

KEY ISSUES IN SUPPLY CHAINS: OPACITY VS. TRANSPARENCY

Lecture 8

EAS 501

Thursday, September 18, 2025

Key Issues in Supply Chains

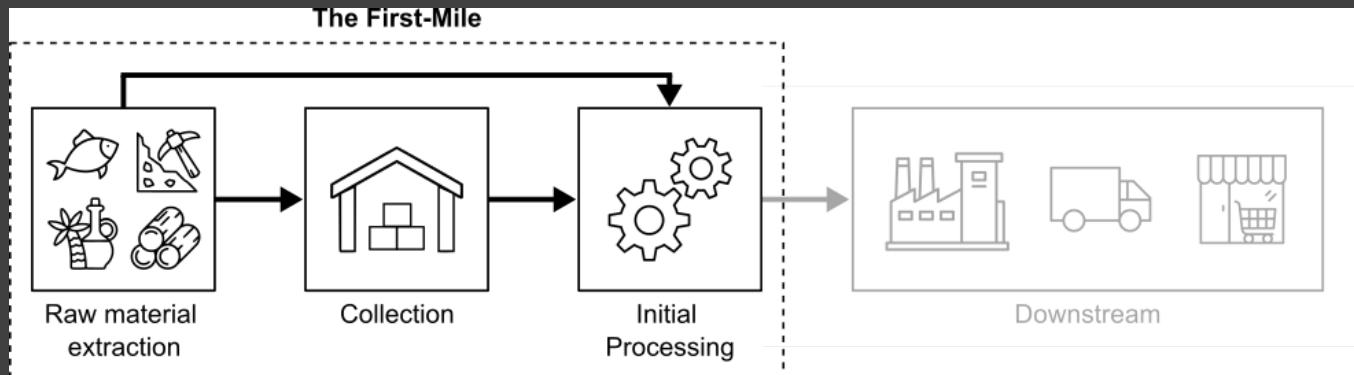
Module #2: Key Issues in Supply Chains				
Tues, Sept 16 Lecture 7	Sustainability and Supply Chains	O'Rourke (2014)	<ul style="list-style-type: none">LectureDiscuss readings	Overview of challenges and foci
Thurs, Sept 18 Lecture 8	Traceability vs. Opacity	Fripp et al (2023); Zu Ermgassen et al (2022)	<ul style="list-style-type: none">LectureDiscuss readings	Strategies for traceability
Tues Sept. 23 Lecture 9	Market-based Governance	Lambin et al (2018)	<ul style="list-style-type: none">LectureDiscuss readings	Key governance mechanisms and strategies
Thurs, Sept 25 Lecture 9	Certification	TBD	<ul style="list-style-type: none">LectureDiscuss readings	Private Sector Initiatives
Tues, Sept. 30 Lecture 10	Government-Led: EUDR (Guest lecture: Charlotte Sedlock)	Chandra et al (2024)	<ul style="list-style-type: none">LectureDiscuss readings	Multilateral government efforts
Thurs, Oct 2	Scope 3 Emissions	Stenzel and Waichman (2023)	<ul style="list-style-type: none">LectureDiscuss readings	GHG supply chain accounting
Tues, Oct 7	Midterm Exam Review	No Required Reading	<ul style="list-style-type: none">Review material for exam	
Thurs Oct 9	Midterm Exam	No required reading	<ul style="list-style-type: none">Multiple choice and short answer exam	MIDTERM

Structure

- Final Groups report out on their supply chains
- First-Mile Problem in Supply Chains
- Overview of Traceability and Transparency in Supply Chains – WRI report
- Discuss Zu Ermgassen et al article

I. The First-Mile Supply Chain Challenge: Diagnosis, Strategies & Tactics, and Prospects

The First Mile Problem in Supply Chains

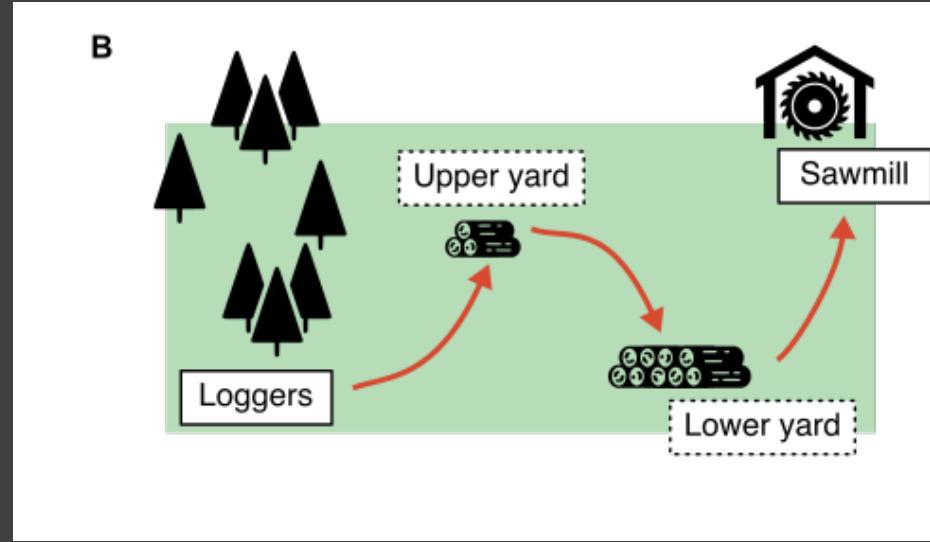


DEFINITION

The first portion of a supply chain where nature is extracted as a location by a particular set of actors, who subsequently transfer a flow of resources downstream for initial processing.

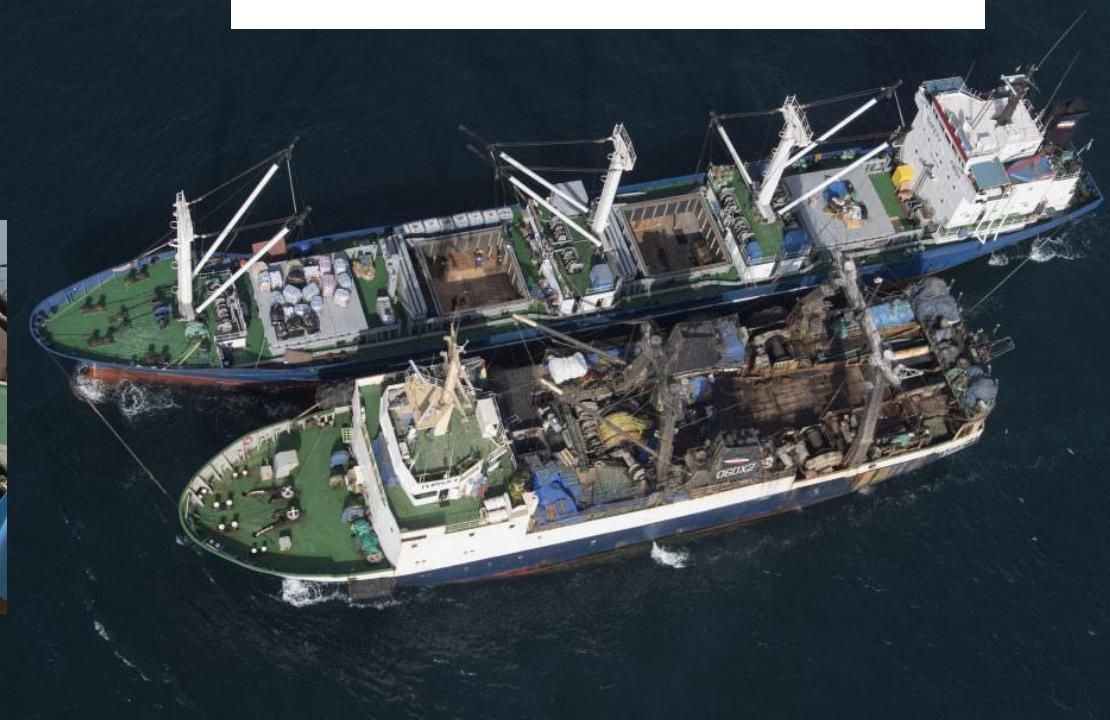
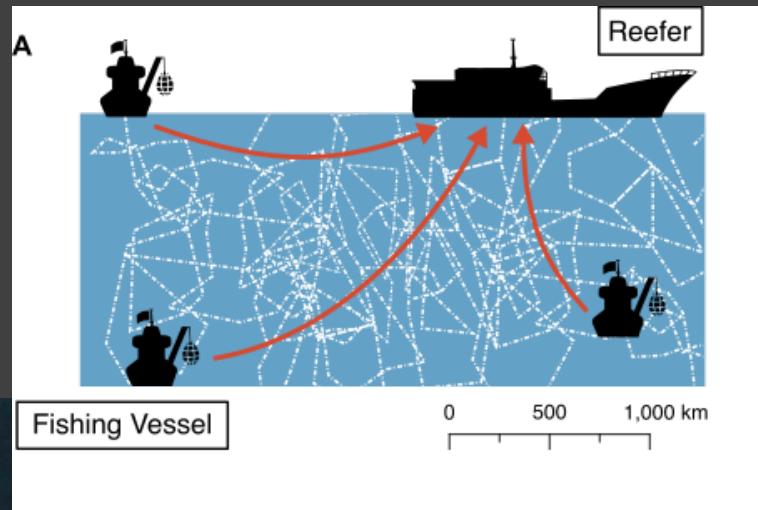
From Forest to Mill: Opacity and Fluidity

- Small logging companies conduct sanitary logging on short-term leases
- Timber aggregated in log yards – upper and lower



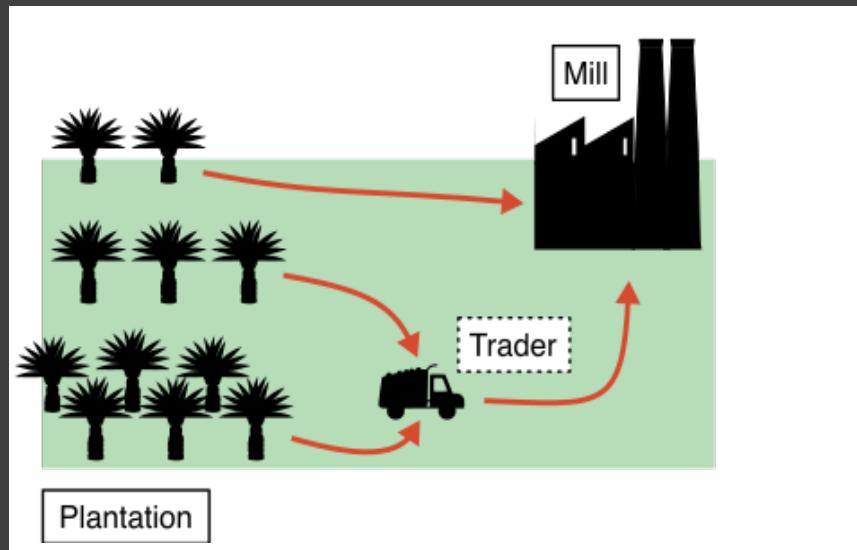
Western Pacific Ocean Tuna Fisheries

- Catch by purse seiner vessels transferred to transshipment reefer



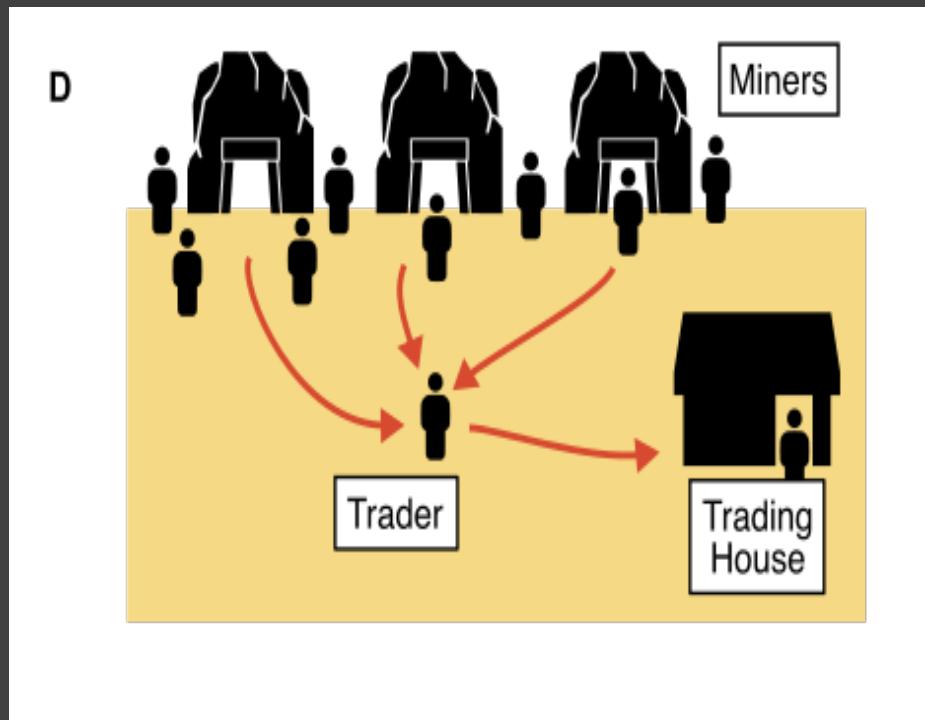
Palm Oil from Indonesia

- Smallholder farmers, traders, and company affiliated plantations
- Supply fresh oil palm fruit to mills



Cobalt from Democratic Republic of Congo

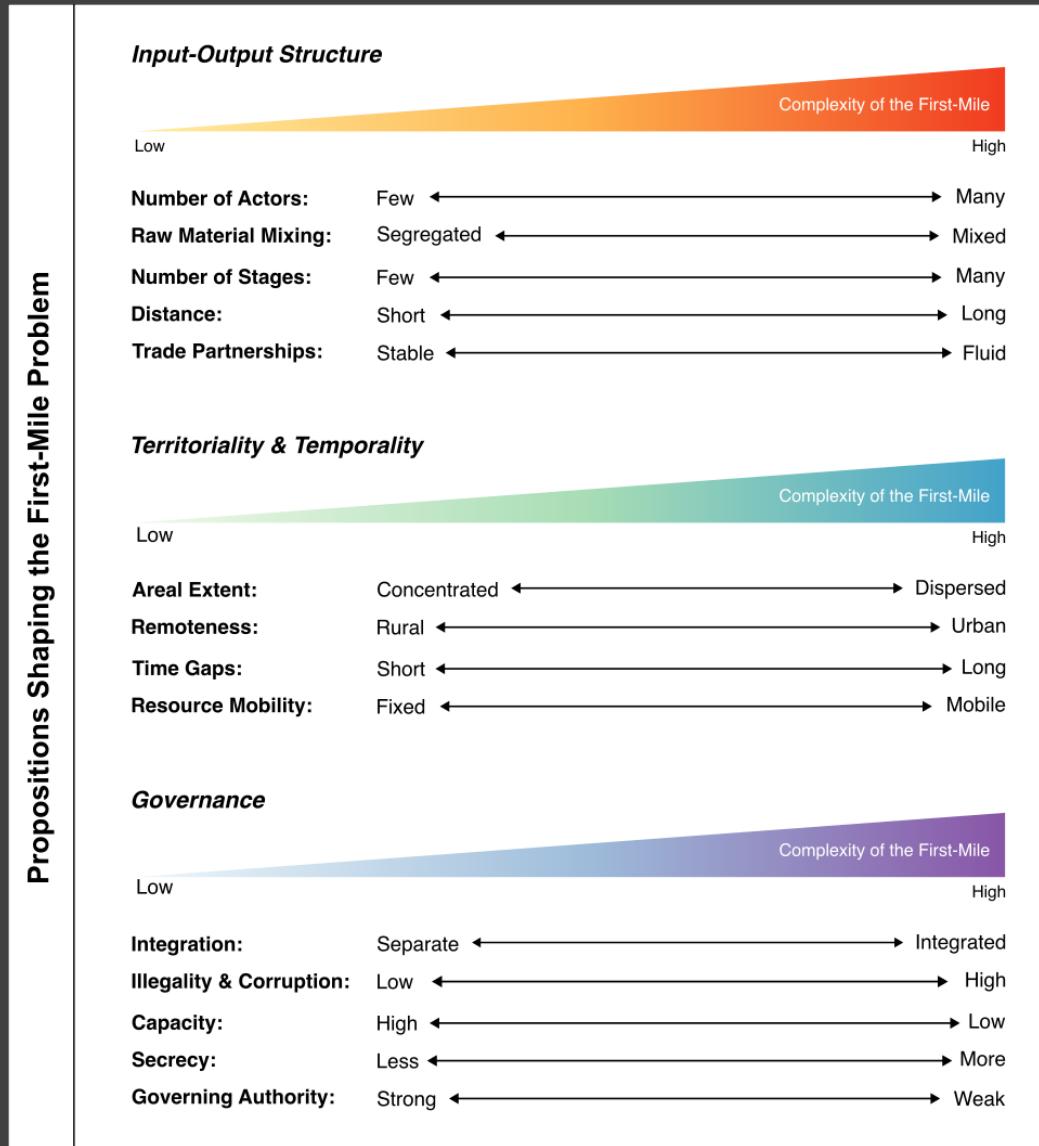
- Artisanal miners sell cobalt to traders
- Trader supply trading houses



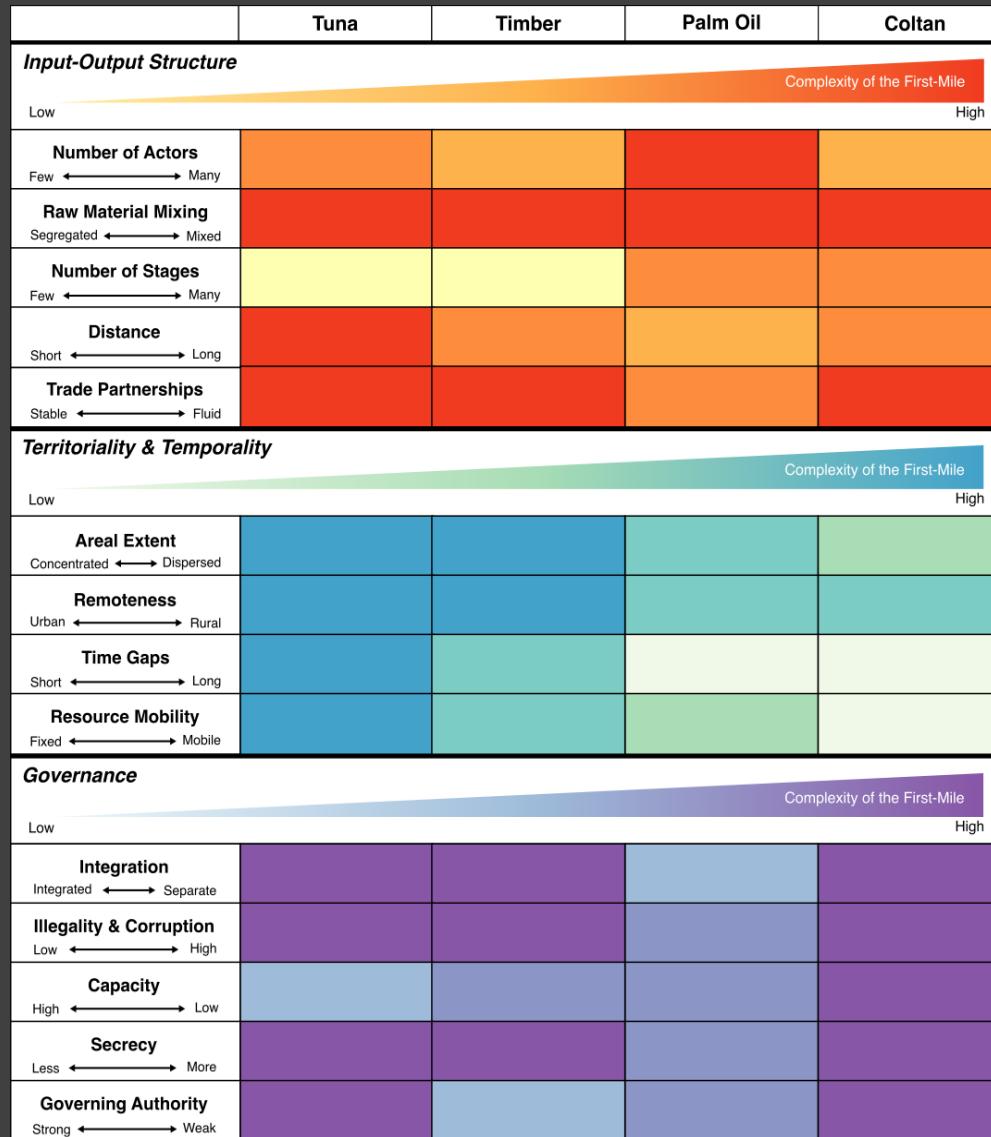
So What? Why should we care?

- Certification and traceability systems and processes
- Life cycle assessments and social impact assessments
- Carbon footprint of products, companies, and regions
- Impacts on people and biodiversity
- Supply chain resilience under climate change
- Carbon offset schemes

Diagnosis: Input-Output Structure, Territoriality, and Governance



Diagnosis: First-Mile Variation by Sector



II. Traceability and Transparency Report

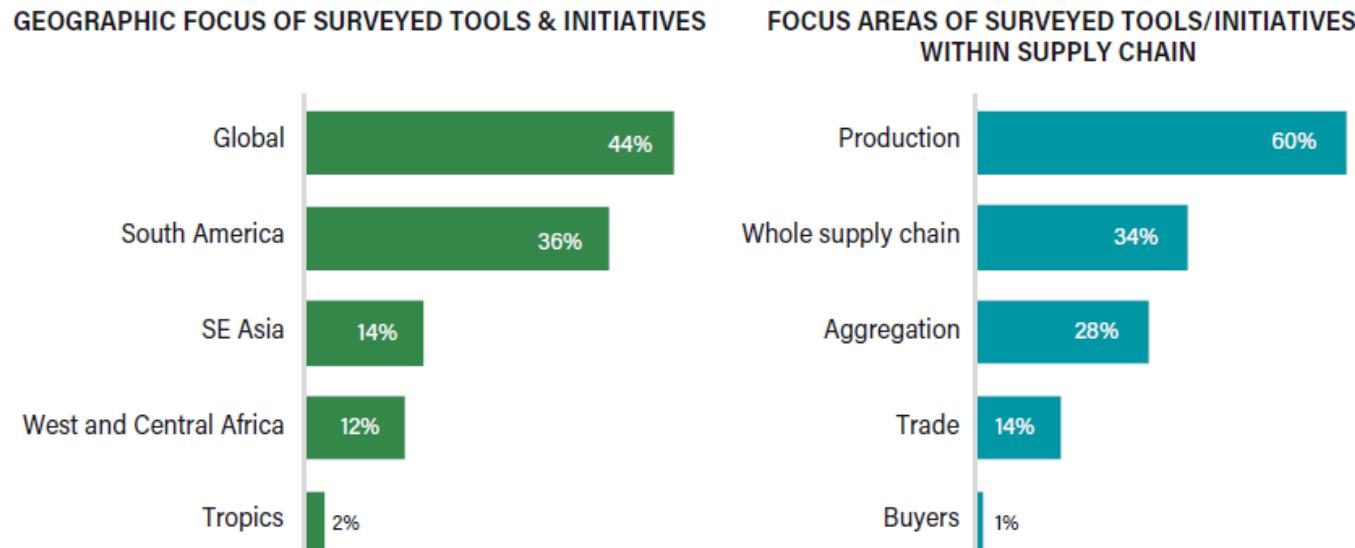
Key Terms

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

Survey of Tools and Initiatives

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.

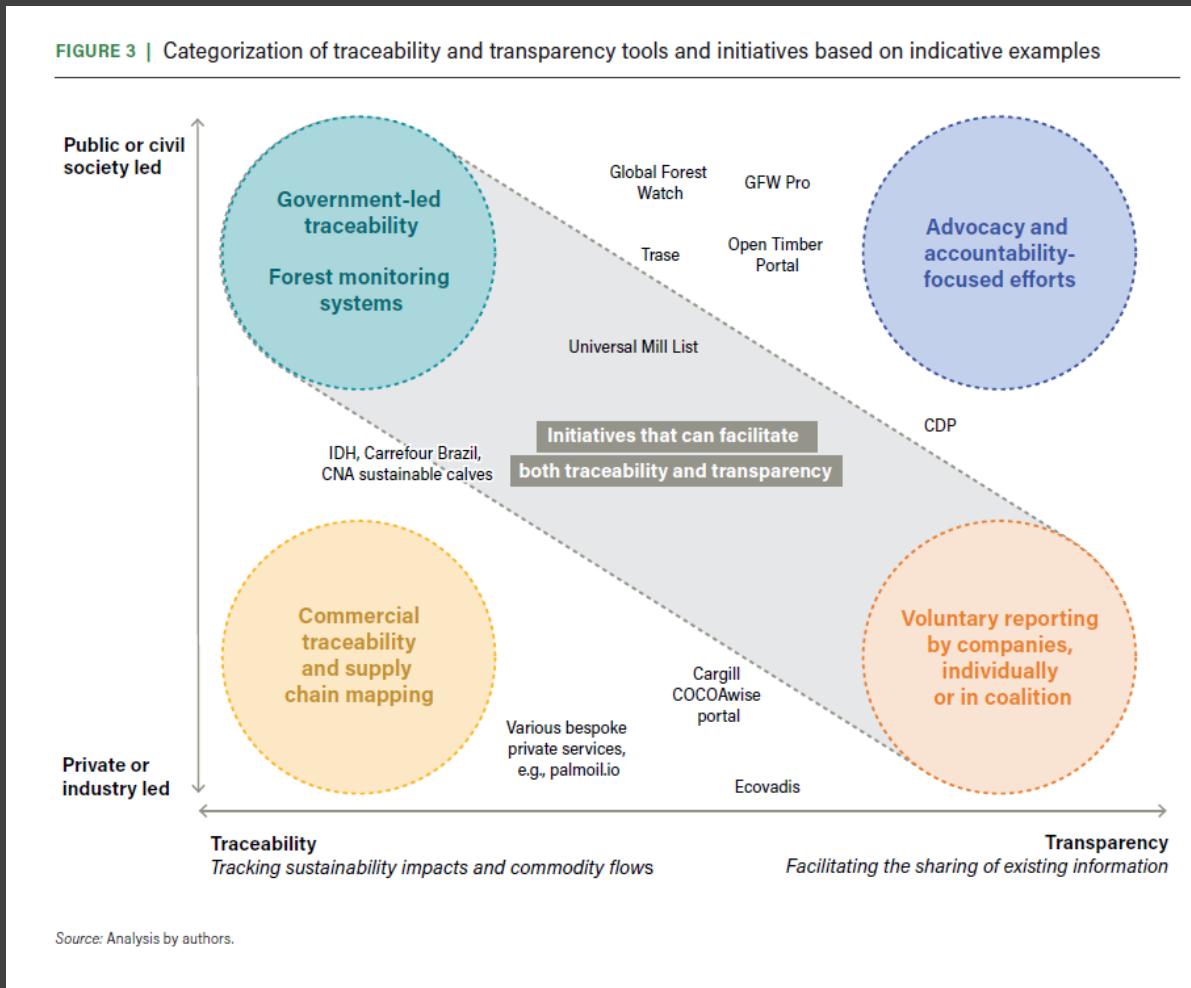
Key Elements of Traceability Systems

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

KEY ELEMENTS OF TRACEABILITY	DESCRIPTION
Objective	<ul style="list-style-type: none">PurposeTarget users of traceability information (e.g., government, private sector, civil society)
Scope	<ul style="list-style-type: none">GeographyCommoditySupply chain stagesSpecified characteristics (e.g., legality, sustainability, deforestation or forest degradation impacts, qualification as deforestation-free, presence of certification)
Governance structure	<ul style="list-style-type: none">Monitoring and oversight over the system, based on purpose and audienceInternal or external leadership
Mechanism to control commodities through the chain of custody	<ul style="list-style-type: none">An approach for physical management of commodity volumes (e.g., mass balance, segregated, identity preserved)
Conformity requirements and assessment framework	<ul style="list-style-type: none">Defined metrics for success
Monitoring framework	<ul style="list-style-type: none">Defined inputs: Data needs, sources, definitions, guidelines, reporting flow, and frameworkDefined outputs: Characteristics of data to be shared between successive steps of the supply chainControl mechanisms
Data: Management approach, including privacy and integrity	<ul style="list-style-type: none">System for data collection and maintenance of data that corresponds to the purpose (see "Objective" above)Systems for quality management of dataRules for data sharing among players along the supply chainData-sharing processes (including practical aspects and tools)Safeguards for managing commercial sensitivities and compliance with data privacy protection laws
Data: Interoperability and usability	<ul style="list-style-type: none">Alignment on definitions, methods, and what constitutes credible evidenceData in a format and with context that enables decision-making on the defined purpose (see "Objective" above)
Assurance and verification	<ul style="list-style-type: none">Monitoring accuracy of assessmentValidation of data and identifying and correcting errors in the systemAssurance models: First-party assurance, second-party verification, or external third-party verification, corresponding to system objective
Reporting systems	<ul style="list-style-type: none">Transparency of data, methods, and system components

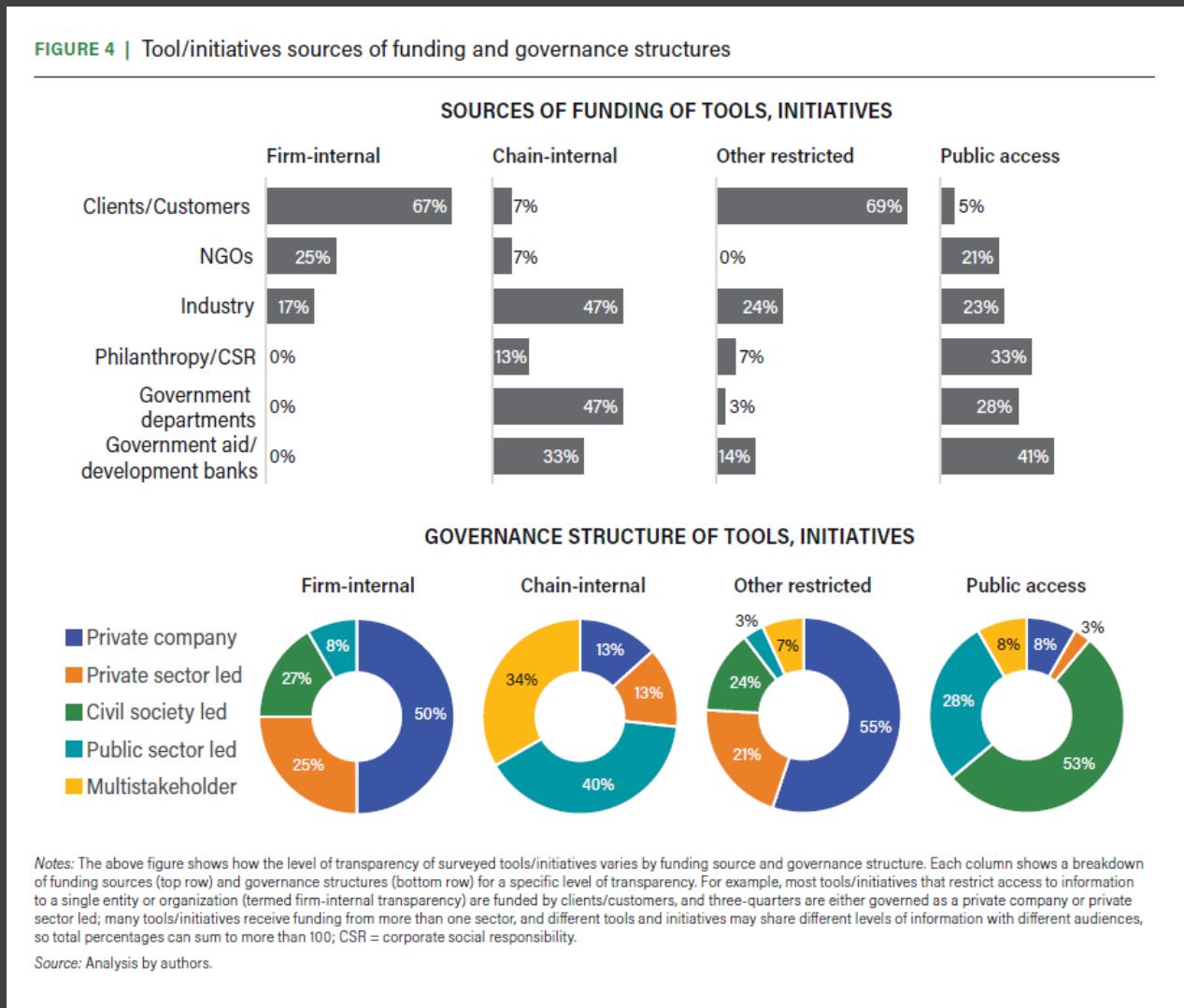
Source: Compilation by authors.

Categorizing Traceability and Transparency Tools and Initiatives



Tools/Initiatives Sources of Funding and Governance Structures

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



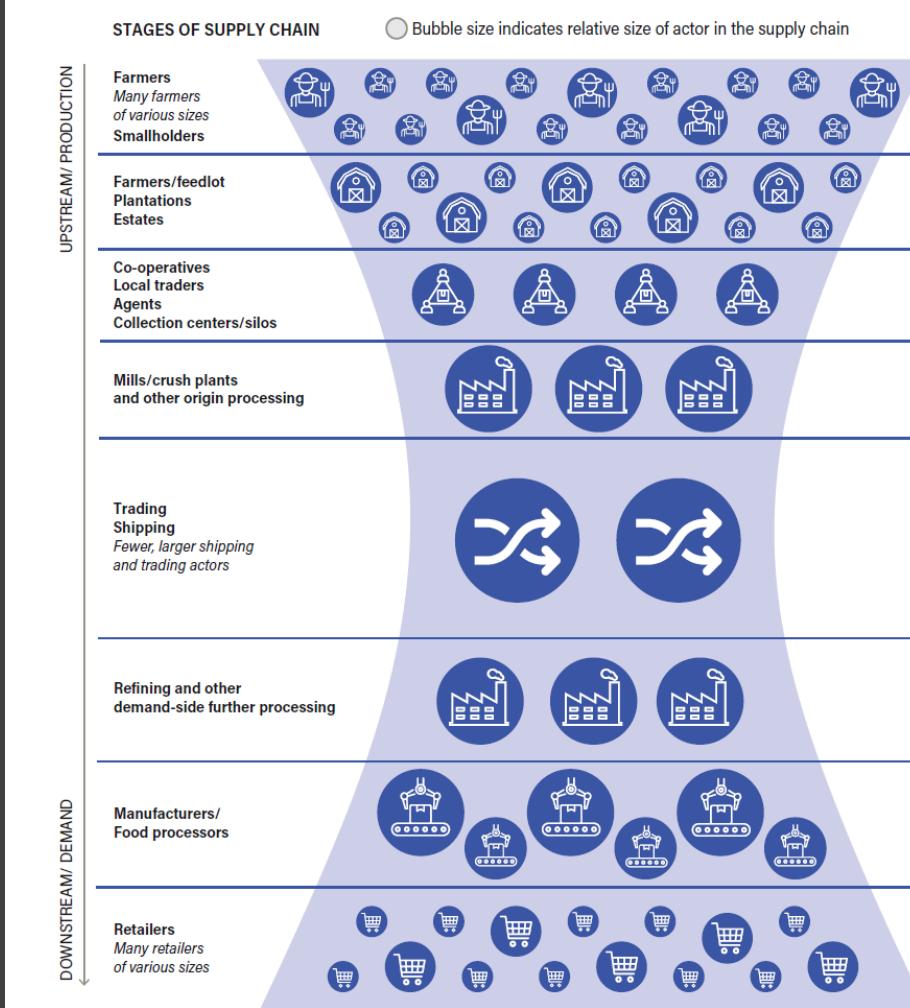
Examples of Corporate Commitments across Commodities

TABLE 8 | Examples of corporate commitments across the commodities

COMMODITY	EXAMPLE OF COMMITMENT	EXAMPLES OF COMMITMENTS ON TRACEABILITY AND TRANSPARENCY
Palm oil	<ul style="list-style-type: none"> Wilmar's "No Deforestation, No Peat, No Exploitation" policy launched in 2013 and updated in 2019^a 	<ul style="list-style-type: none"> 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^d
Soy	<ul style="list-style-type: none"> 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^f also sets a 2025 target date for the removal of deforestation for soy production in the Amazon, Cerrado, and Chaco^d 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 chainsⁱ Trader Roadmap set a target to enable the traceability of the full cattle supply chain in Brazil by the start of 2023^j
Timber	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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

Generic Supply Chain Model

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/5b48c2572487fd7ff29d1c/t/6107e38471685d416f2cd05d/1627906949303/ENG+BN2A_05July2021.pdf.

Private sector-led Systems in commodity 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 ^b	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 ^c	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. ^d 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. ^e GAR has worked with a series of partners to develop its traceability and verification process, including GeoTraceability (for software development) and Kotliva, 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. ^f 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., Vispec) ^g 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. ^h	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 ⁱ	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.
Global Coffee Platform, collective reporting ^j	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. ^k	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]." ^l
Agridience RubberTrace (previously HeveaConnect) ^m	Natural rubber	Agridience 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. ⁿ	A common issue with traceability in natural rubber is the high proportion of smallholders and the high number of intermediaries between production and manufacture. Agridience 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) ^o and makes its marketplace compatible with these various data sources so users have access to useful information.
EcoVadis ^p	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/soywise>; b. GAR 2011; c. For more information, see GAR's web page "Palm Supply Chain Traceability & Transformation" at <https://www.goldenagri.com.sg/sustainability/palm-supply-chain-traceability-and-transformation/>; d. GAR 2021; e. For more information, see Vispec's website at <https://www.vispec.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/143219800895/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 at <https://www.globalcoffeeplatform.org/latest/2022/snapshot-report-2021/report-facts>; m. GCP 2022; n. For more information, see the Agridience Rubber website at <https://rubber.agridience.com/solution/>; o. For more information, see the EcoVadis website at <https://ecovadis.com/>; p. For more information, see the Agridience Rubber website at <https://rubber.agridience.com/projects/agridience-rubbertrace-farm-mapping-pilot-and-rubberway-study/>.

Challenge: Indirect Suppliers and Smallholders

- Supply Chains with *Indirect Suppliers* and *Smallholders* present challenges when implementing traceability and transparency systems
- Can lead to exclusion through supply chain reconfiguration or data gather structures

Chain-of-Custody Models for Sourcing Commodities

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.

Priority Actions by Actor Group and Topic

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	<p>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</p> <p>Pursue monitoring of not just direct but indirect supply</p>	<p>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</p> <p>Include requirements for accessibility in funding models, which tend to determine the transparency levels of different tools</p>	<p>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</p>	<p>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</p> <p>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</p>
Data and information	<p>Work toward greater public disclosure in general, and aligned standards for data disclosure and publication, a key enabler of greater disclosure and transparency</p>	<p>Prioritize coordinated and integrated approaches, including on linkages among data initiatives</p>	<p>Provide data to create the enabling conditions for effective traceability and transparency systems, and to deliver on their national policies and priorities</p>	<p>Leverage innovation to facilitate data sharing while protecting commercially sensitive data</p> <p>Learn lessons from other sectors (e.g., medicine and banking) and across sectors</p>

Priority Actions by Actor Group and Topic

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.

III. Addressing indirect sourcing

Addressing indirect sourcing in zero deforestation commodity supply chains

Erasmus K. H. J. zu Ermgassen, Mairon G. Bastos Lima, Helen Bellfield, Adeline Dontenville, Toby Gardner, Javier Godar, Robert Heilmayr, Rosa Indenbaum, Tiago N. P. dos Reis, Vivian Ribeiro, Itohan-osa Abu, Zoltan Szantoi, Patrick Meyfroidt



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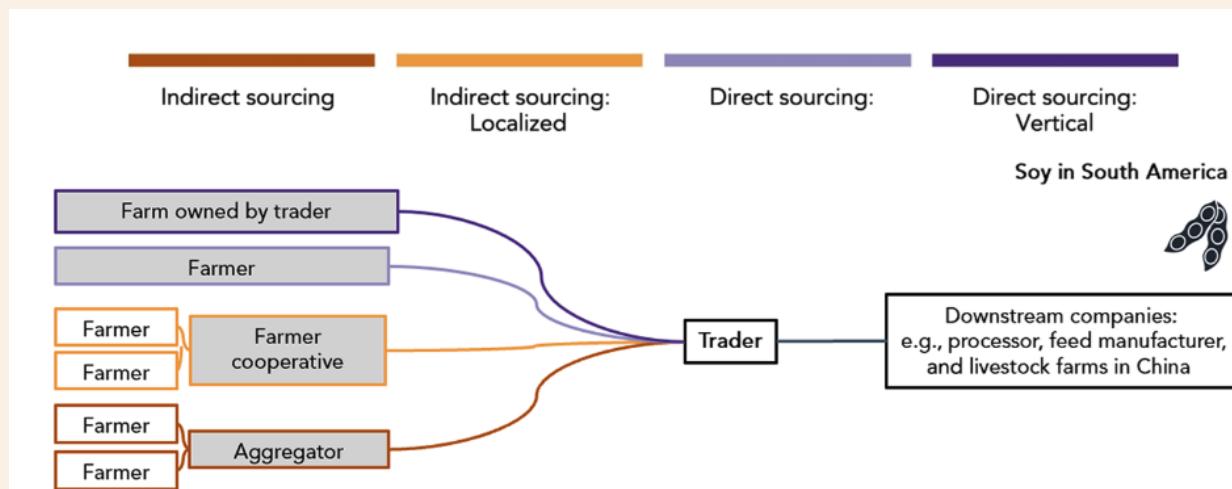
Key Takeaways

-Traders are a “pinch points” in the supply chain.

-Traders source “directly” (from producers) vs. “indirectly” from other intermediaries (brokers, aggregators).

-Traders source more than 40% of commodities “indirectly” via local intermediaries.

-Why do traders source indirectly?



Key Takeaways

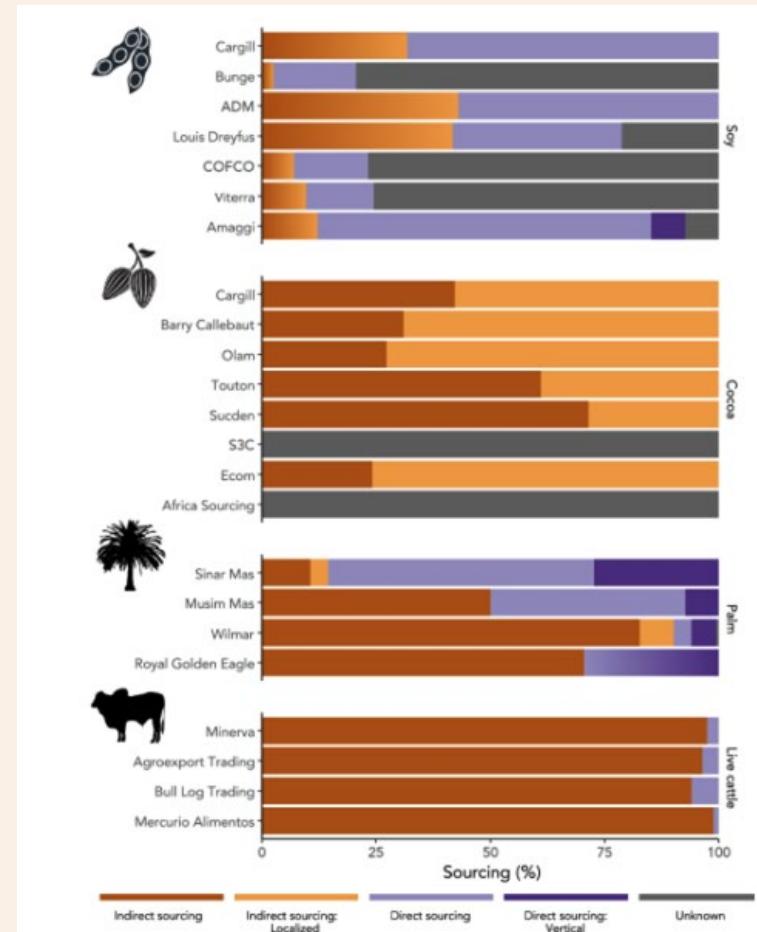
-Why do traders source indirectly?

- Reduce price, reduce transaction costs, reduce business risk with a diversified supply base, unavoidable due to upstream supply aggregation

-Sustainability risks are higher through indirect sourcing

-Ways to mitigate sustainability risks of indirect sourcing.

- Direct sourcing
- Cascading compliance
- Certification
- Traceability
- Transparency
- Landscape and Jurisdictional Approaches



Discussion Questions

-In your groups, brainstorm the following and be ready to report back on your main takeaways

1. Is **vertical integration** the answer to supply chain opacity? What are the sustainability opportunities and limitations to indirect sourcing (think environmental, economic, and social considerations)?
2. Who in the supply chain should be **responsible** for tracing the supply chain?
 1. Tracing a supply chain is expensive. **Who should pay** to trace the supply chain? Is who pays and who is responsible different?
3. Make an argument why complete supply chain traceability is **1) necessary and 2) unnecessary**.
4. Will we ever have complete supply chain traceability? What are the **consequences to a business if its supply chain is 1) fully traceable and 2) fully transparent**?