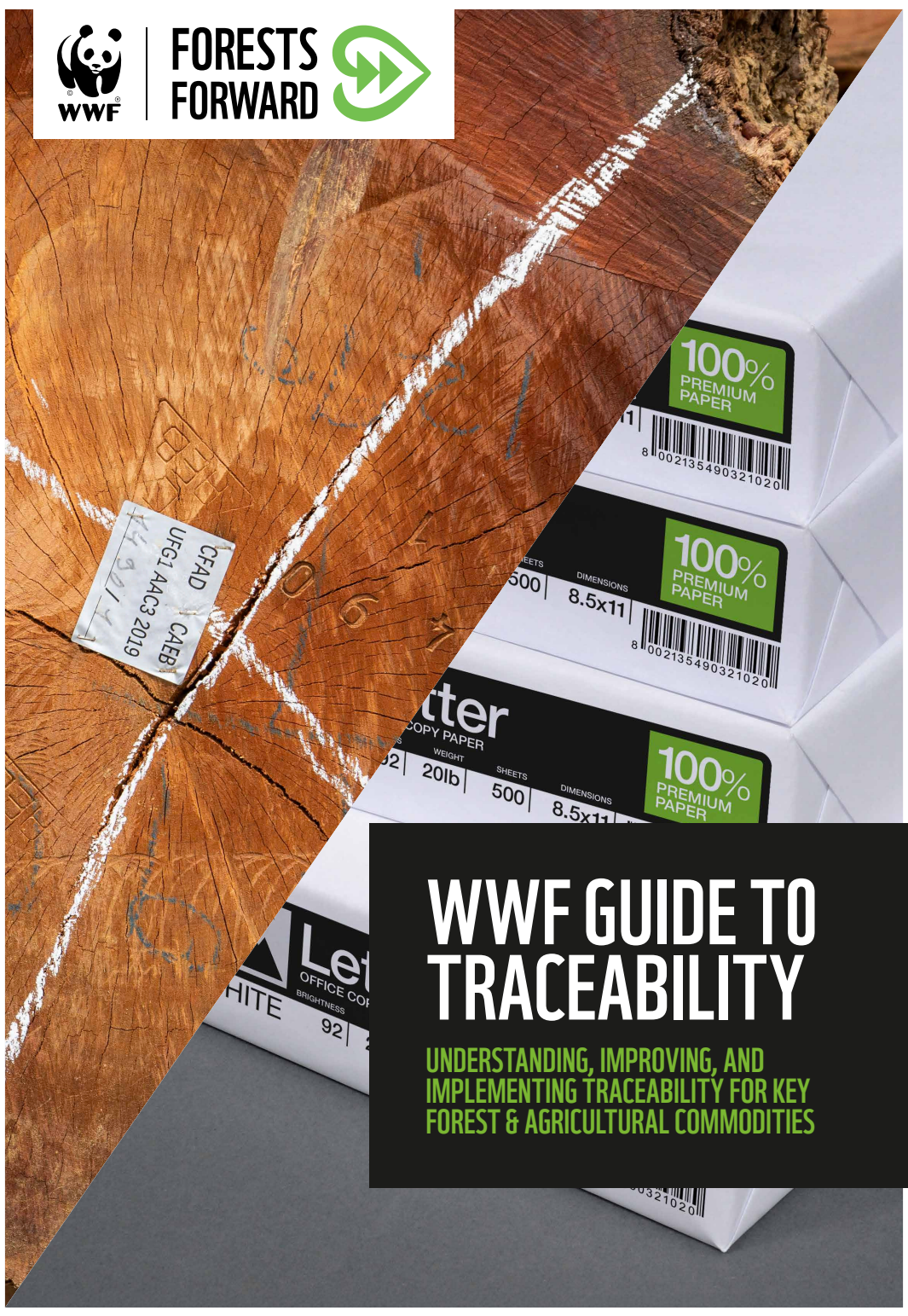




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# WWF GUIDE TO TRACEABILITY

UNDERSTANDING, IMPROVING, AND  
IMPLEMENTING TRACEABILITY FOR KEY  
FOREST & AGRICULTURAL COMMODITIES

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## ABOUT FORESTS FORWARD:



**Forests Forward is a signature WWF program for corporate action in support of nature, climate and people.**

Through engaging with Forests Forward, WWF can help companies:

- Gain access to WWF's technical expertise and convening opportunities, including on responsible sourcing, certification and more
- Invest in high-quality forest landscape programs and projects
- Monitor and report on impact to substantiate progress
- Strengthen credibility and global reach

Forests Forward provides tools, guidance and research to help transform the forest sector. Explore more guides for companies or contact the Forests Forward team:

[forestsforward.panda.org](https://forestsforward.panda.org).

### **Acknowledgments:**

This guide builds upon the *Traceability Guide for Leather* developed by Rever Consulting. The work was led by Jason Grant (Manager, Corporate Engagement, WWF-US Forest Team) with input from Fernando Bellese, Sara Bratager, Tim Cronin, Damian Fleming, Blake Harris, Shaun Hurrell, Claire Jones, Lisa King, Per Larsson, Daniel Silva, Amy Smith, Travis Snapp, Tobias Stauble and Josh Taylor. Design by Ross Hogin Design.

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# OVERVIEW

The purpose of this guide is to support companies, governments, tool developers, certification systems, nongovernmental organizations (NGOs) and other stakeholders in understanding and implementing effective traceability, with the larger goal of advancing the responsible sourcing of specific commodities linked to deforestation, conversion, illegality and/or human rights violations.

## Specifically, this guide seeks to:

- Clarify the key elements that traceability, monitoring, and assurance tools and systems should incorporate to be as effective as possible, given current knowledge and technology
- Drive the development and enhancement of these tools and systems

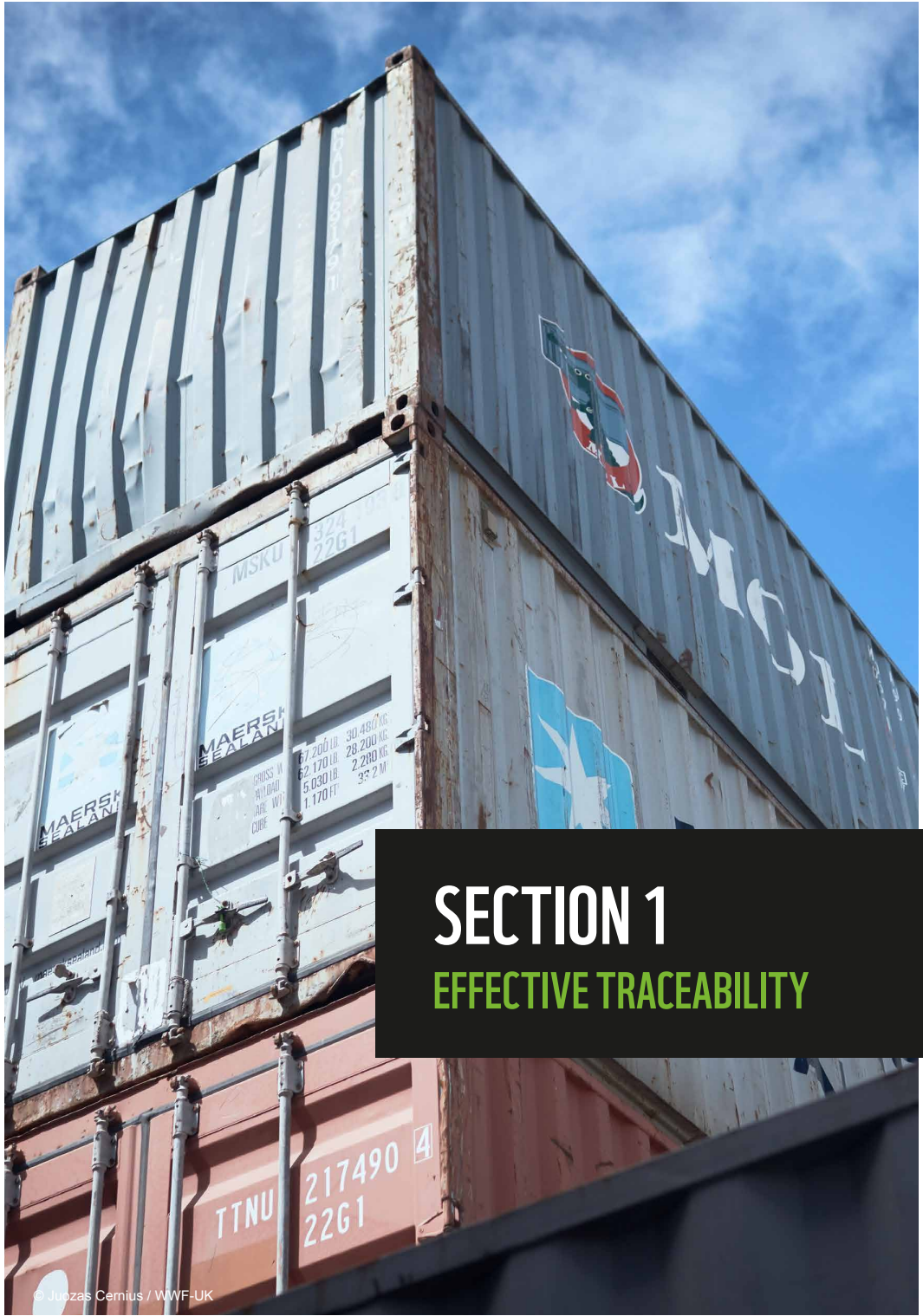
Additionally, it should be noted that traceability is just one (albeit important) element of best practices around responsible supply chain commitments and implementation. It is intended to

supplement and elaborate on broader, more comprehensive resources, including:

- **Operational** and other guidance provided by the **Accountability Framework initiative** (AFI), a consortium of major NGOs in which WWF participates. AFI is a definitive resource for information on the establishment and fulfillment of deforestation- and conversion-free (DCF) commitments.
- WWF's ***Vision, Guiding Principles and Asks for Deforestation- and Conversion-Free Supply Chains***



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# SECTION 1

## EFFECTIVE TRACEABILITY

# TRACEABILITY: DRIVERS & CHALLENGES

In international trade, there is a growing demand for traceability mechanisms in key commodity supply chains, including—but not limited to—for forestry and agricultural commodities that are linked to deforestation, conversion, illegality and/or human rights violations such as timber, palm oil, soy, rubber, cocoa, beef/leather, and coffee.

This guide focuses on improving traceability for these key commodities. While the current document will mostly refer to DCF sourcing, the same benefits and elements of traceability apply to all aspects of responsible sourcing.

Increasingly, private companies are being held responsible not only for the impacts of their own operations—but also for the impacts of their suppliers throughout the supply chain, from the sites of commodity production down to the final consumer. In recent years, a number of regulations have sought to enshrine the principle of accountability throughout the supply chain. This is the case of regional regulations such as the [European Union Deforestation Regulation \(EUDR\)](#) and the [EU Corporate Sustainability Due Diligence Directive \(CSDDD\)](#), as well as national laws like the [French Duty of Vigilance Law](#) and the [German Supply Chain Act](#). These laws require companies to exercise due diligence by assessing, monitoring and mitigating the risks of

human rights violations and environmental harms such as deforestation throughout their global operations.

Beyond the increasing need for regulatory compliance, it is self-evident that companies with greater visibility into and understanding of their supply chains are better able to identify and mitigate risks and to respond effectively to supply disruptions, be these environmental, geopolitical or economic. Thus, investing in supply chain traceability strengthens business resilience.



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For companies to carry out due diligence and for governments to enforce laws, effective traceability mechanisms are a critical element. Traceability is the ability to trace the history, application or location of an object. It is one of the keys that will determine whether the implementation of trade regulations and voluntary commitments to the environment and human rights will achieve their intended outcomes.

Accurate traceability of key commodities rests on the collection, transmission and, ultimately, the verification of key data (such as the geolocations of source farms and forests) that follows the movement and changes to a product as it flows throughout the supply chain. The task of data collection, transmission and validation is complicated by several factors, e.g.:

- Global supply chains are typically complex and fragmented, involving a multitude of actors across regions with varying regulatory environments and production practices. The complexity is still greater where there are large numbers of smallholders and intermediary traders at the start of supply chains, as is often the case.
- Commodities from numerous different origins are commonly mixed at different stages of the value chain—manufacturing, storage and/or transport—in ways that can make traceability from end product back to exact and specific sites of production challenging, increasing the risk of unintentional mixing or intentional laundering of unacceptable materials with compliant ones.

- There is often an absence of standardized data collection—both in terms of what data is collected across the supply chain and the format in which it is compiled and shared—impeding informational consistency, interoperability and the effective implementation of traceability systems.
- There is the problem of “contamination risk,” where false data is entered into traceability systems and/or the material to which traceability data applies is unintentionally or intentionally mixed with other material. In such cases unacceptable material can be laundered and passed off as acceptable, meaning that the traceability system masks rather than solves the underlying problems.

These factors combined create challenges to establishing and maintaining robust, transparent, DCF supply chains.

*Overcoming them requires coordinated action, standardized traceability frameworks, and strengthened supplier engagement at every stage of the value chain.*



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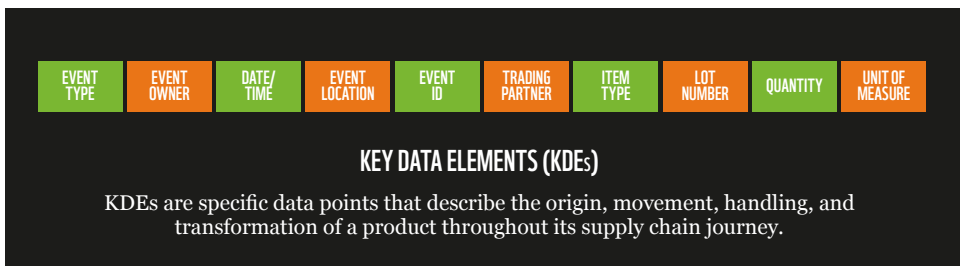
# ELEMENTS OF EFFECTIVE TRACEABILITY

Several of the key elements of and terms related to effective traceability are summarized here and are elaborated in the subsections that follow:

- **End-to-end material-forward tracking:** Systems that track materials' journey from specific production units (e.g., farm, plantation, ranch, forest management unit) forward through every stage of processing and distribution all the way to the final product are *far more effective* than systems that establish

traceability for only a portion of supply chains (partial traceability) or those that rely on product-backward tracing, where a downstream company such as a finished goods manufacturer, importer, or retailer attempts to implement traceability up to the source through multiple tiers in a supply chain.

- **Event-based traceability:** Event-based traceability focuses on capturing and recording two essential components, as detailed in the chart below.



Infographic concept courtesy of Institute of Food Technologists

- **Data standards:** Robust event-based traceability must be grounded in a data standard: a set of agreed-upon requirements applied to a given

commodity for capturing, sharing, and managing data across various actors within a supply chain. This ensures that data collected from and

exchanged between different systems are compatible and interoperable, allowing seamless information flow across the value chain. This approach reduces data fragmentation and strengthens transparency—key enablers for

regulatory compliance, risk mitigation, and credible sustainability claims.

- **Serialized & lot-based traceability:**

Two primary methods of tracking products are recognized in this guide:

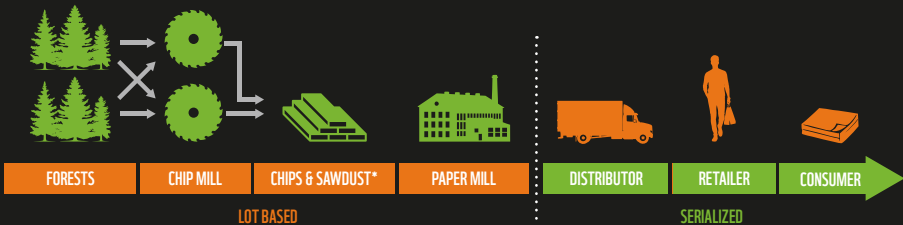
### SERIALIZED TRACEABILITY



*Example scenario: beef supply chain*

Serialized traceability tracks each individual item typically using unique identifiers such as barcodes or Radio Frequency Identification (RFID) tags. Serialized traceability offers a high level of precision, enabling companies to track each product from its origin to the final consumer. This ensures that every item's journey is fully traceable, providing enhanced granularity for risk assessment and sustainability verification. However, implementing serialized traceability across an entire supply chain can be costly and data intensive and where manufacturing processes break down and mix materials from multiple sources such that their individual identity is lost, it becomes impossible.

### LOT-BASED TRACEABILITY



*Example scenario: paper product material journey*

Lot-based traceability tracks groups of input materials or “lots” that share common characteristics and are processed in the same manufacturing batch. Lot-based traceability is more cost-effective and is often used for materials that undergo similar processing steps. The disadvantage is that strict traceability to specific farms or forests becomes less granular.

Instead, origin and other information related to those sources is aggregated and passed forward in association with products from the batch.

\*Residuals from lumber manufacturing

# THE CRITICAL ROLE OF COMPANIES

**Primary suppliers & first mile traceability:** Primary suppliers are defined here as companies that occupy the first major point of aggregation (and usually production) of raw commodities, e.g.:

- Sawmills or pulp mills that procure logs from forests;
- Rubber processing factories that procure field latex and cup lumps from rubber farms and industrial plantations;
- Palm oil mills that procure palm oil fruit from palm plantations;
- Slaughterhouses that process meat and hides from cattle;
- Cooperatives that aggregate cocoa from farmers; and
- Soy traders who concentrate beans for primary processing.

*Well-resourced primary suppliers are best positioned to implement material-forward tracking* through systems that cover the “first mile” between the production units that supply them, either directly or indirectly through intermediary traders. At minimum, such first mile traceability systems will collect critical data and pass it forward down the supply chain in a form and manner that meets the needs of downstream companies. Ideally, it will also be embedded within, or linked to, systems for incentivizing producers

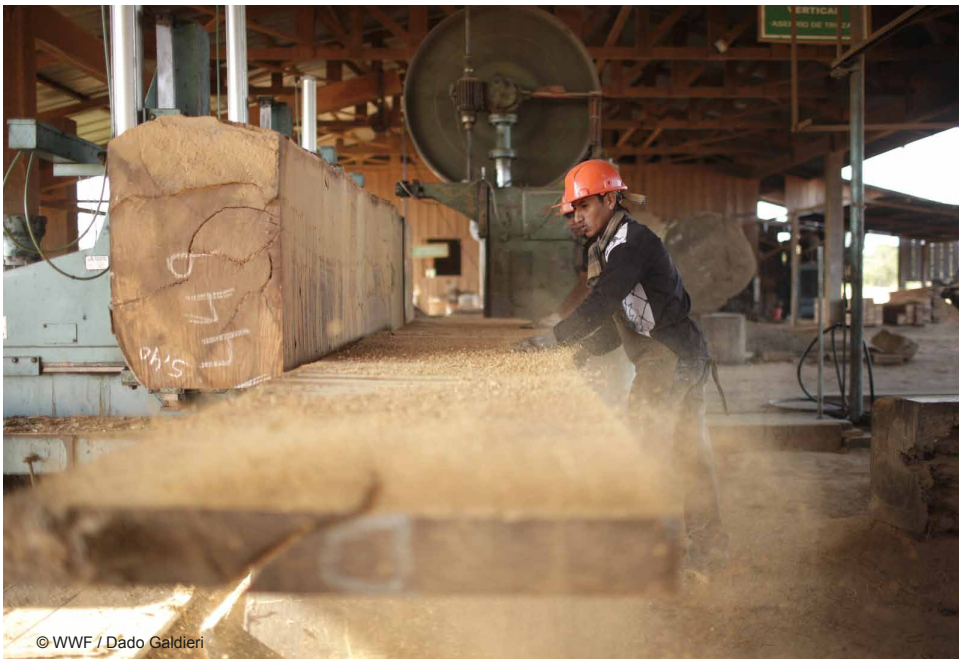
to provide needed data, supplying them with tools for digitization, promoting more nature-positive and effective production practices, and avoiding unacceptable material by assessing, monitoring and mitigating environmental and social risks.

**Downstream companies:** *Large, downstream companies such as major brands have an extremely important role to play in driving the development of effective traceability.* DCF sourcing claims require traceability systems that can link materials directly to forest- or farm-level origins. Without this level of traceability, it is impossible to confirm that a product or material genuinely originates from DCF-compliant sources. As more companies commit to sourcing DCF commodities, it becomes essential to define clear, verifiable traceability and data requirements for suppliers at every stage of the supply chain. These requirements should align with established frameworks and market expectations such as the Accountability Framework that provide practical guidance for structuring supplier expectations and verifying origin-linked compliance.

To enhance traceability and verify DCF sourcing, downstream companies and their suppliers should:

- Establish effective systems for mapping supply chains and collecting, storing, and sharing relevant data in alignment with business needs;

- Establish systems that incorporate end-to-end material-forward traceability or, where this is not currently possible, systems that establish partial traceability;
  - Preference robust certification systems, government-led systems (e.g., national or subnational measurement, reporting, verification [MRV] or traceability tools), or digital traceability tools that incorporate material-forward tracking and utilize shared data standards;
  - Encourage voluntary certification and government-led systems to adopt best practices in regard to traceability;
  - Identify primary suppliers of high-risk commodities and push them to secure credible certification and/or implement effective first mile traceability, monitoring and control systems;
  - Employ best practices to address contamination risk and laundering of unacceptable material;
  - Implement a monitoring system to manage supply chain compliance and ensure that all stakeholders adhere to DCF criteria; and
  - Disclose key information related to their sourcing and supply chain commitments, both publicly—reporting designed to provide information about performance to all stakeholders—and business-to-business (B2B) reporting through which companies can provide information on supply origin, sustainability attributes, compliance with the requirements of regulations, buyers, and investors, etc.
- Detail on all these measures is provided on the pages to follow.



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# MULTILATERAL & NATIONAL INITIATIVES TOWARD DIGITAL PUBLIC INFRASTRUCTURE

There are numerous international and national efforts underway whose shared purpose is the creation of Digital Public Infrastructure (DPI)—a set of essential digital systems that facilitate secure and seamless interactions between people, businesses, and governments. Instead of each company or government building isolated solutions, DPI provides common building blocks—such as registries, geospatial tools, and data standards—that can be reused across different contexts.

Multilateral initiatives such as the United Nations Transparency Protocol (UNTP) and platforms like the Digital Integration of Agricultural Supply Chains Alliance (DIASCA) are advancing decentralized, cross-sector infrastructure designed to realize DPI and enable secure data exchange, digital product passports, and regulatory alignment across supply chains. At the same time, voluntary sustainability

certification systems are increasingly interested in shared data standards and interoperability to reduce duplication, strengthen assurance, and improve scalability.

Additionally, numerous national governments are actively developing components of DPI in response to the EUDR and other demand drivers, including through government-owned traceability systems. To take just one example, the Nigerian government, in support of and in collaboration with its cocoa industry, is investing in digitalization and centralization of data collected along the supply chain, traceability, farm mapping, and satellite-based land monitoring.

Together, these developments signal a broader shift toward interoperable traceability as foundational infrastructure for nature-positive trade.



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# TRACEABILITY FUNDAMENTALS

Traceability is the ability to trace the history, application or location of an object.

When considering a product or a service, traceability can relate to origin of materials and parts, processing history, and distribution and location of the product or service after delivery. It also allows companies to link product volumes to specific attributes of suppliers and/or production sites.

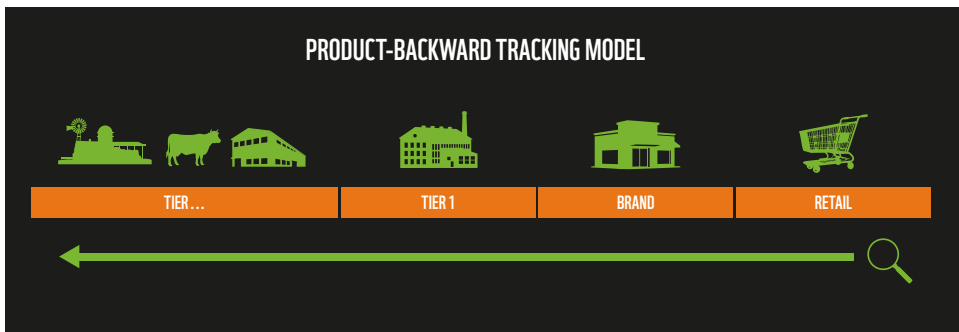
Rather than relying solely on static product information, a robust traceability system documents every action—such as shipping, receiving, transforming, or storing materials—linked with accurate timestamps, locations, and actors involved. This enables real-time visibility and supports more robust risk management, compliance, and product authenticity claims.

**There are two basic approaches to traceability:**

## PRODUCT-BACKWARD TRACING

Product-backward tracing is typically initiated by a downstream manufacturer, importer, or retailer of finished goods and reaches up supply chains to identify prior processing and distribution steps up to the point of origin. Product-backward tracing could also be termed *probabilistic* or *speculative traceability*, reflecting the reality that it uses historical or inferred data to predict or identify probable sources of materials rather than tracking verified product movements.

Product-backward tracing starts with **supply chain mapping**. While often discussed in similar contexts, supply





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chain mapping and traceability serve distinct functions in building transparency and compliance across value chains. Recognizing their differences is essential—particularly in complex supply chains where the two must be strategically combined.

Supply chain mapping is the process of documenting and visualizing the network of suppliers, facilities, and processes *potentially* involved in the production of goods across different tiers of the supply chain. It typically involves mapping suppliers tier by tier, providing downstream companies with a network-level view that answers “who” and “where” and helping them understand the potential actors in their supply chains.<sup>1</sup> While this is a critical step in allowing companies to advance broader transparency efforts

and align supply chain management with their corporate strategies, in and of itself it does not deliver traceability. Traceability enables companies to follow the actual journey of a batch or product through key events from origin to final product. Mapping identifies the universe of potential actors, while traceability validates what actually happened to a specific product or material within that universe.

There are several challenges and limitations associated with the product-backward approach:

- **Supply chain mapping identifies a universe of suppliers, many of which do not supply material:** In fragmented supply chains, mapping often reveals thousands of potential suppliers, yet only a small fraction may actively

<sup>1</sup> For more information on the difference between traceability and supply chain mapping: [https://textileexchange.org/app/uploads/2023/06/DFCTA\\_Supply-Chain-Mapping-Guide-1.pdf](https://textileexchange.org/app/uploads/2023/06/DFCTA_Supply-Chain-Mapping-Guide-1.pdf).

supply material for a specific product. For example, a leather brand attempted to map its bovine leather supply chain and identified over 50,000 farms as potential sources. However, few of these farms directly supplied the leather used in their final products. This demonstrates the high cost and effort involved in mapping, which may not always yield actionable product-specific insights.

- **Heightened contamination risk:**

Where supply chains are lengthy and complex, product-backward traceability systems must reach up through multiple tiers of suppliers to gather critical data, placing pressure on them to provide information that is often challenging for them to obtain. This creates significant risks of “garbage in/garbage out” scenarios where suppliers at some point in the chain provide inaccurate data. The reliance on second-hand (third-hand, fourth-hand, etc.) data that is sought up the chain rather than cascading down increases the risk of gaps in traceability and reduces a downstream company’s ability to monitor and verify effectively.

- **Challenges in tracing backward to point of origin:** More specifically, because many supply chains are highly fragmented and disaggregated, a lack of direct supply relationships and data gaps along transactions make it difficult to achieve backward tracing to forests or farms of origin. For companies aiming to comply with regulations like the EUDR<sup>2</sup> or fulfill voluntary commitments to DCF sourcing, traceability to geolocated forests or farms is required. Accurate

geolocation data is difficult to obtain without first mile digitization and integration of forest/farm-level data into traceability systems.

Given these limitations, downstream companies should be cautious about relying on product-backward systems—or investing heavily in them—as a standalone solution.

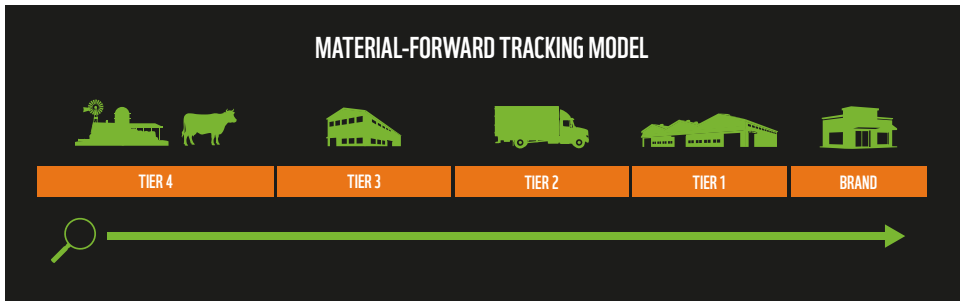
## MATERIAL-FORWARD TRACKING

Material-forward tracking offers a significantly stronger approach to establishing traceability than does product-backward tracing. It involves tracking materials’ journey from farms or forests of origin through every stage of processing and manufacturing, all the way to the final product. It is most effective when supplier engagement is high and real-time data capture is implemented.

Also known as *event-based traceability* or *product tracking and tracing*, material-forward tracking enables downstream companies to:

- Gather more accurate origin information in line with the EUDR and similar regulations.
- Reduce the risk of laundering noncompliant materials.
- Strengthen sustainability claims made to consumers and stakeholders.
- Build more resilient supplier/buyer relationships

<sup>2</sup> For more information on the EUDR: [https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products\\_en](https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en).



By systematically recording CTEs and KDEs at each point of transfer along the supply chain, this forward-looking model increases data integrity and supports compliance with deforestation and conversion-free sourcing requirements and other regulatory frameworks.

It should be acknowledged that there are challenges to the implementation of material-forward tracking. It requires greater levels of digitization and data sharing than product-backward tracing because with the latter information is gathered on request while with the former it is continuous. Also, for full material-forward tracking to be put in place, actors at the start of the supply chains, such as smallholders and small businesses that may have limited technological knowledge or access, must be equipped to provide the data needed in a reasonably efficient manner. There is therefore a need to work progressively toward building capacity, with well-resourced downstream companies and primary suppliers providing needed support.

## CRITICAL TRACKING EVENTS & KEY DATA ELEMENTS

The ability to systematically identify and track the history, application, and location of a product or material by means of recorded data is related to the concept of **event-based traceability**, which focuses on capturing and recording two essential components<sup>3</sup>:

- **Critical tracking events:** These are specific events that occur during the product's journey through the supply chain, such as receiving, transforming, packing, shipping, and transporting materials. In the leather industry, key CTEs might include processing at tanneries, movement from tanneries to manufacturers, and final distribution to retailers. In the natural rubber sector, key CTEs could include movement of rubber from farms to dealers, movement of rubber from dealers to processors, movement of processed rubber from processors to tire manufacturers, and final distribution of tires to vehicle manufacturers or retailers.

<sup>3</sup> A helpful overview of the CTE and KDE concepts can be found in this *Global Dialogue on Seafood Traceability* document on event-based traceability: <https://thegd.org/wp-content/uploads/2024/05/Event-Based-Traceability.pdf>

- **Key data elements:** These are specific data points that describe the movement, handling, and transformation of a product throughout its supply chain journey. For example, KDEs might include what, when, where, and why of each supply chain step—such as the date and time of a transformation event, the origin location of a raw commodity, supplier information, and other critical details.

## DATA STANDARDS

In turn, robust event-based traceability must be grounded in **data standards**. According to the [\*GS1 Global Traceability Standard\*](#), a data standard is a set of agreed-upon requirements for capturing, sharing, and managing data across various actors within a supply chain. In traceability, a data standard ensures that data collected from different systems are compatible and interoperable, allowing seamless information flow across the value chain. This approach reduces data fragmentation and strengthens transparency—key enablers for regulatory compliance, risk mitigation, and credible sustainability claims.

Key benefits of standards-based traceability include:

- **Improved data quality:** Ensures data is consistent, accurate, and timely, reducing the risk of errors and enhancing trust across the supply chain.



Infographic concept courtesy of Institute of Food Technologists

- **Cost control:** Harmonization of data reduces costs and complexity for the development and use of traceability tools.
- **Stakeholder alignment:** Standard definitions of KDEs and CTEs facilitate seamless collaboration among upstream and downstream actors.
- **Regulatory compliance:** Prepares companies to meet rigorous disclosure and due diligence obligations, such as those set out by the EUDR.
- **Fraud control:** Reduces the risk of false claims by enabling transparent and verifiable traceability across the entire chain of custody (CoC).
- **Risk management:** Improves management of food safety and quality risks.
- **Accurate reporting:** Increases confidence in the accuracy of public and B2B reporting.

In the context of increasing regulatory pressure, notably the EUDR, standards-based traceability has become a critical tool. The [\*\*\*GS1 in Europe White Paper on Deforestation\*\*\*](#) highlights how global standards—such as [\*\*\*EPCIS \(Electronic\*\*\*](#)

[\*\*\*Product Code Information Services\)\*\*\*](#) and the [\*\*\*Data Framework for Interoperable Electronic Traceability for Deforestation-Free Cattle In Brazil\*\*\*](#)—can directly support companies in meeting EUDR requirements.

## DATA STANDARD IN THE SEAFOOD SECTOR—A CASE STUDY



© Antonio Busiello / WWF-US

In the seafood industry, where multi-stage supply chains also complicate traceability, the [\*\*\*Global Dialogue on Seafood Traceability \(GDST\)\*\*\*](#) framework has played a pivotal role in standardizing and scaling traceability efforts. Launched in March 2020 after three years of collaboration among over 60 global companies, the GDST established the first international standards for interoperable seafood traceability systems.

These standards aim to:

- Enhance the reliability of seafood information
- Reduce traceability costs
- Minimize supply chain risks by eliminating IUU (Illegal, Unreported, and Unregulated) products
- Secure long-term social and environmental sustainability in the sector

The GDST framework defines:

- Internationally agreed-upon KDEs linked to seafood products
- Technical specifications for traceability systems that are vendor-neutral and applicable across the entire seafood supply chain

This standardized approach makes traceability scalable, fostering industry-wide collaboration and providing robust proof of sustainability from production to consumption.



© Ola Jennersten / WWF-Sweden

These standards enable the linking of physical goods with digital records, ensure the verifiability of geolocation data, and facilitate the secure and structured flow of traceability information throughout complex supply chains.

By implementing such standards, companies are better positioned to collect and communicate the KDEs and CTEs, including geolocation at plot level, timestamps, actors involved, and transformation or aggregation points along the chain. These structured and interoperable systems provide a foundation for building traceability that is scalable, auditable, and regulation ready.

## SERIALIZED & LOT-BASED TRACEABILITY

Within the end-to-end material-forward approach recommended in this guide, two primary methods of tracking products are

recognized: **serialized and lot-based traceability.**

- Serialized traceability:** This method tracks each individual item (e.g., a single cow or a single hide, a single log), typically using unique identifiers such as barcodes or RFID tags. Where serialized traceability is applied throughout the length of a supply chain, it offers a high level of precision, enabling downstream companies to track products from their precise origins to the final consumer. This ensures that every item's journey is fully traceable, providing enhanced granularity for risk assessment and sustainability verification. However, implementing serialized traceability across an entire supply chain can be costly and data intensive, and where manufacturing processes break down and mix materials from multiple sources such that their individual identity is lost, it becomes impossible.

- **Lot-based traceability:** This approach tracks groups of input materials or “lots” that are processed in the same manufacturing batch and generally share common characteristics. Lot-based traceability is commonly used in bulk commodity supply chains where materials are routinely mixed. It is more cost-effective and is often used for materials that undergo similar processing steps. The disadvantage is that traceability to specific farms or forests is less granular. Instead, origin and other information related to those sources is aggregated and passed forward in association with products from the batch.<sup>4</sup>

Both serialized and lot-based tracing<sup>5</sup> can be integrated within a single supply chain. For example:

- A sawmill could use a first mile traceability system based on serialized tracing for the logs they procure and then apply lot-based tracing in processing them, consolidating the information

associated with logs from many sources and tying it to batches of lumber that are sold to a flooring mill;

- The flooring manufacturer could use lot-based tracing for batches of wood flooring made from lumber procured from several different sawmills, aggregating the data provided by those mills and passing it forward to their customers; and
- Finally, serialized tracing could be used to track the finished flooring product throughout the rest of the supply chain, from wholesale distribution through retail.

Data standards for commodities should integrate both serialized and lot-based traceability to ensure a cost-effective, feasible, and data-accurate approach to supply chain management. This dual-method approach balances precision and practicality, making it possible to trace products at the necessary levels of detail while minimizing costs and data complexity.



<sup>4</sup>Note that this is not a “declaration in excess” (see next page) because only the farms/forests that are the actual sources for the materials used in the lot are included. In other words, it’s a case of “here are all the sources for the inputs to this product” as opposed to “here are all the potential sources—we know the materials came from some subset of this list but we can’t tell you which ones.”

<sup>5</sup>Serialized tracing is preferable to lot-based tracing for obvious reasons. As new technologies emerge and existing ones improve, it can be hoped that processes that currently rely on the latter can switch to the former.

## END-TO-END TRACEABILITY VS. PARTIAL TRACEABILITY

In manufacturing processes for certain products, input materials are sourced and blended in ways that make it challenging—currently, at least—to tie outputs to a specific source or sources. Take the example of pulp and paper production. Pulp mills often source input materials from a very large number of sources, including pulpwood (low-grade timber) from a shifting base of forest landowners and chips and sawdust from chip mills and sawmills that also source logs from multiple landowners. Once these materials are combined and reduced to fiber for pulp, it becomes complicated to trace individual fibers to a specific set of landowners through lot-based traceability.

Instead, batches of pulp will carry a “declaration in excess”<sup>6</sup> where *all possible* forests of origin for materials in a given batch are declared rather than the actual forests of origin. This could mean that dozens, hundreds or even thousands of possible origins are declared when the true number of sources is small. Declarations will become even longer when a paper manufacturer combines pulp from several suppliers in their process.

In such cases, end-to-end material-forward traceability is lost, but this does not mean that **partial traceability** cannot or should not be established. For example, downstream companies can implement standards-based traceability that tracks material from the primary suppliers in

their supply chains through to Tier 1 companies. Since many primary suppliers procure all or most raw materials from specific supply areas in the geographies where their facilities are located, this permits downstream companies to take steps to assess and mitigate risk within those areas. In such cases, primary suppliers should be required to implement full traceability within their sourcing areas to ensure that they control which farms or forests they are procuring raw materials from.

*Note that WWF strongly recommends that partial traceability and declarations in excess only be used when necessary because they do not establish true traceability and make it harder to prevent unacceptable material from entering supply chains, particularly in the absence of strong first mile controls. Leadership practice is to avoid their use and implement full end-to-end traceability to the greatest extent possible.*

## CONTINUOUS IMPROVEMENT

It is to be expected that improvements in traceability will occur over time, as protocols, practices, and technologies mature and implementation challenges are addressed. Partial and fragmented traceability will not be resolved immediately but can progressively evolve toward more consistent, end-to-end approaches. The long-term objective is lot-based traceability, toward which governments and companies should be expected to work deliberately and incrementally.

<sup>6</sup> The term “declaration in excess” emerged with the introduction of the EUDR’s requirement for importers and other operators to declare “plots” of origin for products placed on the EU market. ISEAL has produced a report that lays out the major advantages and drawbacks of declarations in excess, along with usage scenarios for several forest risk commodities. <https://isealalliance.org/sustainability-news/deforestation-free-supply-chains-role-declaration-excess>.



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## LIMITATIONS OF END-TO-END MATERIAL-FORWARD TRACKING

While end-to-end material-forward tracking is superior to partial or product-backward tracing in the provision of quality data that undergirds effective traceability, it is not a panacea. Tools that incorporate material-forward tracking are also subject to contamination risk: Supply chain actors or government officials can subvert them by entering false information, such as when commodities stemming from a given production unit are entered into separate tools more than once (“double spend”) or when unacceptable materials are laundered

with compliant materials in production, disguising the true identity of the former with documentation associated with the latter.<sup>7</sup>

For these reasons, downstream companies should not rely solely on traceability tools but also implement enhanced monitoring and verification measures such as scientific testing (see below) and independent auditing for high-risk materials. As noted above, in their absence, there is a risk of traceability systems being gamed such that they conceal the very problems they are intended to solve.

<sup>7</sup> For more detail on such vulnerabilities, see the [WWF Topic Brief](#) on traceability systems’ potential to deter illegality and corruption in the timber and fish sectors.

# SUPPORTING TOOLS, SYSTEMS & PRACTICES

There are many dozens of digital tools designed to help companies comply with regulations and implement voluntary commitments to responsible, legal and DCF sourcing of timber and agricultural commodities.

These tools support mapping and managing supply chains, tracking or tracing products, and monitoring source farms and forests. In response to the EUDR in particular, such tools have been proliferating and their capabilities evolving.

Digital tools can be categorized into three main types, most of which are offered commercially (software as service) but a few of which are open access:

- **First mile tools** are designed for use by “primary suppliers”—upstream companies that source raw commodities and often are the first point of aggregation and processing (such as sawmills, palm oil mills, rubber factories, and slaughterhouses). They can be used to establish material-forward tracking, gathering critical information and passing it forward to the next step in the supply chain.
- **Downstream tools** cater to companies that are downstream from primary suppliers in supply chains. Key functionalities include supply chain mapping, gathering and managing information provided by suppliers and subsuppliers, and seeking to achieve traceability via product-backward tracing.
- **Geospatial tools** use remote sensing to monitor commodity supply areas, processing and analyzing satellite imagery to detect environmental risks such as deforestation, conversion and forest degradation (see next page).



There are not hard lines between these categories, and it is not at all uncommon for an individual tool to combine the features and functionalities of more than one type. For example, many downstream and first mile tools now incorporate satellite monitoring (though some do not). And most tools could be implemented at any point in a supply chain, by primary suppliers or by any downstream manufacturers or traders. In practice, however, downstream tools are most commonly used by large, well-resourced companies toward or at the end of lengthy, complex, international supply chains to comply with regulations and/or implement voluntary DCF sourcing commitments.

In addition, there are first mile tools that are established and administered by national governments and can provide evidence of legality and/or DCF status for the commodities they cover, as well as data that could be captured by second mile tools used by exporters in or importers from those countries. Examples include Timber Legality Assurance Systems such as those in Indonesia and Ghana as well as national systems for regulating cocoa in Côte d'Ivoire and Cameroon.

The main actual and potential limitations of these tools have largely been covered above but include the following:

- Downstream tools face all the challenges inherent to product-backward tracing.
- The data managed by tools that are offered by different providers may not be interoperable, particularly in the absence of unifying data standards.

- Geospatial tools can only be relied upon if traceability systems accurately identify the sources of commodity production.
- Both first mile and downstream tools fail if companies or government officials enter false information that goes undetected (contamination risk or garbage in/garbage out).



## TRACEABILITY TOOLS

Preferred by Nature's [Traceability Tools Navigator](#) is an open platform for understanding, exploring and comparing the capabilities of digital traceability and monitoring tools. Supported by WWF and ISEAL, the Traceability Tools Navigator is designed to help companies, certification schemes, tool providers, NGOs and researchers navigate the complex and rapidly evolving digital tools landscape.

## CERTIFICATION SYSTEMS

These are voluntary, formalized systems to verify compliance with predefined standards, typically focusing on sustainability, environmental protection, and ethical labor practices. Consolidated and comprehensive certification systems exist for some but not all commodities. Some existing certification systems are listed by commodity below.

- **Timber:** Forest Stewardship Council® (FSC®) & Programme for the Endorsement of Forestry Certification (PEFC)
- **Rubber:** FSC & PEFC
- **Palm oil:** Roundtable on Sustainable Palm Oil (RSPO)
- **Coffee:** Rainforest Alliance, Fairtrade & 4c
- **Soy:** Roundtable on Responsible Soy (RTRS) & Proterra
- **Fish:** Best Aquaculture Practices (BAP), Marine Stewardship Council (MSC) & Aquaculture Stewardship Council (ASC)
- **Cotton:** Better Cotton, Textile Exchange & Global Organic Textile Standard (GOTS)

Certifications function through a multistep process:

- **Standards development:** Establishing measurable criteria within the scope of the certification (sustainability, labor, quality, etc.).

- **Auditing & verification:** Independent assessments of adherence to these criteria, generally through annual audits.
- **Issuance & labeling:** Granting certification and allowing claims about sustainability, etc.

While most certification focuses on verifying practices at specific sites, traceability focuses on tracking material as it flows through the supply chain. Certifications commonly require documentation to demonstrate compliance with sustainability standards, and basic traceability procedures help ensure that certified materials are accounted for as they move through the supply chain. However, while some certification schemes address traceability through their CoC systems, others currently do not. Where this is the case, they fall short on delivering traceability to origin—a critical requirement under regulations like the EUDR, as well as for the full implementation of voluntary commitments to DCF sourcing.



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Challenges related to certification systems' ability to deliver effective traceability include:

- **Absence of point-of-origin data:** As noted, certification schemes may not have built-in mechanisms to trace products to georeferenced forests or farms of origin (though we should recognize those that do or that are working to improve).<sup>8</sup> This is a critical gap for compliance regulations requiring geolocation data for deforestation-free claims. Without production unit-level data, certified products risk noncompliance.
- **Fraud & integrity risks:** The fragmented nature of many commodity supply chains increases the risk of fraud. Without robust traceability, there is potential for misrepresenting certified products or mixing certified and noncompliant materials (contamination risk or laundering), undermining the credibility of sustainability claims.

## CHAIN OF CUSTODY MODELS

One of the main purposes of certification is to verify practices at individual sites of commodity production (e.g., farms, forests, and fisheries) and down through different stages of production and distribution to retail. The manufacture and trade of products stemming from certified sources are regulated through CoC certification. Standards for CoC typically lay out a set of requirements that control the movement, handling and processing of certified materials within and between companies,

enabling the transfer of claims and communications about certified products. The implementation of these requirements by individual companies is generally verified through annual audits against the standard in question.

There are multiple CoC models. The choice of model impacts the level of assurance and claims that companies can make regarding socio-environmental and other aspects of the product, including DCF materials.<sup>9</sup>

- **Identity preservation:** Materials are kept separate and can be traced back to a single source of origin.
- **Segregation:** Materials from different certified sources are combined but kept separate from noncertified materials.
- **Controlled blending:** Certified input materials are mixed according to certain criteria with noncertified materials, resulting in a known proportion of certified materials in the final output.
- **Mass balance:** Certified input materials are mixed according to defined criteria with noncertified materials, where there is no guarantee of physical presence of specified characteristics in a material.
- **Controlled mass balance:** A variation of mass balance, where all input material entering the production system has specific attributes—most commonly that all the material, whether certified or not, is compliant with a set of minimum specified legal or sustainability requirements.

<sup>8</sup> For example, Rainforest Alliance's Sustainable Agriculture Certification and the RSPO certification have built-in traceability mechanisms.

<sup>9</sup> [ISEAL Chain of Custody Models & Definitions](#) (2025)



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- **Book & claim:** Volume-based certificates are generated and traded independent of any physical material, completely decoupling certified material from the flow of material through the supply chain. This model supports nature-positive production but does not provide traceability.

According to ISEAL, CoC systems are intended to offer the evidence needed to validate sustainability claims such as recycled, organic, or deforestation-free. Even where CoC systems are in place, however, they may not deliver traceability to origin.

## CoC SYSTEMS & TRACEABILITY

CoC and traceability are related but serve distinct purposes within supply chain management. Per the above, CoC is based on documented systems and records governing the handling, processing and transfer of materials according to a defined set of rules. Traceability refers to tracking the journey of specific articles, lots or classes of material through each step of the supply chain, increasingly using digital, event-based data through specified stages of production, processing, and distribution and identifying the material's history, use, or location. It enables organizations to access key information—such as geolocation data, farm or facility of origin,

and critical tracking events—providing visibility and transparency across the entire supply chain. In simple terms:

- CoC answers the question: *Can we prove that this material was handled according to specific requirements?*
- Traceability answers the question: *Can we follow the actual journey of this material—where it originated, how it moved, and where it ended up—based on real-world events and data?*

Some certification programs do integrate traceability or are evolving to do so more deeply. For example, Rainforest Alliance’s Sustainable Agriculture Certification and RSPO certification have built-in traceability mechanisms. Another example outside of the key commodity sectors discussed here is **BAP** certification by the Global Seafood Alliance (GSA), which incorporates both environmental and social criteria in different operations in the seafood supply chain, including feed mills, hatcheries, farms and processing plants. Through the batch coding and tracking system, each group of animals is identified with a unique code that follows them throughout the entire production process—i.e., material forward tracking. This system allows verification that all previous stages are certified and compliant.

## CoC CHALLENGES

For deforestation, a key verification point is whether a production unit linked to a commodity was deforested before a given cutoff date—something that can be confirmed with traceability if the product is tied to one or more geolocated properties

and dated transactions. While CoC systems address certain records and data related to material flows (e.g., shipping, receiving and transformation of certified products), they are often partial or disconnected from actual material flows.

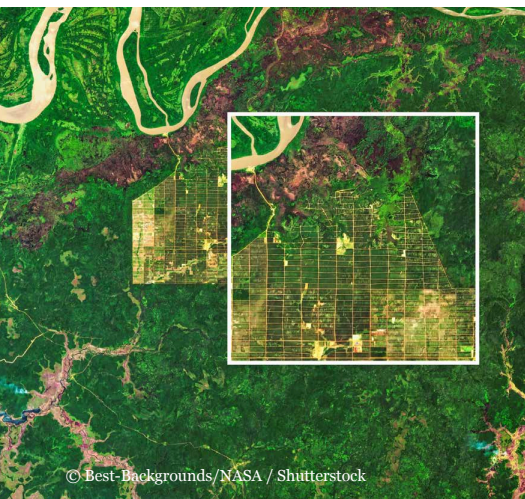
As has been noted, a major risk is the laundering of noncompliant material into CoC certified operations. Without traceability of material flows, it is impossible to detect when unverified material enters the chain. To address this, traceability must go beyond identifying the origin and track actual movements of material between actors, capturing volume and timing to flag inconsistencies that suggest the entry of noncompliant materials. This level of visibility is essential, as static documentation or certification alone cannot close these loopholes. Certifying practices and tracing material flows must work together toward ensuring credible sustainability claims and regulatory compliance.



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## SATELLITE MONITORING & GEOSPATIAL ANALYSIS

Certifications and digital tools that support traceability can be complemented by, and in some cases fully incorporate, additional technologies that aid with monitoring deforestation, forest degradation, and illegal logging.



Satellite monitoring and geospatial analysis offer a powerful means of detecting potential problems in commodity production areas. Geospatial analysis involves collecting, processing, and presenting data associated with specific geographic locations, using satellite imagery, geographic information systems (GIS), GPS data, and other location-based information to interpret spatial patterns and relationships. By examining the geographic context of data, geospatial analysis provides valuable insights into how entities interact within a given space.

There are numerous open-source and commercial geospatial tools available to companies and other actors.

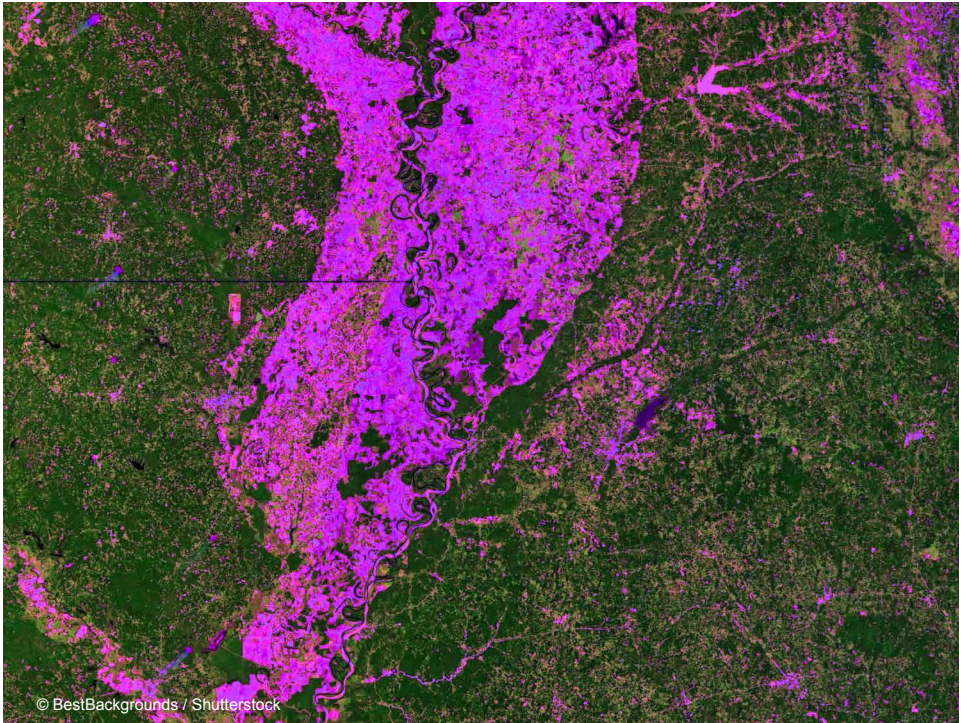
Traceability data with location identifiers enables satellite monitoring by providing precise supply chain information needed to connect commodities with detected deforestation. With comprehensive traceability data, downstream companies such as brands, as well as primary suppliers, can and should integrate geospatial analysis into their systems to go beyond basic compliance and actively monitor and validate their commitments to DCF and legal sourcing. Companies that have identified the primary suppliers, supply areas, and/or production units where the commodities in their products originate can receive automatic alerts when deforestation or unauthorized logging occurs in near real time. Subsequent investigation may be needed for ground truthing, e.g., to determine if natural forests have been permanently cleared or converted or if temporary clearings have been created as part of responsibly managed timber production. Some commercial digital tool providers offer or support on-the-ground investigation and verification. This combination allows for continuous verification and proactive risk management, strengthening due diligence and bolstering DCF and sustainability claims. Additionally, certification systems and governments can also use satellite monitoring to detect activities that potentially violate their standards or laws and can subsequently be investigated.

## SATELLITE MONITORING & GEOSPATIAL ANALYSIS: CHALLENGES

- **Data accuracy & resolution:** High-quality geospatial analysis relies on accurate and detailed data. Inaccurate or low-resolution data may lead to erroneous conclusions and ineffective monitoring, e.g., where timber harvests followed by regeneration in managed forests are mistaken for deforestation or when forests are cleared for development (EUDR compliant) instead of agriculture (EUDR noncompliant).
- **Integration with existing systems:** Incorporating geospatial analysis into existing supply chain management systems can be complex, necessitating

specialized software and expertise where off-the-shelf solutions fall short or data standards are lacking. Ensuring that geospatial data aligns with other operational data is crucial for coherent analysis and decision-making.

- **Cost:** Implementing geospatial analysis involves costs related to data acquisition, software, and personnel training. For companies with limited resources, these expenses can be a barrier. However, the long-term benefits, such as improved supply chain efficiency and sustainability, may outweigh the initial investments. Some more accessible tools such as Global Forest Watch can prove useful for smaller companies.



## METHODS FOR ADDRESSING FRAUD & CIRCUMVENTION

Despite the development of regulations meant to combat illegal or unsustainable operations, undesired material can still enter supply chains. For example, the EUDR’s requirements for geolocations, traceability and due diligence, while essential, entail fundamental shifts in how companies in global supply chains operate. In some cases, companies may choose to implement “paper compliance,” taking a superficial approach to satisfying regulatory requirements rather than embracing structural change. In the worst cases, the threat of market exclusion may lead companies to resort to fraud.

An example would be when a manufacturer that sells into regulated markets establishes an “above-ground system,” where goods are compliant and backed by clean data or paperwork, and an “underground system,” where goods are not. The underground system could operate within a company’s physical facilities or through unauthorized subcontracting to “shadow factories.” In either case, when the company receives an order for regulated goods but does not have sufficient compliant material on hand, there will be a strong temptation to use the noncompliant material to fill the order and disguise it using clean paperwork.

Another type of fraud is the employment of strategies to circumvent regulations. Examples would be when companies:

- Relocate factories to or transship goods through low-risk countries to reduce the compliance burden and aid in disguising raw material origins.

- Use free trade zones as a “black box” where noncompliant goods can be repackaged without being transformed.

Government and industry need to collaborate in developing policy, governance, and technical approaches that address these and other problems, such as the entry of false data into traceability systems. For example, tools such as digital identity management, digital interoperable data exchange and AI analysis of anomalous trade flows may offer solutions. Additionally, while they are not silver bullets for eliminating the risks of fraud and circumvention, following are some technologies that hold promise for managing them:

### SCIENTIFIC TESTING

Scientific testing represents one of the most promising approaches to deterring the laundering of unauthorized and unacceptable materials into commodity supply chains. Under the right conditions, testing methods such as stable isotope ratio analysis, DNA analysis, mass spectrometry, and near infrared spectroscopy can verify the declared origin of key commodities and the identity (species) of timber products. These are being advanced by a global network intent on cracking down on forest crime and deforestation that includes governments, NGOs, due diligence service providers as well as companies. In and of itself, scientific testing will not determine if commodities are deforestation-free or legal, but because it provides a tamper-resistant way to prove or disprove claims of origin/identity, it can be extremely effective in exercising control over supplies and suppliers.

Voluntary certification schemes can also use scientific testing to bolster their effectiveness and integrity. FSC, for example, is increasingly relying on scientific testing to combat fraudulent claims for certified products. MSC uses DNA testing of species origin to check claims in shops. ASC is also exploring the use of scientific testing, as are a number of schemes in the textiles space.

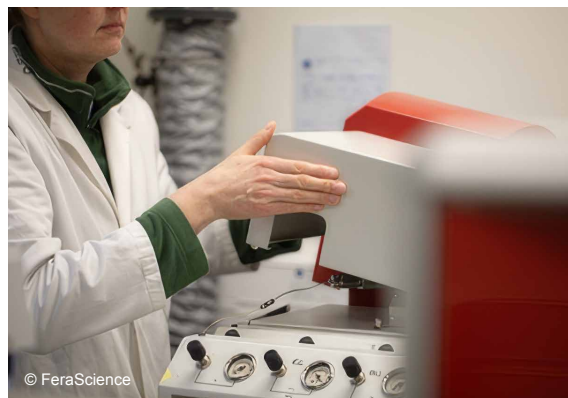
## SCIENTIFIC TESTING: CHALLENGES

- **Ongoing need for expansion of reference data:** All scientific testing methods require previously gathered samples and data against which test results can be compared, and, while a substantial body of reference data exists currently, it must be expanded before scientific testing can reach its full potential. If reference data is already available, then claims for risky or suspect products can be checked more or less immediately. Where reference data is currently lacking, companies can help by encouraging their upstream suppliers to support the gathering of samples for testing. Compliant suppliers should want to participate in such efforts as it will help underwrite their claims for compliance and make them more attractive business partners to operators and traders.

There are extensive international efforts underway to gather reference samples to build an independent institutional infrastructure to house and share the data. One example is **World Forest ID**, a nonprofit organization working to develop a global georeferenced database of timber and agricultural samples to aid

traceability, enable more transparent supply chains, and enforce laws that protect forests.

- **Products with blended materials:** Scientific testing methods generally do not work as well with products whose manufacturing entails extensive blending of materials of different origins or identities, e.g., paper and packaging and composite wood panels such as medium density fiberboard (MDF) and particleboard. When mixed tropical hardwoods are detected, pulp and paper fiber testing can, however, detect the genus of tree species, yielding information such as the likelihood that the fiber is coming from plantations, natural forests or even from deforestation. In these cases, scientific testing methods can be usefully applied at points in the value chain before materials have been blended.
- **Cost:** The cost of scientific testing varies, but individual tests can be priced at \$500 or more. Downstream companies can control costs by a) taking a risk-based, periodic approach, e.g., by implementing a program where high-risk products or



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materials are randomly selected and tested on a monthly or quarterly basis; b) securing quotes from more than one laboratory; and c) negotiating pricing based on a longer-term contract with a lab as opposed to doing one-off testing.

## ADDITIVE TRACERS

Additive tracers offer another potential way to verify the authenticity of materials and claims on the market. Tracers (either chemical or physical markers) are applied to materials at a point in the supply chain (e.g., during primary processing), allowing their detection downstream through various testing approaches—some in-line, others requiring samples to be tested at a lab. With some tracers, it is possible to not only detect presence but also the percentage of traced material in a given product.

Tracers can maintain different types of identity (e.g., unique tracers could be developed per batch). More common are tracers that are unique per manufacturing site or end customer. They are commonly used as security features on money and in packaging of controlled materials (e.g., tobacco). They are increasingly being tested in supply chains as a form of physical verification of materials, particularly in apparel and textile supply chains.

## ADDITIVE TRACERS: CHALLENGES

- **Manual vs. automated application:** Use of additive tracers is most feasible when they can be applied as part of the manufacturing process. Some providers are developing tools to feed marked

materials into manufacturing processes or spraying tracers onto products. While requiring infrastructure investment, this makes application less manual and allows for greater consistency.

- **In-line vs. off-site testing:** Some tools, like **Integritex**, allow for in-line verification using a hand-held tool to detect the presence of marked materials in a product. This is powerful as it allows more real-time verification and broader application (e.g., testing at ports by enforcement agencies). Off-site testing, particularly when samples are sent to remote labs, introduces additional cost and complexity. It also requires a robust CoC for samples.
- **Contamination risk:** The mishandling of materials may lead to contamination and the marking of incorrect materials. Use of certain tracers may also require manufacturers to clean out machinery/storage areas.
- **Processed or blended products:** Additive tracers may be most suitable for homogeneous manufacturing processes where they can be permanently and comprehensively tied to the output product and remain detectable after any further downstream processing. For example, **Haelixa** applies engineered DNA markers (one type of tracer) to cotton at the gin. The identifier remains on the fiber permanently so that all output from a given gin is marked and can still be detected in any downstream product. However, detecting that a garment contains fiber from a gin does not mean that it is made exclusively from the tagged fiber.

With purposeful sampling and detection, it is possible to quantify the risk of contamination with an increased confidence level, but as with most methods, tracers are not fail-safe.

Tracers may also be damaged by certain manufacturing processes (e.g., high heat or the addition of chemicals), and this may result in false negatives on testing. There are also manufacturing processes for certain products where they are inevitably lost. In such cases, they are less useful because they can only serve in the portion of the supply chain up to that process.

- **Laundering risk:** Under high-risk conditions, tracers can even be used for laundering. If actors in control of the tracer are malicious, they could use the tracers with illicit material and mix it into

the supply chain. Robust processes for procuring, handling and applying tracers are required to use them effectively for fraud prevention.

## STRATEGIES FOR ADDRESSING LEAKAGE

Another unintended consequence of regulations is that they can lead to market bifurcation and leakage. This occurs when regulated markets get clean goods and nonregulated markets absorb the rest. For example, exports of Brazilian soy that is linked to deforestation may surge to China while exports of compliant soy are directed to the EU. In this way, market bifurcation and leakage can undermine the EUDR's goals and allow deforestation to continue unchecked.



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Buyers who are committed to complying with regulations like the EUDR may be tempted to de-risk their sourcing by walking away from certain suppliers, or even entire geographies, where risks may be high rather than attempting to fix the underlying issues. Instead, companies that support the intent of the EUDR and similar legislation should partner with suppliers and invest in processes designed to ensure that all production is clean and that bifurcation and leakage is avoided. An example would be a program of random inspections to assess indicators of circumvention and transshipment such as:

- Yield mismatch: The volume of input materials does not mathematically match output volume.
- Implausible timelines: Production speed exceeds plausible limits.
- Capacity inconsistency: Large output claims vs. small facility footprint.

It is, of course, essential that buyers reward suppliers who cooperate, e.g., through long-term relationships or preferential terms. This is a leadership practice that companies can employ to effect real change. Additional examples are provided in the following section.



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# LEADERSHIP APPROACHES

The best designed tools and systems for traceability, monitoring and verification cannot by themselves halt deforestation, forest degradation, and human rights abuses or ensure the nature-positive production of commodities.

Leadership companies will go beyond using and supporting the development of such tools and embrace additional approaches that strike at the roots of the problems and advance durable solutions. For example:

## COLLECTIVE ACTION

Leadership companies should engage in precompetitive collaboration with like-minded peers, government, and other stakeholders to advance solutions that address root causes and not only halt bad practices but further good ones. Effective supply chain management, in particular, can benefit considerably from precompetitive collaboration among companies sourcing from the same areas or groups of suppliers, for example, by sharing information related to risk assessments and supplier noncompliance and by working together on capacity-building activities that support supplier compliance, including traceability.

### Resources:

- The AFI offers a [guidance document](#) on “how companies should collaborate with other stakeholders in the landscapes, jurisdictions, and sectors in which they operate to implement their commitments

effectively. It also suggests specific ways for companies to pursue such collaboration.”

- The [Jurisdictional Approaches Resource Hub](#) offers a menu of types of actions a company could take to engage collaboratively in landscape initiatives.

## NATURE-POSITIVE PRODUCTION & HUMAN RIGHTS

Leadership companies will go beyond traceability and monitoring systems and invest in the improvement and adoption of approaches that uphold human rights and incentivize nature-positive production within the commodity supply areas of the primary suppliers at the top of their supply chains. Examples include:

- Adopting and engaging to improve credible, independent, multistakeholder sustainability certification systems.
- Ensuring that Indigenous Peoples and local communities living within or with rights to the supply area agree to the production of the raw material based on the principle of free prior and informed consent (FPIC).



- Supporting rightsholder mapping as a critical starting point for understanding the type of human rights violated.
- Investing in smallholders and local communities, supporting training on improved practices, technologies and mapping capabilities integrating local and traditional knowledge.
- Supporting producers with legal compliance and recognition of land rights/ownership.
- Ensuring that producers are paid a fair price for compliant commodities, particularly where supply areas are hot spots for deforestation, degradation, conversion, and/or illegality. Primary suppliers are best positioned to provide incentives for local people that create the economic conditions for them to engage in nature-positive farming, forest and ecosystem protection and stewardship.

## SCIENCE-BASED TARGETS FOR CLIMATE & NATURE

Leadership companies will set, pursue and report against goals for reducing their emissions and impacts on nature, as exemplified by the work of the [Science Based Targets initiative](#) (SBTi) and the [Science Based Targets Network](#) (SBTN):

- [SBTi's Forest, Land and Agriculture \(FLAG\) Guidance](#)— Emissions from agriculture, forestry and other land use represent nearly a quarter of global greenhouse gas emissions. While many companies now report their emissions publicly, few account for land-based emissions or include them in their reduction targets due to the lack of available guidance and methods - until now. The *Forest, Land and Agriculture (FLAG) Science-Based Target-Setting*

*Guidance* is the world's first standard method for companies to set science-based targets that include land-based emission reductions and removals. Companies setting FLAG science-based targets should submit a no-deforestation commitment with a target date no later than 2030, with a recommended cutoff year of 2020.

### • **Science Based Targets for Nature**—

These are ambitious and measurable goals that aim to address the urgent challenges posed by environmental degradation and loss of biodiversity. These targets are grounded in rigorous scientific research and are designed to align with the Earth's ecological limits. Good traceability is key for setting these targets. Setting science-based targets requires detailed knowledge of where commodities are coming from in order to identify the specific ecological impacts, thresholds and solutions that need to be addressed. By focusing on key indicators such as species abundance, habitat conservation, and ecosystem health, science-based targets provide a framework for businesses, governments, and organizations to contribute meaningfully to the preservation and restoration of nature. These targets not only acknowledge the interconnectedness of ecosystems that underpin their business operations but also emphasize the importance of nature-positive practices that support the overall health of the planet. By setting science-based targets for nature, stakeholders commit to actions that go beyond legal compliance, fostering a collective responsibility to safeguard the intricate web of life on Earth for current and future generations.

## INVESTMENT IN NATURE-BASED SOLUTIONS

Leadership companies will invest in high-quality nature-based solutions (NbS) in the geographies from which their commodities originate. NbS are actions to protect, sustainably manage and restore natural or modified ecosystems to tackle major societal challenges, including climate change, human health and well-being, and food and water security. High-quality NbS are embedded within a landscape-level strategy to ensure impacts are transformative at meaningful scales and deliver benefits for climate, people, and nature without sacrificing one for another. Specific actions may include, for example, improving access to water, reducing land-based greenhouse gas emissions, enhancing the efficiency and security of local agricultural production, reducing health risks from diseases originating in tropical forests, and reducing exposure to natural disasters. These solutions recognize the importance of nature in providing essential services and contributions to human well-being.

Forest and natural ecosystem landscapes are well positioned to deliver NbS. Many of these actions and benefits are applicable to NbS in other ecosystem types, e.g., other wooded lands, grasslands, etc.

Specific actions could include:

### • **Forest conservation and restoration:**

- Conservation: Protecting existing forests helps maintain biodiversity, carbon sequestration, and other ecosystem services. Conservation efforts

may involve establishing protected areas, implementing improved logging practices, and combating illegal logging.

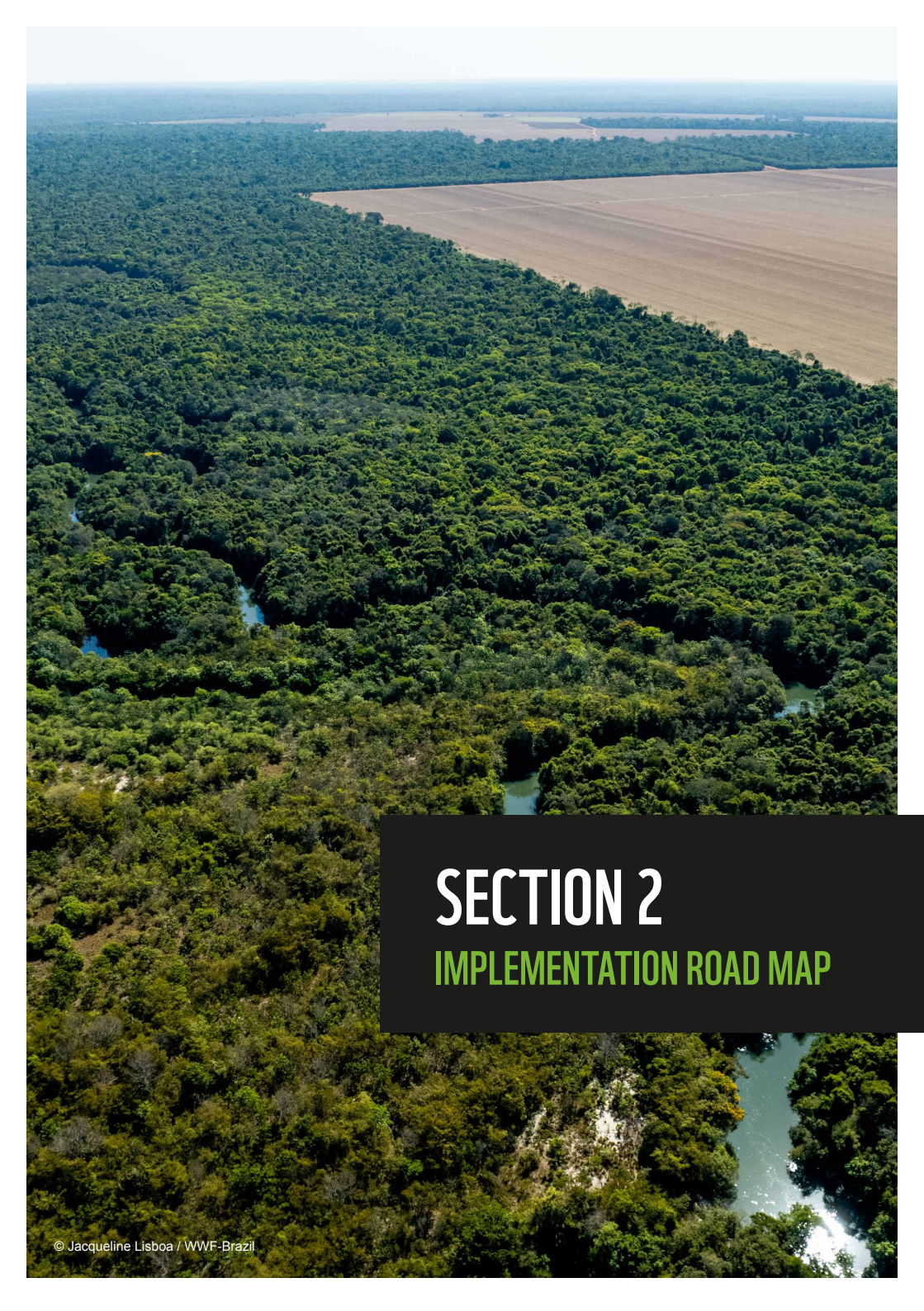
- Restoration: Restoring degraded or deforested areas through various active and passive regeneration techniques enhances ecosystem services and promotes resilience to climate change.
- **Biodiversity conservation:**
  - Many forests harbor a rich diversity of plant and animal species. NbS focus on maintaining and restoring biodiversity to ensure the resilience and functioning of ecosystems. This includes protecting endangered species, creating wildlife corridors, and promoting habitat connectivity.
- **Carbon sequestration and climate change mitigation:**
  - Forests play a crucial role in absorbing and storing carbon dioxide through the process of photosynthesis. NbS leverage forests as carbon sinks to mitigate climate change by reducing greenhouse gas concentrations in the atmosphere. Conservation and restoration contribute to this effort.
- **Water resource management:**
  - Forests influence water cycles, regulate water flow, and contribute to groundwater recharge. NbS in forests focus on maintaining healthy watersheds, protecting riparian zones, and halting deforestation to ensure nature-positive water resource management.

- **Community engagement and livelihoods:**

- Involving local communities in forest management is essential for ensuring NbS have durable impact. Empowering communities through nature-positive practices, agroforestry, and community-based conservation initiatives helps ensure that forests continue to provide resources without compromising their long-term health and that local people benefit from conservation actions.

Companies are advised to seek out reputable conservation partners operating in high-priority conservation landscapes. For example, WWF works with companies via its [\*\*Forests Forward\*\*](#) corporate engagement program both on responsible sourcing of forest-based supplies and to make NbS investments in high-priority landscapes. [\*\*WWF's Nature-Based Solutions Origination Platform\*\*](#) specifically links companies with landscape initiatives where high-quality NbS investments can support rigorous impact claims. WWF works through a number of partnerships on [\*\*Bankable Nature Solutions\*\*](#) (BNS) and published a report [\*\*Bankable Nature Solutions: Blueprint from across the globe\*\*](#) to support understanding of BNS and selection of quality BNS.

WWF has also developed a set of blueprints related to science-based targets and interventions in landscapes: [\*\*Beyond Science-Based Targets: A Blueprint for Corporate Action on Climate and Nature\*\*](#) and [\*\*A Blueprint for High-Quality Interventions that Work for People, Nature and Climate\*\*](#).



# SECTION 2

## IMPLEMENTATION ROAD MAP

# IMPLEMENTATION ROAD MAP

This implementation road map is designed to guide large downstream companies (“brands”) through a clear, practical process for achieving traceability in commodity supply chains.

This step-by-step framework helps organizations build their traceability capabilities incrementally, starting with foundational actions and advancing toward comprehensive system integration.

By utilizing a pilot approach in collaboration with trusted partners, as described below, companies can prioritize practical applications before scaling traceability solutions. This ensures

effective and informed decision-making based on prior testing and evaluation of the most suitable approach for the brand.

Also, the steps are not necessarily sequential. For example, brands could undertake some of the activities described in STEP 11 (Foster Industrywide Collaboration to Increase Volumes) in order to drive the development and uptake of the data standard in STEP 4.

## STEP 1: SECURING LEADERSHIP SUPPORT, ORGANIZING INTERNAL ROLES AND RESPONSIBILITIES

**B**efore engaging with external partners, it is essential to secure senior leadership support. A serious investment in traceability should be owned and championed from the highest levels, and this, in turn, will no doubt necessitate a clear understanding and articulation of the business drivers for traceability.

Leadership support is generally a precondition for establishing internal alignment around roles and responsibilities. The matrix below provides a suggested RACI (responsible, accountable, consulted, informed) framework for key roles typically involved in implementing traceability. Each organization should adapt this structure based on their internal setup, regional operations, and sourcing strategies.

# STEP 1

## SUGGESTED RACI MATRIX—INTERNAL ROLES AND RESPONSIBILITIES FOR TRACEABILITY IMPLEMENTATION

KEY ACTIVITIES	SUSTAINABILITY	PROCUREMENT	COMPLIANCE/ LEGAL	IT/DATA MANAGEMENT	SUPPLY CHAIN	EXECUTIVE SPONSOR
Conduct internal traceability assessment	R	C	C	C	R	I
Define traceability objectives and road map	R	C	C	C	R	I
Identify priority sourcing regions and key suppliers	C	R	I	I	A	I
Align on traceability requirements and standards (e.g., GS1 EPCIS)	R	C	A	A	R	I
Develop and send data request template	R	A	C	A	C	I
Support suppliers in traceability data submission	A	R	I	C	R	I
Review and verify supplier data	R	C	C	C	A	I
Define contractual clauses or specifications on traceability	C	R	R	I	C	I
Present pilot results internally and align on scaling strategy	R	C	C	C	C	A

**R** = Responsible (Executes the task)    **A** = Accountable (Owns the result and decision)

**C** = Consulted (Provides input or expertise)    **I** = Informed (Kept in the loop)

## STEP 2: ASSESSING YOUR COMPANY'S CURRENT TRACEABILITY PRACTICES

**T**he assessment evaluates current capabilities and progress toward traceability. This step identifies achievements and gaps and provides a clear starting point for advancing a company's traceability efforts focusing on internal practices.

**Goal:** *To establish a clear understanding of the company's traceability readiness, enabling companies to address specific challenges and leverage prior progress effectively by determining the optimal starting point for achieving full traceability.*

### How to:

#### 1 **Gather relevant documentation:**

Collect all existing traceability and supply chain-related documents, policies, and records—such as supplier agreements, procurement processes, traceability reports, mapping data, and logistics/transportation documents. This information helps companies understand their current traceability setup, map their internal systems, and identify areas for improvement. Consolidating these documents ensures a comprehensive assessment, allowing companies to determine the appropriate starting point within the step-by-step approach.

#### 2 **Engage key stakeholders:**

Alongside gathering documentation, consult with internal teams (e.g., procurement, traceability, sustainability, compliance) and external stakeholders (e.g., suppliers, auditors) to gain deeper insight into current traceability practices. Their input is essential for achieving a complete understanding of the company's traceability maturity.

#### 3 **Determine starting point:**

Based on the assessment results, identify the appropriate starting point in this document's step-by-step approach. Direct suppliers to the most relevant next step, building on prior progress and ensuring efficient use of resources.



## STEP 3: UNDERSTAND THE VALUE CHAIN AND IDENTIFY TRUSTED PARTNERS

**M**any companies try to implement a product-backward tracing approach, as described previously in this document. To build a reliable traceability system, product-backward efforts should be complemented by a first mile approach that engages producers in a specific sourcing region and works toward establishing real-time traceability at the origin. As traceability initiatives evolve, it becomes crucial to link this first mile data with subsequent production stages. Typically, this integration begins as a small-scale pilot with a select group of trusted partners, allowing brands to refine and scale their approach. Over time, these efforts lead to genuine traceability of the materials the brand is using—detailing the point of origin and the full CoC—so every link is verifiably tied to the brand’s products rather than a broad network of actors who may or may not be part of your operation.

Many companies have already conducted assessments or possess CoC information, enabling them to identify key material suppliers in high-risk areas. Leveraging these existing assessments can further enhance the understanding of the value chain and help identify the most reliable partners to pilot a traceability process.



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### REMEMBER MAPPING VS. TRACEABILITY

As detailed in section 1, mapping is the process of identifying the **universe of potential suppliers** linked to a company’s operations. However, this does not imply a direct material flow or linkage to a specific lot of material. In contrast, traceability establishes a verifiable connection between specific batches or lots and the suppliers involved in their production and handling.

A brand may map 50,000 farms or forests as potential sources in its supply base, but only 500 actually provide the materials used in current production. Mapping is a diagnostic tool—traceability is the operational proof.

**Goal:** *To build a foundational understanding of the value chain and engage a small group of trusted partners to pilot and refine traceability solutions, enabling companies to confidently scale effective practices.*

**How to:**

**1 Conduct a targeted supply chain study to identify key primary suppliers:**

Start by leveraging existing procurement data to pinpoint priority Tier 1 suppliers—those providing significant volumes and/or with longstanding relationships. Determine their main trading partners and the regions in which they operate. Cascade this inquiry from tier to tier, focusing on the next set of major suppliers at each level until primary suppliers—companies that occupy the first major point of aggregation, and usually production, of raw commodities—are reached.

An alternative approach is to start with the country of origin. If the company knows which country supplies raw material, it can focus on that country's major exporters from that region. The brand can focus on determining if Tier 1 suppliers source from one of these dominant exporters. If so, that exporter is a strong starting point, as it likely represents a significant share of the company's volume from that geography. The exporter may itself be a primary supplier or it may buy from one or more primary suppliers. In such cases, it is still necessary to work up the

supply chains in question, but they can be shorter than if a Tier 1 supplier is the starting point.

Remember that the goal is not to catalog every account in supplier databases, whether active or inactive, as it can be both expensive and time-consuming without revealing actual material flows. Instead, aim to identify a subset of entities and trusted partners where material is most likely moving. Continue with the effort and documentation until identifying three to five primary suppliers in priority regions (e.g., those that are high risk) that are sources for raw materials at the top of your supply chains.

**2 Vet candidates for pilot:** After identifying key primary suppliers and their major trading partners, ideally from diverse sourcing regions, companies should gauge each supplier's current engagement and willingness to support traceability initiatives. To build or strengthen these relationships, companies can:

- Discuss opportunities, challenges, and traceability goals
- Share informational resources on traceability, sustainability claims, and best practices
- Provide tools and guidance to help suppliers meet brand expectations
- Offer incentives, training, and education on traceability topics

## STEP 3

This collaborative approach nurtures strong, mutually beneficial partnerships with suppliers that are committed to advancing traceability.

**3 Select trusted partners:** Based on results of the vetting, companies should prioritize a manageable number of primary suppliers (e.g., two to three) and associated trading partners that are willing to participate in a pilot. When selecting these companies, consider those with significant volume, risk profile (suppliers from

high-risk geographies), long-standing partnerships with the brand, and a demonstrated interest or readiness to collaborate on traceability initiatives. It is crucial that these early collaborations emphasize interoperability, ensuring that the systems developed during initial trials can seamlessly integrate with later-stage production processes. Their active involvement is key to testing, refining, and standardizing solutions—avoiding siloed systems that could impede broader scalability.

### PRINCIPLES FOR ENGAGING TRUSTED PARTNERS FOR PILOT

Identifying and engaging trusted partners in traceability is not just a technical task — it is a strategic relationship-building effort. Successful engagement is rooted in mutual value recognition, trust, and a shared long-term vision. To foster this, companies should:

- **Demonstrate long-term commitment:** Suppliers are more likely to engage when they see consistent investment and genuine interest beyond short-term objectives.
- **Cocreate objectives:** Involving partners in the design of traceability solutions from the outset fosters ownership and enhances the quality of collaboration.
- **Acknowledge local capacities and limitations:** Calibrating expectations and timelines to the real operational context of suppliers shows respect and improves feasibility.
- **Align commercial interests with traceability goals:** Clearly communicating how traceability can unlock business benefits—such as market access, supply resilience, or reputation—helps build buy-in.

## STEP 4: ESTABLISH A STANDARDIZED TRACEABILITY DATA REQUIREMENT

Once trusted partners are identified, the next step is to issue a clear and structured data request to align on traceability definitions and material-specific data requirements. Using GS1 standards ensures that the collected data is interoperable and scalable for future traceability solutions. By linking to such data standards, companies can ensure that all data adheres to a consistent framework, facilitating seamless integration with existing systems and reinforcing industrywide best practices.

**Goal:** *To ensure alignment and clarity in data-sharing expectations while leveraging standardized formats to promote system interoperability and scalability.*

### How to:

**1 Align with trusted suppliers:** This preparatory activity focuses on aligning expectations, identifying roles, and outlining clear next steps—ensuring both the company and supplier are ready to implement traceability effectively. Clarify the data request and highlight potential benefits—such as efficiency gains, reduced compliance risks, and competitive advantage. Address concerns regarding data privacy, integration costs, and

regulatory requirements to secure early buy-in and ensure clearly defined adoption roles.

**2 Send a formal written request:** Distribute a formal data request that sets clear expectations on data format, submission process, and deadlines to the trusted suppliers.

**3 Provide the data request template:** To facilitate data collection, the brand can share a standardized data request template and a data sheet, both of which already incorporate GS1 EPCIS standards. Walk suppliers through the template to clarify its structure and requirements and to align on specific data points.

**4 Support suppliers in data submission:** Provide ongoing support to trusted suppliers through one-on-one assistance and Q&A sessions to ensure compliance and improve data quality.

**5 Collect and verify:** Review the submitted data for accuracy, completeness, and adherence to the data request. Identify missing data, determine availability, and outline steps to obtain it.

## STEP 5: CONDUCT A GAP ANALYSIS

**W**ith supplier data in hand, the brand can assess the supplier's traceability efforts, the data available, and the gaps that need to be addressed to meet thorough traceability standards that allow interoperability and scale. By evaluating their current practices, companies can provide targeted feedback to partners and define realistic improvement timelines, ensuring traceability goals are achievable and accomplished collaboratively.

**Goal:** *To evaluate supplier traceability capabilities, identify data gaps, and provide actionable feedback to align their efforts with the company specific traceability objectives.*

### How to:

#### **1 Analyze traceability data & assess supplier capabilities:**

Analyze the traceability data received from the suppliers, focusing on practices and data quality. Identify where suppliers' capabilities align with or diverge from your traceability requirements.

#### **2 Identify alignment points and gaps:**

Based on the traceability data received from suppliers and analyzed in previous steps, brands can quickly identify data gaps. Highlight areas where supplier data meets expectations and identify any gaps or inconsistencies

in their traceability information. This assessment provides a clear road map for targeted improvements.

#### **3 Engage in supplier feedback**

**session:** Organize a feedback session with suppliers to discuss the findings of the gap analysis. Clearly communicate necessary data adjustments, areas for development, and the reasons behind these recommendations.

#### **4 Define realistic timelines for improvement:**

Collaborate with your suppliers to establish practical timelines for addressing identified data gaps and enhancing data quality.

#### **5 Document findings and next steps:**

Record the results of the gap analysis and the improvement plans agreed upon detailing specific measures and time frames for each supplier to meet the requirements. Use this documentation to track progress and ensure alignment in subsequent steps of the traceability implementation process.



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### SUPPLIER FEEDBACK SESSION AND TIMELINES FOR IMPROVEMENT—A CASE STUDY



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As part of a pilot project to test traceability integration in the leather sector, one international brand worked closely with one key wet-blue supplier to evaluate current traceability capabilities and identify data gaps. After sharing the standardized data request (see step 4), the supplier raised questions about the structure and format of the requested information.

To address these challenges, the brand held two clarification sessions with the supplier, focusing on how to interpret the requirements and populate the templates correctly. These sessions enabled a shared understanding of expectations and clarified the rationale behind each data field.

As a result, both sides aligned on a final data format and established a stepwise plan for data submission. A timeline was agreed upon to allow the supplier to gradually enhance its data collection and reporting systems.



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## STEP 6: VALIDATE FEASIBILITY AND DEMONSTRATE SUCCESS

**A**s this approach is rolled out, the brand will uncover both valuable insights and data gaps. Rather than waiting for complete data, solutions can be modeled using available data and historical records to develop a functional traceability prototype. Using existing information, validated assumptions and reporting mechanisms, companies will develop a working model that demonstrates the feasibility of their traceability solution.

**Goal:** *To test and validate a traceability prototype using historical data from trusted suppliers, validated assumptions, and reporting systems; to identify challenges and opportunities for refinement, build confidence in the solution, and lay the foundation for full-scale implementation.*

### How to:

**1 Leverage supplier data:** Start with traceability data from Tier 1 suppliers to establish an initial model and demonstrate early success. Where upstream data is not yet available, companies may use historical purchase order data or indicative inputs as placeholders to simulate likely traceability flows for demonstration purposes. This stepwise approach enables immediate action and analysis of systems while progressively integrating more granular data and supply chain actors, refining the solution over time.

**2 Assess digital traceability solutions:** Scaling traceability across large volumes, transactions, and geographies requires a digital approach. Manual reporting is time-consuming, error-prone, costly, and lacks the operational benefits of real-time data.

Whether developing in-house solutions or using third-party providers, certain factors must be considered when evaluating tools. While interoperability (e.g., GS1 EPCIS compliance) is foundational, it is equally important to assess:

- **System architecture and scalability:** Can the platform support growing transaction volumes and supplier onboarding across regions?
- **Data privacy and access controls:** How are supplier data and commercial sensitivities protected?
- **Auditability and verification mechanisms:** Can the system support third-party verification or integrate with assurance tools?
- **User interface and ease of use:** Is the system practical for daily use by suppliers with different levels of digital maturity?
- **Integration with internal systems:** Can the platform interface with existing PLM, ERP, or procurement platforms?

## STEP 6

- **Analytics and reporting capabilities:** Does it offer dashboards, alerts, or tools to support compliance and decision-making?

**3 Develop a prototype:** Combine the historical data from trusted suppliers with validated assumptions to create a working prototype within the selected traceability system. Use this model to project results, refine its application, and align with the brand's traceability priorities at scale.

**4 Configure reporting systems:** Set up the system for collecting, analyzing, and reporting traceability data. Ensure the system aligns with traceability goals and provides support for decision-making and future scalability.

**5 Showcase the prototype and demonstrate success:** Present the working prototype to stakeholders, including supply chain partners, leadership, and other relevant parties. Highlight the model's success in addressing traceability objectives and its potential for scalability.



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Sheet rubber drying

## STEP 7: INCORPORATE TRACEABILITY INTO PURCHASING SPECIFICATIONS

Suppliers are familiar with quality specifications; traceability data extends these specifications to ensure due diligence and material origin verification. Embed traceability requirements into procurement to standardize expectations, ensure compliance, and classify sourcing regions. Integrating these into purchasing specifications creates a consistent framework with stepwise guidelines for preferred, required, and banned regions or suppliers.

**Goal:** *To formalize traceability requirements within purchasing specifications while establishing clear sourcing criteria, ensuring alignment, compliance, and consistency across all suppliers.*

### How to:

**1** Develop traceability-integrated procurement policies: Update purchasing policies to include traceability requirements—focusing on data quality, standards, and DCF product criteria—and define sourcing materials and suppliers by categorizing them as:

- **Preferred:** Materials or suppliers that meet the highest standards of sustainability and responsibility, prioritized in procurement whenever possible.

- **Required:** Minimum mandatory criteria that all suppliers and materials must meet to be eligible for procurement.
- **Noncompliant:** Materials or practices that do not comply with the company’s ethical, environmental, or regulatory standards and are therefore prohibited from procurement.

**2 Communicate expectations to suppliers:** Share the updated purchasing specifications and sourcing region guidelines with suppliers, providing clear instructions and timelines for compliance.

**3 Standardize supplier agreements:** Incorporate traceability and sourcing region requirements into supplier contracts to formalize expectations and promote accountability.



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## EMBEDDING TRACEABILITY INTO PURCHASING SPECIFICATIONS— A CASE STUDY



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In the seafood sector, one company revised its purchasing specifications to formally require traceability as a condition for procurement. The updated terms mandated that all suppliers adopt traceability platforms compatible with GDST standards and electronically report KDEs for each product.

Suppliers were also required to implement GS1-compliant barcodes and maintain

documentation aligned with the US Food Safety Modernization Act (FSMA) Section 204 Traceability Rule. These specifications were integrated directly into procurement policies, contracts, and onboarding procedures, making traceability a nonnegotiable aspect of supplier compliance.

By embedding clear and standardized traceability requirements into its purchasing process, the company is better positioned to ensure interoperability, improved supply chain transparency, and sourcing practices aligned with regulatory and sustainability commitments.



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## STEP 8: ROLL OUT TRACEABILITY ACROSS OPERATIONS

**W**ith traceability requirements already embedded into purchasing specifications and supplier agreements, the brand is now prepared to extend the traceability model beyond the initial pilot. Begin by enhancing traceability with the suppliers already engaged, then gradually extend the same requirements to additional key suppliers handling significant volumes. This stepwise expansion should be managed across suppliers, facilities, and geographies, with a focus on DCF products to ensure a sustainable, manageable rollout.

**Goal:** *To gradually scale the traceability model across the value chain while increasing the availability of DCF products in individual facilities and broader operations.*

### How to:

#### 1 **Expand with current suppliers:**

Leverage established supplier relationships to scale traceability efforts, expanding volumes in facilities adopting these practices.

#### 2 **Pilot in select geographies or facilities:**

Align requirements across suppliers in the same region to standardize DCF product traceability. Focus on geographies with the highest volume potential.

**3 Communicate demand for DCF products:** Clear market signals mobilize suppliers and partners to meet requirements. Communicating specific, long-term commitments builds supplier confidence for necessary investments. Collaboration with others interested in DCF products (step 11) helps channel demand for all products from compliant facilities.

**4 Define the right data access model:** As traceability scales, it becomes essential to determine how traceability data will be exchanged between suppliers and the brand. Two main approaches are commonly used:

- **Push model (per-transaction submission):** Suppliers submit traceability data for each order or batch. This allows greater control over data flow, aligns well with event-based traceability, and allows real-time integration. However, it requires higher supplier capacity and strong



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## STEP 8

systems integration; it may lead to data duplication or inefficiencies if not automated.

- **Pull model (on-demand access):**

Suppliers maintain traceability data in their systems or on a shared platform, and the brand retrieves it when needed. This reduces supplier burden, offers flexibility for internal auditing and reporting, and allows for staggered system upgrades.

However, it represents a risk of data fragmentation or outdated records if access protocols are not well defined or regularly tested.

Brands should evaluate which approach best suits their supplier base and digital infrastructure. In practice, hybrid models—where critical data points are pushed automatically while full datasets remain accessible on demand—can offer a balanced solution.



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## STEP 9: ENABLE SYSTEM INTEGRATIONS AND ENHANCE TECHNOLOGICAL INNOVATION

To rapidly scale traceability data and DCF products, integrate traceability systems with existing databases and enterprise management systems for more automated data flow. Using a global data standard, such as GS1 EPCIS, enables interoperability, allowing multiple systems and databases to connect efficiently.

Some companies may not have enterprise-level systems in place. For these companies, system integration may still be a future step—hence its classification here as optional. This step explores two complementary pathways:

- **Foundational integration:** connecting traceability systems to existing internal systems (e.g., ERP, PLM, procurement), which is crucial for operational efficiency at scale.
- **Advanced integration (optional):** exploring emerging technologies to future-proof systems and enhance traceability capabilities.

**Goal:** *To ensure traceability data is integrated into broader operational systems, enhancing usability and decision-making while aligning innovations with the company's existing systems and databases to improve efficiency and scalability in traceability efforts.*

### How to:

**1 Integrate with core enterprise systems (foundational integration):** Review existing enterprise platforms (e.g., ERP, PLM, procurement systems) and assess their compatibility with traceability data structures. Integration with these systems reduces reliance on manual data entry and enables traceability to operate at scale. This includes API-based connections, shared databases, and cloud-based solutions.

This foundational integration is essential for brands aiming to automate reporting and manage growing volumes of traceability data efficiently.

**2 Connect with traceability platforms piloted in earlier steps:** If a dedicated traceability platform was tested during the pilot phase, work with internal teams and the provider to expand system use to additional suppliers or regions. This roll-out should be part of the broader operational scale-up described in step 6.

**3 Explore optional emerging technologies (advanced integration):** Brands interested in enhancing traceability capabilities may assess the feasibility of optional emerging tools—such as satellite monitoring, RFID, QR codes, barcodes,

## STEP 9

or DNA marking. These technologies can support material authentication and risk monitoring, particularly in high-risk sourcing geographies.

While technologies like blockchain, AI, and Internet of Things (IoT) receive frequent attention, they should only be considered if they address concrete use cases within the company's traceability goals and infrastructure readiness.

**4 Pilot and refine system integration:** For any system integration—whether foundational or advanced—pilot the approach in

selected operations to validate real-time data exchange, user experience, and system responsiveness. Collect feedback from IT, procurement, and end users to fine-tune configurations and develop a road map for broader deployment.

**5 Participate in cross-sector collaborations:** Partner with technology providers, research institutions, and industry experts to continuously identify traceability trends and innovations and contribute to the development and adoption of global traceability standards.



## STEP 10: IMPLEMENT DATA ANALYTICS AND VERIFICATION

**E**nsuring the reliability of traceability data is essential for building trust and mitigating supply chain risks. This step focuses on validating traceability information through rigorous internal controls, data analytics, and independent third-party verification. By integrating data standards and interoperable frameworks such as GS1 EPCIS, companies can strengthen data integrity, enhance transparency, and pinpoint high-risk suppliers or supply chain vulnerabilities.

Verification processes can draw from principles used in financial auditing, emphasizing consistency, transparency, and accountability. Just as financial data is reported under frameworks like Generally Accepted Accounting Principles (GAAP), traceability data should follow clearly defined standards and guidelines to ensure it is credible, comparable, and auditable.

Beyond verification, traceability data enables geospatial analysis. With accurate supply chain data, brands can integrate geospatial analysis into traceability systems to sourcing regions, monitor risks, and verify DCF claims. This allows brands to go beyond compliance—actively monitoring and validating DCF commitments, making informed sourcing decisions, and strengthening sustainability claims.

In addition to verifying self-declared data, this step also incorporates

**continuous monitoring of traceability flows** to detect anomalies, track supplier behavior, and flag risks proactively. High-quality, event-based data allows companies to move from periodic verification to ongoing oversight.

### VERIFICATION BEYOND DEFORESTATION

While this step emphasizes traceability data and DCF verification, the traceability system should also enable modular verification of other sustainability claims and environmental, social, and governance (ESG) priorities, allowing companies to layer multiple criteria into the same traceability backbone.

This step takes into consideration the three main models of verification according to the [\*\*\*AFi Operational Guidance on Monitoring and Verification\*\*\*](#):

- 1. First-party verification:** Internal checks or supplier self-declarations, common in early stages of traceability efforts. Performed by a different team within the company itself.
- 2. Second-party verification:** Performed by an entity with an

interest in the company being assessed, which can be evaluations conducted by customers or buyers within the supply chain.

### 3. Third-party verification:

Performed by an entity that does not have an interest in the company nor provide other services to it, which encompasses independent assessments by external organizations, offering the highest level of credibility. Third-party verification should be used when a high level of confidence and credibility is needed, such as high-risk sourcing regions.

#### How to:

#### 1 Standardized reporting

**framework:** Companies would report traceability data using a standardized framework established by the data standard for the commodity in question. This framework would define KDEs and CTEs for consistent data collection and reporting.

#### 2 Internal controls and data

**analytics:** Similar to financial internal controls, companies should establish robust processes for recording and verifying traceability data using data analytics tools. This includes documenting supplier inputs, tracking product movement, and validating certifications at each stage of the supply chain.

#### 3 Leverage third-party verification (auditing):

Independent third parties would perform verification audits of the self-reported data. These audits would ensure the data is accurate, complete, and aligned with the standardized framework. The auditors would examine source documents, conduct supplier interviews, and cross-check data for inconsistencies.

#### 4 Identify and address critical points:

Auditors would assess materiality to focus on high-risk areas of the supply chain where discrepancies are more likely. This mirrors the financial auditing process, where the focus is on areas with the greatest impact on financial statements. In the environmental context, a risk-based approach enables companies to focus verification efforts on areas of higher vulnerability, such as sourcing regions with a history of deforestation or facilities lacking prior audits. **The AFi Monitoring and Verification Principle** recommends assessing risk based on:

- Geography (e.g., high-deforestation areas)
- Supply chain complexity
- Supplier performance history

A reliable source of supplier performance insight is traceability data based on actual purchases and transactions of real material moving

## STEP 10

through the supply chain. Even more valuable is granular data tied to specific lots, which offers greater visibility, reveals inconsistencies, and helps flag potential supplier risks.

Lot-level traceability can highlight data inconsistencies, identify at-risk suppliers, and provide a clear basis for targeting interventions. This enables buyers to focus improvement

efforts where they matter most or take proactive steps to reduce risk and ensure supply chain integrity.

**5 Assurance statement:** Following verification of traceability data, the auditor would issue an assurance statement similar to an auditor's opinion in financial reporting, indicating whether the traceability data is accurate and adheres to the reporting framework.

## PRISM—TECHNOLOGY-ENABLED VERIFICATION—A CASE STUDY



Digital tools are revolutionizing verification by automating data capture and validation. For example, [\*\*GSA's Prism platform\*\*](#) demonstrates how real-time data, blockchain records, and AI can enhance transparency and reduce fraud.

Prism leverages digital verification and certification data in the seafood industry to ensure that claims are accurate and traceable to verified

sources. It aggregates audit data from certified entities, flags inconsistencies, and supports continuous compliance with standards. Though developed for seafood, offers a replicable model for leather and other commodities with complex, fragmented supply chains.

## STEP 11: FOSTER INDUSTRYWIDE COLLABORATION TO INCREASE VOLUMES

Scaling fully traceable DCF products requires channeling demand to facilities that meet these standards. Expanding demand across sectors—timber, palm oil, soy, rubber, cocoa, beef/leather, coffee, cotton, etc.—creates a larger pool to distribute traceability costs and increases the number of clients seeking products with the same attributes. Industrywide collaboration with suppliers and sectoral organizations can align efforts and accelerate adoption.

**Goal:** *To expand traceability coverage by working collectively with suppliers, peers, and industry bodies, increasing the volume of traceable products and driving sector-wide adoption.*

### How to:

- 1 Engage in multistakeholder initiatives:** Partner with industry groups and collaborative initiatives to align traceability goals and strategies. Participate in sector-wide discussions to influence policy and regulatory frameworks that support traceability.
- 2 Encourage peer and supplier participation:** Share best practices, cases studies and lessons learned to encourage peers and suppliers to adopt traceability systems.
- 3 Scale traceable product volumes:** Work collectively to address barriers to implementing traceability on a scale and support joint investments in technology and infrastructure to facilitate industry-wide adoption.



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## BETTER FOOD FUTURE—JOINT INITIATIVES—A CASE STUDY



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The **Better Food Future Partnership** exemplifies how companies can come together to invest in and purchase materials with the same sustainability characteristics. Spearheaded by a collaboration between the UN Global Compact Ocean Stewardship Coalition (UNGC) and Wholechain, this initiative unites diverse UNGC signatories to establish common sustainability standards across their supply chains.

### Key elements of the project:

- **Aligned sustainability criteria:** Companies agree on rigorous environmental and social benchmarks—such as DCF practices—to ensure every purchased product meets identical sustainability characteristics.
- **Joint Investment in technology and capacity building:** By pooling resources, partners invest in digital traceability systems and capacity building initiatives. This shared investment enables the development of interoperable data frameworks and standardized reporting, reducing costs and mitigating risks across the value chain.
- **Collaborative approach to procurement:** The partnership creates a unified purchasing framework that allows companies to leverage collective bargaining power. This alignment not only scales traceability volumes but also enhances market transparency and accountability.
- **Scalability and impact acceleration:** Through multistakeholder engagement and coordinated pilot programs, the initiative demonstrates how shared investments lead to improved data quality and traceability. As these best practices expand industrywide, they set new benchmarks for sustainability that are replicable across sectors, including leather, soy, and beyond.

**Outcome:** The Better Food Future Partnership serves as a practical example of industrywide collaboration where companies collectively drive systemic change. By aligning their investments and purchasing strategies, they achieve higher volumes of traceable products, reduce operational risks, and accelerate the transition toward nature-positive supply chains on a global scale.

## STEP 12: INCORPORATE INCENTIVES

**F**ocuses on motivating suppliers and partners to prioritize traceability by implementing incentive mechanisms, fostering collaboration and scalability throughout the supply chain.

**Goal:** *To foster supplier engagement and accelerate traceability adoption by aligning incentives with traceability objectives.*

### How to:

**1 Design incentive programs:** Develop financial or nonfinancial incentives, such as preferential

contracts or recognition programs, to reward suppliers for traceability achievements.

**2 Communicate benefits to suppliers:** Explain how incentives align with suppliers' goals and create mutual value through traceability efforts.

**3 Monitor impact and adjust programs:** Track the effectiveness of incentives and refine them based on supplier feedback and program outcomes.



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MOST PRESSING THREATS  
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