are available, for example, in the Selo Verde program.

PRIORITY ACTIONS

Based on the research conducted, this report draws out the following priority actions, categorized by actor group and topic, in Table 16.

TABLE 15 | Success factors identified in tools and initiatives

SUCCESS FACTOR	DESCRIPTION	EXAMPLES
Scaling up and replicating pilots	Building on pilot projects and successful approaches by expanding their scopes enhances likelihood for success	Bunge's Sustainable Partnership program
Clear objective and scope	Clear scope and corresponding metrics of success enable targeted initiatives that can be evaluated	Global Forest Watch Amazon Soy Moratorium
Investment in relationships to build trust	Building trust through in-person engagement leads to higher uptake of tools among intermediaries as well as farmers, and facilitates data sharing	GAR's smallholder mapping via agents with Geotraceability and Koltiva Sustainable Production of Calves Program
Assurance mechanisms provide credibility	Internal or external verification and audit processes assess the validity of reported data and build data credibility	Amazon Soy Moratorium, Green Protocol of Grains of Pará, Aquaculture Dialogue on Sustainable Soy Sourcing from Brazil via third-party auditing

TABLE 15 | Success factors identified in tools and initiatives (cont.)

SUCCESS FACTOR	DESCRIPTION	EXAMPLES
Consistent definitions and reporting frameworks	Shared definitions, metrics, scopes, and reporting mechanisms are required to make disclosures comparable and to assess progress	UK Soy Traceability Platform, Risk-Calibrated Approach Traceability to Plantation (RCA-TTP) Portal, Implementation Reporting Framework, AFi, and CDP
Safeguards for sharing data	Where sensitivities restrict actors' willingness to disclose data, personal and commercially sensitive data can be protected while the information required to support compliance monitoring can still be shared	Selo Verde
Collaboration and collective action	Collaborating across industry groups helps these groups engage with suppliers, including smallholders, indirect suppliers, and traders; broaden the reach of initiatives; and reduce duplication of efforts	The RCA-TTP Portal is a good example of collaboration across industry groups.
Public-private partnerships	Collaboration among government agencies, the private sector, and civil society can facilitate data sharing under agreed upon conditions, target government funding to areas of highest priority, and reduce duplication of efforts	Cocoa and Forests Initiative, Amazon Soy Moratorium, Green Protocol of Grains of Pará

Source: Compilation by authors.

TABLE 16 | Priority actions by actor group and topic

	COMPANIES INVOLVED IN SUPPLY CHAINS	FUNDERS (GOVERNMENTS, PHILANTHROPIES)	PRODUCING AND CONSUMING GOVERNMENTS	CIVIL SOCIETY, RESEARCHERS
Traceability and transparency systems and tools	Ensure access to tools and platforms is not limited by cost exclusion and that suitable safeguards are in place to manage data privacy issues in a way that encourages data sharing Pursue monitoring of not just direct but indirect supply	Undertake investments in rigorous impact evaluation of traceability and transparency tools to provide further evidence for the link among data; delivery mechanisms; and outcomes for forests, carbon sequestration, and other natural resources Include requirements for accessibility in funding models, which tend to determine the transparency levels of different tools	Ensure access to tools and platforms is not limited by cost exclusion and that suitable safeguards are in place to manage data privacy issues in a way that encourages data sharing	Continue to work toward the development of technological solutions that can integrate datasets, tools, and systems to bring action-oriented information to all decision-makers Ensure access to tools and platforms is not limited by cost exclusion and that suitable safeguards are in place to manage data privacy issues in a way that encourages data sharing
Data and information	Work toward greater public disclosure in general, and aligned standards for data disclosure and publication, a key enabler of greater disclosure and transparency	Prioritize coordinated and integrated approaches, including on linkages among data initiatives	Provide data to create the enabling conditions for effective traceability and transparency systems, and to deliver on their national policies and priorities	Leverage innovation to facilitate data sharing while protecting commercially sensitive data Learn lessons from other sectors (e.g., medicine and banking) and across sectors

TABLE 16 | Priority actions by actor group and topic (cont.)

	COMPANIES INVOLVED IN SUPPLY CHAINS	FUNDERS (GOVERNMENTS, PHILANTHROPIES)	PRODUCING AND CONSUMING GOVERNMENTS	CIVIL SOCIETY, RESEARCHERS
Policy response	Support greater consistency in the objectives of traceability and transparency systems in policy responses (e.g., in what information is required, definitions, reporting formats, and requirements for credible evidence)	Support producers in meeting policy requirements and enforcement in place through targeted funding	Support greater consistency in the objectives of traceability and transparency systems in policy responses (e.g., in information and evidence requirements, definitions, reporting formats) Provide capacity development support to enable setting up and rolling out systems for traceability and transparency	Support greater consistency in the objectives of traceability and transparency systems in policy responses (e.g., in what information is required, definitions, reporting formats, and requirements for credible evidence)
Setting standards and commitments	Ensure coherence and alignment in commitments and actions to mitigate climate change and halt forest loss in mutually supportive and reinforcing initiatives	Prioritize funding for initiatives that are aligning and collaborating with existing stakeholders and ongoing efforts, particularly those including smallholders	Raise standards of commodity production through national-level assurance systems on legality and sustainable production of commodities—this will also help support smallholder access to international markets Provide a clear market signal in both the consuming and producing markets by setting up national-level standards, based on the objectives for improved traceability and transparency specific to each country	Support and promote ongoing efforts to align and collaborate with existing stakeholders and initiatives, particularly those including smallholders
Smallholder inclusion	Assess the specific challenges facing smallholders and small-scale producers and companies in commodity supply chains and take measures to address these challenges (e.g., cocoa and the CFI), including exploring compensation mechanisms	Resource initiatives and programs focused on including vulnerable actors	Set up support programs to ensure smallholders are not excluded from markets	Assess the specific challenges facing smallholders and small-scale producers and companies in commodity supply chains, and take measures to address these challenges (e.g., cocoa and the CFI)

Source: Compilation by authors.

Appendices

APPENDIX A. GLOBAL MAPPING SURVEY RESULTS

This appendix contains an overview of results from our survey of tools, platforms, projects, initiatives, and organizations (hereby referred to as tools/initiatives) carried out as part of the global mapping in this research. It supplements and supports "Results from a global mapping of traceability and transparency tools and initiatives" in the main report, and contains examples of surveyed tools/initiatives and how we categorized them.

Note: Throughout this research, we categorized tools and initiatives, and in many cases, tools and initiatives could fit into more than one category. As a result, it is common for percentages in a chart to sum to more than 100 percent.

Mapping overview: What did the research look at?

This research sought to understand the role of traceability and transparency tools and initiatives in global efforts to reduce forest loss related to agricultural and forest commodities. As part of this, we carried out a survey of 93 tools, platforms, projects, initiatives, and organizations involved in the generation and dissemination of information relevant to the production and trade of commodities and/or their relationship with forest loss. This survey sought to explore questions such as the following: Whom are these tools/initiatives built for? Who built them? What do they do as part of a wider whole system assessment?

The survey process consisted of two activities: drawing up a list of tools/initiatives to review and then gathering information about these tools/initiatives. The core part of carrying out these activities consisted of two main research arms:

- The survey list started with a broad literature review and case study research, compiling tools, platforms, and initiatives that were mentioned as significant in reports or in other literature. For example, many reports have been written on traceability and/or transparency for specific regions or commodities and include overviews of significant tools/initiatives (e.g., IDH et al. 2021b).
- We expanded this list during stakeholder interviews, as interviewees mentioned tools or initiatives that they had used or been involved with or that they thought were promising or worth looking at in our research.

We gathered information about tools/initiatives, which we supplemented and cross-checked with further desk-based research, such as by checking project websites to get more comprehensive information, references to tools/initiatives in reports, and company websites/sustainability pages/reports. We also did internet searches on areas that lacked coverage and reviewed media and NGO reports that mentioned certain programs, projects, or tools. This process of gathering information led to our identifying additional tools/platforms, so we expanded the survey as the research progressed; however, the core of the list is based on a literature review and interviews.

The scope of this project is broad, covering various commodities with different physical and economic traits, across a global range of diverse cultural, political, and legal contexts. This research covered efforts to develop different ways to generate and use data to inform decisions and drew on a wide range of tools/platforms. As a consequence, the criteria for inclusion in the survey were broad (i.e., could this tool/initiative be used by an interested stakeholder to improve their understanding of forest loss associated with agricultural and forest commodities and/or their role in it?), and the categories used to sort and analyze the different tools/initiatives are quite general to encapsulate the various ways that tools function and are used. The process of categorization and analysis is explained below, and a full overview of surveyed tools/initiatives is included in Table A-1 at the end of this appendix.

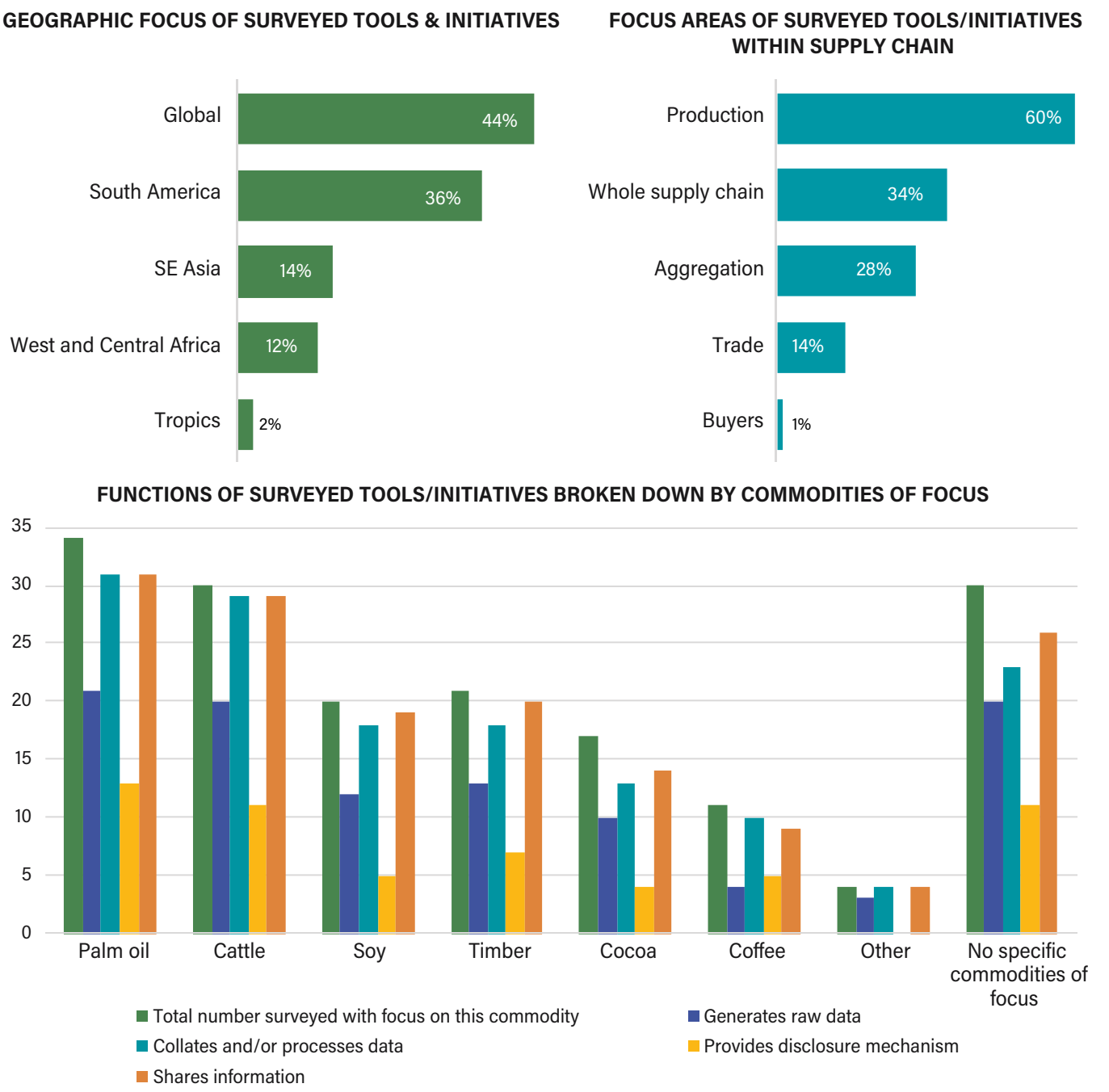
The first area of analysis looked at the following (and the results are summarized in Figure A-1):

- The commodity coverage of tools/initiatives across the range of commodities within the scope of this research
- The geographical coverage across the three key regions (West and Central Africa, Southeast Asia, and South America), the focus of the report since the majority of tropical forests are located in these regions
- The part of the supply chain on which these tools/initiatives focused; a categorization of "production," "aggregation," and "trade," defined below, was used to break down tools/initiatives into supply chain stages (as well as "buyers" for initiatives focused almost entirely within consuming countries)
  - Production: Focus is on farmers, plantations, and/or the forests around them
  - Aggregation: Focus is on the part of the supply chain where commodities are traded and transported within producing countries, before being exported or transformed into consumer products
  - Trade: Focus is on international trade and/or large international trading companies
  - Buyers: Focus is on those actors in the supply chain that sell directly to end consumers

Key findings

- Palm oil, soy, cattle, timber, and cocoa were most commonly featured in the survey—this may reflect governments and civil society focusing on these key commodities in recent years
- Many tools and initiatives were relevant to or usable in West and Central Africa, South America, and Southeast Asia, but had a global focus
- The two most-represented groups in terms of supply chain coverage focused either on the production end of the supply chain or the whole supply chain; very few focused purely on producing or disseminating information relevant only to buyers (i.e., those toward the bottom of a supply chain that do not resell a commodity, like a consumer or food manufacturer)

FIGURE A-1 | Coverage of global mapping survey



Note: The figure at the top shows the geographic focus areas of surveyed tools and initiatives. The figure on the bottom shows the focus areas of surveyed tools/initiatives within a supply chain; This figure shows the functions of the surveyed tools/initiatives broken down by commodity of focus; Many tools/initiatives focus on more than one commodity. Those tools/initiatives that do not focus on any specific commodities are often platforms to generate or share information about the locations and rates of forest loss, regardless of the driver (e.g., Global Forest Watch). An example of an initiative that focuses on the aggregation stage of the supply chain would be the collaborative work to create a standardized Universal Mill List, with common identification across stakeholders, for palm oil mills.

Source: Analysis by authors.

Mapping results: Function of tools and initiatives

We initially categorized tools/initiatives at a high level according to what they do with information to produce or disseminate outputs that can inform decision-makers, summarized in Figure A-2:

- **Generate** data about production circumstances or trade flows of commodities
- **Gather** and/or process data into more easily accessible or decision-ready information for different audiences
- **Disclose**—this tool/initiative gives a template for stakeholders to disclose their private information
- **Share**—this tool or initiative can be used as an information source for interested stakeholders

Example of high-level classification

Trase: Generates spatial datasets about land use for different commodities drawn from satellite imagery platforms; processes existing customs data into insights on trade flows; shares information through reports and an online platform; does not have a disclosure mechanism

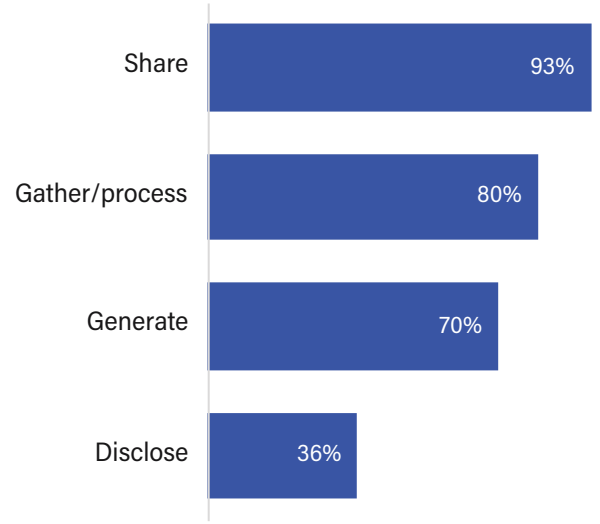
Soy Transparency Coalition: Provides disclosure mechanism for soy traders through a questionnaire approach, sharing aggregated data from responses in a public report and full responses internally with coalition members; processes data from traders rather than generating raw data

Key findings

Note: Many tools/initiatives carried out more than one function, as described in the examples on the previous page.

- The vast majority of tools/initiatives share information that they produce. Information is shared with varying degrees of transparency, as discussed on subsequent pages.
- Those tools/initiatives that do not directly share information are often frameworks to guide stakeholders in generating or sharing their own information (e.g., the Global Reporting Initiative).
- A slightly greater proportion of tools/initiatives in the sample gather and process existing data rather than generating new data.
- A low proportion of tools/initiatives facilitate the sharing of information by third parties by providing disclosure mechanisms.

FIGURE A-2 | What did the different tools and initiatives do?



Source: Analysis by authors.

Mapping results: Data generation and processing

Data generation and processing

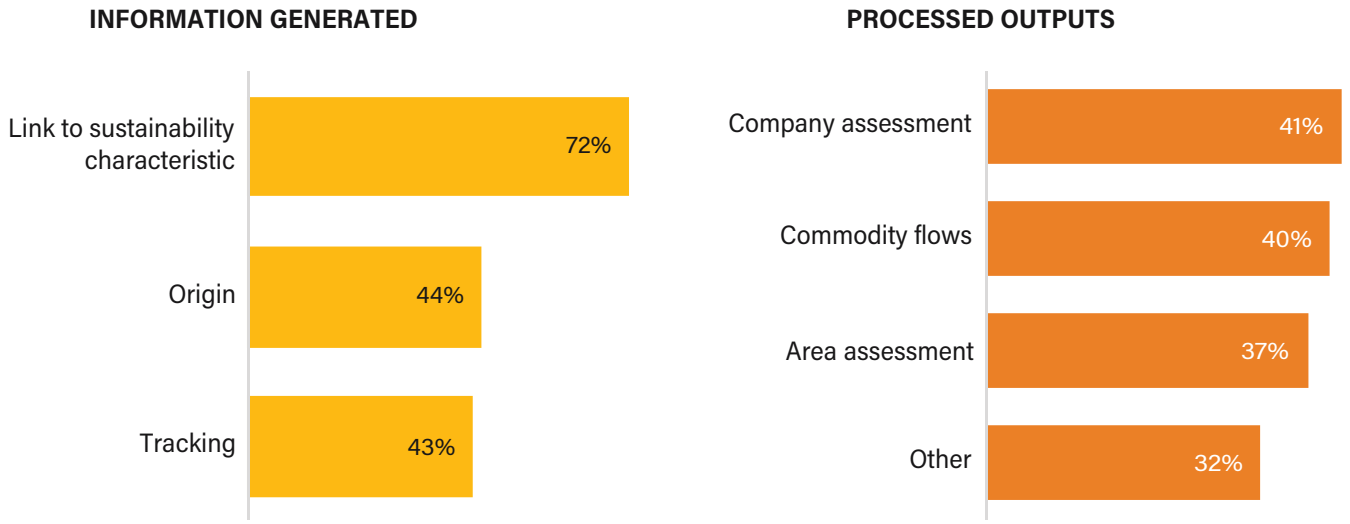
Generated raw data were further categorized into the following:

- Origins—information linking a unit of commodity to a specific production site
- Tracking a unit or flows of commodities through supply chains
- Linking commodities or actors with key sustainability characteristics

Processed outputs were categorized where possible into the following:

- Company assessments—evaluating the behaviors of companies
- Commodity flows—deducing or inferring flows of commodities from other data sources
- Area assessments—identifying the geographical regions where agricultural and forest supply chains are associated with forest loss

FIGURE A-3 | What types of information are being generated (left)? What outputs are collated data being processed into (right)?



Notes: "Other" outputs include information on changing land use that isn't directly focused on tracking forest loss (e.g., Indonesia's government-produced One Map), comprehensive guidance on supply chain management (e.g., Accountability Framework initiative guidance), and the collating and republishing of diverse information with minimal further processing.

Source: Analysis by authors.

Key findings

- Over 70 percent of the tools/initiatives surveyed that generate data aim to track the sustainability impacts of commodities at the location of production.
- Eighty-one percent of tools/initiatives produce outputs corresponding to at least one of the above three main categories (company assessments, commodity flows, or area assessments).
- Additionally, of the tools/initiatives that generate data on a link to sustainability, 66 percent draw from satellite imagery. While there is still a significant role for ground-based professional forest monitoring, especially in calibrating the outputs of satellite imagery–based computer models, some tools/initiatives draw on crowdsourcing through apps.
- Of those tools/initiatives that share data, about 26 percent do not generate any raw data, deriving their outputs wholly from existing datasets.

Data generation and processed outputs by funding source and governance type

To examine which stakeholder types are driving the outputs of tools/initiatives, we gathered information on the prime funding sources and governance structures for each tool/initiative. Funding sources were categorized into the following:

- Government aid/development banks
- Government departments (i.e., the government of the country in which the tool/initiative is operating, such as a department of agriculture, as opposed to foreign aid)
- Industry—generally a coalition of private sector organizations
- Clients/customers (e.g., through service fees or by charging for access to data or for membership)
- Philanthropy/corporate social responsibility
- NGOs, which may themselves have diverse funding sources, including any of the above and/or individual member donations

Governance structures are diverse, ranging from apps developed for use by individuals to global multistakeholder initiatives. As a consequence, we used the following broad categorizations:

- Private sector led (e.g., Palm Oil Collaboration Group)
- Public sector led (e.g., Timber Legality Assurance System)
- Civil society led (e.g., the WWF commodity scorecards)
- Multistakeholder (e.g., Africa Palm Oil Initiative)
- Private company (e.g., private consultancies like Satelligence or Starling)

The breakdown of these groups in the whole sample is shown in Figure A-4.

The funding sources and governance structures of tools/initiatives in the sample that generate data are shown in Figure A-5.

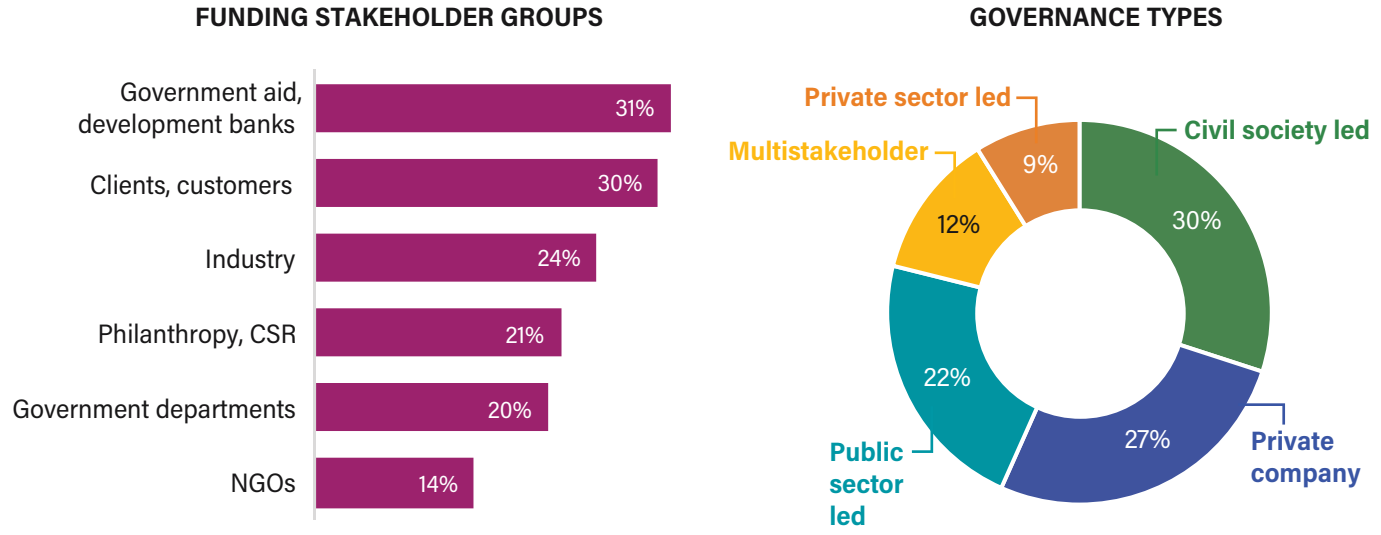
Examples:

- Multiple private companies offer full supply-chain mapping and risk assessment services including **Optel**, which could involve generating data from satellite imaging.
- A public sector–led tool to track commodity flows is **MSPO Trace**, the chain-of-custody system for government-led Malaysian Sustainable Palm Oil Certification.
- Many civil society organizations seek to monitor and map incidents of forest loss, such as **ForestLink**, a platform combining satellite imagery with inputs from local communities.

Key findings

- We found that many funder types invest in the generation of all three types of information output described above. There was slightly stronger representation of government departments and government aid/development banks in the funding for tools/initiatives that generate data about land ownership/commodity origins. Data generated on the links to sustainability showed a stronger representation of philanthropy and corporate social responsibility.
- Private companies have a strong representation as a governance type for tools/initiatives generating all three data types. This may imply that there is a demand for all three types of data from those willing and able to pay.

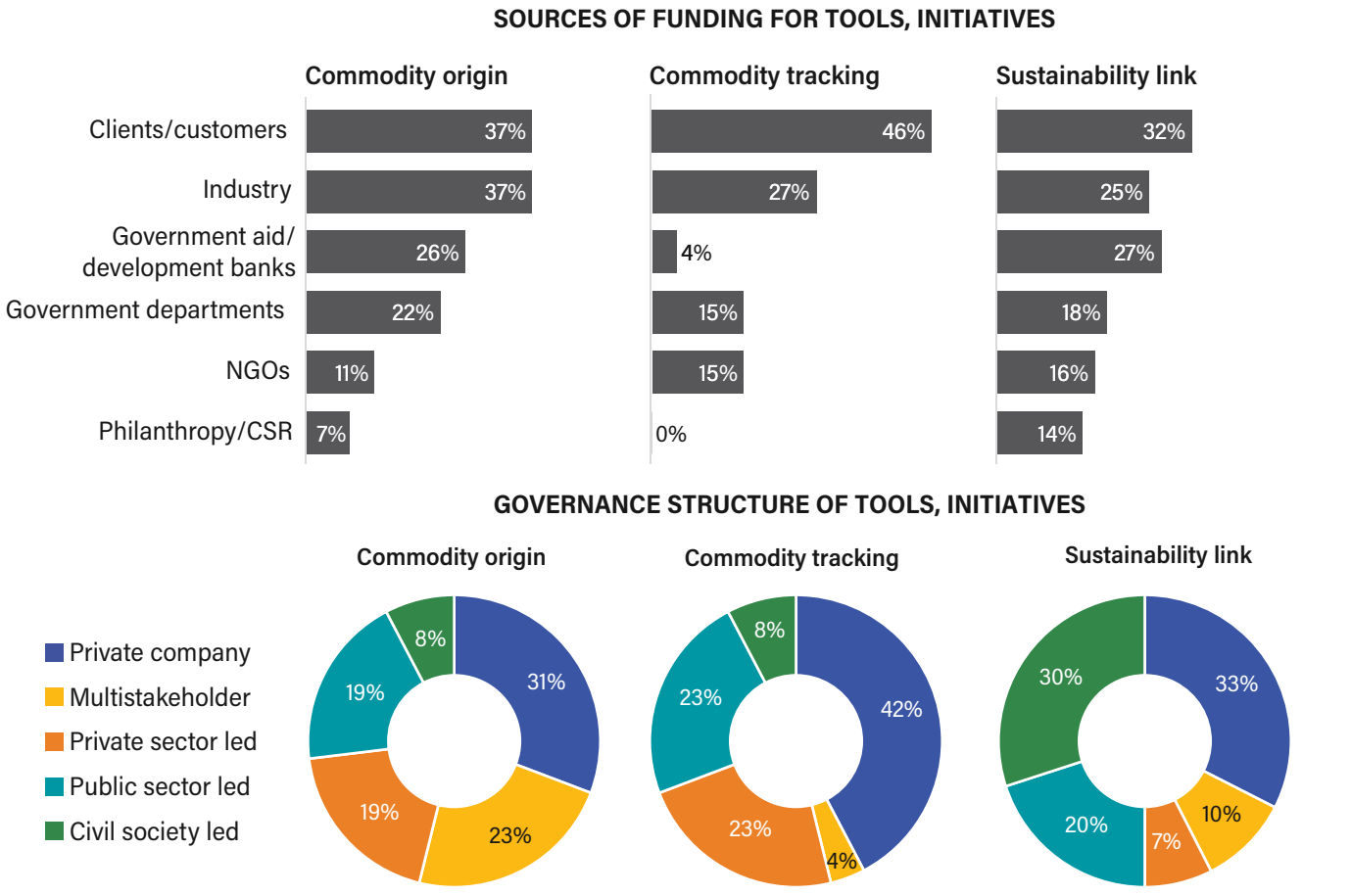
FIGURE A-4 | Proportion of tools/initiatives receiving funding from various stakeholder groups (left) and governance types (right) in sample



Note: CSR = corporate social responsibility; NGO = nongovernmental organization.

Source: Analysis by authors.

FIGURE A-5 | Governance and funding models of tools/initiatives



Note: NGO = nongovernmental organization; CSR = corporate social responsibility.
Source: Analysis by authors.

- Private companies are slightly less well-represented in the generation of data linking commodities to sustainability impacts, while civil society is much more strongly represented there.

Information on how funding and governance types vary with processed information outputs, rather than generation of data, is presented in Figure A-6.

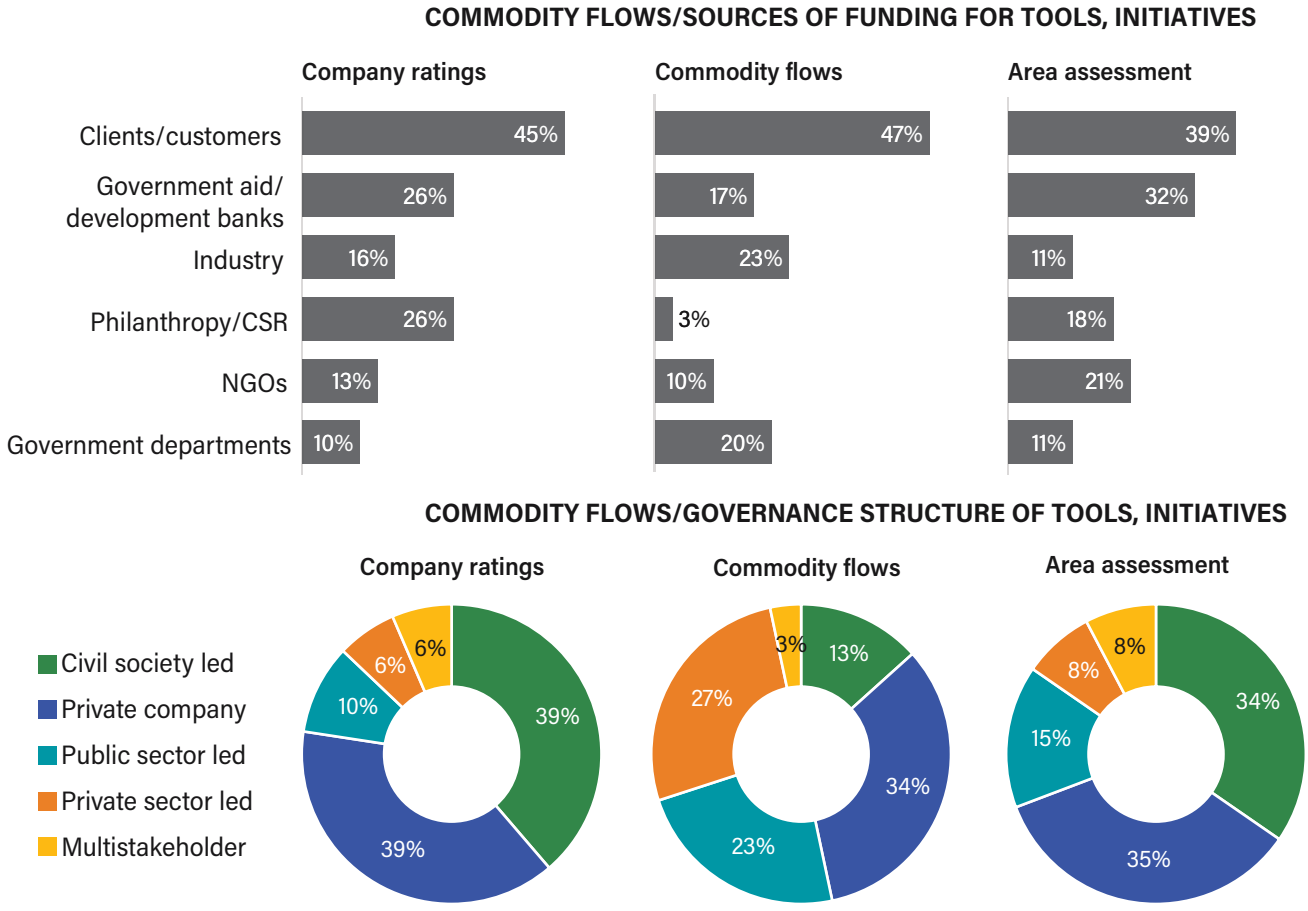
Examples:

- Many of the tools developed by private companies surveyed in this research were initially identified through stakeholder interviews, or by examining the traceability efforts of large organizations, such as the work between **Orbital Insight** and Unilever.
- Civil society–led initiatives that produce information that could be used for area assessments are often based on forest monitoring, such as **RADD alerts** or other geospatial information sources. A very high-level example would be **Chatham House's Forest Governance and Legality platform**, scoring whole countries on forest governance.

Key findings

- Those tools/initiatives that publish ratings of companies or area assessments have a strong representation from civil society in their governance structures.

FIGURE A-6 | Tool/initiative outputs and funding/governance



Note: NGO = nongovernmental organization; CSR = corporate social responsibility.

Source: Analysis by authors.

- Private companies are well-represented as producers of all outputs considered in this research. These were generally tools developed by consultancies or similar service providers, charging for diverse insights, including assistance for full supply chain management.
- Overall, funding sources are diverse for all outputs; however, industry and government departments are more prominent in tools that examine commodity flows than company ratings or area assessments.

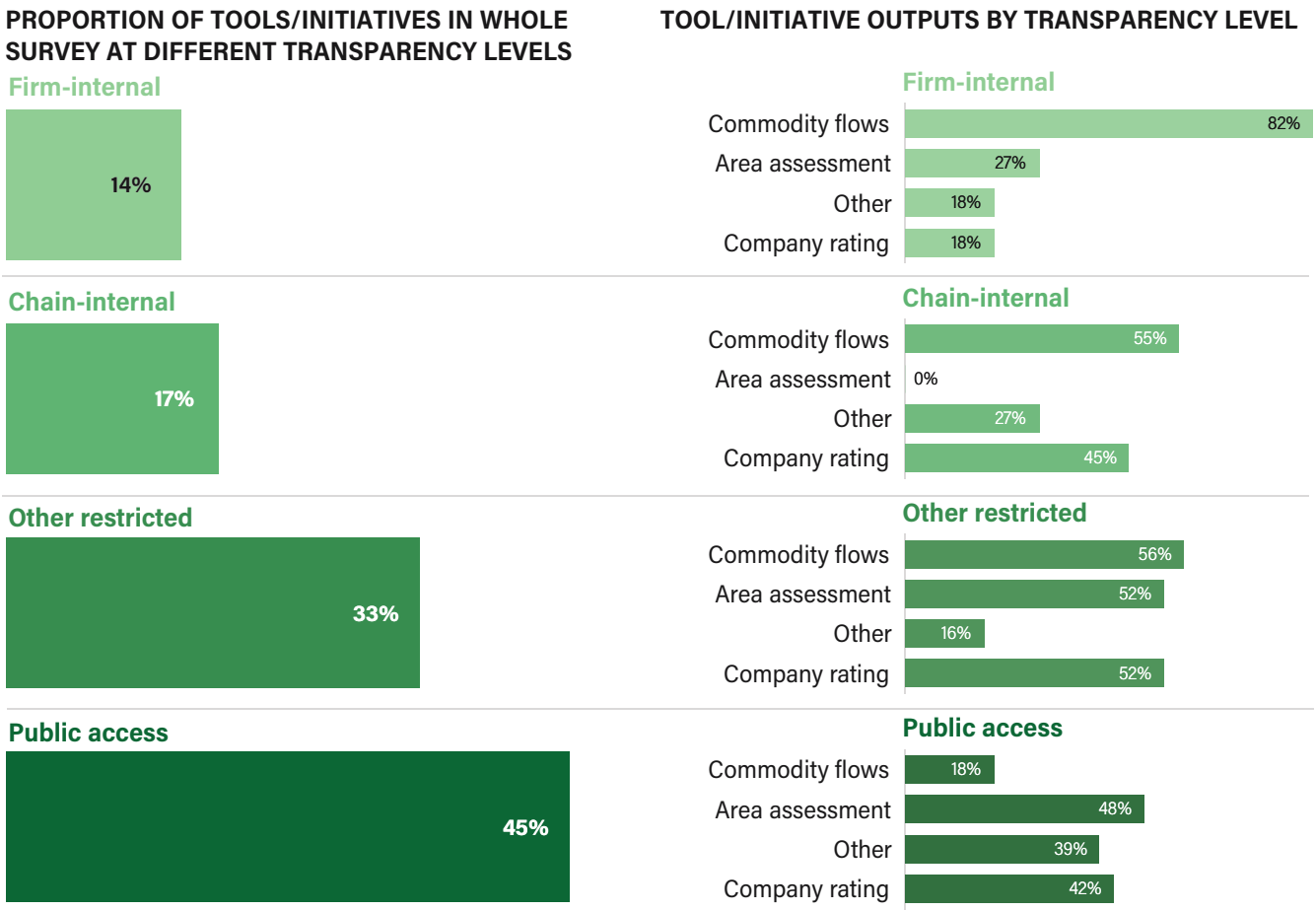
Mapping results: Data sharing and disclosure

We categorized the level of transparency of each tool/initiative on a spectrum from firm-internal (i.e., information is not published) to chain-internal (e.g., information is shared with members of a particular coalition) to open access (see Figure A-7).

Examples:

- The vast majority of "other restricted" transparency consisted of information available for a fee, often a dataset compiled or tool developed by a consultancy that sells access to it as the basis for its business. Another type of restricted transparency are commercially sensitive

FIGURE A-7 | Proportion of tools/initiatives sharing information at different transparency levels (left), and tool/initiative outputs by transparency level (right)



Source: Analysis by authors.

data shared in a closed forum but published in aggregated form; for example, through the **Soft Commodities Forum** annual report.

- One example of an initiative that facilitates chain-internal transparency is **Agritrace Animal**, a public sector–led initiative in Brazil that communicates the requirements of overseas beef purchases with producers, and the characteristics of producers with overseas buyers (verifying with audits). This allows buyers to meet their information needs.
- Open access insights include, for example, company scores provided by **Forest 500**, or various forest monitoring platforms, prominent among which is **Global Forest Watch**.

Key findings

- For firm-internal information, commodity flows are the majority output type, followed by company ratings. Such insights are often produced for companies in partnership with a consulting firm.
- "Other restricted" transparency shows a split among company ratings, area assessments, and commodity flows—private companies offering diverse datasets for a fee. Some data on commodity flows are published in aggregate but not in detail, showing trends without disclosing commercially sensitive information.

- Area assessments are often produced by civil society or private companies, with different funding models allowing for different transparency levels (i.e., service fees allowing paid-for access, with government or philanthropic funding allowing open access).

How transparency varies with funding and governance in the sample is presented in Figure A-8.

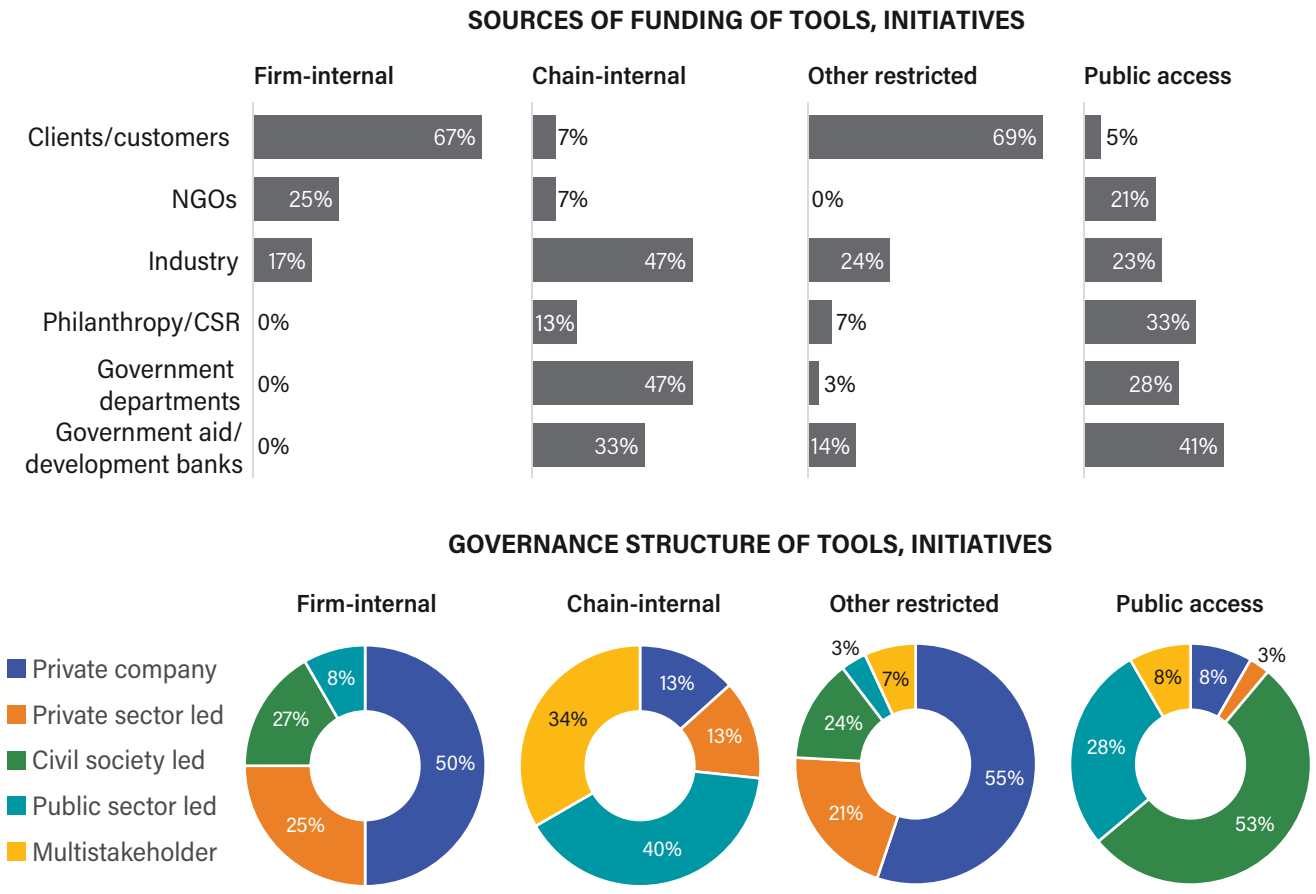
Examples:

- A multistakeholder initiative with chain-internal transparency for some outputs is the **Conecta Monitoring Platform**, operating in the beef sector in Brazil. This was developed as part of the multistakeholder initiative **Parcerias para Agropecuária Responsável** and uses blockchain technology to transfer information from ranches to meatpackers and retailers.

Key findings

- Sixty-seven percent of those tools/initiatives that produce insights with firm-internal transparency receive funding from service fees. For chain-internal outputs, the funding group with the largest representation is industry—these groups are often industry membership associations.
- Other restricted, or paid, access shows more diversity with a strong representation of service fees.

FIGURE A-8 | Tool/initiative transparency levels and funding/governance



Note: NGO = nongovernmental organization; CSR = corporate social responsibility.

Source: Analysis by authors.

- There exists a spectrum of governance structures ranging from zero transparency to public disclosure—public disclosure is mainly civil society led, lower transparency is mainly private sector led.
- The strong representation of private companies that share information but do not publicly disclose information (see "Other restricted" category in Figure A-8) is from companies selling access to datasets that they produce.

Summary of findings from mapping survey

- There is an enormous diversity of technologies, stakeholder types, funders, and users involved in tools/initiatives.
- A significant number of tools/initiatives do not generate new or raw data. Many combine preexisting, publicly available data (either for a fee, openly available, or collected through ground truthing) and apply them to the desired use.
- Tracking within a supply chain is often undertaken by companies themselves or within closed membership groups, highlighting the often commercial sensitivities associated with data sharing.
- There is a growing industry in commercializing data that are freely available by processing them into usable forms. For example, Palmoil.io, a company that sells services to help users understand risk in their palm oil supply chains, uses data based on the Universal Mill List (a public database with information about palm oil mills).[59] This could imply that many published datasets are not fully or properly used by stakeholders—there may be more value in existing data that can be made more available and usable. An example of a free tool that does this is Visipec, which functions as an add-on to existing traceability tools to help users build a more complete picture of their supply chains using available information.
- The level of transparency correlated with the funding and governance models of the tools/initiatives. For example, those that were most transparent tended to be led by civil society.
- As a result, a sustainable funding model may be a crucial factor in determining the outputs and transparency levels of different tools/initiatives, as people seek different requirements or markets from different stakeholders.

Table of surveyed tools/initiatives

Table A-1 provides a list of tools, platforms, projects, initiatives, and organizations that was included in the survey undertaken in this research.

We compiled the list during a research period of three months based on reports, interviews, and further desk-based research. This list is not comprehensive and does not contain all relevant tools/initiatives. It shows the diversity of types of entity, including expert consultants, academic research projects, intergovernmental organizations, private logistics tools, and NGO projects that contribute to the global information ecosystem. The future development of a web-based directory of information sources, tools, guidance, and initiatives, including tools and initiatives like those below and many more, could be a useful resource for stakeholders going forward.

The second column shows whether, under the working definitions given in "Traceability and transparency: Research objectives," these are best described as having been developed to increase either traceability or transparency. As explained in "Stock-take of traceability and transparency tools and initiatives: Key findings," there are many definitions of traceability and transparency in common usage. As a consequence, the categorization in column two is provided as a broad, non-definitive aid to understanding the functions of tools and initiatives, as many can rightly be described as contributing to both traceability and transparency.

TABLE A-1 | List of surveyed tools and initiatives

TOOL/INITIATIVE NAME	PRIMARILY RELATED TO TRACEABILITY OR TRANSPARENCY?	REGION OF FOCUS	COMMODITIES OF FOCUS
Accountability Framework initiative	Transparency	Global	Multiple
Agritrace Animal	Traceability	Brazil	Cattle
Agroideal	Traceability	Brazil, Argentina, Paraguay	Soy, cattle
Agrotools: TerraMatrix, TerraSafe, GeoID	Traceability	Brazil	Cattle
BigChain Tool	Traceability	Global	Multiple
Boi na Linha Project	Transparency	Brazilian Amazon	Cattle
BusCAR (by Terras)	Traceability	Brazil	Cattle
CDP Forests	Transparency	Global	Multiple
Chainpoint	Traceability	Global	No specific commodity focus
Côte d'Ivoire Land Partnership (CLAP), Meridia	Traceability	Côte d'Ivoire	Cocoa
CLASlite	Traceability	Global	No specific commodity focus
Cocoa & Forests Initiative	Traceability	Ghana, Côte d'Ivoire	Cocoa
Cocoa, Forests & Peace initiative	Traceability	Colombia	Cocoa
CocoaWise	Transparency	Cargill's direct sourcing regions, primarily in West Africa for Cocoa	Cocoa
Conecta Monitoring Platform	Traceability	Brazil	Cattle
Do Pasto ao Prato	Traceability	Brazil	Cattle
Earth Resources Observation and Science (EROS) Center	Traceability	Global	No specific commodity focus
EcoVadis	Transparency	Global	Multiple
ESDM One Map Indonesia	Transparency	Indonesia	No specific commodity focus
Eyes on the Forest	Traceability	Sumatra	General, some palm oil focus
FAOSTAT	Transparency	Global	No specific commodity focus
Farmer Connect	Traceability	Global	Cocoa, coffee
FLEGT Watch, Centre for International Development and Training	Traceability	Central and West Africa	Timber
FLOCERT	Traceability	Global	No specific commodity focus
Forest 500	Transparency	Tropics	Multiple
Forest Governance and Legality online platform, Chatham House	Traceability	Global	No specific commodity focus
ForestLink Real-Time Forest Monitoring, Rainforest Foundation UK	Traceability	West and Central Africa, Peru	No specific commodity focus

TABLE A-1 | List of surveyed tools and initiatives (cont.)

TOOL/INITIATIVE NAME	PRIMARILY RELATED TO TRACEABILITY OR TRANSPARENCY?	REGION OF FOCUS	COMMODITIES OF FOCUS
Geobosques	Traceability	Peru	No specific commodity focus
Geoflorestas	Traceability	Brazil	Soy, cattle
GeoRSPO	Traceability	Global	Palm oil
GeoTraceability	Traceability	Global	Palm oil
Global Coffee Platform Collective Reporting on Sustainable Coffee Purchases	Transparency	Global	Coffee
Global Forest Watch (GFW)	Traceability	Global	No specific commodity focus
Global Livestock Environmental Assessment Model (GLEAM) and GLEAM-i	Traceability	Global	Livestock
Global Reporting Initiative	Transparency	Global	No specific commodity focus
IDEAM—SNIF and GEOVISOR	Traceability	Colombia	No specific commodity focus
ImazonGeo	Traceability	Brazilian Amazon	No specific commodity focus
Impact at Origin, Taking Root	Traceability	Nicaragua	Coffee
Kepo Hutan: A Mapping Platform	Traceability	Southeast Asia	Palm oil, timber
KoltiTrace	Traceability	Global	Palm oil, cocoa, coffee
Mapbiomas	Traceability	Primarily Brazil, also Indonesia	No specific commodity focus
Maplecroft	Traceability	Global	No specific commodity focus
Microsoft Planetary Computer	Transparency	Global	No specific commodity focus
MSPO Trace	Traceability	Southeast Asia	Palm oil
NDPE Implementation Reporting Framework	Transparency	Southeast Asia, West Africa	Palm oil
Niceplanet Geotecnologia	Traceability	South America	Multiple
Nusantara Atlas	Traceability	Sumatra, Borneo, Kalimantan, and New Guinea	Palm oil, timber
Open Timber Portal, World Resources Institute	Traceability	Central and West Africa	Timber
OpenForests	Transparency	Global	No specific commodity focus
Open Foris tools: Collect Earth, Collect Earth Online, and SEPAL	Traceability	Global	No specific commodity focus
Orbital Insight GO	Traceability	Global	No specific commodity focus
Palm Industry Platform	Traceability	Global	Palm oil
Palmoil.io	Traceability	Southeast Asia primarily, but incorporates global data	Palm oil

TABLE A-1 | List of surveyed tools and initiatives (cont.)

TOOL/INITIATIVE NAME	PRIMARILY RELATED TO TRACEABILITY OR TRANSPARENCY?	REGION OF FOCUS	COMMODITIES OF FOCUS
PalmTrace	Traceability	Global	Palm oil
PemPem	Traceability	Indonesia	Palm oil
PRODE, TerraBrasilis	Traceability	Brazil	No specific commodity focus
RADD Forest Disturbance Alert	Traceability	Tropics	No specific commodity focus
RCA-TTP Portal	Traceability	Southeast Asia	Palm oil
Responsible Timber Exchange	Traceability	Global	Timber
Satelligence	Traceability	Global	Multiple
Selo Verde (Green Seal) platform	Traceability	Pará, Brazil	Cattle
SIRFLOR	Traceability	Pará, Brazil	Cattle
SISBOV	Traceability	South America	Cattle
SITRAP	Traceability	Paraguay	Cattle
SMGeo Direto and SMGeo Indiretos (Indirect SMGeo)	Traceability	Brazil, Paraguay, Colombia, and Argentina	Cattle
Soft Commodities Forum platform	Traceability	Cerrado, Brazil	Soy
SojaMaps	Traceability	Mato Grosso, Brazil	Soy
Sourcemap	Traceability	Global	No specific commodity focus
Sourceup	Traceability	Global	Multiple
Soy on Track	Transparency	Brazilian Amazon	Soy
Soy Transparency Coalition: Annual Trader Assessment	Transparency	Based in Europe	Soy
SPOTT, Zoological Society of London	Transparency	Global	Palm oil, timber
Starling	Traceability	Global	Multiple
SUMAL, Forest Inspector	Traceability	Other - Romania	Timber
Supplier Group Monitoring Programs (SGMP) on Transform Platform	Traceability	Global	Palm oil
Supply Change	Transparency	Global	No specific commodity focus
Sustainalytics	Transparency	Global	No specific commodity focus
SYDORE: Système de Gestion des Données Régionales	Traceability	Côte d'Ivoire	Cocoa, coffee
Terra-i	Traceability	South America, West Africa, Southeast Asia	No specific commodity focus
The Cocoa Accountability Map	Traceability	Côte d'Ivoire	Cocoa
Timber Chain	Traceability	Global	Timber

TABLE A-1 | List of surveyed tools and initiatives (cont.)

TOOL/INITIATIVE NAME	PRIMARILY RELATED TO TRACEABILITY OR TRANSPARENCY?	REGION OF FOCUS	COMMODITIES OF FOCUS
Trace Beef app by Ecotrace	Traceability	Brazil	Cattle
Transform Platform	Traceability	Southeast Asia, West Africa, South America	Focus on palm oil
Transparency Pathway	Transparency	Global	No specific commodity focus
Transparent Livestock Farming Platform, JBS 360	Traceability	Brazil	Cattle
Trase	Traceability	Global	Multiple
United Nations Comtrade	Transparency	Global	No specific commodity focus
Universal Mill List	Transparency	Global	Palm oil
Uruguay National Agricultural Information System (SNIA)	Traceability	Uruguay	Cattle
Verified Guarantee of Origin Program	Traceability	Brazil	Cattle
VISEC	Traceability	Brazil	Soy
Visipec	Traceability	Brazil	Cattle
Wholechain	Traceability	Global	No specific commodity focus
WWF commodity scorecards	Transparency	Global	Palm oil, soy, timber

Note: SISBOV = Serviço Brasileiro de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos (Brazilian Service for Traceability of the Cattle and Buffalo Production Chain); RCA-TTP Portal = Risk-Calibrated Approach Traceability to Plantation Portal; SIRFLOR = O Sistema de Restauração Floresta (The Forest Restoration System); SNIA = Sistema Nacional de Información Agropecuaria; WWF = World Wildlife Fund.

Source: Analysis by authors.

APPENDIX B. EXPLORING TOP-DOWN VERSUS BOTTOM-UP APPROACHES TO GREATER TRACEABILITY AND TRANSPARENCY AMONG INDIRECT SUPPLIERS: LESSONS FROM THE CATTLE SECTOR IN LATIN AMERICA

The issue

Within commodity supply chains, the large processors and traders commonly contract directly with growers or producers, which may in turn buy from other producers or growers, often referred to as indirect suppliers. In the case of the cattle supply chain, indirect suppliers pose challenges due to the number of actors involved and the difficulty in tracing cattle from birth to slaughter.

Two case studies are explored in this appendix, both from Brazil: the **Sustainable Production of Calves Program;** and the **Working Group on Indirect Suppliers (Grupo de Trabalho dos Fornecedores Indiretos; GTFI) and Visipec**. These case studies illustrate different approaches to the challenge of indirect suppliers—"bottom up," whereby indirect suppliers are engaged directly, often through industry or government initiatives, and "top down," whereby a downstream company aims to trace and identify indirect suppliers through its direct suppliers.

The context

Traceability in the cattle industry presents challenges, partly because many ranches that directly supply meatpackers are not full-cycle ranches covering all production phases from birth to sale, including breeding, rearing, and fattening. As a result, cattle arriving at meatpacking plants from direct suppliers have often been kept on one or more other ranches (Tier 1 indirect and Tier 2 indirect suppliers) before arriving at the final fattening property (see Figure B-1). Some of these ranches may have been converted from forest, as most of the forest loss associated with cattle occurs on ranches engaged in the earlier life cycle stages: breeding and rearing. Cattle are moved between ranches via ranch-to-ranch transfers, as well as sold through other channels, including via auctions, traders, and other intermediaries.[60]

Approaches to traceability and transparency: Overview and case studies

A wide range of tools and systems has been developed to support traceability and transparency for cattle in South America. These are built upon one of two approaches to track and monitor animals: either tracking batches of cattle or tagging and tracking individual animals.

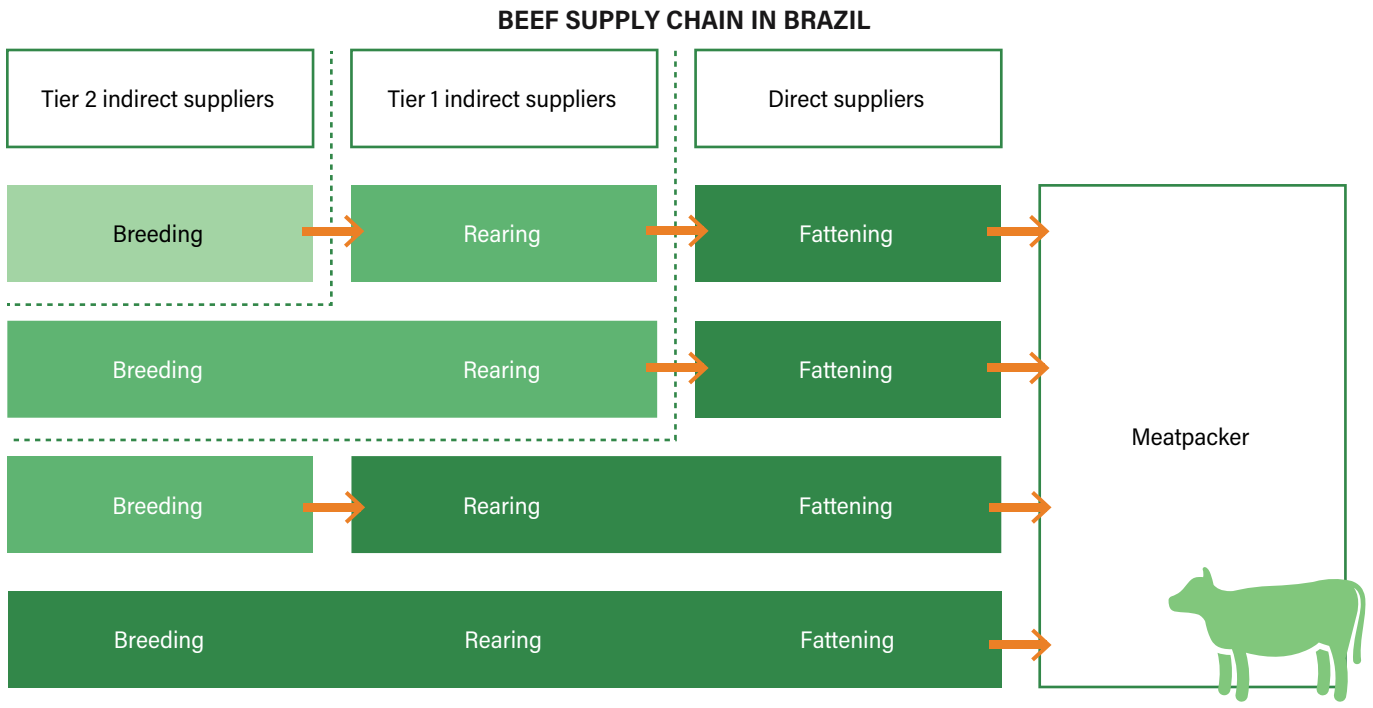
Tracing value chain steps

Lower-cost methods for tracking individual animals through supply chains include brands or tattoos imprinted on animals or ear tags. Higher-tech, higher-cost tracing methods include GPS ear tags, which track the real-time location of an animal; RFID (radio-frequency identification) ear tags; and microchip technology. These tools allow for tracking details of an individual animal, including date of birth, breed, originating ranch, health, and immunization records, from birth to slaughter. Tagging tools have been adopted in major cattle-producing regions across the globe. In some cases, these are wall-to-wall mandatory systems; in others, they are mandatory only for a subset of the herd that is destined for export markets such as the EU but voluntary for the rest of the herd. Mandatory government-driven traceability systems are designed primarily to track animals for sanitary controls and health purposes, rather than for environmental compliance monitoring.

In Argentina and Uruguay, mandatory cattle traceability systems have been designed to provide a unique identifier that tracks individual cattle movements back to the ranch of origin.

- In Argentina, the government required all calves to carry official ear tags installed at birth farms starting in 2007, allowing for full traceability through the supply chain. Ranches are given unique identification numbers and geo-referenced polygons (RENSPA). These data are complemented with the Integrated Management System for

FIGURE B-1 | Cattle suppliers and their roles within the supply chain



Source: Adapted from GTFI 2022.

Animal Health (Sistema Integrado de Gestión de Sanidad Animal; SIGSA)/Electronic Transit Document (DT-e), which tracks cattle movement via permits.

- In Uruguay, the government introduced the Animal Identification and Registration System (Sistema de Identificación y Registro Animal; SIRA) in 2006. The system was made mandatory in 2008, and is free of charge to the farmer, relying on government funding. SIRA is being used for the entire cattle heard in Uruguay, currently consisting of 12 million head of cattle electronically tagged at birth (see Box B-1 for more details).

In Brazil, mandatory traceability systems have been developed in part to meet other market requirements—for example, the Brazilian Service for Traceability of the Cattle and Buffalo Production Chain (Serviço Brasileiro de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos; SISBOV) scheme—for export to markets requiring traceability, such as the EU (see Box B-2). However, SISBOV tracks only the last 90 days of movement of cattle prior to slaughter (rather than the whole life cycle) and cattle rarely move from indirect to fattening farm in that period, limiting the tool's utility for integration into systems monitoring deforestation in supplier ranches. For a tool like SISBOV to be useful for monitoring deforestation, cattle would need to be tagged at birth, such as occurs in Argentina and Uruguay.

In addition, a mandatory traceability system exists for animal health control purposes in Brazil, the Animal Transit Guide (Guia de Transporte Animal; GTA) (see Box B-3). However, this uses a batch (not individual animal) approach to track groups of animals, and comprehensive GTA data are not publicly accessible for all states on a national level. This limits its widespread use by all supply chain actors, including meatpackers, for supply chain traceability and monitoring.

Other individual animal tagging programs are driven by NGO–private sector partnerships, such as the Sustainable Production of Calves Program in Brazil. These can be the basis for an "end-to-end" traceability system, which can trace cattle through all stages of production, processing, and finally to distribution via a retailer (see "Case study: Sustainable Production of Calves Program"). However, to date these have been modest in coverage, generally reaching just hundreds of farms.

BOX B-1 | Uruguay's Animal Identification and Registration System

In 2004, Uruguay developed a voluntary Pilot Plan for Individual Livestock Traceability (Piloto de Trazabilidad Individual; PTI) covering 5 percent of the herd to prepare for a 2010 requirement in the EU for individual animal traceability from birthplace to slaughterhouse since the EU was a major export market for Uruguay in the 2000s. The program required a visual ear tag with a printed identification number as well as an RFID ear tag to be installed for each animal. The system was tested over the course of a few years before being expanded in 2006 into the National Animal Identification and Registration System, SIRA. The system is managed by the Livestock Control Office (División de Contralor de Semovientes; DICOSE) under the Ministry of Livestock, Agriculture, and Fishery (Ministerio de Ganaderia, Agricultura y Pesca; MGAP) and allows complete traceability of the calf from birth to the slaughterhouse, and of leather to the tannery. SIRA data are integrated into the National Livestock Information System (Sistema Nacional de Información Ganadera; SNIG), which also tracks transfers of animals between farms.

Data are registered in the SNIG, including identifying number, DICOSE number of the owner, DICOSE number of the birth farm, birth season and year, sex, and breed. To transfer cattle between ranches, an Ownership and Movement Form is required, which notes details on the cattle brand, livestock breed, seller, buyer, means of transport used, and dates of transport.[a]

Farmers are required to use electronic identifiers and readers, which also read the RFID identifiers on each head of cattle. Ownership and Movement Forms must be submitted as digital images through these reading devices. These data are integrated into the SNIG as well. Finally, data are captured at the slaughterhouse. The National Meat Institute (Instituto Nacional de Carnes; INAC) manages the Electronic Information System of the Meat Industry (Sistema Electrónico de Información de la Industria Cárnica; SEIIC), or the "black boxes," which document all cattle entering authorized slaughterhouses, using scales, scanners, and communication devices, providing real-time data on slaughter.[b]

Gathering these data from farm to slaughter has allowed the government of Uruguay to build a more complete picture of its livestock herds at a national level, including understanding the total number and area of livestock farms, the total land use in hectares for pasture and livestock, the total head of cattle (and sheep), and the mortality rates on farms.

Data gathered at the slaughterhouse help INAC develop sectoral policies that can support the development of the cattle sector. The system has positioned Uruguay as a premier cattle-exporting country in a competitive global market, increased its export capabilities, and strengthened animal health as well as food safety, while also tackling the illegal movement of animals within the country.[c] However, the tool was not designed to monitor environmental and sustainability impacts of production, so it has not been linked to changes in environmental performance at the farm level.

Sources: a. MGAP et al. 2009; b. MGAP et al. 2009; c. MGAP et al. 2009.

BOX B-2 | SISBOV

The Brazilian System of Identification and Certification of Cattle Origin (SISBOV) was launched and made mandatory in 2002 for export to the EU and made mandatory in subsequent years for other regions requiring traceability. SISBOV identifies, registers with a code of up to 15 digits, and monitors individual heads of cattle using ear tags combined with other animal marking methods, such as buttons, brands, tattoos, and/or electronic devices. If the animal lacks an electronic device, it also needs to be accompanied with an animal identification document until slaughter or export. The system, managed by the Ministry of Agriculture, Livestock, and Supply (Ministério da Agricultura, Pecuária, e Abastecimento; MAPA), tracks data for specific animals, including birth month or date the animal was brought to the supplier, sex, and health information. The data are all entered into SISBOV's centralized digital national data bank. A property receives certification (managed by accredited organizations) if it can meet certain criteria, including providing individual identification of 100 percent of the cattle on the property.

Sources: TFA 2022; See this page from an accredited SISBOV certifier for more information on SISBOV: https://sbcert.com.br/pag/sisbov/.

BOX B-3 | The Animal Transit Guide

Since 1995, Brazil's legally required government traceability system has been the Animal Transit Guide (Guia de Trânsito Animal; GTA). Issued by state animal health control agencies, the GTA is used to track the movement of batches (or lots) of cattle in Brazil for sanitary control purposes. It documents information about origin and destination, health conditions, and the purpose of transport. Before transporting cattle, farmers must fill out a GTA for the cattle lot, documenting the date of transfer, the total number of animals in the batch (as well as the ages and genders of the animals), vaccination data, and which farms (or slaughterhouses) are sending and receiving the cattle. At the destination site, a digital record is created for the lot based on the information provided. This record confirms the start and end point of that specific ranch-to-ranch transfer, but it does not contain information about earlier ranch transfers. GTA data are maintained on both state-level databases and the federal MAPA-managed database.

Cattle sold to the slaughterhouses must contain the GTA of the last supplier (but not previous suppliers, whose data are considered confidential). As a result, historically the GTA data have been used only to monitor direct suppliers to the meatpackers. However, tools have been developed, such as Selo Verde and Visipec (see "Case study: GTFI and Visipec"), that link GTA data together, combined with the data submitted by ranchers to the Rural Environmental Registry (Cadastro Ambiental Rural; CAR) to assist in monitoring indirect suppliers throughout the supply chain.

Sources: TFA 2022; Garcia-Drigo et al. 2022.

Linking to sustainability characteristics

While government-initiated traceability systems focus on tracing for sanitary and health reasons, other primarily private sector–driven tools integrate the data from sanitary control traceability systems to monitor for forest loss and social compliance at the farm level.

Brazil is the current epicenter of efforts to trace and monitor cattle supply chains for forest loss, reflected by the number of tools and initiatives from Brazil documented in Table A-1 in Appendix A. This is in part because Brazil's cattle sector accounts for nearly one-quarter (24 percent) of global tropical forest loss (Ritchie and Roser 2021a) and cattle pasture covers two-thirds of cleared land (Mapbiomas 2018 as cited in zu Ermgassen et al. 2020).

Despite the known challenges in reaching full traceability, there have been efforts to increase traceability and monitoring of the Brazilian cattle sector—and particularly meatpackers—to reduce deforestation. Meatpackers have been engaged via public sector initiatives as well as requests from downstream markets and NGO campaign efforts. In 2009, following a campaign by Greenpeace, meatpackers Bertin, JBS-Friboi, Marfrig, and Minerva committed to ban cattle purchases from newly cleared areas in the Brazilian Amazon, under an agreement termed the Public Commitment on Cattle Ranching (Compromisso Público da Pecuária; CPP) (Capóssoli Armelin et al. 2020), sometimes referred to as the "G4" commitment. In the same year, several meatpackers in Pará State also signed the Terms of Adjustment of Conduct (TAC), an agreement not to buy cattle from recently cleared land (Hofmeister 2021). The effort, led by the Federal Prosecution Office, was later rolled out across nearly all Brazilian Amazon states. These commitments covered only direct suppliers in the Brazilian Amazon. The TAC requires meatpackers to follow a monitoring protocol, with an agreed on protocol for independent audits. So far these have been conducted publicly only for direct suppliers in the state of Pará, but there are plans to expand the scope to indirect suppliers, as well as to other states. In addition, some states are considering expanding the scope beyond the Brazilian Amazon biome to the Cerrado. Researchers have found that 31 percent and nearly 18 percent of Brazil's cattle exports were covered by the TAC and G4 agreements, respectively; these figures increased to 82.6 percent and 69.6 percent when looking at exports just from the Brazilian Amazon biome (zu Ermgassen et al. 2020).

In addition to being signatories to joint agreements like the G4 and TAC, the major exporting meatpackers in Brazil, including JBS, Marfrig, and Minerva, have adopted their own various commitments to increasing traceability and addressing forest loss within their supply chains, and monitoring supplying properties for deforestation.

In Brazil with animal tracing, some level of verification of compliance with social and environmental criteria is possible for individual ranches using existing government data sources, such as the following:

1. An embargo list maintained by the federal agency Brazilian Institute of the Environment and Renewable Natural Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis; IBAMA), which imposes restrictions on farms with illegal deforestation
2. Embargo lists maintained at a subnational level, such as the list by the Pará State environmental department (Secretaria de Estado de Meio Ambiente e Sustentabilidade; SEMAS/PA)
3. The federal government's slave labor "dirty list," which lists companies that have been found to use slave labor
4. Information about forest loss using data from DETER or PRODES from the National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais; INPE) or other monitoring tools
5. Property mapping and registration information from the governmental CAR system, which is required under the Brazilian Forest Code; deforestation is permitted outside of legal reserves (a fixed proportion of each farm that by law must retain native vegetation cover) and Permanent Preservation Areas (PPAs) in line with the Environmental Compliance Program (Programa de Regularização Ambiental; PRA); overlaying these CAR property, legal reserve, and PPA boundaries with forest loss data allows stakeholders to determine if native vegetation loss has occurred within a farm, or specifically within areas allocated for protection

Several cattle traceability platforms and tools have been developed using data from the country's data sources mentioned above as well as animal transport systems, combined with geospatial data, to support more coordinated and aligned forest and land use monitoring programs by meatpackers within their supply chains (see Table B-1).

TABLE B-1 | Systems and tools used to trace and monitor the cattle supply chain in Brazil

Combining traceability and monitoring tools to promote sustainability in supply chains

INITIATIVES	AGROTOOLS	VISIPEC	SAFE TRACE	NICEPLANET	ECOTRACE	CONECTA
Objective	Social and environmental monitoring of cattle suppliers	Deforestation monitoring of indirect cattle suppliers	Social and environmental monitoring of cattle suppliers	Identify good cattle supply farms that meet legal commitments	Information hub; provides traceability from the origin to the final consumer	Social and environmental monitoring of cattle suppliers in Amazon
Methodology	Combines traceability and monitoring tools	Combines traceability and monitoring tools	Combines traceability and monitoring tools	Analysis of all socio-environmental criteria, purchase to purchase	Internet of Things, Artificial Intelligence, Blockchain	Combines traceability and monitoring tools and protocols
Scale	Amazon and Cerrado (Brazil)	Brazil	National	Amazon	Global	Brazil
Tool	TerraMatrix, TerraSafe, GeoID	Visipec	Safe Trace platform	SMGeo Indireto	SMGeo Indireto (Niceplanet)	Conecta Monitoring Platform
Main users	Slaughterhouses and retailers	Slaughterhouses	Consumers and retailers	Producers and slaughterhouses	Consumers	Producers and slaughterhouses
Blockchain			X		X	X
GTA/GTA-e	X	X	X	X	X	X
SISBOV			X			X
CAR	X	X	X	X	X	X
Direct suppliers	X	X	X	X	X	X
Strategy for indirect suppliers	X	GTFI	Individual identification	SMGeo Indireto	SMGeo Indireto	GTFI
Reach indirect suppliers	Limited	Complete	Complete	Complete	X	Complete

Note: GTFI = Grupo de Trabalho dos Fornecedores Indiretos (Working Group on Indirect Suppliers); GTA = Guia de Transporte Animal (Animal Transit Guide); GTA-e = electronic GTA; SISBOV = Serviço Brasileiro de Rastreabilidade da Cadeia Produtiva de Bovinos e Bubalinos (Brazilian Service for Traceability of the Cattle and Buffalo Production Chain); CAR = Cadastro Ambiental Rural (Rural Environmental Registry).

Source: Adapted from TFA 2022.

A range of tools exists to support traceability for cattle in Brazil (see Table B-1), integrating data on forest loss at the farm level: Tools such as Visipec are designed for use primarily by meat-packers and can be used alongside other voluntary tools such as SMGeo and the Connecta platform for supplier prioritization efforts. Some tools, such as SMGeo Indireto and the Connecta platform, are also designed for use by producers to monitor their own supplying farms more effectively.

Some meatpackers have developed their own traceability systems, with partners such as Ecotrace and Niceplanet; some also use their proprietary systems alongside tools such as Visipec. JBS developed the Transparent Livestock Farming Platform with Ecotrace. Participation is currently voluntary, with a 2025 deadline for ranchers to register and share data. Marfrig has tested Visipec with its own traceability systems. Minerva Foods integrated Visipec with its own system and launched the new app SMGeo Prospec in 2021 in partnership

with Niceplanet to allow its suppliers to use the same technology that Minerva uses for its supplier analysis for cattle purchases. All these systems allow companies to analyze forest loss in their supplier properties.

The current voluntary proprietary systems advanced by private sector actors are rarely subject to voluntary third-party verification and auditing. As a result, these systems may be subject to errors in data quality and accuracy, eroding their credibility with stakeholders. For example, despite JBS's traceability systems in place, reports continue to link JBS to deforestation through indirect suppliers sourcing from farms in the Brazilian Amazon causing legal and illegal deforestation (Global Witness 2020; Wasley et al. 2020). Investors, customers, and NGOs have continued to call on meatpackers to strengthen their existing traceability and monitoring systems, including the verification and auditing of systems.

Ultimately, these voluntary commitments by major meatpackers like JBS, Marfrig, and Minerva cover a significant but still small proportion of Brazil's beef market share, less than half of Brazil's cattle slaughter (JBS makes up 11.5 to 19 percent of market share, Marfrig makes up 4.5–7.5 percent, and Minerva makes up a similar 4–7 percent) (Slob et al. 2020). Even if these commitments as well as their operationalization; auditing; and monitoring, reporting, and verification (MRV) systems are strengthened, harmonized, and fully implemented, these major companies cannot on their own fully transform the Brazilian cattle sector.

Efforts need to be made to ensure that other slaughterhouses, including small and medium enterprises (SMEs) and slaughterhouses located outside of the Amazon, also adopt aligned traceability approaches and systems. Industry trade organizations such as Brazilian Beef Exporters Association (Associação Brasileira das Indústrias Exportadoras de Carnes; ABIEC), which covers 98 percent of the country's beef exports and 81 percent of the registered Federal Inspection Service (Serviço de Inspeção Federal; SIF) slaughterhouses in Brazil as of 2023, could play an important role in aligning all members around emerging best practice industry standards on traceability.

Beyond individual private sector actor efforts, a number of regional and national initiatives play an important role in driving the adoption of and innovation in traceability and transparency platforms in the cattle supply chain in Brazil (see Box B-4).

The following case studies provide examples of how animal movement tracing systems, combined with traceability and monitoring platforms, are used in practice.

Case study: Sustainable Production of Calves program

Context

In 2016, the Sustainable Trade Initiative (IDH) engaged in a dialogue with the Brazilian beef supply chain actors to understand their vision on how to improve the sustainability of the sector. During 2017, IDH used these insights in developing a program aiming to support small-scale producers of calves in Brazil. In 2018, IDH and Carrefour Brasil Group launched the Sustainable Production of Calves program to support 450 farmers operating calving ranches with more than 135,000 calves in two regions of Mato Grosso (IDH 2021e). The program was designed to provide technical and financial support as well as access to credit to small-scale producers to increase income and include smallholders in the supply chain. Key aspects of the technical assistance model were pasture management, herd nutrition, diversification of incomes, and bankability. Those elements together led to production efficiency and reduced carbon emissions and deforestation pressures. In addition, the program supported farmers in meeting legal requirements such as land title regularization and compliance with the Brazilian Forest Code, including restoration of degraded areas in what should be Permanent Preservation Areas. Beyond improving farmers' lives, the aim was improved calf quality with a resulting increase in productivity and stocking intensity, while accessing new markets with a higher-quality product (IDH 2018). Some of these cattle would then be fully traceable through the supply chain, from birth to slaughter, such as all the animals in the Juruena Valley in the Amazon biome.

More than €3.5 million was invested in this initial project; the Carrefour Brazil Group invested €1.9 million and IDH co-invested €1.6 million. The program was also supported by the Mato Grosso State government, the private sector, and civil society as a contribution to the Produce, Conserve and Include (Produzir, Conservar, Incluir; PCI) Strategy (IDH 2018) and built upon an existing jurisdictional approach implemented by IDH—the Juruena Valley Compact[61]—to improve traceability systems.

BOX B-4 | Cattle traceability and transparency platforms and initiatives in Brazil

Selo Verde. Selo Verde (Green Seal) is the Pará State government's social and environmental traceability platform. It provides data on agricultural production and environmental compliance for more than 250,000 farms registered in Pará's CAR. The platform provides information on the links for indirect suppliers up to five levels upstream.[a]

The Brazilian Roundtable on Sustainable Livestock. In early 2021, the Brazilian Roundtable on Sustainable Livestock (Mesa Brasileira da Pecuária Sustentável; MBPS) launched its Traceability Working Group, which aims to assess existing knowledge and bottlenecks and articulate sectoral needs to advance traceability.[b]

The Working Group on Indirect Suppliers. GTFI was created in 2015 to help tackle the challenges related to indirect suppliers in meatpackers' supply chains (see "Case study: GTFI and Visipec").[c]

Beef on Track. Managed by Imaflora and approved by Brazil's public prosecutor's office, Beef on Track was launched in 2019 to cover some of the remaining gaps in the implementation of the TAC and CPP, including recruiting additional non-signatories to zero-deforestation pledges, and harmonizing monitoring protocols across all signatories. As part of this work, Imaflora developed the Monitoring Protocol for Cattle Suppliers in the Amazon.[d]

The Cerrado Protocol. The Voluntary Monitoring Protocol for Cattle Suppliers in the Cerrado, also known as the Cerrado Protocol, was designed by Proforest and Imaflora, building on Imaflora's experience developing a similar protocol for suppliers in the Brazilian Amazon.[e]

The Protocol for Sustainable Production of Calves. Launched in 2022, the protocol aims to enroll a million breeding calves originating in Mato Grosso and Pará States in a pilot blockchain-driven system designed to verify socially and environmentally responsible calf production, beginning at birth and traced to the direct supplying farms selling to slaughterhouses. The plan is to include seven million animals in the platform by 2030. Supported by IDH (the Sustainable Trade Initiative), the Brazilian Confederation of Agriculture and Livestock (Confederação da Agricultura e Pecuária; CNA) manages the initiative, validates field information against official data from the Ministry of Agriculture (MAPA), and verifies if the protocol guidance is being met. The system does not share participating farmers' data with other supply chain actors due to data protection legislation. The process is audited by TÜV Rheinland.[f]

Sources: a. Brabo 2021; b. See the homepage of the GTPS traceability working group for more information: https://pecuariasustentavel.org.br/grupos-de-trabalho/rastreabilidade/; c. See the homepage of the GTFI for more information: https://gtfi.org.br/; d. See the homepage of Beef on Track for more information: https://www.beefontrack.org/; e. Further information on the Cerrado Protocol can be found here: https://www.cerradoprotocol.net/the-cerrado-protocol; f. IDH 2022a.

Types of information

Information on the date and geolocation of ranch of birth and calf parents was associated with individual calves through ear tags installed after birth at the calving ranches. Each ranch transfer was documented in the system.

All ranches were monitored according to numerous criteria, such as no deforestation (PRODES 2008 onwards), no IBAMA embargo, not within Indigenous lands or within a conservation unit, no slave labor, and other socioenvironmental elements.[62]

Finally, a subset of the cattle passed through a slaughterhouse that packaged the meat with a QR code on the end-product label. This QR code contained information on the final meatpacker name and processing date, as well as every transfer of the animal from birth to slaughter, including the date of sale, and origin and destination site or farm name.[63]

Processes

IDH supported program design and management. The field activities, such as technical support for farmers and animal tagging, were coordinated by NatCap, Agro Jacarezinho, and Acrimat (CDP GPT 2022). Wholechain, a blockchain-based traceability solution, managed these animal-specific data.

Improved information

A portion of the cattle in this program were verified and sold as product not associated with forest loss. In 2021, Carrefour sold its first batch of 100 percent deforestation-free beef in supermarkets, traced from "birth to shelf," with information available to the consumer via a QR code printed on the product's label.[64]

Improved outcomes

In 2022, the program aimed to expand to cover a total of 557 producers breeding more than 190,000 head of cattle, thus covering 210,000 hectares of pastureland and roughly 188,000 hectares of protected area in the Amazon, Cerrado, and Pantanal biomes in Mato Grosso, Brazil (IDH 2022a).

While this program was designed as a prototype in an incubator model, it is being scaled to other municipalities in Mato Grosso and Pará States. It spurred the development of the Protocol for Sustainable Production of Calves. This new protocol, launched in 2022, aims to scale up the program significantly (see Box B-4).

Case study: GTFI and Visipec

Context

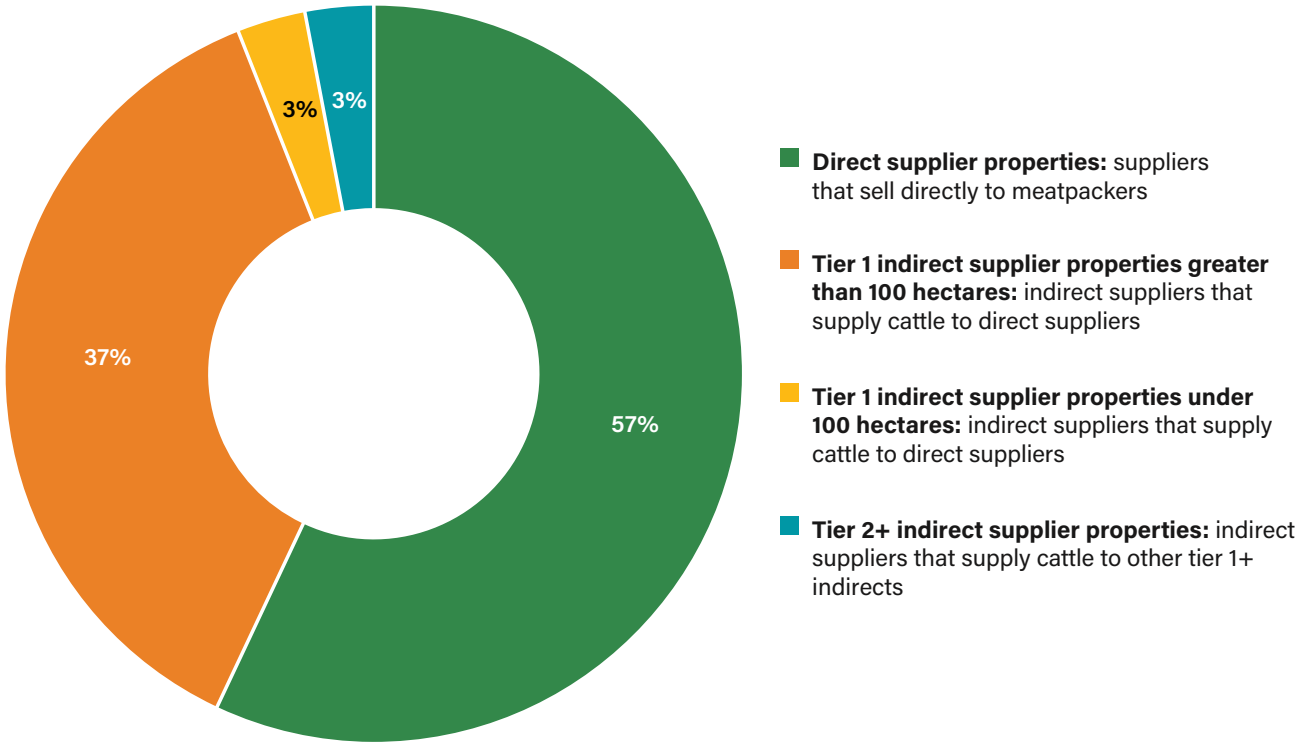
Historically, the systems that major meatpackers set up to trace and monitor suppliers in the Brazilian Amazon covered only direct suppliers, not indirect suppliers.

In part to address this gap, in 2015, the Working Group on Indirect Suppliers (GTFI), a multistakeholder group, was established to align around a common set of definitions and practices for traceability in indirect supply chains. With more than 20 member groups, including the main meatpackers, retailers, monitoring service providers, banks, NGOs, academics, and more, it serves as the main discussion forum for issues relating to tracing and monitoring indirect suppliers in the cattle supply chain in Brazil. In 2019, the GTFI reached a consensus on the "Good Practices for Implementing Monitoring Systems for Indirect Suppliers in the Livestock Chain," which set a cutoff date of August 1, 2019, after which no forest loss associated with cattle production was accepted.

A number of partners including the National Wildlife Federation, the University of Wisconsin-Madison, the International Sustainability Institute, and Amigos da Terra developed the Visipec tool to help meatpackers monitor their indirect suppliers based on the GTFI principles. GTFI member meatpackers monitor their Tier 1 indirect suppliers (as agreed in the Good Practices) by matching CAR and GTA data, though the data go only through 2019 in some Brazilian states due to limitations in access to data after that year.[65] While current monitoring systems that focus on direct suppliers cover 41 percent of deforestation for cattle in the Brazilian Amazon, use of the Visipec tool expands monitoring to Tier 1 indirect suppliers, the last suppliers to direct suppliers of meatpackers, covering an additional 48 percent of the deforestation identified by Visipec by linking the CAR and GTA.[66]

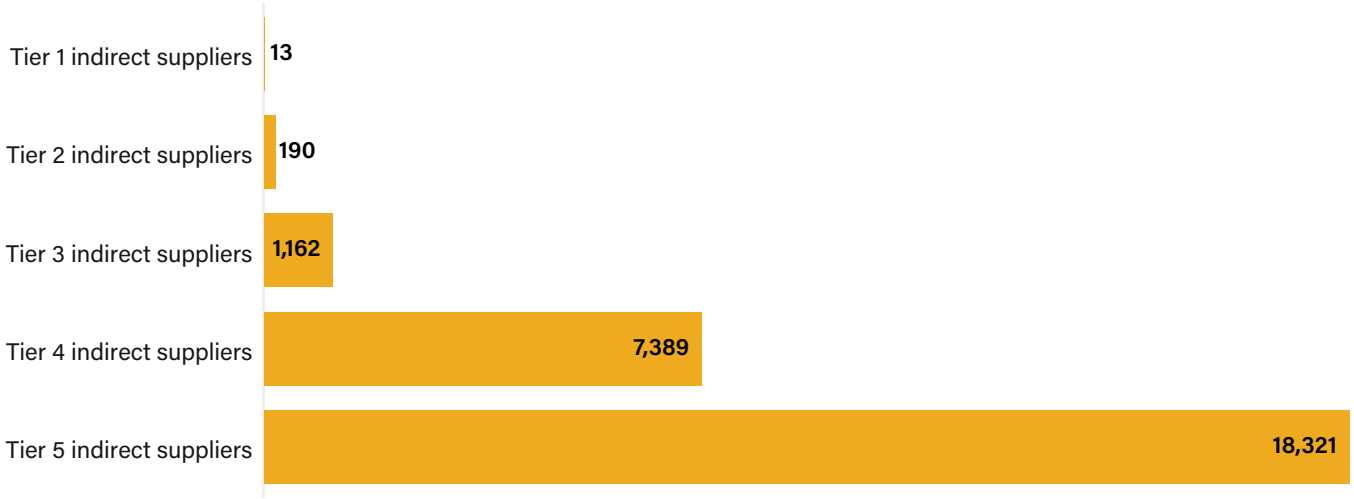
While GTAs can be used to trace multiple sets of transactions among indirect suppliers, starting with a direct supplier and connecting back to all their suppliers and all the suppliers of their suppliers, this can create a universe of thousands or even tens of thousands of supplier properties to monitor and engage with (see Figure B-3). The GTA tool does not allow buyers to distinguish among these many farms, tell which specific farms an individual animal was raised on, or trace an individual animal to farm of origin. As a result, the GTFI and Visipec tool have chosen to trace back to only Tier 1 indirect suppliers. Visipec's analysis in Pará found that 94 percent of remaining forests are located in direct supplier properties or Tier 1 indirect supplier properties greater than 100 hectares (see Figures B-2 and B-4). As a result, Visipec can cover the majority of the remaining forest at risk with inclusion of only Tier 1 indirect suppliers and direct suppliers (GTFI 2022). This approach allows for focused interventions with a much smaller subset of indirect suppliers, which may be in the dozens or hundreds as opposed to thousands.

FIGURE B-2 | Origin of remaining forest in Pará, Brazil



Source: Adapted from GTFI 2022.

FIGURE B-3 | Average number of unique properties that the GTA connects to a single direct supplier in Pará State



Note: Adapted from GTFI 2022, with additional inputs from Nathalie Walker Senior Director, Tropical Forests and Agriculture, National Wildlife Federation.
Source: Adapted from GTFI 2022.

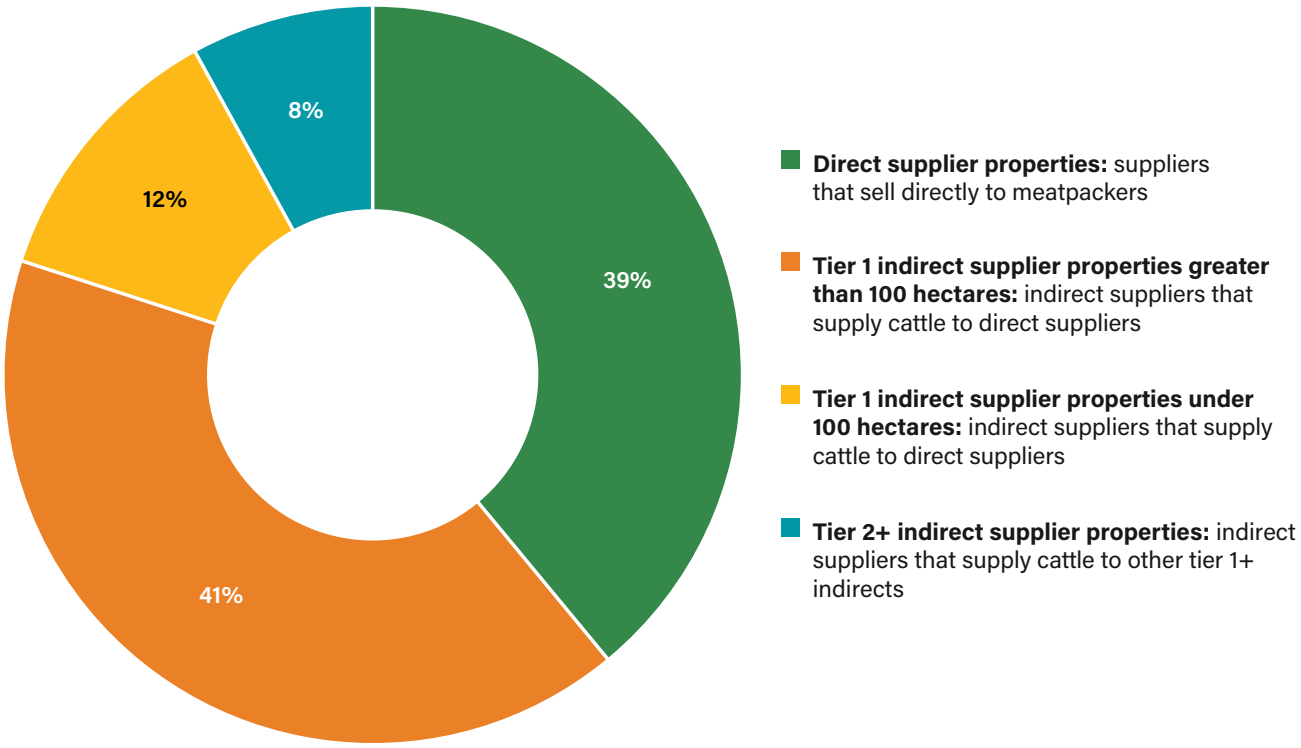
The batch-level GTA traceability data reflect transactions between properties, and therefore the number of ranches that *potentially* supply each direct supplying ranch. Each step back in the supply chain therefore results in a compounding number of potential transactions.

Companies like Marfrig have launched pilot tests with Visipec, integrating the tool with their existing systems for monitoring direct suppliers. To trace its supply chain, Marfrig has asked its direct suppliers to provide details on Marfrig's indirect suppliers. Cattle ranchers who will not share this information are blocked from sales to Marfrig, until the data are made available and the ranchers commit to Marfrig's environmental commitments.

Improved information and outcomes

To date, meatpackers have not made publicly available many results linked to the use of Visipec, though Minerva has shared summary results of its initial testing of the tool (Minerva Foods 2021). However, Visipec's aggregated results from an analysis of 12 meatpackers were shared with the GTFI in April 2023, and highlighted that just 1 percent of indirect suppliers were responsible for "contaminating" half of the noncompliant volume. The GTFI agreed to use these results to support collective efforts to facilitate rancher compliance with the GTFI Good Practices (Walker 2023).

FIGURE B-4 | Origin of cattle-related deforestation in Pará, Brazil



Source: Adapted from GTFI 2022.

Conclusions

A lack of publicly available data has limited progress made by meatpackers through top-down approaches.

While the major meatpackers have been successful in tracing 100 percent of their direct suppliers, there has been only limited progress in tracing indirect suppliers, with insufficient evidence of traceability to origin. Traceability and monitoring systems largely remain in private ownership, limiting access, or are not integrated. There is only one system in the public domain in Brazil, Selo Verde, and it covers only Pará State. There are no publicly available systems that link CAR and GTA data across multiple transactions for the entire Brazilian cattle supply chain. Systems developed by individual actors or small consortia remain limited in reach in part because data remain siloed or are not shared across actors.

Bottom-up approaches using individual ear tagging show that traceability is possible but lacks scale.

The initiatives described show that individual ear tagging can be done, even if the reach of existing projects is limited.

Brazil's herd consists of 217 million animals, and individual tagging systems have been seen by some actors as costly and unnecessary. While individual animal traceability is required for some export markets, most of Brazil's cattle are produced to meet domestic demand; in 2020, just over one-quarter of meat was exported while three-quarters was for domestic consumption. As a result, there has been little demand for individual cattle tagging.

SISBOV uses individual animal tagging in Brazil and, if combined with CAR and required from date of birth, SISBOV data could be used to monitor properties for deforestation. However, it is a voluntary system, except for exporting producers, and a very small percentage of Brazil's cattle herd are registered via this system. Only a few thousand farms have pursued SISBOV certification—largely those farms exporting to the EU—out of millions of cattle farms. Even those animals that are individually tagged under the SISBOV system may be tagged at the last fattening ranch before export since the system requires tracking for only the last 90 days of movement of animals, rather than from the calving ranch, so the tool cannot effectively be used to track animals from birth to slaughter. Adaptations to the system, requiring registration at the birth farm combined with expansion of the program, either through mandatory requirements or spurred by incentives for voluntary adoption, could increase SISBOV's utility for sustainability monitoring.

This, combined with upscaling other traceability efforts such as the Protocol for Sustainable Production of Calves, could allow for increased traceability of the Brazil cattle supply chain to farm of origin. However, until individual ear tagging is in place, systems reliant on batch tagging will need to be advanced.

Collaborative efforts to align on definitions and protocols have played an important role and should be expanded.

Various commitments and collaboration efforts have gained traction and expanded geographically within Brazil. These include efforts led by regional governments, civil society, and retailers sensitive to market pressure.

Where there has been greater collaboration across major meatpackers there has been progress, for instance, with the Public Commitment on Cattle Ranching, Beef on Track, and monitoring protocols, which all include an important traceability and transparency component.

However, individual approaches still make up the majority of interventions. More focus should be placed on harmonization and alignment, and on working collaboratively across actors in the sector.

Availability of public datasets on environmental and social conditions at the farm level and for animal transport has been essential, but lack of integration is a barrier.

Access to government-held data including farm geolocation and legal status, land use change, producer names to check for cases of slave labor, and animal transportation information has facilitated and supported the cattle sector in Brazil to monitor legality and forest loss compliance but availability remains limited.

While some stakeholders may push for total transparency of government data, such as GTA and CAR data being released into the public domain, partial disclosure may be sufficient for traceability. For example, personal and sensitive data can be protected under strict access protocols, as Selo Verde and Visipec have done, while still sharing information to support compliance monitoring.

Greater integration of and access to existing government-provided data systems for monitoring cattle can enable effective monitoring at scale. Governments can help address the information gap occurring when data are scattered among various

agencies and departments in the public sector. For example, even when government data are available, systems could be further improved to allow integration of relevant datasets and information flows across state and federal agencies. This could be integrated into a publicly available, centralized traceability and transparency platform that incorporates data on property-level legal compliance, embargoes and fines, animal movement data, and deforestation monitoring.

Investments are needed for progress in harmonizing systems, digitizing systems, scaling up pilots, and enabling wider rollout.

The private and public sector platforms and initiatives described above have helped align expectations and approaches, as well as reporting frameworks, so that both producers and consumers of cattle products have confidence in the quality of traceability and monitoring approaches. Where there has been harmonization and alignment of systems and rules on traceability through collaborative approaches, systems have been able to improve monitoring and reduce forest loss risk.

However, to achieve broader impact and scale up implementation, more investment is needed. Processes require funding for engagement, alignment, and building trust among actors.

Governments in particular can help address the information gap occurring when data are scattered among various actors in the public, private, and civil society sectors. The lack of efficient information flows and exchange across multiple sector actors limits effective policy design and interventions. Rather than creating new systems, the focus can be on strengthening the linkages of existing systems, protocols, datasets, and certifications across both the public and private sectors. Trade organizations can be important partners to support these efforts.

Incentives and support can spur farmers to opt in to voluntary traceability and transparency systems.

Corporate traceability systems that rely on voluntary self-reporting by suppliers are vulnerable to incomplete or false reporting by ranchers who may withhold information that could impede their access to the market. As a result, the opt-in systems cannot comprehensively assess a meatpacker's supply chain without the permission of its upstream suppliers.

Programs should consider complementing the continuous engagement with and capacity building of farmers to incorporate producer needs and build trust. Working with national organizations that work directly with rural agricultural producers can help significantly scale programs' reach and impact. An example of this is the Protocol for Sustainable Production of Calves in Brazil, which will grow with the support of the Brazilian Confederation of Agriculture and Livestock (CNA), which represents and organizes Brazilian rural producers. Forging this partnership has led to significantly expanded goals for cattle traceability in Brazil, with the aim of initially enrolling a million calves in the program.

Existing government initiatives and jurisdictional approaches create a favorable environment for further progress on traceability. The Sustainable Production of Calves program was able to build on the PCI Strategy and Juruena Valley Compact to improve traceability systems. These programs often have already laid groundwork for participation by ranchers in efforts to increase yields, reduce costs, increase revenue, and comply with legal and market demands.

Strengthened verification and control mechanisms are needed.

It is important to consider how private sector commitments and traceability and transparency systems can be effectively implemented and monitored across all types of data generated. This requires verification mechanisms of data quality and accuracy, especially with the opportunities for fraud and incomplete reporting if systems do not include a robust validation mechanism. This applies both to paper-based and electronic systems, and in particular systems that rely on self-reporting. The existing traceability systems in Brazil can be subject to fraud. Paper-based GTA documents can be manipulated. Monitoring systems built upon the GTA require that producers register moves between farms. Some ranchers may avoid registering moves between farms to avoid being blocked as a "risky supplier" to meatpackers. A seller may also change cattle registration data to mask their origin to engage in "cattle laundering" (EIA 2022). Cattle production that is not documented may continue inside protected areas or Indigenous territories.

Voluntary measures cover a limited part of the sector, preventing wider impact.

The largest meatpackers engaged in the "visible" economy have taken voluntary measures to set up traceability and monitoring systems beyond the Amazon and beyond direct suppliers. Large meatpackers can benefit from increased traceability, as it can lead to higher-quality sourcing and compliance with legal requirements. Traceability can also support

market differentiation by providing more information on the socioenvironmental impacts of cattle production, which is of increasing importance to a subset of retail supermarket chains and their consumers, though their market share accounts for only a quarter of production.

However, other meatpackers may see little value in these benefits, thus these requirements do not reach all the cattle produced for domestic consumption. Given the lack of domestic requirements for traceability, and, at present, a lack of consumer and regulatory pressures from other markets, the majority of the sector has no financial or regulatory pressure to adopt strong traceability protocols. This is particularly true for the portion of the production chain constituted by smaller actors, typically operating locally and informally. Furthermore, some of these smaller actors are unregulated and clandestine meatpackers serving local markets (Walker et al. 2013); these slaughterhouses may choose not to record animal transit transactions with state agencies, as the seller pays a fee and the slaughterhouse may be taxed. To fully address deforestation risk from the cattle sector, increased effort should be made, including by the government and industry associations, to improve and enhance traceability by and for the domestic market.

To move the sector toward full traceability, more slaughterhouses will need to voluntarily adopt strong traceability systems for their entire supply chains and across all their sourcing regions, or regulation will be needed to create a level playing field by mandating requirements for all slaughterhouses.

APPENDIX C. CHALLENGES OF FIRST-MILE DATA: LESSONS FROM THE PALM OIL SECTOR IN SOUTHEAST ASIA

The issue

In complex supply chains, gathering data on the origin of a particular commodity is not always easy or straightforward. This appendix explores the challenges of collecting and using "first-mile data"[67] related to smallholders and considers scenarios in which these data may be necessary for supply chain actors. Lessons are drawn from the palm oil sector due to the advancements made in this area by industry and producing governments.

This appendix includes three case studies that explore company efforts to achieve full traceability to farm level: **Musim Mas** in Indonesia and **Sime Darby** and **AAK** globally.

The context

Starting in the early 2010s, public campaigns led to the adoption of "No Deforestation, No Peat, No Exploitation" policies by the vast majority of global palm oil refiners and traders, as well as pledges to reach 100 percent traceability to origin or place of production, known as traceability to plantation (TTP), for all oil palm fruit. These first-mile TTP data document origin—at either estate or farm—before the product reaches a mill. Achieving TTP allows downstream buyers to link sustainability impacts and attributes to production; monitor plantations and associated plasma, or scheme, smallholders[68] for deforestation and compliance with NDPE policies; and prioritize the highest-deforestation-risk smallholder production areas and plantations for capacity building and technical support.

Despite these TTP pledges, CDP's 2021 reporting overview of the palm oil sector found that only 4 percent of companies reported fully tracing their palm oil to plantation, indicating the complexity and challenges of the task of reaching full traceability.

Approaches to traceability and transparency: Overview and case studies

The palm oil sector has seen significant progress in documenting and making publicly available first-mile data for oil palm fruit originating from plantations. There is general agreement in the sector about the level of geolocation data required to

achieve TTP for plantations: ownership data and full polygon (boundary) data are necessary to monitor the production base for sustainability impacts. Many palm oil traders, processors, and refiners, as well as downstream brands, are now publishing TTP first-mile data on supplying estates.

However, it remains challenging to document first-mile data for oil palm fruit reaching mills from smallholder farms, particularly for independent smallholders, which make up a substantial portion of palm oil producers in Malaysia and Indonesia.[69] A number of palm oil traders, processors, and refiners are reporting on their progress in capturing these TTP data. However, it can be challenging to compare company reporting due to differences in how companies define TTP, and the level of detail required to claim TTP documentation, as TTP data requirements for geolocation for independent smallholders vary across industry actors. Some buyers require GPS coordinates of a point within the farm (but not the full farm boundary data); other buyers document the GPS coordinates of only the nearest village.

Tracing to independent smallholders can be a time-consuming, challenging, and resource-intensive process. This is because some mills source oil palm fruits from intermediaries that buy from and mix oil palm fruits from various smallholder farmers; these intermediaries are often not formally registered in any system. Furthermore, these transactions are unregulated and unregistered. Independent smallholders lack unique identification, which allows buyers to trace and verify the origin, legality, and sustainability of oil palm cultivation. Ever-changing, dynamic, and informal selling relationships, combined with limited data collection and self-declaration, make traceability to origin difficult (EFI 2022). Small-scale digital traceability solutions are being piloted by various palm oil buyers to formalize the sector and enhance traceability, but none are yet scaled up across entire supply chains.

Individual supply chain actors are driving most TTP initiatives focused on independent smallholders, in part due to the absence of government-led palm oil traceability systems or limited use of these systems by smallholders.

- The Indonesia Sustainable Palm Oil standard was introduced by the government of Indonesia in 2011 and primarily aligns with legal and regulatory requirements. ISPO is a required government standard but currently does not provide formal guidance for the implementation of traceability. Without a national-level traceability system, private sector actors and civil society have been leading efforts to trace fresh fruit bunches (FFBs) and crude palm oil to origin within individual supply initiatives (Nurfatriani et al. 2022).
- In Malaysia, traceability has been integrated into the government-managed Malaysian Sustainable Palm Oil certification scheme, launched in 2013. MSPO is a required government certification for all oil palm plantations, independent and organized smallholdings, and palm oil mills. As of mid-2020, one-quarter of the smallholders had been certified under MSPO (Yap et al. 2021). The MSPO Trace traceability module integrates data from a certification module and traceability information (supplier, buyer databases, and transaction records), which connects the entire value chain from the plantations onwards to milling, refining, processing, and manufacturing facilities. The traceability module also works with the MSPO logo module as the key to traceability.[70]

In 2020, ISPO certification covered 32 percent of Indonesia's total mature production area and MSPO certification covered 98 percent of Malaysia's licensed planted area. However, these proportions alone do not give an accurate picture of the progress in rolling out ISPO and MSPO certification. As of July 2020, ISPO and MSPO certification covered 5.5 million and 5.1 million hectares, respectively, meaning that, despite its lower proportional coverage, ISPO certification covered a larger production area.

Companies operating in Indonesia and Malaysia face some similar and some different challenges in reaching TTP for independent smallholders, as evidenced by the examples of TTP efforts within Musim Mas's supply chains in Indonesia (see "Case study: TTP in Musim Mas's supply chain") and AAK's and Sime Darby's global supply chains, including efforts in Malaysia (see "Case study: TTP in AAK's supply chain" and "Case study: TTP in Sime Darby's supply chain"). Companies like Musim Mas, Sime Darby, AAK, and others rely on a suite of data sources, tools, technical service providers, and initiatives that support traceability and related transparency in the palm oil supply chain. Some of the most prevalent ones are described below.

Origin

There are several publicly available tools that support mapping and monitoring supply chains for land use change at origin, including palm oil concessions and surrounding landscapes:

- GeoRSPO (global, RSPO member concessions only)

- GFW (palm oil concession data are available only for certain concessions in Indonesia; Sarawak, Malaysia; Liberia; Republic of Congo; and Cameroon)
- Kepo Hutan (Indonesia)
- Nusantara Atlas (Sumatra, Borneo, Kalimantan, and New Guinea)

Palm oil traders typically rely on one of a small number of monitoring services to evaluate their supply chains for deforestation:

- Satelligence monitoring system, integrating radar and optical satellite data
- MapHubs Palmoil.io, which integrates information on crushers and refineries, over 2,000 mills, over 4,000 palm oil concessions, and over 100,000 supply chain relationships
- Earthqualizer Supplier Group Monitoring Program and the Transform Platform, which as of 2021 covered 3,600 concessions in Indonesia, 3,400 concessions in Malaysia, and 52 concessions in Papua New Guinea, managed by 700 corporate groups

Tracing value chain steps

The Universal Mill list, available via GFW and created through a multistakeholder effort, harmonized the names, certification statuses, and geolocations of over 2,000 global palm oil mills, each one allocated a unique mill ID, to ensure standardized reporting across private sector actors.

There are a number of certification schemes available to trace palm oil through the supply chain:

- MSPO, which offers the MSPO Trace website, which provides information for all certified entities, from oil palm plantings down the supply chain
- RSPO, which offers PalmTrace, which tracks volumes sold as physical oil or as RSPO Credits
- Other certification schemes that track volumes include the International Sustainability & Carbon Certification (ISCC) and Roundtable on Sustainable Biomaterials (RSB)

A number of private sector tools facilitate traceability documentation down to the farm or village level, typically requiring either palm oil buyers or sellers (e.g., farmers, agents, mills) to document information. The following are a few of the most used tools:

- Koltiva KoltiTrace, which supports farm mapping, farm profiling, digital finance, and tracking of every transaction from farm to mill
- OPTEL GeoTraceability software, which supports companies in collecting data on their smallholder farmers and transactions
- PemPem, which supports farm mapping, provides payment solutions for smallholder farmers, and produces real-time traceability data
- The RCA-TTP Portal, which pools mill-level TTP data in a database used for reporting to multiple supply chain downstream buyers

In addition to digital traceability apps and data platforms, which rely on inputs by farmers, agents, or NGO and company staff, there are emerging traceability methods that rely on automated digital information capture. An example is Orbital Insight, which uses GPS technology to track FFB delivery trucks from mills all the way back to the village of origin.

Linking to sustainability characteristics

The NDPE Implementation Reporting Framework, or NDPE IRF, is one of the most widely used tools for palm oil sector actors to report on the sustainability impacts of their supply volumes. Developed by the Palm Oil Collaboration Group, consisting of more than 30 companies from the palm oil supply chain (including producers, refiners, traders, manufacturers, and retailers), the tool allows these companies to report on the percentage of volumes that are traceable and meeting No Deforestation, No Peat, No Exploitation principles, as defined through the framework.

Data published by private sector actors are also used by NGOs to monitor progress in the sector, through tools such as WWF Scorecards; Forest 500; the Palm Oil Transparency Coalition's first importers assessment; and SPOTT's transparency assessments of 100 palm oil producers, processors, and traders. In addition, there are a number of global, multicommodity frameworks for reporting on the sustainability impacts of palm oil production and trade (such as CDP Forests) as well as multicommodity tools for tracing risk (such as Trase).

Outside of public sector systems and certification, most traceability reporting is occurring at the refinery level, and also at the mill level for integrated actors. Refineries now publish traceability reports to mills, using the harmonized Universal Mill List unique mill ID; mills often publish their own reports on

TTP, listing the names and percentage volumes from all supplying estates, as well as percentage volumes from scheme smallholders and others (such as agents).

Case study: TTP in Musim Mas's supply chain

Context

Musim Mas is one of the world's largest palm oil companies, with operations in 13 countries. It was the first major oil palm group to reach 100 percent RSPO certification for all its managed plantations in Indonesia (in 2012) and the first major oil palm group to be verified by the Palm Oil Innovation Group. Its main operations are in Indonesia, where 40 percent of Musim Mas's supply originates from smallholders.[71]

Given the volumes provided from independent smallholders, Musim Mas has been designing programs since 2015 to both improve livelihoods and allow smallholders to produce sustainably (Musim Mas 2021c). Some examples include deployment of its smallholder hubs in multiple locations,[72] a program with the International Finance Corporation in North Sumatra and Riau to provide smallholder access to financing and legal land titles and help smallholders seeking certification under the ISPO standard (Musim Mas 2021c; Setiawati et al. 2022). By 2025, Musim Mas aims to achieve 100 percent traceability to suppliers' plantations, including to independent smallholders, using a risk-based traceability approach (Musim Mas 2021a). The company also plans to have a supply chain verified as 100 percent free of forest loss by 2025.

Types of information

Musim Mas currently monitors 9.2 million hectares of supplier concessions for deforestation with monitoring partner Earthqualizer. For a plantation to be considered traceable, the company name, plantation name, plantation map, and size of the concessions must be provided.

Musim Mas also requests the boundaries of supplying smallholders and out-growers, if available, to ensure that these do not overlap with designated conservation and peat areas. For smallholders to be considered traceable, the farm's location with the size of the farm or the village name where the farm is located must be provided (Musim Mas 2021a). To date, Musim Mas has used the data on independent smallholder suppliers to track and monitor deforestation and engage in select outreach accordingly, though this does not comprehensively cover 100 percent of smallholder sourcing. In addition, Musim Mas has deployed the radar-based deforestation system (RADD) in part to identify smallholder-driven deforestation, launching field verification pilots in Aceh and Riau in 2021.

Musim Mas reached 100 percent TTP for the FFB supply base of its managed mills in 2020; it reached 93 percent TTP for third-party mills in 2021 and aims to reach 100 percent by 2025 (Musim Mas 2021a).

Processes

Musim Mas uses one of two approaches to gather data on TTP for independent smallholders; one is the "ideal" approach and the other is the "supply shed" approach. For either, the supplying farmer data are first gathered from agents, cooperatives, farmer groups, or local traders selling to Musim Mas mills; volumes are allocated to each farmer. Musim Mas's traceability and supplier engagement team then goes into the field to verify data and capture geocoordinates. When Musim Mas staff verify the farmer information, they also verify the farm's legality status.

- For the ideal approach, every farmer would be mapped. However, the data are time-consuming to both gather and verify, given that data provided by agents may be inaccurate or inconsistent. Musim Mas has found that it takes about nine months to map the 6,000–8,000 independent smallholders supplying to an individual mill. Even after data have been verified, they can become outdated and inaccurate if land rights are sold.
- Due to the extensive time and cost associated with tracing each individual farm, Musim Mas has adopted a risk-based supply shed farmer verification approach. The farmer data are organized by village, and in each village the total area planted in oil palm is identified and then mapped against a landscape map to look for overlap with protected areas and peatlands. Those farmers are selected for data verification via field verification programs and ground truthing. Musim Mas estimates that this risk-based approach is three times as fast and 13 times cheaper to deploy than the ideal approach.[73]

If mapping and field verification show that FFBs are produced within no-go areas, the mills are given a list of these regions, and must reject those sources of FFBs at the mill (Musim Mas 2021b).[74] Musim Mas recently developed an "augmented village-based traceability approach," integrating all of these data (village boundary data with data on peat and conservation areas) alongside maps of palm-planted areas available via

official or open-access sources. When the palm-planted area in a village overlaps with no-go areas by more than 10 percent, it triggers further investigation (Musim Mas 2021b). This allows Musim Mas to screen out false positives, where there has been clearing in peat and conservation areas, but for non-palm oil purposes.

Musim Mas manages its traceability data in-house; the data also undergo independent verification.

Improved information

Musim Mas reports on the number of independent smallholders trained (and hectares of farms managed by those farmers) for each of its mills (Musim Mas 2023), but does not report on the percent TTP for each mill.

Increased TTP allows for improved claims related to sourcing of and reporting related to verified deforestation-free palm oil for each refinery, including through the Implementation Reporting Framework. Musim Mas publishes IRF profiles for all its refineries. Refinery data also include volumes sourced from, and names and locations of, managed mills, third-party direct mills, and third-party indirect mills.

Improved outcomes

Musim Mas has used the TTP data (to estates and scheme smallholders) to proactively monitor its supply chain for deforestation, development on peat, and fires, leading to early interventions. Confirmed cases of noncompliance in its supply chain trigger its grievance mechanism.

TTP data for independent smallholder farms have been used to monitor for encroachment into protected areas and no-go zones, with a focus on preventing illegal deforestation and conversion in the smallholder supply base. Musim Mas has used its TTP data for smallholders to identify specific protected areas in high-risk regions, such as the Leuser Ecosystem in the Aceh Timur District in Aceh, and engage its suppliers to ensure that agents are not sourcing from within those areas (Musim Mas 2019). The company also uses TTP data to identify where smallholders are found to be in noncompliance due to harvesting fresh fruit bunches within conservation areas or from palms planted illegally after the cutoff dates in peat and forest moratorium areas. Musim Mas reports that it excludes these smallholder supplies from the supply chain until the smallholders have committed to end encroachment into peat and conservation areas, consistent with the Musim Mas NDPE policy (Musim Mas 2021b).

In addition, the data are used to develop or support programs targeting independent smallholders on issues related to increased yields, good agricultural practices, and NDPE practices.[75]

Case study: TTP in Sime Darby's supply chain

Sime Darby is the world's largest producer of certified sustainable palm oil. The company has its own managed estates in Malaysia, Indonesia, Papua New Guinea, and the Solomon Islands, and sources from third-party mills for its refineries. In 2021, Sime Darby sourced from more than 1,200 suppliers, including mills, traders, and refiners; roughly 55 percent of its volumes originated from Malaysia, nearly 25 percent from Indonesia, and 11 percent from Papua New Guinea, with the remainder from Thailand, the Solomon Islands, Colombia, Honduras, Guatemala, Costa Rica, Brazil, and Cambodia. Nearly half of its FFBs were sourced from its own plantations, with the rest sourced from external plantations and other sources.[76] The company aims to be fully traceable to plantation by 2025.

Types of information

Sime Darby defines a supplier as traceable to plantation if the following information is known: company name, plantation/smallholder name, and location (address, coordinates, or map).[77] It then monitors these concessions and scheme smallholders for forest loss. As of March 2022, Sime Darby had traced 71.2 percent of its global supply chain to plantation.[78] Sime Darby uses these traceability data to assess compliance with its zero-deforestation commitments aligned with the IRF; as of the first quarter of 2022, 64 percent of its global volumes complied (Sime Darby 2022).

Processes

Sime Darby uses Earthqualizer (through partner AidEnvironment), which provides deforestation monitoring at the concession level. Sime Darby acts on deforestation alerts within concessions using its grievance system.

Improved information

Sime Darby publishes its lists of supplying mills for each refinery and palm kernel crusher. It also publishes its traceability data on a publicly available tool called Crosscheck, which includes Sime Darby plantation mill locations and estate boundaries; smallholder boundaries in Indonesia, Papua New Guinea, and the Solomon Islands; and Malaysia outside crop

providers. Sime Darby publishes its percent traceability to plantation for each refinery on a biannual basis. In addition, the company uses the TTP data to produce its NDPE IRF profiles for each refinery and to report on the percentage of volumes from its supplying mills that are "delivering" zero-deforestation oil consistent with NDPE principles.

Improved outcomes

Sime Darby uses the TTP data, combined with deforestation monitoring, to respond to noncompliance, work with suppliers to develop action plans and cease deforestation, or suspend suppliers. For example, tracing its supply base has allowed Sime Darby to detect more than 32,000 hectares of potential forest and peatland clearing from its suppliers. With these data, the company can engage the suppliers, work to halt the deforestation, and actively monitor these estates for ongoing clearance.[79]

Case study: TTP in AAK's supply chain

AAK plays a different role in the palm oil ecosystem compared with companies like Sime Darby and Musim Mas, which buy directly from mills. Only about 20 percent of AAK's global palm oil volumes are sourced directly from mills—primarily in Mexico and Colombia where AAK operates its own refiners. However, 80 percent of its volumes originate from Tier 1 refiners such as Cargill, ISF, Mewah, Musim Mas, and Golden Agri Resources.[80] By 2025, the company aims to be fully traceable to plantation, and 100 percent verified deforestation-free.[81]

Types of information

AAK works in partnership with its suppliers at the refinery level to advance TTP, beginning with mill and dealer outreach in high-risk regions. AAK requires its suppliers to demonstrate that their TTP protocols and definitions align with AAK's, and then submit their TTP figures (as opposed to full datasets). While in Indonesia, AAK's suppliers are often able to secure TTP data to origin; AAK's suppliers have found that dealers in Malaysia are generally hesitant to disclose data on their supplying smallholders as they consider themselves competitors to the very mills they supply with FFBs (AAK 2022). As a result, in Malaysia, it relies on a risk-calibrated approach to TTP to map smallholders to the village unit only (AAK 2022). Proforest supports AAK and select suppliers in this risk-calibrated approach to mapping in Malaysia. In addition, AAK aims to rely on the MSPO's program to ensure certification including dealers to close the existing traceability information gaps related to dealer sourcing.

By the first half of 2022, AAK had reached 84 percent TTP across its global supply chain and 70 percent of AAK's volumes were verified deforestation-free.[82]

Processes

Earthqualizer and Satelligence provide near-real-time access to deforestation alerts via satellite monitoring of AAK's global concession supply base.

Improved information

AAK has not yet published a series of IRF profiles for its supplying refineries. It publishes its supplying mill list based on information provided by its Tier 1 suppliers.

Improved outcomes

AAK uses TTP data, combined with deforestation monitoring, to respond to noncompliance, work with suppliers to develop action plans and cease deforestation, or suspend suppliers.

Conclusions

Data gaps remain, but where data exist, quick interventions can address forest loss.

Data gaps persist at different scales, making TTP challenging and resource intensive to achieve. These data gaps include the following:

- Absence of complete, accurate, and updated farm/smallholder registration systems, including details on legality of land title
- Absence of geo-referenced farm data for smallholder producers
- Absence of formal registration data for unregulated intermediaries, like agents, in the supply chain
- Lack of accurate documentation of transactions between farmers and agents/intermediaries
- Lack of accurate and complete concession data in public domain

However, where they exist, TTP data combined with deforestation monitoring allow buyers to quickly identify noncompliance with their sustainability commitments—particularly in relation to zero deforestation. Deforestation alerts linked to production estates have allowed buyers to investigate potential noncompliance and work with suppliers to develop action plans and

cease deforestation. This has been part of the sector's success in seeing drastic reductions in deforestation for palm oil in Southeast Asia in recent years.

Combined data from the private sector, civil society, and certification bodies can be used to monitor land use change, but official comprehensive concession maps would facilitate traceability.

Most origin data are accessible via private sector actors, NGOs, and certification bodies only—not through public sector sources. While there are a number of available origin data tools in the public domain, none of them contain comprehensive, official datasets of oil palm concessions across the producing landscape.

Supply chain actors have relied on a combination of data sources such as publicly available concession data from the Roundtable on Sustainable Palm Oil and Global Forest Watch with data from satellite monitoring service providers and data collected directly from suppliers to map out supply chains. As a result, companies have high degrees of confidence in their ability to monitor their supplying estates for deforestation, fires, and development on peat.

However, official public sector datasets play an important role in enabling traceability and transparency through datasets on land use, land use change, rural property registration, land titling, and trade.

There is no integrated large-scale approach that enables effective monitoring of forest cover on smallholder farms.

Most of the data captured on TTP to scheme and independent smallholders are not integrated into deforestation monitoring systems. There is not yet a workable large-scale model of how to act on the TTP data collected to effectively monitor smallholder-driven deforestation. Instead, the data are primarily used to develop capacity-building programs to improve farmer livelihoods and sustainability practices, which aim to reduce the pressures on existing forests and protected areas. It is not yet clear how trends in deforestation in smallholder-dominated landscapes are changing as a result of these capacity-building programs in high-risk regions.

In addition, not all forest clearance in smallholder-dominated landscapes can be linked to oil palm development. By cross-checking clearance against maps of oil palm planted areas, buyers can more effectively determine if the recent clearance was followed by oil palm planting. This allows capacity-building work and landscape-level interventions to be tailored to the context of which drivers are actually contributing to deforestation. This requires developing maps of planted palms, in formats suitable for analysis. This does not yet exist across all oil palm production regions (Musim Mas 2021b).

Government- or private sector–led certification can serve as a lever for TTP, but needs to consider local contexts and specific challenges.

In terms of traceability systems in the public sector, the MSPO in Malaysia is a mandatory requirement for all estates and smallholders, and the system aims to integrate traceability transactions into MSPO Trace for all transactions, beginning at the origin level, through the supply chain, including those conducted through dealers. Once MSPO coverage reaches 100 percent of the oil palm production base in Malaysia, companies sourcing in Malaysia should be able to report 100 percent TTP and confirm that all sourcing meets MSPO sustainability criteria.

In Indonesia, ISPO, while mandatory, does not currently integrate a formal traceability system, meaning that in Indonesia private sector actors will still need to heavily invest in initiatives to reach full traceability. One of the key challenges for achieving TTP in Indonesia relates to documentation of ownership of the land for independent smallholders, which relies on data available due to the registration process in the Regional Plantation Office (Dinas Perkebunan) or National Land Agency (Badan Pertanahan Nasional). However, most independent smallholders are not registered with the government, creating additional work to address these data gaps, such as securing geo-referenced farm data and verifying legality.[83] Furthermore, smallholders may lack evidence of a plantation permit. While smallholder farmers are expected to secure their registration permit/Surat Tanda Daftar Budi Daya (STD-B), which contains the identity of the farmer and farm location, in practice many farmers have not secured their permits. A similar requirement exists within MSPO, and presents similar challenges for supply chain actors in Malaysia.

Certification through RSPO, ISCC, and RSB also offer traceability through chain-of-custody systems. For example, certification through the RSPO offers guarantees of traceability to mills (which receive the production-level certificate). IP RSPO-certified oil originates from a single RSPO-certified IP mill, while Segregated RSPO-certified palm oil may originate from multiple certified mills. Mass balance allows for mixing of certified and uncertified oils; however, uncertified volumes in

mass balance applied at the mill level come from sources that must provide information on the geolocation of FFB origins and proof-of-ownership status. When mass balance is applied at the refinery level, this geolocation information will be lost if mixing with oil from non-RSPO-certified mills occurs.

To date, most traceability efforts have been limited to single supply chain actors, with confidentiality and legal requirements as obstacles to integrated approaches.

In terms of data collection, there are no systems at scale integrating data from multiple supply chain actors. Mostly, individual actors pay for fee-for-service support to trace their own supply chains and track their own data in their own databases. Collaboration is hindered by legal and commercial limitations with respect to the sharing of concession maps and smallholder farm geo-data. There are limited, but growing, opportunities for collaboration at jurisdictional and industry-wide scales and in public-private partnerships (see "Collaboration beyond individual supply chains").

Harmonization of TTP reporting across private sector actors lessens the reporting burden.

Significant time is invested in reporting TTP data through various mechanisms and questionnaires to various buyers. The sector can harmonize TTP reporting standards and frameworks to minimize the reporting burden. More investment is needed in collaborative approaches to data collection, management, and public reporting to support a shift away from individual initiatives.

One example of harmonization of reporting of mills' TTP data is via the Risk-Calibrated Approach TTP Portal, which allows documentation of risk-calibrated traceability to village data from approximately 250 mills feeding into about 50 refineries managed by a half dozen integrated or downstream actors. Mills can then select which downstream buyers have access to these data, making consistent reporting possible across the supply chain. Another example of harmonization, the NDPE IRF, is fast becoming the harmonized industry approach to reporting on sustainability characteristics linked to volumes sourced.

Verification of data and systems is not yet the industry norm and needs to be mainstreamed.

While some companies have begun to verify their data, through partners like Control Union, many others still lack formal verification of their data and systems. This lack of verification along with the fragmented data landscape make effective oversight difficult.

Without data verification, effective implementation and oversight over traceability and transparency systems and company commitments is not possible. There are best practices for data quality assurance and fraud control that need to be implemented by the sector for their efforts to be recognized as valid. This is particularly true in supply chains that involve many actors per volume produced, such as commodities produced by smallholders, and in geographies where land ownership is not regularized and documented.

The public sector can play an important role in supporting private sector traceability targets by

- ensuring that producers, including independent smallholders, are formally registered with secure land titles;
- establishing mandatory certification programs with associated traceability and transparency systems;
- introducing digital systems that trace palm oil sales transactions from the site of production downstream through the supply chain; and
- developing universal traceability databases, potentially hosted by the ministries of agriculture, with independent oversight and supported by a regulatory framework.

At the subnational level, governments could partner with national-level agencies to require registration of informal actors in the supply chain, such as traders, supplemented by resourcing for the accelerated mapping and registering of independent smallholders, so that production permits and identity information could be used to trace the origin of FFBs. Governments could require mills to accept FFBs only when accompanied with origin information.

Approaching 100 percent TTP for independent smallholders is feasible, but requires significant time and resources.

Companies have shown that, even with independent mills, it is possible to trace to smallholder farms. However, significant staffing, time, and financial resources are associated with reaching TTP for independent smallholders, especially for mills with dynamic sourcing models. Even the industry TTP leaders, which have invested significantly in boots-on-the-ground approaches for years, have not yet reached 100 percent TTP. The companies sourcing from smallholders that have reached the highest TTP figures are those that have either in-house teams that travel to the field, or have partnered with partners like Koltiva, with extensive field staff, to do so. This is partly

because even if oil palm agents and intermediaries input data into applications, trained staff must verify the accuracy of the data at that farm level to improve the quality of data capture and remove errors.

Also, TTP mapping captures a snapshot of a dynamic sourcing landscape. The traditional model of tracing supplies to the farm using field staff generates a snapshot of farms and farmer relationships at one moment in time. Data can become outdated due to land transfers and because of the fluidity of selling and buying relationships among independent smallholders and agents, who are not wedded to selling to a specific mill.

Efforts to achieve full traceability should be complemented with a risk-based intervention approach.

Full traceability will remain a goal for some supply chains, but complementary approaches are needed to achieve the end goal of reducing forest loss in high-risk areas. Resources should also be allocated to collective, multistakeholder interventions to reduce deforestation pressures in high-risk areas.

Curbing deforestation in smallholder-dominated landscapes will require coordination across governments, buyers, sellers, consumer-facing brands, and key stakeholders from local communities—as well as other supply chain actors linked to deforestation drivers—to deliver on capacity building, land use planning, ongoing deforestation monitoring, and sustainability interventions in these landscapes.

Funding and financial incentives are needed for more sophisticated data management systems and real-time traceability data collection.

Small and midsize actors in the palm oil sector often lack data tracking and reporting systems. This applies particularly to collection centers and mills, but also to some small palm kernel crushers. They may have immature data management and reporting systems, or may collect inconsistently, introducing errors into the reported data.

The sector needs to move away from static capture to real-time capture of traceability data. Most new tools designed to capture real-time data require accurate inputs into apps by agents and intermediaries, which often resist using new technologies such as apps as they have traditionally relied on limited, paper-based documentation of commercial transactions. Financial incentives are needed to drive uptake of technologies, yet incentives (such as premiums) are limited in the palm oil sector, especially in the case of noncertified volumes. More attention needs to be paid to incentives to change agent behavior. New technologies are more likely to be adopted in contexts where there has already been significant field engagement and capacity building.

Farmers and agents are more likely to adopt new technologies, including apps, and share data after face-to-face meetings and trainings. Building trust through relationships has allowed more consistent use of new technologies and higher-quality data capture, as well as increased the likelihood that potentially commercially sensitive supply chain data are shared.

More funding is also needed to reinforce and update existing data management approaches that work but need to be scaled up or integrated through collective approaches.

TTP efforts remain largely top-down-driven approaches.

The demands for TTP are driving top-down approaches, originating from larger downstream actors that are cascading demands through the supply chain, often to small and midsize actors that do not see obvious benefits from investing in the systems to deliver traceability. In many cases, effective incentives, such as premiums or obvious co-benefits, are not provided to spur development and effective deployment of traceability systems. In fact, formalization of traceability within the sector may lead to detrimental outcomes for upstream actors, such as higher taxation or exclusion from specific markets. The palm oil sector needs to focus more on the development and delivery of incentives to spur traceability by upstream SMEs and smallholders to ensure that the benefits of traceability are shared across the sector.

More resources are also needed to support fresh fruit bunch dealers or intermediaries. Significant resources and capacity-building programs have targeted both mills and smallholders. However, agents have not benefitted from the same level of training, outreach, and capacity building. Yet, they provide services to independent smallholders beyond simply buying and transporting FFBs; in some cases, they harvest FFBs and offer cash advances. The industry needs to better include dealers in outreach and capacity-building programs.

APPENDIX D. WORKING COLLABORATIVELY TO CREATE THE RIGHT ENABLING ENVIRONMENT FOR COLLECTIVE ACTION: LESSONS FROM THE COCOA SECTOR IN WEST AFRICA

The issue

Cocoa supply chains are very complex, from smallholder farmers to cocoa traders to chocolate manufacturers to end users. Farmers often supply to several collectors and processors and through government-controlled commodity boards, with the supply base for one company overlapping with that of another. In such cases, a collaborative, multistakeholder approach is required, which goes beyond individual supply chains, to work together to solve environmental and social issues within the supply chain.

This appendix explores collaborative, multisectoral approaches to achieving traceability and transparency, focusing on the case of the **Cocoa & Forests Initiative** in Ghana and Côte d'Ivoire.

The context

There are complex intersections among forest protection and restoration on one side and cocoa farmers' livelihoods on the other, together with other issues such as child labor. Companies also tend to share the same supply base. This complexity requires a collaborative approach that goes beyond individual company supply chains. Furthermore, the overlap between forest and cocoa production areas, including in agroforestry systems, means that collective action and multistakeholder collaboration might need to be developed and implemented beyond the cocoa sector. Among other initiatives, the CFI in Ghana and Côte d'Ivoire offers a good example of such an approach.

Approaches to traceability and transparency

Over the last few decades, companies have been under increasing pressure from civil society, market requirements, regulations, and, to a certain extent, consumers. There are growing demands for companies to improve their sustainability credentials, reduce their negative environmental and social impacts, and show where they are sourcing their cocoa beans from. Several companies have responded by creating their own programs, aiming to increase traceability and transparency of their supply chains and improve the sustainability of cocoa production. These efforts include avoiding forest and biodiversity loss, eradicating child labor, and ensuring cocoa growers can earn a living income. A focus on livelihoods is particularly important since approximately 90 percent of producers are smallholder farmers with less than five hectares of land (Bermudez et al. 2022a).

Voluntary producer certification standards, such as the Rainforest Alliance Sustainable Agriculture Standard, are commonly used in the cocoa sector, and require traceability systems to be in place. For instance, Ferrero, in its 2020/2021 annual cocoa progress report, claims that 100 percent of its cocoa was "sourced through certification and independently managed sustainability standards." It reports that 96 percent of its cocoa was traceable to the farm level via GPS and 88 percent via polygon mapping (Ferrero 2022a; 2022b; 2022c).

The CFI, launched in 2017, was the first multistakeholder platform involving governments, industry, and cocoa farmers, with civil society organizations added shortly afterward. The initiative developed Joint Frameworks for Action, which were signed by the governments of Côte d'Ivoire and Ghana and leading cocoa and chocolate companies at the November 2017 UN Climate Change Conference in Bonn.[84]

Along with the governments of Côte d'Ivoire and Ghana, the CFI currently includes 35 leading cocoa and chocolate companies (more than three times the 12 initial signatories), with the aim to "end deforestation and restore forest areas." Prac-

tical actions toward the achievement of the initiative's overall objectives include supporting farmers to grow more cocoa on less land, reforesting, and mapping farms to better understand where their cocoa comes from (see Box D-1).

In March 2019, CFI signatory companies published plans with concrete actions to "end cocoa-related deforestation" and strengthen transparency and accountability in the cocoa supply chain. These action plans focus on three pillars: forest protection and restoration; sustainable cocoa production and farmer livelihoods (including "more cocoa on less land"); and community engagement and social inclusion. Since 2020, CFI signatory companies have published individual annual progress reports, which are publicly available, as are progress reports published annually by the governments of Ghana and Côte d'Ivoire.[85]

According to the 2021 CFI annual progress report (published in July 2022), "the government of Côte d'Ivoire has mapped 1 million farmers with 3.2 million ha of cocoa farms, [while] in Ghana a total of 515,762 farmers owning 845,635 farms have been registered in the national Cocoa Management System, accounting for 72 percent of the total cocoa area" (IDH 2022d). Companies reported achieving 72 percent traceability in their direct supply chains, including mapping farmers' individual plots, assigning unique farmer IDs, and actively tracking the cocoa purchased (IDH 2022b).

BOX D-1 | The eight core commitments of the CFI

In line with Sustainable Development Goals 13 (Climate Action) and 15 (Life on Land) and the Paris Climate Agreement, Cocoa & Forests Initiative companies and governments have committed to doing the following:

- **Prohibiting and preventing activities in the cocoa sector that cause or contribute to any further deforestation or forest degradation**—for Côte d'Ivoire, this relates to national parks and reserves, classified forests, and conserved forests in the rural domain, such as sacred forests; for Ghana, this relates to wildlife sanctuaries, wildlife resource reserves, forest reserves, and unprotected off-reserve forest lands
- **Respecting the rights of cocoa farmers**, including identifying and mitigating social risks, and sequencing the implementation of actions to minimize potential adverse social and economic impacts
- **Promoting the effective restoration and long-term conservation** of national parks and reserves, and classified forests in Côte d'Ivoire; and of national parks, wildlife sanctuaries, wildlife resource reserves, forest reserves, and unprotected off-reserve forest lands in Ghana
- **Strengthening supply chain mapping**, with the end goal of full traceability at the farm level
- **Implementing verifiable actions and timebound targets** based on sound data, robust and credible methodologies, stakeholder consultations, and realistic timeframes
- **Implementing agreed-on actions in the context of a broader landscape-level approach**, with strong links to similar initiatives in other commodities, and full alignment with the national REDD+ strategy and other relevant strategies and plans such as the new Ghana Cocoa Sector Development Strategy II and the Ivorian Forest Preservation, Rehabilitation, and Expansion Strategy
- **Working together to implement the framework actions**, and mobilize the necessary financing, resources, and technical support for implementation, including continued engagement in a multistakeholder process for dialogue on key issues; development of effective implementation plans, joint learning, and knowledge sharing; and creation of institutional capacity
- **Providing effective monitoring and reporting** on progress on commitments and actions to ensure transparency and accountability

Source: For more information on the aims of development of the CFI, see its page on the website of the World Cocoa Foundation: https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/.

CFI is facilitated by the World Cocoa Foundation, which focuses on private sector engagement, and IDH (the Sustainable Trade Initiative), which focuses on collaboration with the governments of Ghana and Côte d'Ivoire. Financial partners include the Dutch Ministry of Foreign Affairs, the German Federal Ministry for Economic Cooperation and Development, Partnerships for Forests, and the World Bank. CFI is also collaborating with the Amsterdam Declarations Partnership, Beyond Chocolate, the Dutch Initiative for Sustainable Cocoa, the German Initiative on Sustainable Cocoa, Proforest, the Rainforest Alliance, the Swiss Initiative for Sustainable Cocoa, the Tropical Forest Alliance, WRI, and WWF.[86]

Among others, CFI signatory companies include Barry Callebaut, Cargill Cocoa and Chocolate, Cococo Chocolatiers, the Export Trading Group, Ferrero, General Mills, Godiva Chocolatier, Guittard Chocolate Company, The Hershey Company, Lindt & Sprüngli Group, Marks & Spencer, Mars Wrigley, Mondelēz, Nestlé, Olam Cocoa, Sainsbury's, Starbucks, Touton, Unilever, and J.H. Whittaker & Sons.[87]

Conclusions

Overall, the CFI has been defined as an enabling or umbrella initiative since it provides a framework and governance structure within which institutions can take action. Each stakeholder type has a role to play and responsibilities to fulfill.

Private sector

The reassurance, risk mitigation, and accountability provided by the CFI establishes a trusted environment, making it easier for cocoa and chocolate companies to develop ambitious action plans and then report annually to the World Cocoa Foundation on the progress they have made within their individual cocoa supply chains (see Box D-2).

For example, Cargill sources approximately 60 percent of its cocoa directly and 40 percent indirectly, but it aims to achieve 100 percent traceability from farm to first point of purchase for both its direct and indirect supply chains by 2030. It proposes reaching this goal both by supply chain mapping to the farm level, via GPS farm polygon maps, and first-mile traceability, "tracking which farms and farmers supplied the cocoa beans coming into their direct supply chain" (IDH 2021b). Through its Cargill Cocoa Promise program, the company has implemented a traceability system for its direct supply chain, and "has started to map its indirect supply chain by mapping its first-tier suppliers and then mapping their suppliers, effectively Cargill's second tier suppliers" (IDH 2021b).

Similarly, Barry Callebaut's traceability system focuses on its direct supply chain (approximately 40 percent of its cocoa sourcing). As one of the largest cocoa processors and chocolate manufacturers, it claims that, as of December 2020, it had reached 100 percent traceability to farm for cocoa sourced through its direct supply chain in Ghana (up to Tier 3—farmer cooperatives and farmer communities) and in Côte d'Ivoire (up to Tier 2—farmer cooperatives), while it continues working on traceability in its indirect supply chain (IDH 2021a).

BOX D-2 | Company action plan highlights in 2019

Although the CFI seems to be currently perceived much more like an umbrella or enabling initiative rather than as a delivery mechanism in itself, from a traceability and transparency perspective, CFI signatory companies' action plans, published in March 2019, overall, had the following aims and objectives:

- Improving cocoa traceability from farm to first purchase point with a focus on farm mapping
- Putting in place systems to ensure that no cocoa is sourced from protected areas
- Conducting deforestation risk assessments throughout sourcing areas
- Promoting cocoa agroforestry as a driver of forest restoration and protection
- Supporting farmers in registering trees on their farms and securing land tenure rights
- Investing in sustainable agricultural intensification to grow more cocoa on less land; for example, through training farmers in Good Agriculture Practices, crop nutrition, and soil fertility
- Promoting sustainable livelihoods and income diversification for cocoa farmers
- Promoting financial inclusion to deepen farmers' access to working capital and investment funds
- Scaling up work with communities to protect and restore degraded forests, with a focus on women and youth

Source: IDH 2020a.

However, these private sector claims cannot be validated without the assurance of a national-level traceability system.

Public sector

Tracking cocoa beans and assuring that their production has not been linked to forest loss or degradation requires the combination of two traceability systems: a forest monitoring system and a cocoa tracking system.

The governments of Côte d'Ivoire and Ghana are each developing or have developed forest monitoring systems to regulate the timber trade and track forest loss. The development of these systems has been mainly driven by the EU's FLEGT VPA process in both countries (VPA A-LA 2022).

In Ghana, there is strong engagement and involvement by the Forestry Commission, where the Ghana Wood Tracking System is already being implemented—although it has been created to allow for continuous improvement. The Ghana Cocoa Board is developing the Cocoa Management System as a tracking system in close collaboration with the Forestry Commission. The aim is to link the Ghana Wood Tracking System with the new Cocoa Management System to identify and address forest loss and drivers to assess whether any cocoa beans are linked to forest loss. In Côte d'Ivoire, Le Conseil du Café-Cacao, which has a similar role to the Cocoa Board in Ghana, is still in the very early stages of developing a national cocoa traceability system.

There are currently efforts underway in Ghana to incentivize cocoa farmers, especially smallholders, to disclose data by linking the new national pension scheme to this cocoa tracking system. This would create a financial incentive for farmers to provide accurate cocoa production data, including on hectares and yields, since this information would then be used as the basis for calculating incomes and future pension payments. This positive financial incentive will help mitigate the risk of farmers underreporting volumes produced.

In addition to the CFI, there are also several other initiatives, both in Ghana and Côte d'Ivoire, at the national and/or landscape level that are working to, for example, eliminate forest loss; increase forest cover; improve the sustainability, traceability, and transparency of cocoa supply chains; eliminate child labor; increase farmers' incomes; and improve smallholders' livelihoods, often among additional interlinked objectives. Examples in Côte d'Ivoire include the FAO project "Scaling up cocoa based food systems with transformative innovations in land use and restoration in Côte d'Ivoire" (SCOLUR-CI) in the Cavally, La Mé, Guémon, and Indénie-Djuablin regions; the Forest Investment Program, phase II, which aims to conserve and increase forest stock and improve access to sources of income from sustainable forest management for select communities in target areas; and the "Projet de développement intégré de la chaîne de valeur du Cacao" ("Integrated Cocoa Value Chain Development Project"), which aims to support the sustainable economic, social, and environmental development of, and increase the value-added associated with, the cocoa value chain in Côte d'Ivoire (IDH 2020b; 2021c; 2022c).

Similarly, in Ghana, the CFI works alongside other programs and initiatives including the Ghana Cocoa Forest REDD+ Program (GCFRP), launched in October 2019 (see Box D-3); the Green Ghana Project (Green Ghana Days), launched in June 2021 to restore Ghana's lost forest cover and contribute to the global fight against climate change, aiming to create enhanced nationwide awareness of the necessity for collective action toward restoring degraded landscapes in the country; the Ghana Forest Investment Program; the National Alternative Employment and Livelihood Program; and the community resource management areas (IDH 2020a; 2021d; 2022b).

In particular, the GCFRP works at the landscape level to "significantly reduce carbon emissions resulting from cocoa expansion into forest areas through the promotion of climate smart cocoa production systems to increase cocoa yields and improve rural livelihoods and economies" (NRS n.d.).[88] The program is co-led by the Climate Change Directorate (National REDD+ Secretariat) of the Forestry Commission and Ghana Cocoa Board. Their approach to implementation includes actions on farm shade trees, landscape planning and zoning, rural enterprises, improved governance, and reforestation, among others, in six initial hotspot intervention areas. Among other partners, Olam, Touton, Solidaridad West Africa, Rainforest Alliance, IUCN-Netherlands, and SNV have been involved in this program to help protect and/or restore Ghana's high forest zone, where low-yielding, expansive agricultural practices—predominantly cocoa—coupled with the progressive growth of other extractive industries, like timber production, have led to forest degradation and forest loss.[89]

In Ghana, implementation mechanisms and activities include, but are not limited to, the community resource management area mechanism; payments for ecosystem services and results-based activities; extension and input packages linked to farmers' credit and risk management facilities (e.g., yield index insurance); community-based forest monitoring paired with forest law enforcement; agroforestry and tree planting initiatives; growing cocoa and other tree crops onto appropri-

BOX D-3 | Ghana's Cocoa Forest REDD+ Program

This program seeks to significantly reduce emissions driven by cocoa expansion into forest areas, coupled with illegal logging, whereby over 820,000 ha of forest were lost between 2000 and 2010. Ghana's strategy to achieve these emission reductions across the program area bridges the following interventions, with the clear understanding that no single intervention will yield the expected results on its own:

- Facilitate multistakeholder dialogue and institutional collaboration
- Improve rights and tenure regimes through forward-thinking, innovative implementation of forestry policies to foster a positive change in de facto management of trees and forests
- Link farmers' and farming communities' access to packages of critical farming resources, which work together to improve yields and incomes with their adoption of climate-smart practices on farms and emission reduction management systems across the landscape
- Implement localized landscape-level planning and development of local bylaws to guide sustainable and socio-culturally appropriate use of land, agriculture, and forest resource use and support effective forest law enforcement
- Develop an integrated data management platform and MRV system that supports results-based implementation and monitoring at different scales

Source: For more information on Ghana's Emissions Reductions Program for the Cocoa Forest Mosaic Landscape, see the following summary from the Forest Carbon Partnership: https://www.forestcarbonpartnership.org/system/files/documents/Ghana%20Summary_0.pdf.

ate soils and climate conditions; and implementation of tree tenure and benefit-sharing policy reforms. Therefore, although the main objective of the GCFRP is to "tackle deforestation and forest degradation in the Cocoa Forest Mosaic Landscape," it also aims to catalyze economic, ecological, and socio-political benefits on a scale equal to that of the carbon benefits (Proforest 2021a; 2021b).[90]

Once national traceability and transparency systems for cocoa are developed, they will play an important role by providing a unified system for data management. It will be possible to assess effectiveness only when these systems have been implemented, including to what extent they can prevent and/or address forest loss–related risks linked to cocoa production. However, since poverty seems to be one of the main root causes of cocoa expansion toward forests and protected areas, economic incentives linked to sustainable cocoa production will likely be needed to disincentivize forest loss and degradation along with other support to improve cocoa tree yields.

Multistakeholder collaborative approaches build enabling conditions for other programs.

The CFI operates in the same context as many other public and private sector initiatives in the same landscapes where other programs including the GCFRP are much more focused on implementation. The CFI could be seen as having provided the basis and some of the enabling conditions for other initiatives working on the ground.

In addition, it could also be argued that, especially in Côte d'Ivoire, where the FLEGT-VPA process started later, the CFI might have also contributed to revising and strengthening the national legal framework, particularly with respect to the approval of the Forest Preservation, Rehabilitation, and Extension Policy in 2018, since the CFI is a key component of this strategy led by the Ministry of Water and Forests, and the enactment of the new Forest Code in 2019, as well as regulations for its enforcement. Similarly, Ghana already had a Forest and Wildlife Policy, a National Climate Change Policy (with sectoral actions), a Forestry Development Master Plan, a Forest Plantation Strategy, a Cocoa Sector Development Strategy, and a REDD+ Strategy (as previously mentioned above).

High visibility and government leadership paved the way for other on-the-ground initiatives.

The multistakeholder aspect of the CFI and the formal launch in the context of COP23 contributed to the CFI's high profile. However, due to its setup as an umbrella mechanism to create enabling conditions to address the issues faced in the cocoa sector, it was inevitable that this high-level initiative appears to have a greater impact at the landscape level where there is another initiative working on the ground, including REDD+ related programs. The CFI seems to benefit from working in synergy with other more action-focused initiatives,

which implies that other landscape-focused, action-oriented programs are required to supplement implementation in additional areas to deliver tangible impact.

Clear legal frameworks are an important enabling condition for the development of national-level traceability systems.

The legislative framework is a critical part of the enabling environment. Multistakeholder processes like FLEGT-VPA can support the development of an enabling legislative framework, which can provide important preconditions for national-level traceability systems.

Harmonized approaches can expand the reach and impact of initiatives.

Too much fragmentation and too many initiatives can hinder progress if they are not fully aligned since they can lead to duplication of efforts and leakage. When several initiatives work toward achieving the same objectives, but at different levels and with different stakeholders, there can be efficiencies and an amplification of messages, actions, and impacts.

The governments of Ghana and Côte d'Ivoire are developing national traceability systems. The CFI could have a role to play in supporting the development of such national systems by facilitating and supporting pilot testing with some of its signatory companies as well as sharing supply chain data directly with the governments to contribute to the development and updating of the national traceability system. Similarly, the CFI may also be able to provide an expanded funding mechanism for national institutions in Ghana and Côte d'Ivoire to financially support the creation of national cocoa traceability systems and/or potentially facilitate collaborations with international partners.

Sectoral approaches can help address interrelated social and environmental challenges.

Overall, the key lesson learned is that no actor or sector alone (e.g., different private sector traceability systems and sustainability programs in silos) can solve complex issues; doing so requires collective action and a shared responsibility and trust-building approach to deliver impact at scale. Government-coordinated initiatives need to be part of the mix of measures.

APPENDIX E. COLLECTIVE AND INNOVATIVE APPROACHES TO TRACEABILITY AND TRANSPARENCY: LESSONS FROM THE SOY SECTOR IN BRAZIL

The issue

Collaborative efforts have dominated approaches to traceability and monitoring of the soy supply chain and delivering on sustainability commitments, with a particular focus on Brazil. Research documented 8.2 million hectares of land deforested for soy between 2001 and 2015 globally, more than 97 percent of which was in South America. Over half (61 percent) of that clearance was in Brazil, followed by Argentina (21 percent), with the remainder in Bolivia, Paraguay, and other regions. In Brazil, nearly half (48 percent) of deforestation for soy was found in the Amazon, with almost the same amount (45 percent) in the Cerrado (GFR 2022).

Early traceability efforts focused primarily on monitoring direct suppliers, particularly on illegal deforestation. A more recent focus is on increasing traceability and transparency in the indirect supply chain, while advancing incentives for farmers to adopt zero-conversion practices in soy production.

Three case studies are explored in more depth in this appendix: the **Green Protocol of Grains of Pará,** the **Soft Commodities Forum (SCF)**, and the **Responsible Commodities Facility (RCF)**. These case studies illustrate different approaches to collaborative efforts: the first aiming to advance traceability while shifting farmer behavior through a public-private sector collaboration, the second cascading the traceability and deforestation monitoring requirements of downstream soy traders to their intermediary suppliers, and the third engaging farmers directly through financial incentives.

The context

Several collaborative initiatives to address the high rates of land conversion associated with soy cultivation in Brazil have been successful. These include agreements between companies and associations to avoid sourcing from areas cleared after a defined cutoff date, such as the Amazon Soy Moratorium, a trade agreement signed in 2006 between the Brazilian Association of Vegetable Oil Industries (Associação Brasileira das Indústrias de Óleos Vegetais; ABIOVE), the

National Association of Grain Exporters (Associação Nacional dos Exportadores de Cereais; ANEC), the national government, and civil society. Another example is the public-private partnership among governments and companies committing to avoid sourcing from illegally cleared areas or protected areas in Pará, Brazil (see "Case study: The Green Protocol of Grains of Pará").

In addition, following public pressure, major soy supply chain actors have committed to removing all conversion from their supply chains and instituting traceability systems. These companies have also banded together in collective initiatives to meet shared objectives. Major soy traders have significant market share and thus influence over how soy is produced by their direct suppliers, with whom they contract directly and can monitor easily for land use change. However, tracing and monitoring volumes from indirect supply farms proves more difficult. In the case of indirect suppliers, intermediaries, such as cooperatives, buy from individual producers and resell to the traders. These intermediaries may choose not to share their supplier data with downstream buyers due to commercial concerns. This poses a challenge for reaching full traceability in soy supply chains. However, this challenge can be overcome with a third-party audit verifying the traceability from the cooperatives, while preserving information confidentiality. The companies are aiming to address challenges like these through collective efforts of engagement with suppliers (see "Case study: Soft Commodities Forum").

Market-based mechanisms, such as the Amazon Soy Moratorium (ASM), and individual private sector zero-conversion commitments and related monitoring actions can result in excluding specific farms on which forest clearance is taking place from the supply chains of the largest export-oriented soy traders, but these farms can still sell to domestic markets. A number of recent efforts have aimed to address this risk by providing financial incentives to farmers who voluntarily adopt zero-conversion practices that go beyond legal requirements. Innovative approaches are being developed that offer financial and technical support to farmers for retaining native vegetation, such as the SCF Farmers First Clusters and the Responsible Commodities Facility (see "Case study: The Responsible Commodities Facility"). However, it remains to be seen if these programs can be scaled up to incentivize protection of the millions of hectares of remaining native vegetation at risk of legal conversion.

Approaches to traceability and transparency: Overview and case studies

The initial focus of most initiatives in Brazil was on the Amazon region; however, due to the restrictions imposed by the ASM, more recently conversion of natural savannah ecosystems for soy cultivation has expanded into the Cerrado, prompting increased efforts to also address conversion there.

Tracing value chain steps

The main traceability approaches for soy in Brazil are via independent certification or individual traceability systems set up by individual private sector actors.

Despite dozens of certification systems for soy, certification has a very limited role in the soy supply chain, with only 3 percent of global production certified in 2020 (Ritchie and Roser 2021b). This is partly due to a lack of demand or premiums offered for certification, as the majority of soy is a "hidden commodity" used as animal feed (Schilling-Vacaflor et al. 2021). These certification systems offer chain-of-custody models ranging from identity preservation models, providing the greatest level of traceability, to certificate trading models, which offer limited visibility (Efeca 2020). The main certification programs are the Round Table on Responsible Soy, Proterra, and Certified Responsible Soya (Planet Tracker 2022) (see Appendix G for more information).

The major soy traders—ADM, Amaggi, Bunge, Louis Dreyfus Company (LDC), COFCO International, Cargill, and Viterra—all report on their own traceability systems, covering both direct and indirect suppliers. In addition, some traders have developed their own certification approaches to verify environmental compliance at the farm level, primarily for products sold to the EU market following European Feed Manufacturers' Federation's Soy Sourcing Guidelines (FEFAC SSGs). Examples of these trader-specific traceability and certification programs include the following:

- Cargill's Triple S system similarly delivers certified products from farms verified for compliance with FEFAC SSGs
- Bunge's e PRO-S certification system, which combines third-party verification audits with ongoing monitoring utilizing its Ace-Track monitoring system, which covers 9,000 farms in South America (Bunge 2021a)
- ADM's Responsible Soybean Standard

These traceability systems rely on a range of chain-of-custody approaches, from book and claim to mass balance, area mass balance, and segregation (see Appendix G).

Linking to sustainability characteristics

A number of joint initiatives have been set up to monitor environmental compliance at the supplying farm level, including the Amazon Soy Moratorium, the Green Protocol of Grains of Pará, and the Aquaculture Dialogue on Sustainable Soy Sourcing from Brazil. Box E-1 contains brief overviews of these and other joint initiatives, and further below are short case studies.

In addition to joint initiatives, a few service providers and tools allow for farm-based and geography-based risk mapping. Agrosatélite is one of the main monitoring service providers in Brazil, supporting efforts of the ASM, as well as land use change monitoring in the Cerrado (alongside ABIOVE). The company's SIMFaz tool allows for monitoring of land use change at the farm level. Similar to use in the cattle supply chain, risk assessment tools like Trase and GFW can help determine the level of risk when sourcing from specific geographies.

Case study: The Green Protocol of Grains of Pará

Context

The Green Protocol of Grains of Pará is a public-private partnership jurisdictional approach to eliminating illegal deforestation for soy, rice, and maize in the state of Pará. Launched in 2014, the program was advanced by a coalition of public sector actors, including the Pará State government, the public prosecutor's office of Pará, and local public officials at the municipality level. This is a multistakeholder umbrella effort to which more than 30 grain sector companies opted in by 2021. While this is not a regulatory measure, it still covers the vast majority of the Pará market; producers responsible for 96 percent of the state's production comply with the measure (Planeta Campo 2022). The criteria for sourcing are similar to the Terms of Adjustment of Conduct in the cattle supply chain.

Types of information

Volumes and supplying property CAR details are secured by buyers.

Processes

Signatories verify that their supplying farms are registered in the CAR, have regular purchase invoices, have not engaged in illegal deforestation after July 2008, and are not on the list of embargoed areas (due to environmental noncompliance) or so-called slave labor dirty list (*lista suja do trabalho escravo*). Signatories also ensure that their supplying farms do not overlap with conservation units, Indigenous land, and Quilombos (protected community settlements of descendants of African slaves). Buyers also review volumes sold by each property against the productive capacity of the farm to check for "grain laundering," where grain is produced on a noncompliant farm but sold via a compliant farm. The signatories' compliance with the protocol is evaluated through independent audits, which are informed by a steering committee of representatives of both public and private sector signatories. The penalty for signatories' purchases from noncompliant farms is a three-year embargo on buying any soybeans in Pará State (De Maria et al. 2022).

Improved information

The project is supported by Soy on Track, an effort to strengthen key soy value chain commitments in the Amazon and Cerrado, including the ASM, the Green Protocol of Grains of Pará, and emerging sectoral and private sector commitments in the Cerrado. The Soy on Track platform aggregates reporting across these various initiatives in one spot, including data, protocols, and audits.

Unlike the ASM, full annual audit information has not been made publicly available. Furthermore, not all signatories have been audited. However, the limited existing audit findings have already contributed to increased awareness of the real issue of grain laundering. Just over 80 percent of volumes from a recent audit were compliant; the other farms sold more volumes than were estimated as viable based on production capacity (De Maria et al. 2022).

Improved outcomes

While the protocol eliminates purchases only from farms with illegal deforestation (unlike the ASM, which prohibits purchases from farms with any deforestation), the protocol also includes social sustainability related to slave labor, Indigenous land, and Quilombos. As most of the state is located in the Amazon biome, which was already covered by protection through the ASM, the protocol does not offer significant additional protections for forests in Pará. However, there are

BOX E-1 | Joint sustainability initiatives

Amazon Soy Moratorium. The ASM is a landmark multistakeholder agreement among ABIOVE, ANEC, the government, and civil society in Brazil, where signatories agreed not to trade or finance soybeans from deforested areas in the Brazilian Amazon biome after July 2006.[a]

The Green Protocol of Grains of Pará. This program, driven by the public prosecutor's office in Pará, ensures that soybean farms are not engaged in illegal deforestation. The protocol is supported by representatives from the public prosecutor's office; the government of the state of Pará; and representatives from municipalities, unions, and soy trading companies.[b]

Aquaculture Dialogue on Sustainable Soy Sourcing from Brazil. Aquaculture supply chain companies from this dialogue, including producers, traders, and NGOs, work alongside Proterra to ensure that all direct soy purchases for the salmon industry in Europe originate only from Brazilian suppliers whose soybean value chains are 100 percent deforestation- and conversion-free.[c]

Initiatives that support traceability and related transparency

Soy Working Group. Coordinated by Greenpeace and ABIOVE, this working group is responsible for overseeing the Amazon Soy Moratorium. It also includes representatives from the main soy traders and NGOs including WWF Brasil, The Nature Conservancy, Imaflora, Amazon Environmental Research Institute (Instituto de Pesquisa Ambiental da Amazonia; IPAM), and the Earth Innovation Institute.[d]

Soy on Track. The Soy on Track platform is a centralized data source, aggregating key documents, audits, publications, and more related to the implementation of the Soy Moratorium in the Amazon, the Green Protocol of Grains of Pará, and sectorial and corporate deforestation-free efforts in the Cerrado.[e]

Soft Commodities Forum. The SCF is a soy trader forum focused on building transparent and traceable supply chains in the Cerrado. The initiative works to increase supply chain traceability and transparency in the Brazilian Cerrado and offers a common monitoring and reporting methodology for traceability in the region (see "Case study: Soft Commodities Forum").[f]

Consumer Goods Forum's Forest Positive Coalition Soy Working Group. This group comprises consumer goods companies and retailers aiming to eliminate native vegetation conversion and deforestation from their supply chains. The group works with partners, such as the SCF, to lay out soy sourcing guidelines and aligned data, definitions, and frameworks for sourcing, and has produced the *Soy Roadmap* and *Soy Sourcing Guidelines*.[g]

Soy Transparency Coalition. The coalition consists of downstream soy users, primarily in the retail and manufacturing sector, that produce an annual trader assessment evaluating soy traders' progress on delivering sustainable soy.[h]

UK Soy Manifesto. Established in November 2022, this group comprises over 35 companies representing the UK soy supply chain supported by the feed industry and four key traders supplying the UK animal feed market, and works toward a joint plan for greater traceability and transparency of soy entering UK supply chains.[i]

Retail Soy Group. Formed in 2013 to address a sector-wide gap in addressing demand for sustainably produced soy, this independent group of international retailers works collaboratively to find industry-wide solutions to sourcing sustainable soy for their animal feed and human food supply chains.[j]

Sources: a. Inakake de Souza et al. 2016; b. See the website of the protocol for more information: https://protocolodegraos.com.br/en; c. Skettring 2019; d. ABIOVE 2019; e. See the homepage of Soy on Track for more Information: https://www.soyontrack.org; f. See the homepage of the Soft Commodities Forum on the website of the World Business Council for Sustainable Development for more information: https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Soft-Commodities-Forum; g. See the homepage of the Forest Positive Coalition on the website of the Consumer Goods Forum for more information: https://www.theconsumergoodsforum.com/environmental-sustainability/forest-positive/; h. See the website of the Soy Transparency Coalition for more information: https://soytransparency.org/; i. See the website of the Soy Transparency Coalition for more information: https://www.uksoymanifesto.uk/; j. See the website of the Retail Soy Group for more information: https://www.retailsoygroup.org/.

some signatories to the protocol that have not signed the ASM. Together, the protocol and ASM act as complementary initiatives that make the process of deforestation monitoring—and coverage of supply chain actors—more robust.

Case study: Soft Commodities Forum

Context

The Soft Commodities Forum, founded in 2018 and facilitated by the World Business Council for Sustainable Development (WBCSD), brings together six soy traders—ADM, Bunge, Cargill, COFCO International, LDC, and Viterra—to collaborate on approaches to eliminate soy-driven deforestation and conversion of native vegetation in the Brazilian Cerrado. In particular, the members are increasing transparency of soybean sourcing in the 61 focus municipalities, which constitute 70 percent of recent native vegetation conversion to soy in the Cerrado (WBCSD 2021).

Part of this work requires engaging with direct suppliers on how to improve monitoring and traceability of indirect suppliers.

Types of information

SCF members define traceability to the farm level (for direct suppliers) if there is a polygon of the farm where soy is being produced. Then, these farms are monitored by PRODES Cerrado 2020 (or a similar private monitoring service).

However, SCF members do not directly report on traceability to the farm level for indirect suppliers; instead, they report on percent traceability to the first aggregator. They do, however, use traceability to farm-level data to calculate deforestation- and conversion-free (DCF) soy for the Verified DCF performance indicator, which embeds both direct and indirect sourcing.

Processes

Members manage their own monitoring of direct suppliers through internal systems and with independent service providers. They report on these volumes following the methods published on the SCF platform.

To address the gap related to indirect supply volumes, SCF members developed a collective protocol for engaging with indirect suppliers and improving their capacities to monitor their own suppliers. SCF members launched a collaboration with ABIOVE to work with 19 indirect suppliers to assess the viability and costs of adoption of traceability and monitoring systems. In 2022, the SCF and ABIOVE began reaching out to some of these suppliers with awareness-raising activities, followed by evaluation of the suppliers' capacity to trace and monitor their supply bases. With these data, the SCF and ABIOVE will develop a roadmap for enhancing traceability and monitoring systems (WBCSD 2022a).

Indirect suppliers buy volumes from individual producers and resell to traders and are generally unwilling to share their supplier data due to commercial concerns. This is particularly the case with farming cooperatives or third-party traders that may be concerned about being circumvented (Schreiber et al. 2021). This challenge can be overcome with a third-party audit verifying the accuracy of data related to traceability from the cooperatives. In this case, traceability would be verified and confidentiality of the information would be preserved.

Improved information

The SCF online platform provides transparency on the methods for selecting SCF focus municipalities, monitoring traceable volumes, and reporting on DCF soy.

Member companies publish biannual reports sharing sourcing data, including disclosing what percentage of their volumes are sourced directly and indirectly, and what percentage of sourced volumes are verified deforestation- and conversion-free in the 61 priority municipalities. The SCF has worked with downstream buyers through the Consumer Goods Forum (CGF) Forest Positive Coalition of Action, aiming to harmonize deforestation and conversion risk definitions, including factors, maps, and thresholds for Cerrado soy sourcing; this information will be published in the CGF Soy Sourcing Guidelines.

Data on indirect supply volumes are still largely absent from the platform and company reporting due to challenges in securing details on indirect supply volumes and farms via cooperatives and intermediaries.

Improved outcomes

While the major traders established traceability and monitoring systems for their direct suppliers years ago, many of the small and midsize intermediaries, such as cooperatives, lacked sophisticated systems until recently. Increasingly, resulting from engagement with SCF members, these cooperatives and intermediaries are beginning to adopt traceability and monitoring systems for their own supply chains. It is likely that transparency among these actors will improve in future years, especially as these intermediaries are asked to provide verified

percentages of DCF sourcing to the SCF member companies, which must report on these figures as part of their pledge to increase transparency.

While it is too early to definitively evaluate the impacts of SCF members' sourcing on the broader trends of deforestation for soy in the Cerrado, Agrosatélite was commissioned to analyze what percentage of soy in the crop year ending 2021 was free of native vegetation conversion since the 2020 Cerrado cutoff date. The research indicated that in the 61 focus municipalities, 99.68 percent of the soy production was free of native vegetation conversion (WBCSD 2022a).

Alongside the work of tracing and monitoring volumes sourced, SCF members are developing financial interventions to help farmers adopt practices to protect the remaining native vegetation on their Cerrado properties, going beyond legal compliance. They have evaluated strategies for incentivizing sustainable land use at the farm level, including incentives for retaining surplus native vegetation on their farms. In addition to work tracing and monitoring sourced volumes, in 2022, the SCF launched a three-year strategy for the new Farmer First Clusters Initiative in western Mato Grosso, southern Maranhão, western Bahia, and Tocantins; the aim is to provide compensation for surplus legal reserve, support restoration of degraded areas and further expansion on already cleared areas, and provide financial and technical assistance (WBCSD 2022c). The SCF companies are initially investing up to $7.2 million for farms in 8 of the 61 priority municipalities (WBCSD 2022d).

Case study: The Responsible Commodities Facility

Context

Research has shown that Brazil's soy farmers are likely to clear new areas when they have the economic means and motivation, and that environmental concerns play a nominal role in decision-making (de Andrade Aragão et al. 2022). ABIOVE has made the case that these farmers deserve financial incentives, such as payments for ecosystem services, to prevent legally allowable clearance.[91] It has been estimated that $250 million would be needed over five years to reward Cerrado farmers for producing soy only on already cleared land, retaining all remaining native vegetation (Byrne 2019).

Direct payments are one option, but there are other financing mechanisms that can drive preservation of this vegetation. The Responsible Commodities Facility was set up to offer low-interest loans to Cerrado farmers who commit to a set of criteria, including a commitment to no conversion of native vegetation. The program was designed by Sustainable Investment Management, and is funded by an $11 million investment by UK supermarkets Tesco, Sainsbury's, and Waitrose, as well as financial support from cocoa and chocolate manufacturer Barry Callebaut. The initiative sells green bonds to raise capital, which is then reinvested in the form of low-interest loans to farmers engaged in sustainable practices.

Types of information

RCF works with an agricultural credit management company to source and screen farmers for participation in the loan program.

RCF uses farm polygons to verify that farmers comply with the Forest Code, have retained the required legal reserves, and have surplus native vegetation. The RCF uses Landsat images to monitor for deforestation to ensure that no clearance on the farm has occurred after the cutoff date of January 1, 2020; it also uses a third party to verify that clearance has not occurred within the farm boundaries as of that date. In addition, farms are checked against the "dirty list" of slave labor to ensure that there is no use of child or slave labor and national databases are used to make sure farms do not have any embargoes.

Processes

The RCF is overseen by an environmental committee made up of representatives from the UN Environment Programme, The Nature Conservancy, BVRio, WWF, Conservation International (Brazil), Proforest, and IPAM (SIM 2022). In its first year of operation, the RCF offered financing to 32 farms in the Matopiba, Goiás, and Mato Grosso regions, which produce 50,000 tonnes of soy per year (SIM et al. 2023).

Improved information

The program has enabled RCF to gather traceability data (as participating farms share their lists of buyers) and will now explore how to trace through the supply chain.

The RCF publishes annual reports, verifying socio-environmental compliance by the program's participating farms.

Improved outcomes

To date, the mechanism has driven protection of 3,495 hectares of native vegetation in excess of legal reserves (Blackham 2023).

Conclusions

Successful reduction of conversion from soy production was achieved through collaborative public-private sector approaches.

In the soy sector, collaborative public-private sector umbrella initiatives such as the ASM and the Green Protocol of Grains of Pará have strongly shaped approaches to traceability and monitoring of the supply chain, often with more enhanced market coverage than in other sectors. This has allowed for greater progress in advancing traceability and MRV systems than in other sectors, such as the cattle sector, where there has been less collaboration and alignment among meatpackers regarding the adoption of aligned traceability and MRV approaches.

Market signals are as important as MRV systems in driving change.

While the ASM did not implement an MRV system for its first two years, deforestation for soy in the Brazilian Amazon still dropped dramatically after the initial announcement of the ASM, indicating that a strong market signal that farms will be traced and monitored can contribute to an initiative's success. The risk of being excluded from a supply chain, communicated through a unified industry message, as in the case of ABIOVE and ANEC and major soy traders, plays a critical role in the success of a program, even in the initial absence of a fully functional MRV system. Initiatives that focus on the technical details of developing a robust MRV system, while not simultaneously sending strong market signals to suppliers, may not see the same level of success.

Sector-based agreements and data sharing can deter leakage.

The ASM was signed by industry associations ABIOVE and ANEC in addition to individual supply chain signatories. Similarly, ABIOVE was a signatory to the Green Protocol of Grains of Pará. This can ensure a more level playing field of expectations across the companies controlling most traded volumes in a sector, driving wider-scale transformation of the sector, rather than bifurcating a market into deforestation-free and deforestation-agnostic volumes. Strong market penetration, such as what occurred with the ASM, was crucial in creating a market signal for compliance.

Part of the success of jurisdictional or sector-wide agreements is alignment on noncompliant properties that cannot be in supply chains. In the ASM, a singular list of noncompliant farms is created on an annual basis; all ABIOVE member companies use the same list. Other initiatives could similarly adopt a shared approach to identifying noncompliant farms, and sharing it with intermediaries, rather than each supply chain actor individually determining and communicating which farms are noncompliant.

A sector- or region-wide approach involving intermediaries should be adopted.

A more collaborative approach may have more influence over bottlenecks and challenges in the supply chain—such as working with intermediaries and cooperatives to advance indirect supplier traceability and monitoring—because they are making the same requests of upstream actors. This approach may have evolved in the soy sector due to the dominance of a relatively small number of traders.

Protocols and agreements that involve intermediaries help downstream buyers more effectively trace and monitor supply chains. In the case of the Green Protocol of Grains of Pará, when companies do not buy soy directly from a farmer, they agree to buy only from warehouses of companies that are signatories to the protocol.

Provide support to help SME suppliers adopt traceability processes.

Many small and medium-size businesses in the soy sector, such as cooperatives, may lack sophisticated traceability procedures. Adoption and management of new data systems can be time and resource intensive. Downstream soy traders can play a capacity-building role, training suppliers how to assess capacity needs and then adopt systems. One example of this is the Bunge Sustainable Partnership program, launched in 2021, which works with direct suppliers to adopt independent imaging services or use Bunge's geospatial monitoring service at no cost to help these suppliers monitor their own sourced volumes. Similarly, the SCF works to support intermediaries and cooperatives in developing their own traceability and monitoring systems.

If these intermediaries' systems and data are monitored and verified according to protocol agreements, this can eliminate many of the challenges involved in tracing and monitoring indirect supply chains for downstream soy traders.

Data privacy concerns can be a barrier to advancing traceability and transparency.

Data privacy concerns limit the willingness or ability of various actors to transfer information about origin through the supply chain. Soy intermediaries, such as cooperatives, may be unwilling to share the commercially sensitive specifics of their suppliers, such as polygons or geolocation information, to traders. This is partly because they are both competing for the same soy volumes in a region. While in some cases intermediaries may put their buyers in direct contact with their suppliers to gather traceability information, in other cases buyers will need to rely on self-reported data without specifics on properties. This will depend on the development of robust frameworks for monitoring and verifying data and associating that data with the transfer of volumes through the supply chain to avoid double-counting volumes sold. The SCF is aiming to overcome this challenge with a third-party audit verifying the traceability from the cooperatives. In this case, traceability would be verified and confidentiality of the information preserved.

Investments are needed to establish harmonized monitoring, reporting, and verification processes.

Traceability and monitoring protocols and procedures can be harmonized across the supply chain to produce a level playing field. Private and public sector platforms can play a role in harmonizing expectations and approaches, as well as reporting frameworks, so that both producers and consumers of soy products have confidence in the quality of traceability and monitoring approaches. The ASM, the Green Protocol of Grains of Pará, and the SCF for the Cerrado are examples of alignment related to how to trace, monitor, and report on soy supply chains.

Because of the collaborative approach in the soy sector, with additional effort, the industry may be able to avoid some of the pitfalls seen in other commodity traceability approaches, such as lack of alignment, leading to the inability to compare trader or meatpacker performance due to differing definitions, datasets, and approaches to reporting and verification.

However, more harmonization is required for approaches for indirect suppliers, and outside of the Amazon. While major soy traders ADM, Amaggi, Bunge, LDC, COFCO International, Cargill, and Viterra have all designed their own traceability systems and report publicly on data collected, reporting differs significantly across actors outside of the joint SCF reporting. Many traders do not offer details about their individual systems, such as definitions of deforestation, a list of datasets used, clear definitions of traceability to farm (particularly for indirect suppliers), or verification protocols related to data. Furthermore, most individual soy traders do not use third-party audits to verify their traceability data for sourcing across Brazil.[92]

Third-party verification builds the credibility of trusted systems.

Systems such as the ASM, Green Protocol of Grains of Pará, and Aquaculture Dialogue on Sustainable Soy Sourcing from Brazil are lauded as highly successful and provide moderate to significant transparency on outcomes as well as credibility via third-party auditing. These audit protocols can be developed in agreement with all signatories and auditors and ratified by third parties such as municipal or federal government actors like the Federal Prosecution Office and government of Pará, in the case of the Green Protocol of Grains of Pará. Audits can protect commercially confidential information while building trust and credibility in a system.

The private sector could mirror the approach taken in these public-private and multistakeholder initiatives. Private sector verified deforestation- and conversion-free claims, and the traceability data these are built upon, will be more credible if verified against an industry-consistent and widely endorsed protocol.

There are some recent efforts to introduce more standardization of traceability data across the private sector; for example, the SCF reports that member groups should have secured third-party verification of claims related to directly sourced volumes in the Cerrado by the end of 2022. However, more advances need to be made in the direction of verification to have credible and robust systems, with transparent reporting, that will be trusted by the marketplace and NGOs.

Public data availability can accelerate traceability and transparency efforts.

Many of the datasets that are used to verify traceability and monitor for environmental impacts are in the public domain, including property boundaries (CAR; Sistema Nacional de Cadastro Ambiental Rural, SICAR), and data available via PRODES; Portal Embrapa (silos); National Indigenous Foundation (Fundação Nacional do Índio; FUNAI); Environmental Ministry (Ministério do Meio Ambiente; MMA); Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatistica; IBGE); Agriculture, Livestock and Supply Ministry (MAPA); state departments of agriculture of Mato

Grosso and Pará States; and Instituto Nacional de Colonização e Reforma Agrária (INCRA), which regulates land reform and registers rural properties. This allows soy sector companies to effectively monitor the socioeconomic performance of their suppliers.

Financial and other incentives can encourage farmers to go beyond legal compliance.

Financial incentives for farmers are an enabling condition to help ensure that areas of native vegetation on farms that are not legally protected are not converted. A combination of financial incentives to prevent legal conversion include payments for ecosystem services, green bonds, carbon market access, carbon financing, and low-interest loans for expansion onto degraded pastures or annual operational costs such as the loans provided by the Responsible Commodities Facility. Blended finance, including government aid, can help reduce the risk associated with these ventures, helping to recruit more traditional investors to join efforts.

APPENDIX F. TRACEABILITY AND TRANSPARENCY IN MANDATORY GOVERNMENT SYSTEMS AND VOLUNTARY CERTIFICATION: LESSONS FROM THE TIMBER SECTOR

The issue

Demand for sustainable and legal products in the timber sector predates similar demand in other commodity supply chains by many years. In response, the forest sector over the past few decades has developed traceability and transparency systems to provide legality and sustainability assurance. This evolution to meet demand also reflects the changes and advancements in technology in the sector, in particular with a shift from paper-based to electronic systems such as those described in this appendix.

Lessons from applying traceability and transparency in timber supply chains can help prepare the ground for applying similar methodologies and processes in other supply chains.

This appendix compiles experiences and lessons from a case study in the Republic of the Congo (RoC): the **SIVL traceability system** (Système Informatique de Vérification de la Légalité; Digital System for Legality Verification). A country rich in forest resources, the RoC is working with external/development aid support to help strengthen its governance and forest management systems. This appendix also draws on experiences with voluntary third-party certification and transparency platforms developed by NGOs.

The context

As in other commodity supply chains, companies producing for markets sensitive to legality and sustainability criteria have used certification to reduce negative environmental and social impacts. Voluntary third-party certification schemes were developed starting in the 1990s (see Appendix G). As with several other commodities, there have been only a few incentives to cover the additional cost of voluntary certification. Voluntary third-party certification has achieved only limited coverage, for example, in 2023 FSC certification covers 194 million hectares worldwide,[93] representing only a fraction of global forest area.

Instead, in many countries government agencies have strengthened their mandatory traceability systems, which generally cover all timber production, including domestic and

nonsensitive markets. Some of these respond to requirements set out by consuming countries mandating legal harvest and trade, such as the EU and UK Timber Regulations, U.S. Lacey Act, and Australian Illegal Logging Prohibition Act. The EU FLEGT VPA process in the RoC and other countries includes a requirement for a Timber Legality Assurance System to support the FLEGT licensing process (see Box 13, "Traceability and transparency through the supply chain"). In addition, governments have pursued mandatory timber traceability systems in an effort to formalize production, increase tax revenue, and improve natural resource management (Stäuble et al. 2022).

A TLAS is based on common elements, such as a legality definition and an independent verification or audit. These government-owned systems can play an important role in raising the bar across the timber sector, thereby affecting a much larger share of the market than voluntary certification could (see also Box 13 on elements of a TLAS).

Approaches to traceability and transparency: Overview and case studies

Approaches to traceability and transparency in timber production differ according to the value chains. There are three principal value chains in the timber sector in the RoC (WWF-France and FAO 2018):

- Export to Asia and the Middle East, leading both in terms of value and in volume, and mostly consisting of raw logs
- Export to Europe and the United States, consisting mostly of sawnwood but also logs
- Export to African countries and domestic consumption, including both sawnwood and raw logs

These value chains could shift in the coming years since the RoC is working to implement a log export ban in coordination with several neighboring countries (ATIBT 2021), which would require logs to be processed in-country.

There are requirements that apply to any timber production in the RoC across all value chains. The 2020 Forest Code in the RoC (Law No. 33-2020 of July 8) lays out the requirements for concession holders, including reduced-impact felling techniques, forest management plans, felling permits, prohibition of cutting outside of concession boundaries, and felling above the allowable permit volume (ATIBT 2020b). The code also lays out mandatory taxes, royalties, and the establishment of a dedicated community development fund. Most of the forest concession areas have been awarded to companies, but significant areas do not yet have an approved forest management plan (UNEP-WCMC 2020).

In addition to the mandatory government traceability requirements, some timber producers in the RoC voluntarily use their own traceability and transparency systems, often tied to certification using labels such as the FSC,[94] Bureau Veritas Certification's OLB (Origine et Légalité des Bois; Timber Origin and Legality),[95] and others. Such labels support sustainability claims made for markets demanding sustainable timber and can support due diligence for market requirements.

There are two leading firms that use FSC certification and manage around 20 percent of the RoC's forest concession area: Olam's Congolaise Industrielle des Bois (CIB), with 2.1 million ha of forests, and Interholco's Industrie Forestière de Ouesso, with 1.2 million ha of forests. However, around two-thirds of the forest area is managed without certification.[96] Large-scale producers exporting to Asia include SICOFOR (Sino-Congo-Forest), Asia-Congo, and others. Some of these have been the target of campaigns over their sustainability performances.

The firms in the RoC that maintain sustainability certification usually also operate sophisticated timber traceability systems. For example, CIB leverages technology available from its parent company, Olam. Several operators, CIB, and others used to operate a system with log markings using bar codes and this will be made mandatory under the SIVL, but some operators are already introducing the use of radio-frequency identification. RFID relies on a chipset to be attached to logs and/or sawnwood. The RFID tags can be read-only or read-write in proximity to a reading device using electromagnetic fields. These tags make it possible to automatically trace timber from the forest through harvesting, transport, and processing in the sawmill.

For firms with forest management certification, such as CIB, external third-party verifications are required. FSC certification requires an extensive initial audit and subsequent annual monitoring audits. The initial audit takes several weeks to complete and involves a comprehensive review of a firm's management system and observation of management practices. Subsequent annual audits still involve significant effort and aim to ensure continued compliance with requirements.

Case study: The SIVL in the Republic of the Congo

The RoC government is working to strengthen the mandatory system for timber tracking and set up a comprehensive TLAS, le Système Informatique de Vérification de la Légalité. The system is hosted in the Ministry of Finance data center. Once operational and fully accepted, the SIVL will issue FLEGT licenses and provide important evidence for market requirements. Additionally, the SIVL will provide a means to track compliance of operators against laws and regulations.

Government requirements can deliver a paper trail through the regulatory process for natural resource management, which often includes collecting information on provenance. In the RoC, existing regulations on timber transport and export require the forest management plan, annual cutting permit, logbook, and waybills for transport, in addition to registered company markings on logs.[97] For log transport, the waybill includes information on the logbook and the concession from which a batch of timber originates. Downstream actors can use this paper trail to verify the origin to the level of forest management unit (Núñez del Prado et al. 2022). However, there are limitations to this paper trail. After processing, the paper trail refers back only to the sawmill as point of origin. There is no centralized repository for the paper trail (Núñez del Prado et al. 2022).

The SIVL will expand the information collected and include a dedicated timber tracing approach. During harvest planning, trees will be individually marked and assigned numbers recorded in a file and/or map showing the felling areas with the geo-referenced positioning of trees. During harvest, each log will receive a barcode. Species, length, diameter, volume, cutting area, and a unique tree felling number will be recorded for each log. The tree felling number will be preserved in processing and be assigned to batches of finished products.

The SIVL will also incorporate a legality grid (ATIBT 2020a) based on a list of indicators organized by regulatory categories,[98] such as incorporation, logging titles, interaction with the local population, compliance with environmental regulations and forest management planning, and transport.

The existing traceability system includes checks by government representatives at several points during the harvest, processing, and transport of timber. Comprehensive third-party verification does not occur within the paper-based national forest management framework. Instead, independent forest monitors from civil society organize field missions to record observations of suspected noncompliance and submit monitoring reports to a reading committee made up of government, private sector, and civil society representatives. Independent monitors have voiced concerns around illegal logging and fraud in the RoC.[99]

There are efforts to complement the government-based traceability system with civil society efforts. For instance, independent monitoring observations are compiled on the Open Timber Portal, which serves as a repository of information on forest concessions for the RoC and other Congo Basin countries.[100] The Open Timber Portal brings together information from four sources: official information from the Ministry of Forest (concessions, list of registered companies, concession contracts), information from logging firms that voluntarily upload documents to demonstrate compliance, information from independent forest monitors such as Resource Extraction Monitoring and other civil society organizations (Vallée et al. 2022), and remote sensing information from Global Forest Watch. Taken together, the information provided can support sourcing decisions for timber.

The SIVL is a web-based application where logging companies upload documents that attest to the legality of the company and detailed data from the inventory through production, transport, and processing operations all the way to export. It is based on internal and external manual data collection forms, in part following mandatory administrative formats. There are 17 modules in all (see Table F-1). Taken together, the data requirements correspond to the items included in the VPA's legality grid.

The VPA also lays out how the RoC will improve timber markings to enable better traceability and transparency. During timber cutting, trunks will be marked with bar code labels, with the bar code associated with a range of information (e.g., allowable annual cut number, name of the operator, year of exploitation, allowable annual cut area, number of parcels concerned). Bar codes and associated information are collected in a centralized database. During transport, storage, processing, and export, logs are traced through repeated scanning of codes.

The information in the RoC's SIVL will undergo external verification. The VPA lays out the terms for an external auditor to regularly review its performance. The independent audi-

TABLE F-1 | List of modules in the SIVL

0: Navigation principles
1: Account management
2: Legality
3: Bar codes
4: Pre-operation
5: Operation
7: Transportation
8: Storage
9: Transformation
10: Exits
11: Taxation
12: FLEGT authorization
13: History of a product
14: Geographical information system
15: Statistics
16: Mobility
17: System administration

Note: FLEGT = Forest Law Enforcement, Governance and Trade.
Source: Adapted from Momballa-Mbun et al. 2023.

tor would check the SIVL and its operation, verify the use of FLEGT licenses, identify any loopholes in the SIVL, and evaluate follow-up to earlier audit reports.

The deployment of the SIVL has been delayed because of connectivity challenges in remote regions of the RoC, where many of the forest concessions are located. The government installed IT infrastructure and undertook training of its staff. In addition, outreach and engagement with companies that will be obliged to use the system has occurred (RoC and EU 2021).

Conclusions

Traceability systems enable better-informed decision-making, contributing to sustainable commodity production.

There are various ways in which the information collected by a government traceability system is used to improve decision-making on natural resource management, whether paper-based or electronic and whether mandatory and operated by the government or part of voluntary efforts:

- Several government agencies in the RoC already use information from the current paper-based system when regulating timber production, trade, processing, and export, and for tax collection, which the forthcoming SIVL could greatly facilitate.
- Entities that import timber into regulated markets need to undertake due diligence for compliance. Mandatory government traceability systems and supply chain transparency platforms like the Open Timber Portal provide important evidence for such due diligence.
- Forest operators use the information collected by traceability and transparency systems to support their own operations. For example, detailed stem-level inventories help avoid loss during cutting and transport, detailed real-time information on volume flow can optimize processing chains, and detailed information on quality and volume of logs can improve forest management. This information can translate into optimized management and lower business risk.

Mandatory systems raise the bar across the sector.

Mandatory government systems reach a wider set of actors than voluntary systems. In the RoC, the SIVL will institute a mandatory traceability and transparency system for all timber and forest products produced in the RoC, whether destined for export or for the domestic market. Designing mandatory systems at the national level can take time and face challenges in funding availability, IT connectivity, and human resources, but can set a higher bar for the entire timber sector.

Voluntary systems can serve as a bridging component.

Until the SIVL is rolled out and operational, voluntary tools and certification systems can provide information to markets that require due diligence. In addition, several NGO-led initiatives undertake independent forest monitoring, and information from these efforts can serve as alternative sources of informa-

tion. The RoC is included in the Open Timber Portal;[101] there is a Forest Atlas (Mertens et al 2006); and several Independent Forest Monitors[102] are active in the RoC, both mandated and non-mandated. These platforms and information sources can provide alternative evidence to enable supply chain risk assessment and risk management, and support law enforcement in the RoC and import markets.

Mandatory traceability and transparency systems can meet resistance from parts of the sector.

Despite the benefits of improved traceability and transparency, the introduction of mandatory national traceability systems can face resistance from companies. A mandatory traceability system will require all producers to allocate additional resources and staff time to comply. The required level of extra effort will depend on a firm's operational sophistication. Some firms may be unable to meet requirements. Moreover, there could be resistance in cases where enhanced transparency could reveal instances of incomplete compliance with applicable regulations.

Progress toward establishing mandatory and effective timber traceability has not been uniform. Government authorities should consider incentives for adoption when designing a mandatory system (Stäuble et al. 2022).

Shifting to a mandatory national-level traceability system requires making comprehensive changes in the sector.

Establishing a mandatory government-owned traceability and transparency system requires significant time and resources. The entire timber sector has to change norms and practices to comply. In addition to considering incentives and disincentives for uptake, governments should design traceability systems that match the scope, capacity, and complexity of the sector in question, while ensuring that the system is fit for purpose, reliable, and credible (Stäuble et al. Forthcoming).

Countries may have different objectives in setting up a traceability and transparency system, including formalizing a gray economy, enabling more effective tax collection, improving natural resource management, or complying with market demands. The objective should inform the system design, scope, and ownership.

Experiences from timber traceability and transparency systems can inform similar systems for other commodities.

There have been requirements for traceability to origin and information about production characteristics of forest products for many years. Many countries, including the RoC, have been working toward improved forest sector information management through traceability and transparency solutions. There are lessons from these efforts that could support other sectors in setting up effective systems, in the RoC and in other countries. For instance, the experiences made with the Ghana Wood Tracking System are informing the design of the cocoa management system that Ghana is setting up (see Appendix E).

APPENDIX G. CERTIFICATION

TABLE G-1 | Commodity examples of voluntary (and nationally mandatory) certification schemes

COMMODITY	CERTIFICATION STANDARD	MANDATORY /VOLUNTARY	PERCENTAGE PRODUCTION/ MARKET	COMMENT
Palm oil	Roundtable on Sustainable Palm Oil	Voluntary	19% of total global production of crude palm oil in 2021[a]	Total RSPO-certified land area in 2021 (excluding independent smallholders) was 4.5 million ha[a] compared with a total of approximately 29 million ha of palm oil production area globally[x]
	International Sustainability & Carbon Certification	Voluntary	Calculated as 6.5% of total area harvested globally for oil palm fruit in 2021[b,c]	Calculation made using ISCC data (in hectares, 1,882,860 ha) as a proportion of total estimated harvested area globally (data in hectares from FAOSTAT—28,909,792 ha)[b,c]
	Indonesia Sustainable Palm Oil	Mandatory/ national	Around 32% of Indonesia's oil palm plantations had achieved ISPO certification in 2020[d,e]	Namely, 5.25 million hectares over Indonesia's 16.381 million ha of palm oil plantations;[d,e] available only in Indonesia; no CoC
	Malaysian Sustainable Palm Oil	Mandatory/ national	97.33% of oil palm–planted area in Malaysia had achieved MSPO certification in 2022[f]	Figure comprising oil palm plantations and smallholders, as well as 453 out of the total 464 licensed palm oil mills in Malaysia;[f] available only in Malaysia; CoC in-country, but not outside
Soy	Round Table on Responsible Soy	Voluntary	Calculated as 1.25% of total soybean production globally in 2021[g,h]	Calculation made using RTRS data (4,639,071 tonnes) as a proportion of total estimated soybean production globally (data from FAOSTAT—371,693,592.67 tonnes)[g, h]
	International Sustainability & Carbon Certification	Voluntary	Calculated as 0.14% of total area harvested globally for soybeans in 2021[b,c]	Calculation made using ISCC data (in hectares, 181,128 ha) as a proportion of total estimated harvested area globally (data in hectares from FAOSTAT—129,523,966 ha)[b,c]
	Proterra	Voluntary	Information was not publicly available and could not be retrieved	
	Donau Soja and Europe Soya	Voluntary	Calculated as 0.19% of total soybean production globally in 2021[i,j]	Calculation made using Donau Soja and Europe Soya data (715,000 tonnes) as a proportion of total estimated soybean production globally (data from FAOSTAT—371,693,592.67 tonnes)[i,j]
	Cargill Triple S	Voluntary	Calculated as 0.93% of total area harvested globally for soybeans in 2021[k,l]	Calculation made using Cargill data (in hectares, 1.2 million ha) as a proportion of total estimated harvested area globally (data in hectares from FAOSTAT—129,523,966 ha)[k,l]
	Other traders' schemes		ADM and Cefetra, among others, also have their own voluntary certification schemes, but information was not publicly available and could not be retrieved	

TABLE G-1 | Commodity examples of voluntary (and nationally mandatory) certification schemes (cont.)

COMMODITY	CERTIFICATION STANDARD	MANDATORY /VOLUNTARY	PERCENTAGE PRODUCTION/ MARKET	COMMENT
Cocoa	Fairtrade	Voluntary	Calculated as 10.54% of total cocoa bean production globally in 2020[m,n]	Calculation made using Fairtrade data (609,047 tonnes) as a proportion of total estimated cocoa beans production globally (data from FAOSTAT—5,780,849.94 tonnes)[m,n]
	Rainforest Alliance	Voluntary	Calculated as 5.71% of total cocoa bean production globally in 2021[o,p]	Calculation made using Rainforest Alliance data (318,747.00 tonnes) as a proportion of total estimated cocoa bean production globally (data from FAOSTAT—5,580,432.37 tonnes)[o,p]
	UTZ	Voluntary	Calculated as 19.59% of total cocoa bean production globally in 2021[o,p]	Calculation made using UTZ data (1,093,466 tonnes) as a proportion of total estimated cocoa bean production globally (data from FAOSTAT—5,580,432.37 tonnes)[c,p]
	Organic	Voluntary		262,286 tonnes of organic cocoa were produced in 2019[q]
Coffee	Fairtrade	Voluntary	Calculated as 8.24% of total green coffee production globally in 2020[m,n]	Calculation made using Fairtrade data (889,589 tonnes) as a proportion of total estimated coffee production globally (data from FAOSTAT—10,795,443.50 tonnes)[m,n]
	Rainforest Alliance	Voluntary	Calculated as 8.53% of total green coffee production globally in 2021[r,s]	Calculation made using Rainforest Alliance data (845,947 tonnes) as a proportion of total estimated coffee production globally (data from FAOSTAT—9,917,257.68 tonnes)[r,s]
	UTZ	Voluntary	Calculated as 12.45% of total green coffee production globally in 2021[r,s]	Calculation made using UTZ data (1,234,867 tonnes) as a proportion of total estimated coffee production globally (data from FAOSTAT—9,917,257.68 tonnes)[r,s]
	Organic	Voluntary		370,006 tonnes of coffee were produced as organic in 2019[t]
	4C	Voluntary		1,606,821 tonnes of coffee were produced as 4C compliant in 2019[t]
Cattle	Leather Working Group (LWG)	Voluntary	23% of global finished leather was produced in an LWG-certified facility in its 2020–2021 financial year[u]	
	Various national standards on beef (e.g., Red Tractor in the UK, SBLAS in Ireland)	Voluntary		Standards on cattle/beef include varying sustainability factors and are usually developed based on local farming systems and consumer concerns (e.g., animal welfare)

TABLE G-1 | Commodity examples of voluntary (and nationally mandatory) certification schemes (cont.)

COMMODITY	CERTIFICATION STANDARD	MANDATORY /VOLUNTARY	PERCENTAGE PRODUCTION/ MARKET	COMMENT
Timber	FSC	Voluntary	FSC Certified Area in 2022: 196,342,329 ha[v]	Global figure; more civil society–led standard
	PEFC	Voluntary	PEFC Certified Area in 2022: 288,154,245 ha[w]	Global figure; more industry-led standard
	Sustainable Forestry Initiative	Voluntary		United States only; no CoC for small family farmers
	Various national standards (e.g., China, FLEGT licenses, VPA countries)	Mandatory/ national		Available only in country of origin; existing EU Timber Regulation accepts FLEGT licenses (e.g., SVLK in Indonesia)
Rubber	FSC	Voluntary	Rubber-specific figures could not be retrieved, but certified sustainable rubberwood could be included within the FSC hectarage above	
	PEFC	Voluntary	Rubber-specific figures could not be retrieved, but certified sustainable rubberwood could be included within the PEFC hectarage above	

Note: CoC = chain of custody; SVLK = Sistem Verifikasi Legalitas Kayu; SBLAS = Sustainable Beef and Lamb Assurance Scheme; PEFC = Programme for the Endorsement of Forest Certification; FAOSTAT = the statistics database of the Food and Agriculture Organization of the United Nations.

Sources: a. RSPO 2022b; b. ISCC 2022; c. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; d. GAR 2020; e. CSPO Watch 2021; f. CSPO Watch 2022; g. RTRS 2022; h. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; i. Donau Soja 2022; j. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; k. Cargill 2021; l. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; m. See Fairtrade International's interactive dashboard to learn more about its top seven products: https://www.fairtrade.net/impact/top-7-products-dashboard; n. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; o. Rainforest Alliance 2022a; p. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; q. Bermudez et al. 2022b; r. Rainforest Alliance 2022b; s. See the FAOSTAT website: https://www.fao.org/faostat/en/#data/QCL; t. Bermudez et al. 2022b; u. LWG 2021; v. See the Connect FSC website for facts and figures on global forest area certified based on FSC principles and criteria: https://connect.fsc.org/impact/facts-figures; w. See the PEFC website for further information on PEFC Certification and statistics: https://pefc.org/discover-pefc/facts-and-figures; x. Ritchie and Roser 2021c.

TABLE G-2 | Levels of assurance, evidence, and credibility: Traceability to source provided by certification standards

CHAIN-OF-CUSTODY MODEL	DESCRIPTION	LEVEL OF TRACEABILITY	OPPORTUNITIES/LIMITATIONS
Credits or certificates	One credit purchased equates to 1 tonne of certified commodity produced.	Credit and certificate transactions are not connected to the physical flow of materials within a company's supply chain.	This is a useful first step for downstream companies to support producers and send a market message, drive demand; smallholder credits are available.
Mass balance (MB) Area mass balance	A mass balance model involves the use of both certified and uncertified product; the physical mixing of certified and uncertified product is allowed but not required—the important thing is that the quantities of both are controlled and documented. Credits supplied and bought according to an area mass balance model can be linked to a particular sourcing region, and sometimes even to the physical commodity imported from a specific region of production into specific ports in consuming countries (e.g., Cefetra Certified Responsible Soya area mass balance); this means that there can be a connection between certification and the commodities' physical flows, as certification efforts are concentrated in farms in the particular sourcing regions, and therefore certified commodities can increasingly be embedded into these physical trade flows.	The volume of certified product entering the operation is controlled, and only an equivalent amount can then be sold as certified. Examples: RSPO MB—to mill RSPO MB—to plantation RSPO MB at point of refinery—will lose degree of traceability to origin There are differences among various area mass balance models, but generally they present a limited degree of traceability back to farm, even if they can sometimes provide a certain level of assurance based on the sourcing region.	Both mass balance and area mass balance options can present challenges linked to traceability and legality but can offer a critical step in the transition from credits to fully physically certified options.
Segregated	The segregation model ensures that commodities from multiple certified sources are kept separate from flows of uncertified sources throughout the supply chain, and that output quantities should correspond to input quantities.	This model provides a greater level of traceability (e.g., typically to mill level within palm oil supply chains). Information on the origin of each certified source may not always be available, but there are differences across commodities and schemes.	Segregated supply chains tend to be much more costly than mixed ones, also due to the loss of efficiencies and the need for separate silos, vessels, etc., depending on the commodity and its end use.
Identity preserved	In identity preserved models, certified materials from a single source are kept separate from all other materials throughout the supply chain.	An identity preserved model allows the greatest level of traceability from production to end use, including via separate documentation for each batch of single-source certified product, as opposed to other certified and noncertified products.	Similar to the above, identity preserved supply chains can be even more expensive than segregated ones as there can be no mixing; they therefore tend to be much more common for high-end uses as opposed to input uses, such as materials for animal feed.
Jurisdictional	Jurisdictional programs can provide their own certification schemes, even if this model is still somewhat niche and limited to particular regions (e.g., palm oil from Aceh).	This model can provide a certain level of assurance to the sourcing region (e.g., landscape or jurisdiction).	It is difficult to estimate the impact of these programs as their use has been limited to date.

Note: RSPO = Roundtable on Sustainable Palm Oil.

Source: Efeca 2020.

APPENDIX H. COLLABORATION PLATFORMS

To complement the information about global commodity platforms provided in "Collaboration beyond individual supply chains," this appendix provides an overview of national-level commodity collaboration platforms, national-level commitments, and sector-specific platforms.

National industry collaborations

Initiatives at the national level focusing on one or several commodities, collaborating mainly with private sector actors, include the following examples.

Palm oil: A large number of European national initiatives, comprising the Belgian Alliance for Sustainable Palm Oil, the Dutch Alliance on Sustainable Palm Oil, the Spanish Foundation for Sustainable Palm Oil, the Italian Union for Sustainable Palm Oil, the German Forum for Sustainable Palm Oil, the Palmoil Network Switzerland, the UK Roundtable on Sourcing Sustainable Palm Oil (which is part of the UK Sustainable Commodities Initiative), the Norwegian Initiative for Sustainable Palm Oil, the Danish Alliance for Responsible Palm Oil, the Swedish Initiative for Sustainable Palm Oil, the Polish Coalition for Sustainable Palm Oil, the French Alliance for the Preservation of Forests, and the Initiative for Sustainable Palm Oil in the Czech Republic and Slovakia (EPOA et al. 2022). Beyond Europe, there is the Singapore Alliance for Sustainable Palm Oil, China Sustainable Palm Oil Alliance, and the Sustainable Palm Oil Coalition for India.

Cocoa: European network ISCOs (National Initiatives on Sustainable Cocoa), comprising the Forum Nachhaltiger Kakao, or German Initiative on Sustainable Cocoa (GISCO); the Swiss Kakaoplattform (often called SWISSCO); Belgian Beyond Chocolate; the Dutch Initiative on Sustainable Cocoa, DISCO, which superseded the earlier Dutch Declaration of Intent on Sustainable Cocoa; and the French Initiative on Sustainable Cocoa, FRISCO, led by the Syndicat du Chocolat and part of the 2018 French National Strategy to Combat Imported Deforestation (SNDI) (MTOS 2018).

Soy: A large number of European soy-focused national initiatives, comprising the Danish Alliance for Responsible Soy; Donau Soja in Austria; the Dutch Soy Platform; FONEI/INA in Germany; the French Platform of Sustainable Animal Feed; the Norwegian Dialogue on Responsible Soy; the Swedish Platform on Risk Commodities; and the UK Roundtable on Sustainable Soya, which is part of the UK Sustainable Commodities Initiative.[103] These soy-focused national initiatives are supported by a secretariat, European National Soya Initiatives, which is funded by IDH, and links the Collaborative Soy Initiative and the Amsterdam Declarations Partnership at the European level.[104]

UK and French Soy Manifestos

Through the UK Soy Manifesto, agreement was reached in November 2022 with traders to report deforestation- and conversion-free status of soy imported into the UK on a quarterly basis starting in 2023.[105] The UK feed industry association (Agricultural Industries Confederation, or AIC) agreed to develop an independently audited industry standard for verified deforestation- and conversion-free soy. This provides a mechanism through which traceability and assurance on deforestation- and conversion-free soy can be delivered through complex UK soy supply chains.[106] The French Soy Manifesto is making similar progress for national imports of soy, with support from the French government (Earthworm Foundation 2020).

Sector-specific groups

For retailers: The Retail Soy Group, the RPOG (Retailers' Palm Oil Group), and the Retailer Cocoa Collaboration. For traders, crushers, and animal feed producers: European Feed Manufacturers' Federation; FEDIOL (EU Vegetable Oil and Protein Meal Industry Association); COCERAL (European Association of Trade in Cereals, Oilseeds, Rice, Pulses, Olive Oil, Oils and Fats, Animal Feed and Agro-Supply); CAOBISCO, representing the chocolate, biscuit, and confectionery industries; and Action for Sustainable Derivatives.

APPENDIX I. AVAILABILITY OF SPATIALLY EXPLICIT CROP EXTENT DATA BY COMMODITY

Table I-1 provides an overview and visual summary of available datasets on crop extent and whether the datasets are one-off mapping efforts or updated annually. The public availability and coverage of spatially explicit datasets on crop extent are constantly developing; for example, a new dataset on rubber was in pre-print at the time of publication (Wang et al. 2022). This table is representative of the authors' knowledge as of writing.

TABLE I-1 | Availability of spatially explicit crop extent data by commodity

COMMODITY	GEOGRAPHIC COVERAGE	TIME SCALE	DATA TYPE	SOURCE
Detailed data				
Oil palm	Tropics (for Malaysia also available in five-year increments from 1990 to 2015 and for Indonesia, also available for 1990, 1995, and annually from 2000 to 2019)	2019	Vector polygons	Available in the Spatial Database of Planted Trees (SDPT) (Harris et al. 2019), a compilation of data sources mapping planted forests, including for commodities such as palm oil, rubber, and cocoa (Gaveau et al. 2022)[a]
Soy	South America	Annual, 2000–2022	Raster, 30 m	Song et al. 2021[b]
Rubber	Mainland Southeast Asia; Yunnan Province, China; DRC; Cameroon; Brazil; Indonesia; Malaysia; India	Single year dates vary, 2013–2018	Raster, 30 m, and vector polygons	Available in SDPT (Harris et al. 2019)[a]
Coffee	N/A	N/A	N/A	None—no spatially explicit sources were seen to be available by authors during research period
Cocoa	Ghana and Côte d'Ivoire	2019	Vector polygons	Abu et al. 2021,[c] Kalischek et al. 2023
Wood fiber	China, Rwanda, Vietnam, South Korea, Argentina, Brazil, Cambodia, Indonesia, Malaysia, India	Dates vary	Vector polygons	Available through SDPT (Harris et al. 2019)[a]
Pasture	Brazil; Peru; biomes maps for Amazon, Atlantic Forest, Chaco, Pampa	Date ranges vary, annual from 1985 to 2021 and from 2000 to 2021	Raster, 30 m	Annual data available for Brazil through Atlas de Pastagens[d] and for other biomes through Mapbiomas[e]
Coarse data				
Cocoa, coffee, soy	Global, where spatially explicit data do not exist	2000, 2005, 2010 (2020 update underway)	Raster, 10 km	IFPRI 2019[f]
Pasture	Global, where spatially explicit data do not exist	2000	Raster, 10 km	Ramankutty et al. 2008[g]

Notes: DRC = Democratic Republic of the Congo; N/A = not available; m = meter; km = kilometer.

Sources: Table prepared for this report by Liz Goldman, WRI. a. Data available for download through Global Forest Watch: https://data.globalforestwatch.org/documents/gfw::planted-forests/about. SPDT v2 is currently in development—see Mazur et al. (2023b) for crop extent datasets by country; b. Data available for download from the University of Maryland: https://glad.umd.edu/projects/commodity-crop-mapping-and-monitoring-south-america; c. Data available for download from the authors; d. See pasture maps, methodologies, and data downloads at https://atlasdaspastagens.ufg.br/; e. See this guide to downloading data from MapBiomas on the "MapBiomas Collections" web page: https://mapbiomas.org/en/colecoes-mapbiomas-1?cama_set_language=en; f. Data available for download through the Harvard Dataverse at https://doi.org/10.7910/DVN/PRFF8V; g. Data available for download from EarthStat at http://www.earthstat.org/cropland-pasture-area-2000/.

LIST OF ABBREVIATIONS

AFi	Accountability Framework initiative
CDP	Carbon Disclosure Project
CFI	Cocoa and Forests Initiative
CGF	Consumer Goods Forum
CPP	Public Commitment on Cattle Ranching
EO	earth observation
ESG	environmental, social, and governance
FACT	Forest, Agriculture and Commodity Trade
FEFAC	European Feed Manufacturers' Federation
FLEGT	Forest Law Enforcement Governance and Trade
IDH	The Sustainable Trade Initiative
IRF	Implementation Reporting Framework
ISPO	Indonesian Sustainable Palm Oil
MRIO	multi-regional input-output
MRV	monitoring, reporting, and verification
MSPO	Malaysian Sustainable Palm Oil
NDCs	Nationally Determined Contributions
NDPE	No Deforestation, No Peat, No Exploitation
REDD+	Reducing Emissions from Deforestation and forest Degradation
RSPO	Roundtable on Sustainable Palm Oil
SBTi	Science Based Targets initiative
TAC	Terms of Adjustment of Conduct
TLAS	Timber Legality Assurance System
TTP	Traceability to Plantation
UML	Universal Mill List
UNFCCC	United Nations Framework Convention on Climate Change
VPA	Voluntary Partnership Agreement

ENDNOTES

1. For more information, see the website of the FACT dialogue: https://www.factdialogue.org/.
2. For more information on VPAs see this page on illegal logging from the European commission: https://environment.ec.europa.eu/topics/forests/deforestation/illegal-logging_en.
3. For more information on the impact of FLEGT and VPAs, see these country and global impact assessment reports from CIFOR: https://www.cifor.org/gml/publications/country-level-flegt-vpa-reports/.
4. For more information, see the UNFCCC's page on the Race to Zero campaign: https://unfccc.int/climate-action/race-to-zero-campaign.
5. For more information, see the Consumer Goods Forum Forest Positive Coalition's commodity-specific roadmaps and guidance: https://www.theconsumergoodsforum.com/environmental-sustainability/forest-positive/key-projects/commodity-specific-roadmaps-and-reporting/.
6. See the Glasgow Financial Alliance for Net Zero's website for more information: https://www.gfanzero.com/.
7. See the website of the Task Force on Climate-related Financial Disclosures for more information: https://www.fsb-tcfd.org/.
8. See the website of the Taskforce on Nature-related Financial Disclosures for more information: https://tnfd.global/.
9. See the "About" web page on GWF's grants and fellowships for more information: https://www.globalforestwatch.org/grants-and-fellowships/about/.
10. In this research, we categorized the level of transparency of each tool/initiative on a spectrum from firm-internal (e.g., information produced with a tool is accessible only to those using the tool), to chain-internal (e.g., information is shared with members of a particular coalition) and "other restricted" transparency (e.g., information is available for a fee, or is published only in a modified form such as aggregated), to full open access.
11. See the website of the Forest Data partnership for more information: https://forestdatapartnership.org/.
12. See the World Bank's open data toolkit at this link: http://opendatatoolkit.worldbank.org/en/essentials.html.
13. For more information on the FAIR principles, see the website of the GO FAIR initiative: https://www.go-fair.org/fair-principles/.
14. For more on the concept of how open data can effect change, see the Theory of Change of the Open Data Institute: https://theodi.org/about-the-odi/our-vision-and-manifesto/our-theory-of-change/.
15. See the OneMap platform, developed by Esri, here: https://www.onemap.id/.
16. See the homepage of Visipec for more information: https://www.visipec.com/.
17. See the methodology page of SPOTT for more information: https://www.spott.org/spott-methodologies/.
18. See Trase's homepage for more information: https://www.trase.earth/.
19. The Cocoa Accountability Map can be viewed on Mighty Earth's website through this link: https://www.mightyearth.org/cocoa-accountability/.
20. For more information, see the website of the HCV Network: https://www.hcvnetwork.org/.
21. For more information, see Musim Mas's sustainability page: https://www.musimmas.com/sustainability/traceability/.
22. For more information, see Wilmar's page on traceability: https://www.wilmar-international.com/sustainability/supply-chain-transformation/traceability/.
23. See ADM's Policy to Protect Forests, Biodiversity and Communities through this link: https://www.adm.com/globalassets/sustainability/goals--programs/responsible-sourcing/pdfs/protect-biodiversity-forests-communities-v2.pdf.
24. For more information, see RSPO's page on gaining certification as a smallholder: https://rspo.org/as-a-smallholder/.
25. For more information, see the homepage of the Accountability Framework initiative: https://accountability-framework.org/.
26. For more information, see the website of the UK Soy Transparency Coalition: https://soytransparency.org/.
27. For more information, see the website of the NDPE IRF: https://www.ndpe-irf.net/.
28. For more information, see the "About" page of the GPSNR: https://sustainablenaturalrubber.org/about-us/.
29. Calculation made using data from RTRS and FAO—see Appendix G for further details.
30. For more information, see this page from the European Commission on deforestation: https://environment.ec.europa.eu/topics/forests/deforestation_en.

31. For more information, see the homepage of the UK Soy Manifesto: https://www.uksoymanifesto.uk/.

32. For more information, see the website on FLEGT licensed timber essential information by the European Forest Institute: https://flegtlicence.org/www.flegtlicence.org/index.html.

33. For more information, see this overview on the Timber Regulation by the European Commission: https://environment.ec.europa.eu/topics/forests/deforestation/illegal-logging/timber-regulation_en.

34. Figure may include use of stocks from previous years or imports.

35. For more information, see the website of Forest 500: https://forest500.org/.

36. For more information, see the website of the Open Timber Portal: https://opentimberportal.org/.

37. For more information, see ZSL SPOTT's website: https://www.spott.org/.

38. For more information, see WWF's Palm Oil Buyers Scorecards: https://wwf.panda.org/discover/our_focus/food_practice/sustainable_production/palm_oil/scorecards/.

39. For more information, see WWF's Timber Scorecards: https://www.wwf.org.uk/timberscorecard.

40. Explore the content of NDCs on this page from Climate Watch: https://www.climatewatchdata.org/ndcs-explore.

41. For more information, see this FAO web page on reference levels for forest emissions and REDD+ reporting: https://www.fao.org/redd/areas-of-work/forest-reference-emission-levels/en/.

42. For more information, see Global Canopy's page on working with governments: https://globalcanopy.org/who-we-work-with/governments/.

43. For more information, see the page summarizing the Risky Business report on WWF-UK's website: https://www.wwf.org.uk/riskybusiness.

44. These include 100 producers, 241 processors, 137 traders, 378 manufacturers, and 185 retailers.

45. For an up-to-date list of companies with public science-based targets, see the SBTi's web page on companies taking action: https://sciencebasedtargets.org/companies-taking-action.

46. For an up-to-date list of companies with public science-based targets, see the SBTi's web page on companies taking action: https://sciencebasedtargets.org/companies-taking-action.

47. For an up-to-date list of companies with public science-based targets, see the SBTi's web page on companies taking action: https://sciencebasedtargets.org/companies-taking-action.

48. For more information, see ESA WorldCover's website: https://esa-worldcover.org.

49. Find the datasets on the Dynamic World website: https://dynamicworld.app/.

50. For more information, see the page "Assessing the Legality of Deforestation Using Spatial Data: An Adaptable Methodology to Support Policy Makers and Market Operators" on Transparency Pathway's website: https://transparencypathway.org/insights/assessing-legality-deforestation-using-spatial-data-adaptable-methodology-support-policy-makers-market-operators.

51. See more information on the Code4Nature website: https://code4nature.org/.

52. See the "Projects" page on the GFW website for more information: https://www.globalforestwatch.org/grants-and-fellowships/projects/.

53. See PemPem's website for more information: https://www.pempem.io/about-us.

54. See the website of Project TREE for more information: https://project-tree-natural-rubber.com/.

55. See the website of RubberWay for more information: https://rubberway.tech/.

56. See the website of Google Earth Engine for more information: https://earthengine.google.com/.

57. See the website of Microsoft Planetary Computer for more information: https://planetarycomputer.microsoft.com/.

58. See the Codex Alimentarius on FAO's website here: https://www.fao.org/fao-who-codexalimentarius/en/?no_cache=1.

59. For the list of mills that palmoil.io uses data from, see https://www.palmoil.io/mills. For more information on the UML, see https://data.globalforestwatch.org/documents/gfw::universal-mill-list/about.

60. For more information, see the website of Zero Deforestation Cattle: https://www.zerodeforestationcattle.org/.

61. For more information, see IDH's page on the Juruena Valley PCI Compact: https://www.idhsustainabletrade.com/juruena-valley-regional-pci-compact/.

62. For more information about the Sustainable Production of Calves program, see the online portal at https://app.globalcad.com.br/apiv2/InvokePublicFunc?formContract=1214&token=S@13T7&uiculture=pt-BR&method=querypage-results#.

63. For more information about the Sustainable Production of Calves program, see the online portal at https://app.globalcad.com.br/apiv2/InvokePublicFunc?formContract=1214&token=S@13T7&uiculture=pt-BR&method=querypage-results#.

64. For more information about the Sustainable Production of Calves program, see the online portal at https://app.globalcad.com.br/apiv2/InvokePublicFunc?formContract=1214&token=S@13T7&uiculture=pt-BR&method=querypage-results#.

65. For more information, see the page on monitoring of indirect suppliers on the GTFI website: https://gtfi.org.br/monitoring-of-indirect-suppliers/.

66. For more information, see this summary on the Visipec website: https://www.visipec.com/wp-content/uploads/2020/10/Visipec_Executive-Summary_English.pdf.

67. First-mile data are related to tracing a commodity along the first leg of transport in the supply chain, from the farm or plantation of origin to the first buyer.

68. Plasma, or scheme, smallholders are contractually linked to a "nucleus estate" run by a plantation company that supports the smallholder plantations; they differ from independent smallholders who are not contractually bound to sell to a specific estate. For more information on scheme smallholders, see this explainer page from RSPO: https://rspo.org/as-a-smallholder/scheme-smallholders/.

69. For more information, see IDH's web page on the traceability working group: https://www.idhsustainabletrade.com/initiative/traceability-working-group/.

70. For more information, see the page on MSPO trace on the website of the Malaysian Palm Oil Certification Council: https://www.mpocc.org.my/mspo-trace.

71. For more information, see the page on traceability on Musim Mas's website: https://www.musimmas.com/sustainability/traceability/.

72. For more information, see the page on independent smallholders on Musim Mas' website: https://www.musimmas.com/sustainability/smallholders/independent-smallholders/.

73. For more information, see Musim Mas's web page on traceability and sustainability: https://www.musimmas.com/sustainability/traceability/.

74. For more information see Musim Mas's web page on traceability and sustainability: https://www.musimmas.com/sustainability/traceability/.

75. For more information, see Musim Mas's web page on independent smallholders: https://www.musimmas.com/sustainability/smallholders/independent-smallholders/#.

76. See an overview of Sime Darby's activities and data relevant to deforestation-free supply chains on this online platform: https://smart.simedarbyplantation.com/gisportal/apps/storymaps/stories/5cbf2dfbd920417488f6a1e765e2e5fa.

77. See an overview of Sime Darby's activities and data relevant to deforestation-free supply chains on this online platform: https://smart.simedarbyplantation.com/gisportal/apps/storymaps/stories/5cbf2dfbd920417488f6a1e765e2e5fa.

78. See Sime Darby's web page on supply management and sustainability for more information: https://www.simedarbyoils.com/sustainability/supply-chain-management.

79. See an overview of Sime Darby's activities and data relevant to deforestation-free supply chains on this online platform: https://smart.simedarbyplantation.com/gisportal/apps/storymaps/stories/5cbf2dfbd920417488f6a1e765e2e5fa.

80. See AAK's web page "All about Better Sourcing of Palm" for data on its supply chain: https://www.aak.com/sustainability/better-sourcing/palm/all-about-better-sourcing-of-palm/.

81. See more information on AAK's palm sourcing on its "Better Sourcing of Palm" web page https://www.aak.com/sustainability/better-sourcing/palm/.

82. See AAK's web page "All about Better Sourcing of Palm" for data on its supply chain: https://www.aak.com/sustainability/better-sourcing/palm/all-about-better-sourcing-of-palm/.

83. For more information, see Musim Mas's web page on traceability and sustainability: https://www.musimmas.com/sustainability/traceability/.

84. For more information on the development of the CFI, see the homepage of the CFI on the World Cocoa Foundation's website: https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/.

85. For more information on the development of the CFI, see the homepage of the CFI on the World Cocoa Foundation's website: https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/.

86. For more information on the aims of development of the CFI, see its homepage on the website of the World Cocoa Foundation: https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/.

87. For more information on the aims of development of the CFI, see its homepage on the website of the World Cocoa Foundation: https://www.worldcocoafoundation.org/initiative/cocoa-forests-initiative/.

88. For more information on Ghana's Cocoa Forest REDD+ Program, see this list of projects available: https://www.reddsis.fcghana.org/projects.php?id=4.

89. For more information on Ghana's Emissions Reduction Program for the Cocoa Forest Mosaic Landscape, see the following summary from the Forest Carbon Partnership's website: https://www.forestcarbonpartnership.org/system/files/documents/Ghana%20Summary_0.pdf; and the following overview of Ghana's Cocoa Forest REDD+ Program: https://www.forestcarbonpartnership.org/system/files/documents/1b.%20Ghana%20overview.pdf.

90. For more information on Ghana's REDD+ program, see the following summary on the Forest Carbon Partnership's website: https://www.forestcarbonpartnership.org/system/files/documents/Ghana%20Summary_0.pdf.

91. For more information, see the website of the Cerrado Conservation Mechanism: https://psacerrado.com.br/.

92. See Musim Mas's web page on sustainability and independent smallholder farmers for more information: https://www.musimmas.com/sustainability/smallholders/independent-smallholders/.

93. See the "Facts & Figures" page on the FSC portal: https://connect.fsc.org/impact/facts-figures.

94. For more information, see the FSC's website: https://fsc.org/en.

95. For more information, see this overview of OLB on the website of Groupe Sefac: http://www.groupesefac.com/certification/olb-timber-origin-and-legality/.

96. The Open Timber Portal (https://opentimberportal.org) lists around 4.7 million ha out of 14.4 million ha as certified under FSC, FSC CoC, LegalSource, and OLB.

97. See this overview of the legal framework for Forest Management and Timber Trade in the Republic of the Congo: https://www.timbertradeportal.com/en/republic-of-the-congo/154/legal-framework.

98. Five principles: Principe 1: L'entreprise a une existence légale au Congo. (The company is legally registered in Congo.); Principe 2: L'entreprise détient les droits d'accès légaux aux ressources forestières dans sa zone d'opération. (The company retains the rights to legally access the forest resources in its zone of operation.); Principe 3: L'entreprise implique la société civile, les populations locales et autochtones à la gestion de sa concession et respecte les droits de ces populations et des travailleurs. (The company includes civil society, local populations, and Indigenous peoples in the management of its concession and respects the rights of these populations and of its employees.); Principe 4: L'entreprise respecte la législation et la réglementation en matière d'environnement, d'aménagement, et d'exploitation forestière. (The company respects the legal framework and regulations on the environment, and the management and harvest of forest resources.); Principe 5: L'entreprise respecte la réglementation en matière de transport et de commercialisation du bois. (The company respects the legal framework and regulations on the transport and sale of wood.)

99. According to BVRio, main types of fraud in the RoC relate to illegalities associated with the allocation of timber rights; Illegal logging and timber theft; and operational illegalities and irregularities at the forest level.

100. See the Open Timber Portal website for more information: https://opentimberportal.org/.

101. See the Open Timber Portal website for more information: https://opentimberportal.org/.

102. For example, information about nonprofit Resource Extraction Monitoring can be found here: https://rem.org.uk/monitoring/congo-brazzaville/.

103. For more information, see the European National Soya Initiatives' website: https://www.ensi-platform.org/#members.

104. For more information, see the Amsterdam Declarations Partnership's website: https://ad-partnership.org/.

105. For more information, see the UK Soy Manifesto's website: https://www.uksoymanifesto.uk/.

106. For more information, see the "Animal Feed" page on AIC's website: https://www.agindustries.org.uk/sectors/animal-feed.html.

REFERENCES

AAK. 2022. "Accelerating Traceability and Deforestation-Free Palm Oil in AAK's Upstream Supply Base," August 25. Malmö, Sweden: AAK. https://www.aak.com/news-and-media/news/accelerating-traceability-and-deforestation-free-palm-oil-in-aaks-upstream-supply-base/.

ABIOVE (Associação Brasileira das Indústrias de Óleos Vegetais; Brazilian Association of Vegetable Oil Industries). 2019. "GTS Signatories," May 10. https://abiove.org.br/en/compromisso/soy-moratorium-signatories/.

Abu, I.-O., Z. Szantoi, A. Brink, M. Robuchon, and M. Thiel. 2021. "Detecting Cocoa Plantations in Côte d'Ivoire and Ghana and Their Implications on Protected Areas." *Ecological Indicators* 129 (October): 107863. https://doi.org/10.1016/j.ecolind.2021.107863.

AFi (Accountability Framework initiative). 2020a. *Operational Guidance on Supply Chain Management.* New York, NY: Accountability Framework initiative. https://accountability-framework.org/fileadmin/uploads/afi/Documents/Operational_Guidance/OG_Supply_Chain_Management-2020-5.pdf.

AFi. 2020b. *The Accountability Framework Initiative: Public Summary of AFi Phase 2 Strategy (2020–2022).* New York, NY: Accountability Framework initiative. https://accountability-framework.org/wp-content/uploads/2020/05/AFi-Phase-2-Strategy-Public-Summary-2020-5.pdf.

AFi. 2022. *Deforestation and Conversion-Free Supply Chains and Land Use Change Emissions: A Guide to Aligning Corporate Targets, Accounting, and Disclosure.* New York, NY: Accountability Framework initiative. https://accountability-framework.org/wp-content/uploads/2022/09/AFI-LUC-and-Emissions-Guidance-09_2022.pdf.

AFi and CDP. 2022. *From Commitments to Action at Scale: Critical Steps to Achieve Deforestation-Free Supply Chains*. New York, NY: Accountability Framework initiative; London, UK: CDP. https://cdn.cdp.net/cdp-production/cms/reports/documents/000/006/368/original/CDP_AFI_Forest_Report_2022_%2814%29.pdf?1654614758.

AFi, CDP, CERES, Climate Advisers, Climate Focus, Forest Trends/Supply Change, Global Canopy, et al. 2019. *Common Methodology for Reporting and Assessment*. https://accountability-framework.org/use-the-accountability-framework/for-reporting-initiatives/common-methodology-for-reporting-and-assessment/.

ATIBT (Association Technique Internationale des Bois Tropicaux; International Tropical Timber Technical Association). 2020a. "Grilles de légalité des bois provenant des forêts naturelles et des plantations forestières au Congo." ("Legality Grids for Timber from Natural Forests and Forest Plantations in Congo.") ATIBT. https://www.atibt.org/wp-content/uploads/2020/03/grilles_de_legalite_apv.pdf.

ATIBT. 2020b. "Republic of Congo: The New Forest Code Promulgated," July 24. ATIBT. https://www.atibt.org/en/news/12212/republic-of-congo-the-new-forest-code-promulgated.

ATIBT. 2021. "Log Export Ban: CEMAC Postpones Entry into Force to 2023," August 27. ATIBT. https://www.atibt.org/en/news/13044/log-export-ban-cemac-postpones-entry-into-force-to-2023.

Bateman, A., and L. Bonanni. 2019. "What Supply Chain Transparency Really Means," August 20. *Harvard Business Review*. https://hbr.org/2019/08/what-supply-chain-transparency-really-means.

Berger, A., T. Schofield, A. Pickens, J. Reiche, and Y. Gou. 2022. "Looking for the Quickest Signal of Deforestation? Turn to GFW's Integrated Alerts," March 9. Blog. Global Forest Watch. https://www.globalforestwatch.org/blog/data-and-research/integrated-deforestation-alerts/.

Bermudez, S., V. Voora, C. Larrea, and E. Luna. 2022a. *Cocoa Prices and Sustainability.* Winnipeg, Canada: International Institute for Sustainable Development. https://www.iisd.org/system/files/2022-11/2022-global-market-report-cocoa.pdf.

Bermudez, S., V. Voora, and C. Larrea. 2022b. *Coffee Prices and Sustainability.* Winnipeg, Canada: International Institute for Sustainable Development. https://www.iisd.org/system/files/2022-09/2022-global-market-report-coffee.pdf.

Blackham, G. 2023. Personal Communication between authors and Grace Blackham, director of land use and operations, BVRio (Bolsa Verde do Rio de Janeiro; Environmental Exchange of Rio de Janeiro).

Borcea, S. 2023. "Introducing Global Forest Watch's 2023 Small Grants Fund Recipients," March 1. Blog. Global Forest Watch. https://www.globalforestwatch.org/blog/people/2023-global-forest-watch-small-grants-fund-recipients/.

Bourscheit, A. 2022. "Prodes and Deter: Get to Know These Strategic Systems in the Fight against Deforestation in the Amazon," February 15. InfoAmazonia. https://infoamazonia.org/en/2022/02/15/prodes-and-deter-systems-against-deforestation-amazon/.

Brabo, B. 2021. "Pará Lança Plataforma SeloVerde Em Apoio à Agropecuária Sustentável e à Rastreabilidade Da Cadeia Produtiva Do Estado." ("Para Launches the SeloVerde Platform to Support Sustainable Agriculture and Livestock Management and the Traceability of Each Value Chain in the State.") April 26. Agência Pará. https://agenciapara.com.br/noticia/27809/para-lanca-plataforma-seloverde-em-apoio-a-agropecuaria-sustentavel-e-a-rastreabilidade-da-cadeia-produtiva-do-estado.

Bunge. 2021a. *Bunge Certification Program for Sustainable Agricultural Sourcing, v. 2021*. Chesterfield, MO: Bunge. https://www.bunge.com/sites/default/files/pro-s_sustainable_sourcing_certification_bunge2021.pdf.

Bunge. 2021b. "Bunge Launches Unprecedented Program to Monitor Soybean Crops from Its Indirect Supply Chain in the Brazilian Cerrado," March 3. Bunge. https://www.bunge.com/news/bunge-launches-unprecedented-program-monitor-soybean-crops-its-indirect-supply-chain-brazilian.

Bunge. 2022. *Non-deforestation Commitment: 2022 Global Sustainability Report*. Chesterfield, MO: Bunge. https://www.bunge.com/sites/default/files/2022_non_deforestation_report.pdf.

Bunn, C., P. Fernandez-Kolb, R. Asare, and M. Lundy. 2019. "Climate Smart Cocoa in Ghana." CGIAR Research Program on Climate Change, Agriculture, and Food Security. IFO Institute. https://www.ifo.de/en/publications/2019/monograph-authorship/climate-smart-cocoa-ghana-towards-climate-resilient.

Byrne, J. 2019. "Tesco, Nutreco and Grieg Seafood Announce Funding for Soy Farmers in the Cerrado Region of Brazil," December 6. *Feed Navigator.* https://www.feednavigator.com/Article/2019/12/06/Businesses-announce-funding-for-soy-farmers-in-the-Cerrado.

Capóssoli Armelin, M.J., P. Carvalho Burnier, and N. Tiso B.R. Grossi. 2020. *10 Years of Terms of Adjustment of Conduct in Pará and the Public Commitment on Cattle Ranching: The Importance of Beef Traceability in Reducing Deforestation in the Amazon.* Amigos da Terra - Amazônia Brasileira. https://amigosdaterra.org.br/wp-content/uploads/2020/08/ADT-tac-compromisso-EN.pdf.

Cargill. 2020. "CocoaWise Portal Keeps Sustainability Data at the Fingertips of Cargill's Cocoa and Chocolate Customers," October 1. Cargill. https://www.cargill.com/2020/cocoawise-portal-keeps-sustainability-data-at-the-fingertips.

Cargill. 2021. *South American Soy Sustainability Report 2021*. Wayzata, MN: Cargill. https://www.cargill.com/doc/1432208365625/south-american-soy-sustainability-report-2021.pdf.

Cargill. 2022. "ESG Sustainable Supply Chains: Soy." Wayzata, MN: Cargill. https://www.cargill.com/doc/1432218790740/2022-esg-sustainable-supply-chains-soy.pdf.

CDP GPT (CDP Global Policy Team). 2022. "Accelerating the Adoption of Nature-Based Solutions (NbS) in the Brazilian Cattle Sector," October 6. CDP Global Policy Team. https://www.cdp.net/en/articles/governments/accelerating-the-adoption-of-nature-based-solutions-nbs-in-the-brazilian-cattle-sector.

CGF (Consumer Goods Forum). 2021. "Leading Consumer Goods Retailers and Manufacturers Launch Actions to Transform Production Landscapes to 'Forest Positive' by 2030," November 6. Consumer Goods Forum. https://www.theconsumergoodsforum.com/press_releases/leading-consumer-goods-retailers-and-manufacturers-launch-actions-to-transform-production-landscapes-to-forest-positive-by-2030/.

COP26 (Twenty-Sixth United Nations Climate Change Conference–United Kingdom). 2021. "Glasgow Leaders' Declaration on Forests and Land Use." Glasgow, UK: United Nations Climate Change Conference. https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/.

CSPO Watch (Certified Sustainable Palm Oil Watch). 2021. "ISPO Indonesian Sustainable Palm Oil," last updated July. CSPO Watch. https://www.cspo-watch.com/indonesian-sustainable-palm-oil.html.

CSPO Watch. 2022. "Monitoring the Malaysian Sustainable Palm Oil (MSPO) Scheme," updated April 30. CSPO Watch. https://www.cspo-watch.com/malaysian-susainable-palm-oil-scheme-progress.html.

de Andrade Aragão, R.B., M.G.B. Lima, G.L. Burns, and H. Ross. 2022. "To Clear or Not to Clear: Unpacking Soy Farmers' Decision-Making on Deforestation in Brazil's Cerrado." *Frontiers in Sustainable Food Systems* 6 (October): 942207. https://doi.org/10.3389/fsufs.2022.942207.

De Maria, M., G. Zanello, L. Nakagawa, J. Sigles Robert, J. Visentin, P. Bruna, P. Branco, et al. 2022. *Moving towards a Sustainable Soybean Supply Chain: A Sustainable Policy Toolbox for Brazilian Stakeholders and Other Global Actors*. UK Research and Innovation Global Challenges Research Fund; Trade, Development and the Environment Hub. https://doi.org/10.34892/HA52-MA53.

Donau Soja. 2022. *Donau Soja 10 Years Anniversary and Annual Report 2022*. Vienna, Austria: Donau Soja. https://www.donausoja.org/wp-content/uploads/2022/09/DonauSoja_AnniversaryReport2022.pdf.

Earley, S., D. Henderson, and Data Management Association, eds. 2017. *DAMA-DMBOK: Data Management Body of Knowledge*. 2nd edition. Basking Ridge, New Jersey: Technics Publications.

Earthworm Foundation. 2020. "Soy and Forests Can Prosper Together," November 18. Earthworm Foundation. https://www.earthworm.org/fr/news-stories/soy-and-forests-can-prosper-together.

EC (European Commission). 2013. "Timber Regulation." European Commission. https://environment.ec.europa.eu/topics/forests/deforestation/illegal-logging/timber-regulation_en.

EC. 2022. "Corporate Sustainability Due Diligence: Fostering Sustainability in Corporate Governance and Management Systems." European Commission. https://commission.europa.eu/business-economy-euro/doing-business-eu/corporate-sustainability-due-diligence_en.

EC. 2023. "12th Meeting of the 'Expert Group/Multi-stakeholder Platform on Protecting and Restoring the World's Forests' (Deforestation)—Stakeholders & MS." Meeting. European Commission. https://ec.europa.eu/transparency/expert-groups-register/screen/meetings/consult?lang=en&meetingId=46222&fromExpertGroups=false.

Efeca. 2020. "Soya Certification Options." Efeca. https://www.efeca.com/wp-content/uploads/2020/04/Soya-Certification-Options-Briefing-2020.pdf.

EFI (European Forest Institute). 2022. *The Terpercaya Initiative: Jurisdictional Palm Oil Traceability in Indonesia.* Joensuu, Finland: European Forest Institute. https://efi.int/sites/default/files/files/flegtredd/Terpercaya/Briefings/10.%20Terpercaya%20Briefing%20-%20EN.pdf.

EIA (Environmental Investigation Agency). 2016. "Romania Creates Revolutionary Public Access in New Online Wood Tracking System," December 9. Environmental Investigation Agency. https://us.eia.org/press-releases/romania-creates-revolutionary-public-access-in-new-online-wood-tracking-system/.

EIA. 2022. *Deforestation in the Driver's Seat: Illegal Cattle Ranching, Amazon Deforestation, and the Automotive Leather Industry*. Washington, DC: Environmental Investigation Agency. https://us.eia.org/report/deforestation-drivers-seat/.

EPOA (European Palm Oil Alliance), IDH, RSPO. 2022. *Sustainable Palm Oil: Europe's Business Facts, Analysis, and Actions to Leverage Impact*. By NewForesight Consultancy. Consultant Report, Utrecht, Netherlands.

Fairtrade. 2022. "Open Letter to the EU: Producers Call for Inclusive and Impactful Due Diligence Legislation." https://files.fairtrade.net/PO-letter-to-the-EU-May-2022-EN-updated.pdf.

FAO (Food and Agriculture Organization of the United Nations). 2022a. *FRA 2020 Remote Sensing Survey*. Forestry Paper No. 186. Rome: FAO. https://doi.org/10.4060/cb9970en.

FAO, ed. 2022b. *The Geography of Food and Agricultural Trade: Policy Approaches for Sustainable Development*. The State of Agricultural Commodity Markets 2022. Rome: FAO. https://doi.org/10.4060/cc0471en.

Ferrero. 2022a. *Annual Cocoa Progress Report 2020/21*. Alba, Italy: Ferrero. https://s3-eu-west-1.amazonaws.com/ferrero-static/globalcms/documenti/4465.pdf.

Ferrero. 2022b. *Cocoa Action Plan*. Alba, Italy: Ferrero. https://www.ferrerosustainability.com/int/sites/ferrerosustainability_int/files/2022-03/20220128_cocoa-actionplan-light.pdf.

Ferrero. 2022c. *Cocoa Charter*. Alba, Italy: Ferrero. https://s3-eu-west-1.amazonaws.com/ferrero-static/globalcms/documenti/4347.pdf.

Fink, L. 2022. "The Power of Capitalism." BlackRock. https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter.

Forest 500. 2022a. *A Climate Wake-Up: But Business Failing to Hear the Alarm on Deforestation. 2022 Annual Report*. Oxford, UK: Global Canopy. https://forest500.org/publications/climate-wake-business-failing-hear-alarm-deforestation.

Forest 500. 2022b. "What Makes a Company Tweet about Deforestation?" February 8. Forest 500. https://forest500.org/analysis/insights/what-makes-company-tweet-about-deforestation.

Furqium, N.R., and D.C. Cyrillo. 2012. "SISBOV Pros and Cons: The Perspective of the Beef Production Chain Economic Agents in Brazil." Working Papers, Department of Economics, University of São Paulo (FEA-USP), revised February 21, 2014. https://www.researchgate.net/profile/Denise-Cyrillo/publication/241767317_SISBOV_pros_and_cons_the_perspective_of_the_beef_production_chain_economic_agents_in_Brazil/links/5406faad0cf2bba34c1e7f3d/SISBOV-pros-and-cons-the-perspective-of-the-beef-production-chain-economic-agents-in-Brazil.pdf.

GAR (Golden Agri-Resources). 2011. "Forest Conservation Policy." Singapore: Golden Agri-Resources. https://goldenagri.com.sg/wp-content/uploads/2016/01/1._GAR_Forest_Conservation_Policy_-_updated_links_10_Jan_2014.pdf.

GAR. 2018. "GAR Announces 100% Traceability to the Plantation for Owned Mills," February 27. Golden Agri-Resources. https://goldenagri.com.sg/wp-content/uploads/2018/02/PressRelease_GAR_TTPannouncement_FIN.pdf.

GAR. 2020. "Indonesian Sustainable Palm Oil Factsheet." Singapore: Golden Agri-Resources. https://goldenagri.com.sg/wp-content/uploads/2020/06/Indonesian-Sustainable-Palm-Oil-ISPO-Fact-Sheet.pdf.

GAR. 2021. "Traceability Essential to Ensuring Sustainable Palm Oil Production at Scale," December 15. Singapore: Golden Agri-Resources. https://www.goldenagri.com.sg/traceability-essential-to-ensuring-sustainable-palm-oil-production-at-scale/.

GAR. 2022. *Sustainability Report 2021*. Singapore: Golden Agri-Resources. https://www.goldenagri.com.sg/wp-content/uploads/2022/06/GAR28-30-06-2022-SR2021.pdf.

Garcia-Drigo, I., L. Inakake de Souza, and M. Piatto. 2022. *From Commitment to Action: The Track of Responsible Beef in the Brazilian Amazon*. Beef on Track Program. São Paulo, Brazil: Imaflora. https://www.beefontrack.org/wp-content/uploads/2022/10/LIVRO-BOI-NA-LINHA-From-commitment-to-action-14x21cm-INGLES_V4-WEB.pdf.

Gardner, T.A., M. Benzie, J. Börner, E. Dawkins, S. Fick, R. Garrett, J. Godar, et al. 2019. "Transparency and Sustainability in Global Commodity Supply Chains." *World Development* 121 (September): 163–77. doi:10.1016/j.worlddev.2018.05.025.

Gaveau, D.L.A., B. Locatelli, M.A. Salim, Husnayaen, T. Manurung, A. Descals, A. Angelsen, et al. 2022. "Slowing Deforestation in Indonesia Follows Declining Oil Palm Expansion and Lower Oil Prices." Edited by R.G. Zang. *PLOS ONE* 17 (3): e0266178. https://doi.org/10.1371/journal.pone.0266178.

GCP (Global Coffee Platform). 2022. "Sustainable Coffee Purchases Snapshot 2021." Global Coffee Platform. https://www.globalcoffeeplatform.org/wp-content/uploads/2022/08/GCP_Snapshot21.pdf.

Gehl, D., and A. Hagatis. 2022. Personal communication between authors and David Gehl, Environmental Investigation Agency, and Adrian Hagatis, executive director, Code4Nature. November 4.

GFR (Global Forest Review). 2022. "Deforestation Linked to Agriculture." Washington, DC: World Resources Institute. https://research.wri.org/gfr/forest-extent-indicators/deforestation-agriculture.

GFW (Global Forest Watch). 2022. "Universal Mill List." Global Forest Watch. https://data.globalforestwatch.org/documents/gfw::universal-mill-list/about.

Global Canopy. 2021. "Thirty Financial Institutions Commit to Tackle Deforestation," November 2. Global Canopy. https://globalcanopy.org/press/thirty-financial-institutions-commit-to-tackle-deforestation/.

Global Witness. 2020. "Beef, Banks and the Brazilian Amazon." Global Witness. https://www.globalwitness.org/en/campaigns/forests/beef-banks-and-brazilian-amazon/.

Goldman, E. 2022. "Presentation, Forest Legality Week 2022, Washington DC. October 19th 1:30 PM to 3:00 PM: Updates on Early Warning Systems for Monitoring Forests. Cited Information from 00:12:00–00:14:00," October 19. Forest Legality Initiative. https://forestlegality.org/event/forest-legality-week-2022.

Goldman, E. 2023. Personal communication between authors and Liz Goldman, research manager, Global Forest Watch. January 17.

Goldman, E., and S. Carter. 2022. Personal communication among authors and Liz Goldman, research manager, Global Forest Watch, and Sarah Carter, research associate, Global Forest Watch. November 14.

Goldman, E., M.J. Weisse, N. Harris, and M. Schneider. 2020. "Estimating the Role of Seven Commodities in Agriculture-Linked Deforestation: Oil Palm, Soy, Cattle, Wood Fiber, Cocoa, Coffee, and Rubber." Technical Note. Washington, DC: World Resources Institute. wri.org/publication/estimating-the-role-of-sevencommodities-in-agriculture-linked-deforestation.

GPSNR (Global Platform for Sustainable Natural Rubber). 2021. *Review of Transparency & Traceability Tools & Solutions, Prepared for the Global Platform for Sustainable Natural Rubber (GPSNR)*. Consultant Report. Hong Kong: e-Audit Hong-Kong Ltd. By H. de Bonafos. https://sustainablenaturalrubber.org/news-publications/seeing-through-to-a-solution-traceability-and-transparency-tools-and-technology-studies/.

GRI (Global Reporting Initiative). 2022. "A Business Case for Environment and Society." Global Reporting Initiative. https://www.globalreporting.org/media/ervdeb02/gri-perspective-business-case-for-environment-and-society.pdf.

GRI Taskforce (Global Resource Initiative taskforce). 2020. *Global Resource Initiative Final Recommendations Report*. London, UK: Department for Environment, Food & Rural Affairs. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/881395/global-resource-initiative.pdf.

GRI Taskforce. 2022. *Global Resource Initiative Finance Report 2022*. Prepared for Partnerships for Forests, by Jonathan Gorman, Efeca Ltd. Consultant report, Dorchester, UK. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1087635/global-resource-initiative-finance-report-may-2022.pdf.

GSPNR (Global Platform for Sustainable Natural Rubber). 2021. "Seeing through to a Solution: Traceability and Transparency Tools and Technology Studies," January. Global Platform for Sustainable Natural Rubber. https://sustainablenaturalrubber.org/2021/01/.

GTFI (Grupo de Trabalho dos Fornecedores Indiretos; Working Group on Indirect Suppliers). 2022. "Importance of Tier 1 Indirect Supplying Properties in the Beef Supply Chain in Brazil." GTFI. https://gtfi.org.br/gtfi_site2020/wp-content/uploads/2022/08/Boas-Pra%CC%81ticas-ENG-Final.pdf.

Harris, M. 2022. Personal communication between the authors and Maddie Harris, ecosystem analyst, Joint Nature Conservation Committee. November 11.

Harris, N., E. Goldman, and S. Gibbes. 2019. "Spatial Database of Planted Trees (SDPT Version 1.0)." Technical Note. Washington, DC: World Resources Institute. https://www.wri.org/research/spatial-database-planted-trees-sdpt-version-10.

Henderson, J. 2021. "How to Support Small-Holder Farmers through Equitable Data and Digital Technology," October 25. Blog. Global Partnership for Sustainable Development Data. https://www.data4sdgs.org/blog/how-support-small-holder-farmers-through-equitable-data-and-digital-technology.

Hofmeister, N. 2021. "Deforestation-Free Beef Stymied by Brazil's Unequal Supply Chain," May 5. *Mongabay*. https://news.mongabay.com/2021/05/deforestation-free-beef-stymied-by-brazils-unequal-supply-chain/.

Ichsan, M., W. Saputra, and A. Permatasari. 2021. "Oil Palm Smallholders on the Edge: Why Business Partnerships Need to Be Redefined." Information Brief. Jakarta: SPOS Indonesia. https://sposindonesia.org/wp-content/uploads/2021/07/28.-eng-Oil-palm-smallholders-on-the-edge-Why-business-partnerships.pdf.

IDH (Sustainable Trade Initiative). 2018. "Brazil: Carrefour Group, Its Foundation and IDH Commit More than EUR 3 Million to Protect Tropical Forest through Sustainable Beef Production," July 10. Sustainable Trade Initiative. https://www.idhsustainabletrade.com/news/brazil-carrefour-group-its-foundation-and-idh-commit-more-than-eur-3-million-to-protect-forest-through-sustainable-beef-production/.

IDH. 2020a. *Cocoa and Forests Initiative Annual Report: Ghana 2019*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2020/05/CFI-2019-Progress-Report-11.7-small.pdf.

IDH. 2020b. *Intermediate Pilot Phase Appraisal of the Cocoa and Forests Initiative January 2018–December 2019*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2020/05/Rapport-Bilan-CFI_EN_Num%C3%A9rique_26052020.pdf.

IDH. 2021a. *Cocoa Traceability Case Study: Barry Callebaut*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2021/06/Case-Study_Traceability_Barry-Callebaut_Final.pdf?x16739.

IDH. 2021b. *Cocoa Traceability Case Study: Cargill*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2021/06/Case-Study-Cargill_Adjusted.pdf?x16739.

IDH. 2021c. *Annual Report Cocoa and Forests Initiative 2020*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2021/05/NUM_ANG_RAPPORT_ICF_VF1.pdf.

IDH. 2021d. *Cocoa and Forests Initiative Annual Report: Ghana 2020*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2021/05/ANNUAL-PROGRESS-REPORT-2020-Final.pdf.

IDH. 2021e. "Carrefour Brazil Group and IDH Brazil Achieve the 'Impossible': 100% Traceable Beef," July 29. IDH. https://www.idhsustainabletrade.com/news/carrefour-brazil-group-and-idh-brazil-achieve-traceable-beef/.

IDH. 2022a. "IDH, Carrefour Group Brazil and CNA Launch Protocol for Sustainable Production of Calves," March 29. IDH. https://www.idhsustainabletrade.com/news/idh-carrefour-group-brazil-and-cna-launch-protocol-for-sustainable-production-of-calves/.

IDH. 2022b. *Annual Report: Ghana 2021*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2022/07/Cocoa-Forests-Initiative-Ghana-2021-Annual-Report.pdf.

IDH. 2022c. *Rapport Annuel Initiative Cacao et Forets: Côte d'Ivoire 2021*. (*Cocoa & Forests Initiative Annual Report: Côte d'Ivoire.)* Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/uploaded/2022/07/Initiative-Cacao-Forets-C%C3%B4te-dIvoire-2021-Rapport-Annuel.pdf.

IDH. 2022d. *Cocoa & Forests Annual Reports 2021*. Utrecht, Netherlands: IDH. https://www.idhsustainabletrade.com/publication/cocoa-forests-annual-report-2021/.

IDH, GISCO, and C-lever.org. 2021a. *Cocoa Traceability Case Study: Mondelez International*. By P. Stoop, N. Ramanan, H. Geens, A. Lambrecht and S. Dekeister. Consultancy Report, C-lever.org. https://www.idhsustainabletrade.com/uploaded/2021/06/Case-Study_Traceability_Mondelez_Final.pdf.

IDH, GISCO, and C-lever.org. 2021b. *Traceability Case Study: Cargill*. By P. Stoop, N. Ramanan, H. Geens, A. Lambrecht and S. Dekeister. Consultancy Report. https://www.idhsustainabletrade.com/uploaded/2021/06/Case-Study-Cargill_Adjusted.pdf.

IDH, GISCO, and C-lever.org. 2021c. *Technical Brief on Cocoa Traceability*. By P. Stoop, N. Ramanan, H. Geens, A. Lambrecht and S. Dekeister. Consultancy Report, C-lever.org. https://www.idhsustainabletrade.com/uploaded/2021/04/Cocoa-Traceability-Study-20.7L.pdf.

IFPRI (International Food Policy Research Institute). 2019. Global Spatially-Disaggregated Crop Production Statistics Data for 2010 Version 2.0. Harvard Dataverse. https://doi.org/10.7910/DVN/PRFF8V.

Inakake de Souza, L., M. Piatto, M. Couto, and V. Guidotti de Faria. 2016. *10-Year of Soy Moratorium in the Amazon: History, Impacts and Expansion into Cerrado Areas*. São Paolo, Brazil: Institute of Agricultural and Forest Management and Certification, Imaflora. https://www.imaflora.org/public/media/biblioteca/IMF-10-years-of-soy-moratorium-WB.pdf.

ISCC (International Sustainability & Carbon Certification). 2022. *ISCC Impact Report 2022*. International Sustainability & Carbon Certification. https://www.iscc-system.org/wp-content/uploads/2022/06/ISCC-Impact-Report-2022.pdf.

ISTA Mielke GmbH. 2022. *Oil World Annual 2022*. Hamburg: ISTA Mielke GmbH.

Jamilla, S. n.d. "Lessons Learned from Evaluating an Open Data Platform—The Impact Assessment of Global Forest Watch." MERL Center. https://merlcenter.org/caseStudies/the-impact-assessment-of-global-forest-watch/. Accessed April 6, 2023.

Kalischek, N., N. Lang, C. Renier, R. Caye Daudt, T. Addoah, W. Thompson, W. J. Blaser-Hart, et al. 2023. "Cocoa Plantations Are Associated with Deforestation in Côte d'Ivoire and Ghana." *Nature Food* 4 (5): 384–93. https://doi.org/10.1038/s43016-023-00751-8.

Kazmaier, G. 2022. "Building the Most Open Data Cloud Ecosystem: Unifying Data across Multiple Sources and Platforms," October 11. Blog. Google Cloud. https://cloud.google.com/blog/products/data-analytics/building-most-open-data-cloud-all-data-all-source-any-platform.

Keating, C. 2021. "European Supermarkets Drop Brazilian Beef Products over Deforestation Links," December 16. *BusinessGreen*. https://www.businessgreen.com/news/4042160/european-supermarkets-drop-brazilian-beef-products-deforestation-links.

LWG (Leather Working Group). 2021. *Annual Report 2020–2021*. Milton Keynes, UK: Leather Working Group. https://www.yumpu.com/en/document/read/65895292/lwg-annual-report-2020-21.

Mapbiomas. 2018. "Projeto MapBiomas—Coleção v3 Da Série Anual de Mapas de Cobertura e Uso de Solo Do Brasil." ("Third Collection of Annual Land Cover and Land Use Maps for Brazil.") Mapbiomas. https://mapbiomas.org/.

Marfrig. 2020. "Marfrig Commitment (Verde+ Manifesto)." São Paulo, Brazil: Marfrig. https://www.marfrig.com.br/en/Lists/CentralConteudo/Attachments/5/MARFRIG%20COMMITMENT%20(VERDE+%20MANIFESTO).pdf.

Mazur, E., M. Sims, and M. Daldoss Pirri. 2023a. "Natural Lands Map Provides Baseline for Companies' No Conversion Targets," May 24. Land & Carbon Lab. https://www.landcarbonlab.org/news-updates/natural-lands-map-companies-no-conversion-targets.

Mazur, E., M. Sims, E. Goldman, M. Schneider, F. Stolle, M. Daldoss Pirri, and C.R. Beatty. 2023b. "Science Based Targets for Land. Version 0.3—Supplementary Material. SBTN Natural Lands Map: Technical Documentation." Science Based Targets Network. https://sciencebasedtargetsnetwork.org/wp-content/uploads/2023/05/Technical-Guidance-2023-Step3-Land-v0.3-Natural-Lands-Map.pdf.

Mertens, B., S. Minnemeyer, L. Ayenika Nsoyuni, and Steil. 2007. *Atlas Forestier Interactif du Congo: Document de Synthèse*. (*Interactive Forest Atlas for Congo: Synthesis Report*.) Global Forest Watch. https://files.wri.org/d8/s3fs-public/pdf/gfw_congo_atlas_v1_francais.pdf.

MGAP, INAC, and IICA (Ministerio de Ganadería, Agricultura y Pesca [Ministry of Livestock, Agriculture, and Fishery]; Instituto Nacional de Carnes [National Meat Institute]; and Inter-American Institute for Cooperation on Agriculture). 2009. *Uruguay's Experience in Beef Cattle Traceability*. San José, Costa Rica: Inter-American Institute for Cooperation on Agriculture. https://www.inac.uy/innovaportal/file/5219/1/libro_trazabilidad_ingles.pdf.

Michelin. 2021. "Michelin Sustainable Natural Rubber Policy, Reference Document, 2021 Edition." Michelin. https://purchasing.michelin.com/wp-content/uploads/sites/34/2021/01/Michelin-Sustainable-Natural-Rubber-Policy_2021_EN.pdf.

Minerva Foods. 2021. "Pioneerism in Indirect Risk Assessment." Minerva Foods. https://www.minervafoods.com/wp-content/uploads/2021/08/Visipec-timeline-ENG.pdf.

MMA (Ministério do Meio Ambiente e Mudança do Clima; Ministry of Environment and Climate Change). 2023. "Declaração Conjunta Brasil-China sobre Combate Às Mudanças Climáticas" ("Joint Declaration between Brazil and China on Fighting Climate Change"), April 14. Brasília: Government of Brazil. https://www.gov.br/mma/pt-br/assuntos/noticias/declaracao-conjunta-brasil-china-sobre-combate-as-mudancas-climaticas.

Moffette, F., J. Alix-Garcia, K. Shea, and A.H. Pickens. 2021. 'The Impact of Near-Real-Time Deforestation Alerts across the Tropics." *Nature Climate Change* 11 (2): 172–78. https://doi.org/10.1038/s41558-020-00956-w.

Mol, A.P.J. 2015. "Transparency and Value Chain Sustainability." *Journal of Cleaner Production* 107 (November): 154–61. doi:10.1016/j.jclepro.2013.11.012.

Momballa-Mbun, C., A. Mgaza, C. Floros, and H.K. Chen. 2023. *An Overview of the Timber Traceability Systems in the Congo Basin Countries*. Yaounde, Cameroon: Traffic. https://www.traffic.org/site/assets/files/20862/traffic-report-_overview_of_timber_traceability_-_20230203.pdf.

Mondelēz. 2022. *Cocoa Life 2021 CFI Progress Report*. Chicago, IL: Mondelēz. https://www.cocoalife.org/~/media/CocoaLife/en/download/article/2022/mdlz-cocoa-life-cfi-2021-report-april-2022.pdf.

Mongabay.com. 2009. "Brazilian Beef Giants Agree to Moratorium on Amazon Deforestation," October 7. Mongabay.com. https://news.mongabay.com/2009/10/brazilian-beef-giants-agree-to-moratorium-on-amazon-deforestation/.

MTOS (Ministère de la Transition Écologique et Solidaire; Ministry of Ecology). 2018. *Stratégie nationale de lutte contre la déforestation importée 2018-2030*. Plan climat. (*National Strategy for Combatting Imported Deforestation*.) Paris: Ministère de la Transition Écologique et Solidaire. https://www.ecologie.gouv.fr/sites/default/files/2018.11.14_SNDI_0.pdf.

Musim Mas. 2019. "Response to RAN Report," September 29. Singapore: Musim Mas. https://www.musimmas.com/response-to-ran-report/.

Musim Mas. 2021a. *Future Ready: Sustainability Report 2021*. Singapore: Musim Mas. https://www.musimmas.com/wp-content/uploads/2022/10/Musim-Mas-SR2021.pdf.

Musim Mas. 2021b. *No Deforestation, No Peat (NDP) Risk Management Framework (September 2021 Update)*. Singapore: Musim Mas. https://www.musimmas.com/wp-content/uploads/2021/09/Risk-Management-Framework-Report-2021.pdf.

Musim Mas. 2021c. "Musim Mas Supports over 1,200 Independent Smallholders to Gain Certification under the New ISPO 2020 Standard—Minister of Agriculture Decree No.38," November 22. Singapore: Musim Mas. https://www.musimmas.com/musim-mas-smallholder-ispo/.

Musim Mas. 2023. "Training for Smallholders March 2023 Data." Singapore: Musim Mas. https://www.musimmas.com/wp-content/uploads/2023/04/March-2023-Training-for-Smallholders-1.pdf.

Nestlé. 2018. "Starling: Taking Forest Protection to New Heights." Vevey, Switzerland: Nestlé. https://www.nestle.co.uk/en-gb/stories/starling-nestle-deforestation-monitoring-system.

Neville, A., and J. Kriswantoro. 2022. "Opinion: Transforming the Indonesian Palm Oil Supply Chain at Scale," June 14. Devex. https://www.devex.com/news/sponsored/opinion-transforming-the-indonesian-palm-oil-supply-chain-at-scale-103417.

NRS (National REDD+ Secretariat, Ghana). n.d. *Ghana Cocoa Forest REDD+ Programme (GCFRP).* https://reddsis.fcghana.org/projects.php?id=4. Accessed August 21, 2023.

Núñez del Prado, I., G. Blackham, P. Moura Costa, and M. Moura Costa. 2022. *Practical Guide to Conducting Due Diligence of Tropical Timber Products: Republic of Congo*. Rio de Janeiro, Brazil: BVRio Institute. https://www.bvrio.org/wp-content/uploads/2022/08/BVRio_Publication_Due_Diligence_Congo.pdf.

Nurfatriani, F., R. Ramawati, G. Kartika Sari, W. Saputra, and H. Komarudin. 2022. "Oil Palm Economic Benefit Distribution to Regions for Environmental Sustainability: Indonesia's Revenue-Sharing Scheme." *Land* 11 (9): 1452. https://doi.org/10.3390/land11091452.

ODH (Open Data Handbook). 2016. "Establish an Open Data Ecosystem." Open Data Handbook. https://opendatahandbook.org/solutions/en/Open-Data-Ecosystem/.

OECD and FAO (Organisation for Economic Co-operation and Development and Food and Agriculture Organization of the United Nations). 2016. *OECD-FAO Guidance for Responsible Agricultural Supply Chains*. Paris, France: OECD; Rome, Italy: FAO. https://doi.org/10.1787/9789264251052-en.

OECD and FAO. Forthcoming. *OECD-FAO Business Handbook on Deforestation and Due Diligence in Agricultural Supply Chains*. Paris, France: OECD; Rome, Italy: FAO.

Pendrill, F., T.A. Gardner, P. Meyfroidt, U.M. Persson, J. Adams, T. Azevedo, M.G. Bastos Lima, et al. 2022. "Disentangling the Numbers behind Agriculture-Driven Tropical Deforestation." *Science* 377 (6611): eabm9267. https://doi.org/10.1126/science.abm9267.

Planet Tracker. 2022. "Increased Soy Certification Would Increase Deforestation Risk," April 5. Planet Tracker. https://planet-tracker.org/increased-soy-certification-would-decrease-deforestation-risk/.

Planeta Campo. 2022. "Pará Produces 96% of Its Soy Compliant with Green Protocol for Grains," August 25. Planeta Campo. https://planetacampo.com.br/para-produces-96-of-its-soy-compliant-green-protocol-for-grains/.

Proforest. 2021a. "Engagement Principles for the Ghana Cocoa Forest REDD+ Program." Accra, Ghana: Proforest. https://www.proforest.net/fileadmin/uploads/proforest/Engagement_Principles_for_GCFRP.pdf.

Proforest. 2021b. *Policy and Governance Review Relevant to the Agro-Commodity Production Landscape in Ghana*. Accra, Ghana: Proforest. https://www.proforest.net/fileadmin/uploads/proforest/Documents/Publications/PLP_Report_Ghana_Policy_07-2021.pdf.

Proforest. 2022. "Ten Countries Commit to Sustainable Commodities in Africa," November 9. Proforest. https://www.proforest.net/news-events/news/ten-countries-commit-to-sustainable-commodities-in-africa/.

Rahman, S. 2020. "Malaysian Independent Oil Palm Smallholders and Their Struggle to Survive 2020." *Perspective* 2020 (144). Singapore: ISEAS–Yusof Ishak Institute. https://www.iseas.edu.sg/wp-content/uploads/2020/12/ISEAS_Perspective_2020_144.pdf.

Rainforest Alliance. 2022a. *Cocoa Certification Data Report 2021*. New York, NY: Rainforest Alliance. https://www.rainforest-alliance.org/wp-content/uploads/2022/05/Cocoa-Certification-Data-Report-2021.pdf.

Rainforest Alliance. 2022b. *Coffee Certification Data Report 2021*. New York, NY: Rainforest Alliance. https://www.rainforest-alliance.org/wp-content/uploads/2022/05/Coffee-Certification-Data-Report-2021.pdf.

Rainforest Alliance. 2023. "The Universal Mill List," last updated June 12. New York, NY: Rainforest Alliance. https://www.rainforest-alliance.org/business/certification/the-universal-mill-list/.

Ramankutty, N., A.T. Evan, C. Monfreda, and J.A. Foley. 2008. "Farming the Planet: 1. Geographic Distribution of Global Agricultural Lands in the Year 2000." *Global Biogeochemical Cycles* 22 (1): n/a-n/a. https://doi.org/10.1029/2007GB002952.

Reboul, M., B. Galin, and R. Gineyts. 2022. Personal communication among authors and Marine Reboul, imported deforestation/fair trade project manager, Ministry of Ecological Transition, French government; Beatrice Galin, senior project officer, French government; and Robin Gineyts, involved in the implementation of the National Strategy for the Fight against Imported Deforestation (SNDI) Forest and Terrestrial Biodiversity at the Ministry of Ecological Transition, French government. October 24.

Republik Indonesia. 2018. "Sistem Verifikasi Legalitas Kayu" ("Timber Legality Verification System"), October 31. Republik Indonesia. https://www.menlhk.go.id/site/post/138.

Rijk, G., T. Steinweg, and M. Piotrowski. 2019. *Deforestation-Driven Reputation Risk Could Become Material for FMCGs*. Washington, DC: Chain Reaction Research. https://chainreactionresearch.com/report/deforestation-driven-reputation-risk-could-become-material-for-fmcgs/.

Ritchie, H., and M. Roser. 2021a. "Drivers of Deforestation." OurWorldInData.org. https://ourworldindata.org/drivers-of-deforestation.

Ritchie, H., and M. Roser. 2021b. "Forests and Deforestation, Soy." OurWorldInData.org. https://ourworldindata.org/soy.

Ritchie, H., and M. Roser. 2021c. "Palm Oil." OurWorldInData.org. https://ourworldindata.org/palm-oil.

RoC and EU (Republic of the Congo and European Union). 2021. *Rapport annuel conjoint 2021: Sur la mise en oeuvre de l'APV FLEGT en République du Congo*. (*2021 Joint Annual Report on the Implementation of FLEGT in the Republic of Congo*.) Republic of the Congo and European Union. https://flegtvpafacility.org/wp-content/uploads/2022/12/Congo_UE_Rapport-annuel-2021.pdf.

RSPO (Roundtable on Sustainable Palm Oil). 2022a. "Share Your Views: RSPO Mass Balance Supply Chain Model," July 24. Kuala Lumpur, Malaysia: RSPO. https://rspo.org/share-your-views-rspo-mass-balance-supply-chain-model/.

RSPO. 2022b. "Latest ACOP 2021 Report Shows Robust CSPO Production and Consumption Growth," September 14. Kuala Lumpur, Malaysia: RSPO. https://rspo.org/latest-acop-2021-report-shows-robust-cspo-production-and-consumption-growth/.

RTRS (Round Table on Responsible Soy). 2022. *Management Report 2021*. Zürich, Switzerland: Round Table on Responsible Soy. https://responsiblesoy.org/management-report-2021?lang=en.

Saunders, J. 2022. Personal communication between authors and Jade Saunders, acting executive director, World Forest ID. November 1.

SBTi (Science Based Targets initiative). 2022a. *SBTi Progress Report 2021*. Science Based Targets initiative. https://sciencebasedtargets.org/reports/sbti-progress-report-2021.

SBTi. 2022b. "Forest Land and Agriculture Pathways Will Require Action on Deforestation," June 2. Science Based Targets initiative. https://sciencebasedtargets.org/blog/forest-land-and-agriculture-pathways-will-require-action-on-deforestation.

SBTi. 2022c. "The SBTi's FLAG Guidance: A Groundbreaking Moment for Addressing Land-Related Emissions," October 13. Science Based Targets initiative. https://sciencebasedtargets.org/blog/the-sbtis-flag-guidance-a-groundbreaking-moment-for-addressing-land-related-emissions.

Schilling-Vacaflor, A., A. Lenschow, E. Challies, B. Cotta, and J. Newig. 2021. "Contextualizing Certification and Auditing: Soy Certification and Access of Local Communities to Land and Water in Brazil." *World Development* 140 (April): 105281. https://doi.org/10.1016/j.worlddev.2020.105281.

Schreiber, W., B. Hamp, S. Allen, and A. Thomson. 2021. *Soy Transparency Coalition 2020 Trader Assessment: Public Report*. Soy Transparency Coalition. https://soytransparency.org/wp-content/uploads/2021/04/STC-2020-report-public-final.pdf.

Setiawati, R., T. Trestya Putri, and R. Nurafiati. 2022. *Measuring Progress towards a Sustainable Palm Oil Supply Chain. A Company's Journey*. Hong Kong: CDP Southeast Asia and Oceania. https://cdn.cdp.net/cdp-production/cms/reports/documents/000/006/522/original/CDP_Palm_Oil_Report_2022_Final.pdf?1660821343.

Shea, K. 2023. "Use of GLAD Alerts Led to 18% Reduction in Deforestation in Monitored African Forests," January 4. Global Forest Watch. https://www.globalforestwatch.org/blog/data-and-research/glad-alerts-reduce-deforestation-africa/.

Sheldon, W. 2020. "Webinar: Automating Forest Carbon Reporting for Smallholder Farmers," November 4. Taking Root. https://takingroot.org/automating-forest-carbon-for-smallholder-farmers/.

SIM (Sustainable Investment Management). 2022. "SIM Launches Zero-Deforestation Soy Initiative Funded by Green Bonds," August 2. Sustainable Investment Management. https://sim.finance/2022/08/02/sim-launches-zero-deforestation-soy-initiative-funded-by-green-bonds/.

SIM, Opea, and Traive. 2023. *Responsible Commodities Facility Annual Report: Crop Season 2022:2023. Providing Finance to Promote the Trading of Responsible Soy and Corn from Brazil*. SIM, Opea, and Traive. https://sim.finance/wp-content/uploads/2023/05/RCF-ANNUAL-REPORT-May-2023.pdf.

Sime Darby. 2022. "Sime Darby Oils Global Supply Chain Q1 2022 NDPE IRF Profile." Selangor, Malaysia: Sime Darby. https://www.simedarbyoils.com/documents/SDO-Global-NDPE-Q1-2022.pdf.

Skettring. 2019. "Salmon Feed Producers Take Action in Brazil to Prevent Deforestation and Protect Wildlife," December 18. Skettring. https://www.skretting.com/en/news-and-stories/salmon-feed-producers-take-action-in-brazil-to-prevent-deforestation-and-protect-wildlife/.

Slob, B., G. Rijk, and M. Piotrowski. 2020. *JBS, Marfrig, and Minerva: Material Financial Risk from Deforestation in Beef Supply Chains*. Washington, DC: Chain Reaction Research. https://chainreactionresearch.com/wp-content/uploads/2020/12/JBS-Marfrig-and-Minerva-Material-financial-risk-from-deforestation-in-beef-supply-chains-2.pdf.

Song, X.-P., M.C. Hansen, P. Potapov, B. Adusei, J. Pickering, M. Adami, A. Lima, et al. 2021. "Massive Soybean Expansion in South America since 2000 and Implications for Conservation." *Nature Sustainability* 4 (9): 784–92. https://doi.org/10.1038/s41893-021-00729-z.

SPOC (Sustainable Palm Oil Choice). 2022. "A Mass Balancing Act: Finding a Solution in between Large-Scale Market Transformation and Full Traceability," November 2022. Sustainable Palm Oil Choice. https://www.sustainablepalmoilchoice.eu/a-mass-balancing-act/.

Starbucks. 2020. "C.A.F.E. Practices: Starbucks Approach to Ethically Sourcing Coffee," February 28. Starbucks. https://stories.starbucks.com/press/2020/cafe-practices-starbucks-approach-to-ethically-sourcing-coffee/.

Stäuble, T., J. Laporte, R. Nogueron, and M. Knorr-Evans. 2022. *Timber Traceability: A Management Tool for Governments. Case Studies from Latin America*. Rome, Italy: Food and Agriculture Organization of the United Nations; Washington, DC: World Resources Institute. https://forestlegality.org/sites/default/files/2022-06/timber-traceability-tool-governments-case-studies-latin-america.pdf.

Stäuble, T., R. Nogueron, M. Knorr-Evans, and T. Schneider. Forthcoming. *Timber Traceability: A Practical Framework for Government-Owned Traceability Systems*. Washington, DC: World Resources Institute.

Streck, C., D.M. Landholm, H. Bakhtary, S. Mithra Manirajah, S. Siantidis, and S.C. Cabezas. 2020. *Supporting Smallholder Farmers for a Sustainable Cocoa Sector.* Climate Focus. https://climatefocus.com/publications/supporting-smallholder-farmers-sustainable-cocoa-sector.

Taylor, A., A. Francis, A. Sands, C. van der Ven, E. Antoni, M. Moraa, A. Buckwell, et al. 2021. *Setting the Standard: Advancing the Case for Core Environmental Standards in the UK*. Surrey, UK: WWF. https://www.wwf.org.uk/our-reports/setting-standard-report.

TFA (Tropical Forest Alliance). 2022. "TFA EU Deep Dives. Geolocation and Traceability Session: Beef." Geneva, Switzerland: Tropical Forest Alliance. https://www.tropicalforestalliance.org/assets/TFA-EU-deep-dives-beef.pdf.

TFA, WWF, and Proforest. 2020. *Landscape Scale Action for Forests, People and Sustainable Production. A Practical Guide for Companies*. Geneva, Switzerland: Tropical Forest Alliance. https://jaresourcehub.org/wp-content/uploads/2020/09/JA-Practical-Guide.pdf.

Tony's Chocolonely. 2020. "Deforestation Is a Major Issue, Also Present in the Cocoa Industry," April 22. Tony's Chocolonely. https://tonyschocolonely.com/uk/en/our-mission/news/deforestation-is-a-major-issue-also-present-in-the-cocoa-industry.

Transparency Pathway. 2023. "Assessing the Legality of Deforestation Using Spatial Data: An Adaptable Methodology to Support Policy Makers and Market Operators." Transparency Pathway. https://transparencypathway.org/insights/assessing-legality-deforestation-using-spatial-data-adaptable-methodology-support-policy-makers-market-operators/.

Trase. 2022. "Supporting France's Plan to Increase Transparency over Deforestation," August 2. Trase. https://insights.trase.earth/insights/supporting-france-s-plan-to-increase-transparency-over-deforestation.

UNEP-WCMC (United Nations Environment Programme–World Conservation Monitoring Centre). 2020. *Republic of the Congo: Country Overview to Aid Implementation of the EUTR*. Cambridge, UK: UNEP-WCMC. https://circabc.europa.eu/ui/group/34861680-e799-4d7c-bbad-da83c45da458/library/85e5975e-bd96-4796-861e-ac25a80b9efc/details.

Vallée, M., V. Vauthier, S. Moukouri, and S. Labaste. 2022. "Independent Forest Monitoring in the Congo Basin: Taking Stock and Thinking Ahead." Working Paper. Washington, DC: World Resources Institute. https://doi.org/10.46830/wriwp.21.00042.

van der Ven, C., E. Antoni, M. Moraa Mokaya, A. Buckwell, and M. Nicholson. 2021. *Core Environmental Standards for UK Imported Agri Food Products: Options for Pesticide and Fertiliser Use*. Consultant Report for WWF-UK. Geneva: Tulip.

VPA A-LA (VPA Africa–Latin America). 2022. "EU and Côte d'Ivoire Conclude Negotiations on an Agreement to Combat Illegal Logging," October 19. VPA Africa–Latin America. https://flegtvpafacility.org/eu-cote-divoire-conclude-negotiations-agreement-combat-illegal-logging/.

Walker, N.F. 2023. Personal communication email with Nathalie Walker, senior director, Tropical Forests and Agriculture, National Wildlife Federation. February 21, 2023.

Walker, N.F., S.A. Patel, and K.A.B. Kalif. 2013. "From Amazon Pasture to the High Street: Deforestation and the Brazilian Cattle Product Supply Chain." *Tropical Conservation Science* 6 (3): 446–67. https://doi.org/10.1177/194008291300600309.

Wang, Y., P.M. Hollingsworth, D. Zhai, C.D. West, J. Green, H. Chen, K. Hurni, et al. 2022. "New High-Resolution Maps Show That Rubber Causes Significant Deforestation." Preprint. *Ecology*. https://doi.org/10.1101/2022.12.03.518959.

Warner, E. 2021. "New Taking Root Project to Reduce Carbon Footprint of Coffee Farms," May 6. Taking Root. https://takingroot.org/new-taking-root-project-to-reduce-carbon-footprint-of-coffee-farms/.

Wasley, A., A. Heal, A. Campos, P. Locatelli, and D. Phillips. 2020. "Brazilian Meat Giant Trucked Cattle from Deforested Amazon Ranch," July 27. The Bureau of Investigative Journalism. https://www.thebureauinvestigates.com/stories/2020-07-27/ecember-meat-giant-jbs-trucked-cattle-from-deforested-amazon-ranch.

WBCSD (World Business Council for Sustainable Development). 2021. *Soft Commodities Forum Progress Report, June 2021*. Geneva, Switzerland: WBCSD. https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Soft-Commodities-Forum/Resources/Soft-Commodities-Forum-Progress-Report-June-2021.

WBCSD. 2022a. *Soft Commodities Forum Progress Report 2022, December 2022, Monitor Land Use*. Geneva, Switzerland: WBCSD. https://wbcsdpublications.org/scf/report-homepage-december-2022/monitor-land-use-december-2022/.

WBCSD. 2022b. *Soft Commodities Forum Progress Report, December 2022*. Geneva, Switzerland: WBCSD. https://wbcsdpublications.org/scf/wp-content/uploads/2022/12/SCF-report_december_EN_Final.pdf.

WBCSD. 2022c. *Soft Commodities Forum Progress Report, December 2022, Transform Landscapes*. Geneva, Switzerland: WBCSD. https://wbcsdpublications.org/scf/report-homepage-december-2022/transform-landscapes-december-2022/.

WBCSD. 2022d. "Six Leading Agribusinesses Launch a Financial Model for Deforestation-Free Soy in the Brazilian Cerrado," November 12. WBCSD. https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Soft-Commodities-Forum/News/Six-leading-agribusinesses-launch-a-financial-model-for-deforestation-free-soy-in-the-Brazilian-Cerrado.

Weisse, M., and E. Goldman. 2022. "Forest Pulse, Global Forest Review, 2022, Update 3." Washington, DC: World Resources Institute. https://research.wri.org/gfr/latest-analysis-deforestation-trends.

Weisse, M., and A. Pickens. 2020. "GLAD Deforestation Alerts, Explained," September 2. Global Forest Watch. https://www.globalforestwatch.org/blog/data-and-research/glad-deforestation-alerts/.

White, O., A. Madgavkar, Z. Townsend, J. Manyika, T. Olanrewaju, T. Sibanda, and S. Kaufman. 2021. "Financial Data Unbound: The Value of Open Data for Individuals and Institutions." Discussion Paper. New York, NY: McKinsey & Company. https://www.mckinsey.com/industries/financial-services/our-insights/financial-data-unbound-the-value-of-open-data-for-individuals-and-institutions.

Wilmar. 2019. *No Deforestation, No Peat, No Exploitation Policy*. Singapore: Wilmar International Limited. https://www.wilmar-international.com/docs/default-source/default-document-library/sustainability/policies/wilmar-ndpe-policy---2019.pdf.

WWF (World Wildlife Fund). 2021. "First Soy Traders Scorecard Shows Major Traders Are Not Taking Sufficient Action on Their Environmental and Social Commitments," May 19. World Wildlife Fund. https://www.worldwildlife.org/press-releases/first-soy-traders-scorecard-shows-major-traders-are-not-taking-sufficient-action-on-their-environmental-and-social-commitments.

WWF-France and FAO. 2018. *Timber Value Chain Study in Republic of Congo, Côte d'Ivoire and Democratic Republic of Congo*. Internal FAO report. Unpublished. Rome, Italy: Food and Agriculture Organization of the United Nations.

WWF-UK and RSPB. 2017. *Risky Business: Understanding the UK's Overseas Footprint for Deforestation-Risk Commodities*. Based on original research undertaken by 3Keel.

WWF-UK and RSPB. 2020. *Riskier Business: The UK's Overseas Land Footprint*. Based on original research undertaken by 3Keel. https://www.wwf.org.uk/sites/default/files/2020-07/RiskierBusiness_July2020_V7_0.pdf.

Wyers, R. 2019. 'The Reputational Risk of Deforestation-Linked Soy: Investors Call for Action on Global Supply Chains," March 11. Food Ingredients 1st. https://www.foodingredientsfirst.com/news/the-reputational-risk-of-deforestation-linked-to-soy-investors-call-for-action-on-global-supply-chains.html.

Yap, P., R. Rosdin, A.A.A. Abdul-Rahman, A.T. Omar, M.N. Mohamed, and M.S. Rahami. 2021. "Malaysian Sustainable Palm Oil (MSPO) Certification Progress for Independent Smallholders in Malaysia." *IOP Conference Series: Earth and Environmental Science* 736 (1): 012071. https://doi.org/10.1088/1755-1315/736/1/012071.

zu Ermgassen, E.K.H.J., J. Godar, M.J. Lathuillière, P. Löfgren, T. Gardner, A. Vasconcelos, and P. Meyfroidt. 2020. "The Origin, Supply Chain, and Deforestation Risk of Brazil's Beef Exports." *Proceedings of the National Academy of Sciences* 117 (50): 31770–79. https://doi.org/10.1073/pnas.2003270117.

zu Ermgassen, E.K.H.J., M.G. Bastos Lima, H. Bellfield, A. Dontenville, T. Gardner, J. Godar, R. Heilmayr, et al. 2022. "Addressing Indirect Sourcing in Zero Deforestation Commodity Supply Chains." *Science Advances* 8 (17): eabn3132. https://doi.org/10.1126/sciadv.abn3132.

ABOUT WRI

World Resources Institute is a global research organization that turns big ideas into action at the nexus of environment, economic opportunity, and human well-being.

OUR CHALLENGE

Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

OUR VISION

We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

ABOUT FAO

The Food and Agriculture Organization (FAO) is a specialized agency of the United Nations that leads international efforts to defeat hunger.

Our goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives. With 195 members—194 countries and the European Union—FAO works in over 130 countries worldwide.

Join us in creating a world without hunger and poverty.

ABOUT EFECA

Efeca provides independent technical advice and support on the sustainable and legal sourcing of natural resources, with a focus on agricultural and forest commodities including palm oil, soy, timber, cocoa, coffee and rubber. Working across the public and private sectors, research and civil society, our focus is primarily on national and international policies, regulations and private sector commitments. Efeca provides specialized advice on responsible sourcing, traceability, transparency, monitoring and reporting, and sustainable trade.

Efeca has a strong reputation for solution-oriented, cross-sector and industry-wide facilitation, along with high quality research and report writing. Efeca is impact driven, highly collaborative and focused on quality of execution.

Efeca is a Tropical Forest Alliance (TFA) partner, a World Economic Forum (WEF) preferred supplier, a UN Global Compact signatory, a Race to Zero committed business and an Accountability Framework initiative (AFi) coalition member. In 2023 Efeca became BCorp certified and is proud to be an accredited UK Living Wage Employer.

ABOUT KANOPI CONSULTING

Kanopi Consulting accelerates transformative change within corporate supply chains, driven by a dedication to reducing deforestation and safeguarding natural ecosystems. We collaborate with companies and NGOs to accelerate the widespread adoption of responsible sourcing and production practices, both at the individual company and sector levels. Through rigorous analysis and targeted advocacy, we identify and champion impactful sustainable land-use interventions for businesses operating in the food, consumer goods, and agricultural commodity sectors.

ABOUT THE FOREST DATA PARTNERSHIP

Initiated in October 2021, this five-year partnership, coordinated by the World Resources Institute (WRI) with support from USAID and the U.S. Department of State, brings together leading organizations, governments and private sector partners to collectively address the challenge of improving land use data. WRI lead the development of the data ecosystem by convening public and private sector stakeholders, providing governance and facilitation, and maintaining technical facilities for implementation. SERVIR, a joint initiative of NASA, USAID and leading geospatial organizations, builds capacity to use geospatial data at national and regional levels through its network of hubs in Asia, Africa and Latin America. Google supports the initiative as the key technology partner and platform provider. Unilever serves as the private sector lead for launching the ecosystem and coordinating private sector involvement.

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