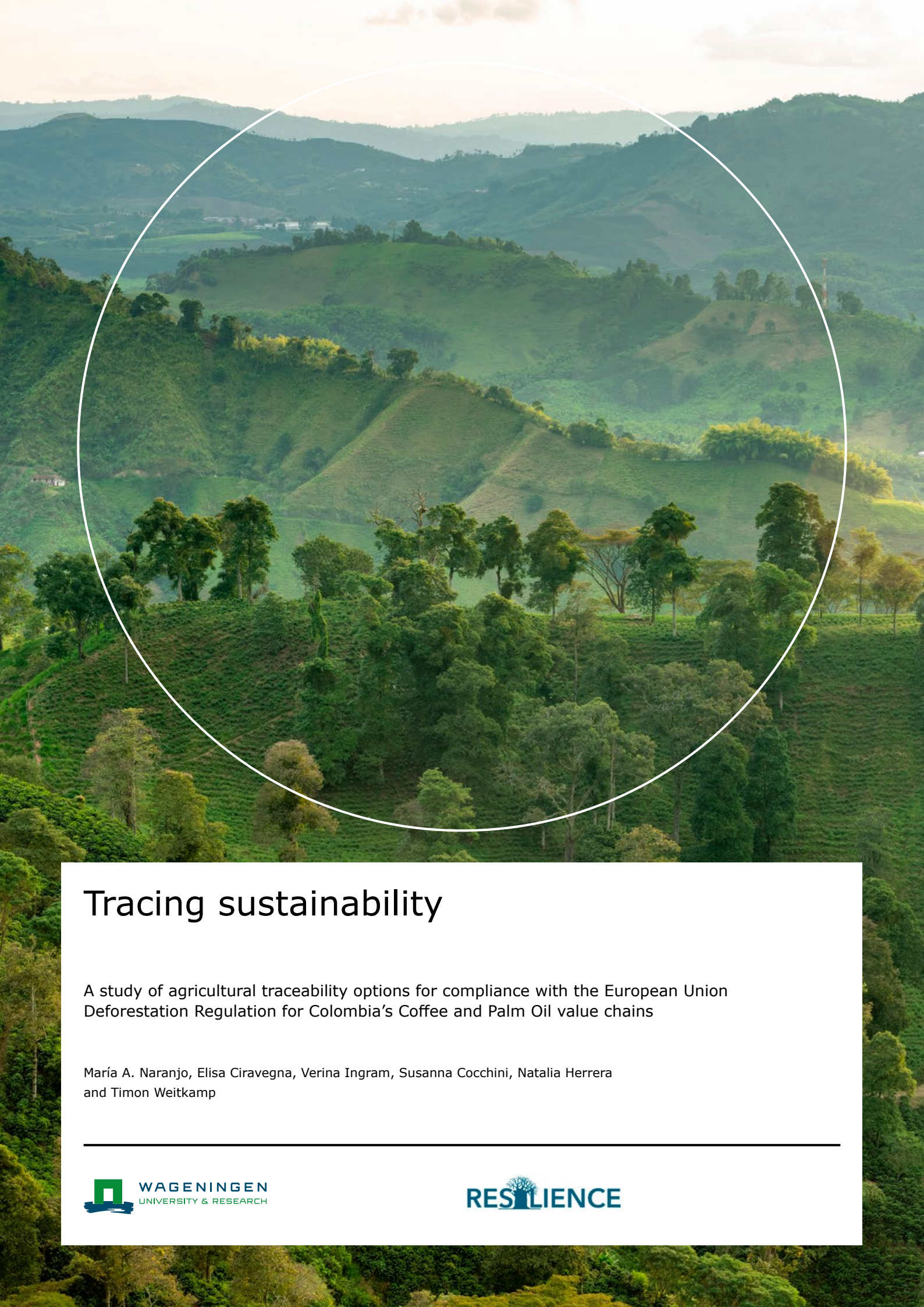

Tracing sustainability

A study of agricultural traceability options for compliance with the European Union Deforestation Regulation for Colombia's Coffee and Palm Oil value chains

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WAGENINGEN UNIVERSITY & RESEARCH

RESILIENCE

Tracing sustainability

A study of agricultural traceability options for compliance with the European Union Deforestation Regulation for Colombia's Coffee and Palm Oil value chains

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The European Union Deforestation Regulation (EUDR) mandates due diligence, requiring geographic coordinates of production plots to prevent deforestation-linked imports. This poses challenges for Colombian agriculture, especially coffee and palm oil exports. While the regulation aims to curb deforestation, compliance demands clear guidelines, process standardisation, traceability technologies, and farmer support to overcome costs and technical barriers. Global case studies provide insights into designing resilient traceability systems in Colombia, highlighting the importance of aligning national and international standards. Despite challenges, the EUDR offers opportunities for sustainable practices, ethical sourcing, and accountability. Colombia's success in meeting EUDR requirements while remaining competitive depends on resolving cost-sharing, fostering innovation, and supporting smallholders. This ensures compliance and ethical sourcing.

De European Union Deforestation Regulation (EUDR) vereist due diligence-onderzoek, waarbij geografische coördinaten van productiesites nodig zijn om invoer gekoppeld aan ontbossing te voorkomen. Dit brengt uitdagingen met zich mee voor de Colombiaanse landbouw, met name voor de export van koffie en palmolie. Terwijl de verordening gericht is op het verminderen van ontbossing, vereist naleving duidelijke richtlijnen, standaardisatie van processen, traceerbaarheidstechnologieën en ondersteuning voor boeren om kosten en technische obstakels te overwinnen. Wereldwijde casestudies bieden inzichten in het ontwerpen van veerkrachtige traceerbaarheidssystemen in Colombia, waarbij het belang van het afstemmen van nationale en internationale normen wordt benadrukt. Ondanks de uitdagingen biedt de EUDR kansen voor duurzame praktijken, ethisch inkopen en verantwoordingsplicht. Het succes van Colombia in het voldoen aan de EUDR-eisen, terwijl het concurrerend blijft, hangt af van het oplossen van kostenverdeling, het bevorderen van innovatie en het ondersteunen van kleinschalige boeren. Dit zorgt voor naleving en ethisch inkopen.

Key words: European Union Deforestation Regulation (EUDR), deforestation-linked imports, Colombian agriculture, coffee, palm oil, traceability.

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Contents

Preface

Transforming food systems is essential to halting deforestation and forest degradation. In response, the European Union has established the Deforestation Regulation (EUDR) to minimise the risk of deforestation-related products entering the EU market. The EU regulation creates profound implications for Colombia's agricultural sector, presenting challenges and opportunities for farmers and producers.

This report aims to provide advice on technologies and processes that stakeholders in the coffee and palm oil sectors can adopt to ensure the improved sustainability and traceability of their products. Our goal is to equip Colombian stakeholders with recommendations to enable them to navigate the new regulatory landscape, identify hotspots, and leverage points to ensure the continued prosperity of agricultural exports while contributing to forest conservation globally.

Disclosure:

All views and interpretations expressed in this document are those of the authors and not necessarily those of the supporting or cooperating institutions or individuals.

The EU has postponed enforcement, officially setting 30 December 2025, as the compliance deadline for the European Union Deforestation Regulation (EUDR). Consequently, the dates in this report have been updated to reflect this revised timeline.

Acknowledgements: we want to thank the Netherlands Embassy in Bogotá, the EU delegation in Colombia, and representatives from the National Federation of Coffee Growers of Colombia (Federación Nacional de Cafeteros de Colombia), the National Federation of Palm Oil Growers, Fedepalma, and referred participants in the interviews for their valuable comments and feedback during the validation process.

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[1] As of 1 January 2025, Wageningen Economic Research & Wageningen Centre for Development Innovations have merged into a new institute called Wageningen Social & Economic Research.

Executive Summary

Traceability and transparency to combat deforestation (Chapter 1)
Traceability involves tracking the journey of a product or material from production to the end user, documenting its history, including locations, owners, and transformations, to ensure its origins meet sustainability and ethical standards. Transparency complements traceability by sharing this information with stakeholders, including land use and monitoring data. The EU Deforestation Regulation (EUDR) emphasises the need for operators to provide due diligence statements, requiring geographic coordinates of production plots to verify compliance and demonstrate that deforestation is not occurring. Traceability and transparency address growing consumer demands, enhance accountability, and support forest protection efforts.

The EU's Deforestation Regulation has significant implications for Colombian agriculture and forests (Chapter 2)
The expansion of agricultural commodity production has significantly contributed to deforestation and forest degradation globally, which are major drivers of climate change and biodiversity loss. Recognising the contributing role of countries importing such commodities, the European Council and Parliament passed a regulation prohibiting importing deforestation-related products into the European Union. The initiative targets seven commodities and their derivate products: palm oil, beef, timber, coffee, cocoa, rubber and soy, and states that only products grown on land 'that has not been subject to deforestation or forest degradation after 31 December 2020' will be allowed into the European Union by 30 December 2025 (large companies) and by 30 June 2026 for small and medium-sized enterprises (SMEs) and benchmarking new deadline to 30 June 2025. Coffee and palm oil are Colombia's flagship products and two of the most exported agricultural products to the EU market. More than half a million Colombian families rely on coffee production, while the palm oil industry provides nearly 200,000 jobs in the country. Hence, the legislation could substantially impact farmers and Colombia's production and trade practices in the short term.

Implementing the EUDR presents significant uncertainties for those involved in the Colombian coffee and oil palm chains due to the need for publicly available guidelines and benchmarking data (Chapter 3)
For implementation to be effective, our study indicates that a mix of technologies is needed to support different compliance pathways (e.g. Corporate Systems, Certifications or National Stakeholder Collaborations). Ensuring the continuity of technology and data, primarily through unique identifiers for farmers (like citizens identification), is crucial. First, processes should be standardised with national legislation and then comply with EUDR due diligence as a commercial requirement. Additionally, it is critical to track the pathways facilitating EU exports and to organise and empower unorganised farmers who might otherwise be excluded from the EU market. Monitoring changes in market shares and evaluating the costs and benefits of EUDR implementation for Colombian value chain actors will help communicate the impacts of the EUDR to the EU. The EUDR may prompt a shift from high-risk production areas towards non-EU markets and could increase risk mitigation costs. The new benchmarking deadline is 30 June 2025. Therefore, a comprehensive approach is needed to manage these potential impacts.

Traceability technologies are vital in combating forest loss and fostering sustainable agricultural production by tracking commodity origins and movements, ensuring transparency and accountability across value chains (Chapter 4)
These technologies, ranging from satellite monitoring to blockchain, have varying applications, advantages, and limitations, often requiring integration and collaboration among stakeholders to create robust traceability systems. However, they cannot fully address deforestation concerns, as gaps remain in monitoring post-harvest stages and ensuring data accuracy through field verification. Additionally, issues like high costs, energy demands, and human errors in data entry highlight the need for complementary approaches beyond technology to achieve comprehensive traceability and accountability.

Global experiences with timber, cocoa, and other agricultural products offer valuable insights for improving coffee and palm oil traceability systems in Colombia (Chapter 5)
Key examples include the EU Geographic Indication and Timber Regulations, Tony's Chocolonely Cocoa initiative, Indonesian and Malaysian Palm Oil Standards, Protocol APSColombia, and voluntary certification standards. These cases highlight best practices and common challenges that can inform the design of resilient traceability systems in Colombia. Aligning Colombian and EU regulatory frameworks and standardised national traceability processes is vital, particularly for smallholder farmers. Resistance to new methods can be addressed by offering examples of successful implementation and aligning advanced technologies like geospatial tools, certification systems, and IoT devices. Existing traceability systems can be revised to support EUDR compliance.

Implementing the EUDR requires a comprehensive understanding of value chain actors, verification processes, and associated risks to ensure deforestation-free supply chains (Chapter 6)
The EUDR mandates that operators and traders provide due diligence statements, demonstrating compliance by documenting the geographic coordinates of production plots and verifying land use legality. In Colombia, this involves ensuring agricultural activities occur within the defined agricultural frontier, excluding forests and protected areas. Traceability systems must identify deforestation-free plots using databases such as the EU Forest Observatory and local sources like SICA and IDEAM, with technology like RFID, blockchain, and certification supporting transparency and integrity. Risk mitigation is crucial to prevent errors, fraud, and product mixing. Operators must verify compliance with the Deforestation Due Diligence Statement Registry during export. At the same time, importers must submit due diligence statements with geolocation data and records demonstrating adherence to deforestation-free standards. These measures promote accountability, transparency, and ethical sourcing across the value chain.

Implementing EUDR presents challenges and opportunities, particularly for major commodity-exporting countries like Colombia (Chapter 7)
While the regulation may have some challenges, it offers a chance to establish a more traceable, fair, and sustainable system for producers and workers, particularly in countries already meeting high sustainability standards. Achieving this requires collaboration among multiple actors, including corporations, governments, and local stakeholders, with diverse technological solutions such as blockchain and geolocation. A key aspect is the need for standardisation across these efforts to ensure effective traceability. Additionally, infrastructure improvements, particularly in connectivity, are critical for supporting the technological framework needed for EU export compliance. Clear EU guidance and state-led infrastructure development will be crucial in ensuring the successful implementation of the EUDR.

Choices are needed about who bears the costs within Colombian traceability systems (Chapter 8)
Colombia's efforts to improve traceability in the oil palm and coffee sectors and the increasing use of technology have created an opportunity for more farmers to be included in the export value chains. However, the question of who bears the costs remains unresolved and requires choices and political decision-making. Achieving effective traceability without overburdening farmers requires coordinated efforts by public and private organisations, cooperatives and governments. A significant challenge for value chain actors is ensuring that small farmers, especially those without geospatial data, are not excluded from the EU market due to the cost and complexity of complying with the EUDR. Without support, these farmers could be marginalised, while deforestation-related products could be redirected to less regulated markets, undermining sustainability efforts. To overcome these challenges, investment in infrastructure, improved connectivity, and the development of user-friendly technologies are essential. Blockchain seems to have the most potential to capture all the steps in the supply chain. However, it should not be considered a standalone solution, as it still has several limitations and needs a data harmonisation system that has yet to be achieved. By promoting an inclusive approach and empowering smallholder farmers, Colombia can meet EUDR requirements while maintaining broad participation in global markets.

Key messages

1. **Continuity of technology and data:** It is crucial to ensure the continuity of technology and data to ensure consistent compliance, for example, by using unique identifiers for farmers and farms. This means addressing issues of legality and legitimacy.
2. **Standardisation and commercial requirements:** Standardising traceability processes in Colombian national legislation and recognising EUDR due diligence as a commercial requirement can help align local practices with international (European) expectations.
3. **Empower farmers:** It is critical to organise and empower unorganised farmers, and prevent their exclusion from the EU market, as this group appears vulnerable, and least able to be able to comply with EUDR requirements without support.
4. **Monitoring market dynamics:** Monitoring changes in market shares and evaluating the costs and benefits of EUDR implementation for Colombian value chain actors will help communicate these dynamics to the EU. Understanding shifts in trade will be essential for the EU and Colombian stakeholders in the coffee and oil palm value chains to make informed decisions.
5. **Market shifts and risk mitigation costs:** The EUDR may prompt a shift in selling products originating from high-risk forest production areas to non-EU markets. Strategies to minimise risks could involve gathering supplementary data, with operators establishing and enforcing policies, controls, and procedures to mitigate and manage non-compliance risks.

1 Why is urgent action needed to protect forests, and how can traceability contribute?

Protecting forests is critical for maintaining biodiversity, regulating the climate, and supporting livelihoods

Deforestation and forest degradation contribute significantly to greenhouse gas emissions, threaten ecosystems, and undermine global sustainability goals (UNDP, 2024). Traceability can play a pivotal role by enabling stakeholders to track the origins and journey of products through the supply chain, ensuring that commodities are sourced responsibly (World Resources Institute, 2024a). Traceability systems help identify and eliminate deforestation-linked practices by providing information about production locations, fostering greater accountability and compliance with sustainability standards (World Resources Institute, 2024a).

Traceability and transparency are critical elements in ensuring sustainability and halting deforestation

Implementing traceability technologies can significantly enhance the transparency and sustainability of coffee and palm oil supply chains, which is essential to meeting consumer demands and addressing environmental and ethical concerns. Traceability refers to connecting the stages through which a product or material from production to the end user is connected with detailed information about its history, including its locations, owners, and transformations throughout the value chain, allowing the ability to follow the movement of a feed or food through specified stage(s) (ISO 2007, ITC 2015, World Resources Institute, 2024). Transparency involves disclosing information by any stakeholder along the value chain. This information is not only information on commodities traceability but also includes details on land use information and whether it has been monitored. However, traceability and transparency can have different meanings for stakeholders in commodity value chains. Transparency can vary in scope, from internal information sharing within an organisation or among companies to sharing with specific stakeholders to making information publicly available (World Resources Institute, 2024a).

Traceability refers to the ability to identify the origin of food feed ingredients and food sources

A traceability system allows the documentation and/or location and thus the ability to follow the movement through specified stage(s) of production, processing and distribution to end use. The EUDR does not define traceability but talks of operators placing relevant products on the EU market being required to use diligence statements to demonstrate compliance with the EUDR. Terms such as tracking, tracing and mapping are used. This means the Regulation requires operators and traders to collect geographic coordinates of the plots of land where the commodities were produced. Traceability to the plot of land (i.e. the requirement to collect the geographic coordinates of the plots of land where the commodities were produced and share this with operators) is thus necessary to demonstrate that there is no deforestation occurring on a specific location.

Strategies for ensuring compliance with the EU Deforestation-Free Regulation in Colombian coffee and palm oil sectors

This study provides advice on technologies that stakeholders in the value chains of coffee and palm oil in Colombia can use to ensure the sustainability and traceability of their products. To achieve this, this study has the following specific objectives:

1. Identify hotspots and leverage points to increase sustainability and inclusivity of the production systems to minimise the expected impacts of deforestation EU regulation (Chapter 2)
2. Provide an assessment of different technologies for traceability and examples of applications in agricultural products (Chapters 3 and 4)
3. Provide a comprehensive analysis of solutions that can help minimise the impact of the upcoming EU deforestation-free value chains regulation for stakeholders in coffee and palm oil value chains in Colombia and recommendations on how to implement traceability technologies (Chapters 5 and 6).

Report based on literature review and expert interviews on the readiness towards implementation of EUDR

To address the research questions, this study examines recent literature and grey reports on deforestation and the implications of the EUDR. This is complemented by interviews with key informants and a detailed analysis of the context and specific needs of two value chains: coffee and palm oil. Interviews were conducted with key contacts provided by the Embassy. These interviews aimed to gather insights into stakeholders' awareness and readiness to comply with EUDR due diligence requirements. First, preliminary interviews focused on evaluating awareness levels and preparedness for implementing EUDR compliance measures. Findings were derived from multiple sources, including insights provided by a total of 16 interviews facilitated by the Embassy (Annex 1). Regional cooperatives and industry associations, such as Fedepalma and the National Federation of Coffee Growers (FNC), were actively engaged to provide context-specific perspectives and additional data. Then, an expert validation process was carried out to ensure the reliability and credibility of the information obtained during the interviews and data collection phases.[2] This comprehensive approach ensured diverse and credible data to support the study's objectives.

We answer key questions addressed in each chapter to achieve the research objectives

Chapter 2 describes the critical elements of EUDR for traceability. Chapter 3 portrays the characteristics of the Colombian context and details aspects of the two value chains, starting with coffee and then palm oil. Chapter 4 shows examples of how traceability technologies have been used to track the origins and movement of commodities, ensuring transparency and accountability across value chains, including coffee and palm oil. Chapter 5 describes other experiences worldwide in timber, cocoa, and other agricultural products and provides valuable lessons for coffee and oil palm traceability in Colombia. To understand the roles and responsibilities of different value chain actors, Chapter 6 draws the main actions and verifications required by the EUDR and the risks associated with these actions. Chapter 7 reviews the roles and responsibilities of the main actors mentioned in the previous chapters to implement traceability systems and the fair use of technology that leaves no one behind. Finally, Chapter 8 provides conclusions and recommendations for implementing the EUDR in Colombia's palm oil and coffee value chains.

[2] Validation meetings were carried out with the EU delegation in Colombia, and key representatives from the National Federation of Coffee Growers of Colombia (Federación Nacional de Cafeteros de Colombia) and the National Federation of Palm Oil Growers (Fedepalma), as specified in Annex 1.

2 What are the critical elements of EUDR?

Global deforestation and forest degradation patterns call for action towards sustainable food systems

Agriculture accounts for 80% of global deforestation, significantly contributing to global biodiversity decline (WWF, 2020) and driving climate change (Curtis et al., 2018; Pendrill et al., 2019, 2022). The urgency of these issues requires concrete and immediate action to mitigate environmental consequences (IPBES, 2019; IPCC, 2019). Changes in food systems are necessary to stop deforestation and forest degradation.

The 2023 EU Regulation on deforestation-free products (EUDR; Regulation (EU) 2023/1115)[3] has been created to reduce the likelihood of introducing products and commodities that contribute to deforestation and forest degradation to the EU market. EUDR applies to companies that import, place on, make available on or export to the EU market-specific commodities.[4] To achieve its aim, the Regulation mandates geolocation and traceability for each land plot where raw materials originated, sets a cut-off date for enforcing mandatory due diligence rules, and introduces a benchmarking system. Implementing these due diligence and traceability requirements presents transparency challenges and opportunities for all value chain actors. This section presents the critical elements for the implementation of the EUDR.

Value chain traceability is more than being traceable to the plot traceability

As defined in the Executive Summary, traceability involves linking a product or material to detailed information about its history, including its locations, ownership and changes it undergoes throughout the value chain, from production to the final consumer. The EUDR does not define traceability but talks of operators placing relevant products on the EU market being required to use diligence statements to demonstrate compliance with the EUDR. In the context of EUDR, traceability refers to the plot of land—specifically, the requirement to collect the geographic coordinates of the land where commodities are produced—which is essential to demonstrate that no deforestation occurs at a given location. Under the Regulation, operators and traders (excluding SMEs) are required to gather these geographic coordinates and include them in due diligence statements submitted to the Information System. Placing products on the EU market or exporting them is prohibited without this data. These traceability requirements apply to each batch of relevant commodities that fall under the scope of the Regulation, whether imported, exported, or traded (European Commission, 2024d). Nonetheless, article 9 specifies that due diligence statements must also include information on the operator or trader from whom the relevant products were sourced and to whom the relevant products were supplied. The information should be verifiable (See Box 2.1). Therefore, we interpret traceability as both traceable to the plot of land and about keeping the product separated through the value chain to ensure that the products reaching the EU have been kept separated and are truly deforestation-free.

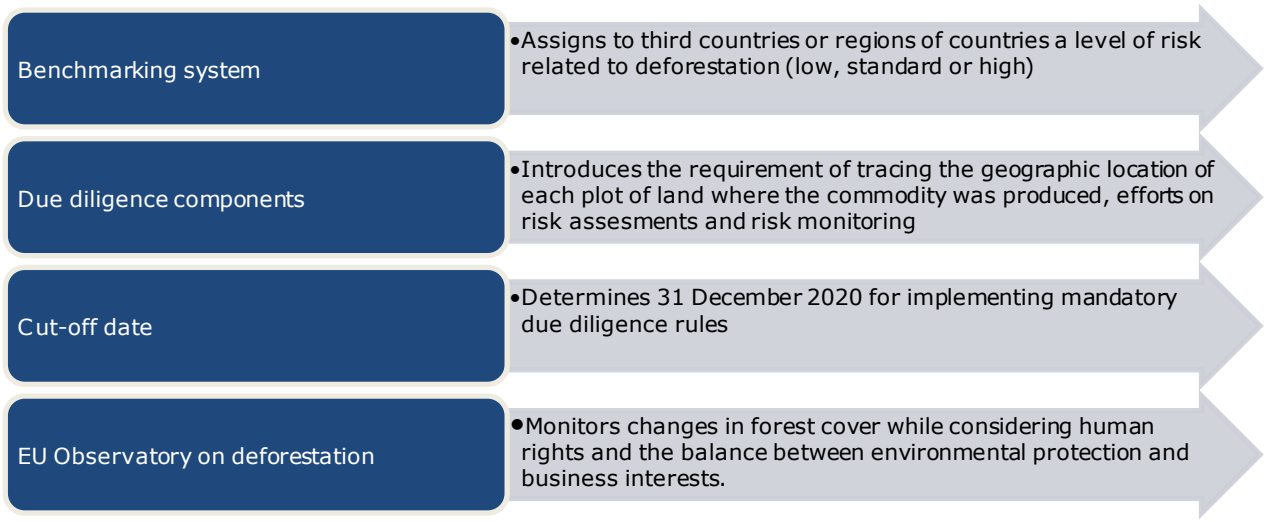
Operators and traders must comply with EUDR guidelines

EUDR differentiates between 'operators,' who introduce these products to the EU market for the first time, and 'traders,' who resell the products (European Commission, 2024; Global Traceability, 2024). An 'operator' is a natural or legal person who places relevant products on the market (including via an import) or exports them during commercial activity. A 'trader' is any person in the value chain, apart from the operator, who resells and makes products available on the EU market. Both groups must adhere to specific requirements to comply with EUDR guidelines, which implies understanding the key aspects of the EUDR, summarised in Table 2.1.

[3] Regulation (EU) 2023/1115 of the European Parliament and of the Council of 31 May 2023 on the making available on the Union market and the export from the Union of certain commodities and products associated with deforestation and forest degradation and repealing Regulation (EU) No 995/2010 (O JL 150, 31.05.2023).

[4] EUDR 'relevant commodities' are cattle, cocoa, coffee, oil palm, soya, rubber and wood, and 'relevant products' are products listed in Annex I of the Regulation that contain, have been fed with or have been made using relevant commodities (Council of the European Union, 2023).

Table 2.1 *Key elements of EUDR*



2.1 Benchmarking system

EUDR introduces a benchmarking system to monitor compliance in producing countries

The benchmarking system categorises 'third countries'[5] or regions within these countries into low, standard, or high risk based on their overall deforestation risk associated with all products covered by the EUDR (Council of the European Union, 2023). The risk assessment, summarised in Box 2.1, determines the obligations of operators and member state authorities regarding inspections and controls (Council of the European Union, 2023). Initially, all countries or regions will be classified as 'standard', with a deadline for classifications set to 30 June 2025.[6] The aggregated deforestation risk across all 'relevant commodities' outlined in the Regulation determines the risk level. Thus, even if a country or region has a low deforestation risk for certain products such as coffee, it must adhere to high-risk due diligence requirements if other high-risk sectors are also present (Naranjo et al., 2023).

Criteria for benchmarking include the rate of deforestation, agricultural expansion and production trends

The list of criteria is described in Article 29 of the Regulation. The decision of the Commission will be based on an objective and transparent assessment of the criteria in Box 2.1. Operators sourcing from standard and high-risk countries or parts of countries are subject to the same due diligence obligations. The only difference is that shipments from high-risk countries will be subject to enhanced scrutiny from competent authorities (9% of operators sourcing from high-risk areas). In that sense, drastic changes in value chains are not warranted or expected. Furthermore, high-risk classification will entail a specific dialogue with the Commission to jointly address the root causes of deforestation and forest degradation to reduce their risk level.

[5] A third country refers to a country that is not a member state of the European Union. This includes territories whose citizens do not enjoy the European Union's right to free movement, as defined in Art. 2(5) of the Regulation (EU) 2016/399 (Schengen Borders Code) (European Commission, 2022).

[6] The EU has postponed enforcement, officially setting 30 December 2025 as the compliance deadline for the European Union Deforestation Regulation (EUDR). Consequently, the dates in this report have been updated to reflect this revised timeline.

Box 2.1. EUDR country risk assessment and random check requirements

The level of risk determines the requirements and specific obligations of operators and member states' authorities regarding inspections and controls. Benchmarking deadline set at 30 June 2025.

The level of risk is determined by:
- Rate of deforestation and degradation
- Rate of agricultural land expansion for relevant commodities
- Production trends of relevant commodities

Level of controls for operators:
- 3% standard risk
- 9% high risk
- 1% low risk

2.2 Due-diligence components

The Regulation has three main due diligence components, and the requirement will depend on the level of risk assigned in the benchmarking process

The EUDR's due diligence process requires that companies manage their operations to align with the regulatory requirements. Requirements will apply from 30 December 2025 for bigger companies to comply, and 30 June 2026 for Small and Medium-sized Enterprises (SMEs).[7] The main three due diligence components are:

- **Information Gathering:** Companies must systematically collect comprehensive information, documents, and data regarding their products. This includes acquiring farm geolocation data (plots) and ensuring verifiable evidence of deforestation-free practices (See Box 2.2). This applies to all companies regardless of the level of country risk.
- **Risk Assessment:** A comprehensive risk assessment of the complete value chain is essential. Companies must assess diverse risk factors in their value chain and the magnitude of deforestation and forest degradation linked to their activities, including forests. This applies to companies in standard-risk countries.
- **Risk Mitigation:** In regions where higher risks of non-compliance are detected, companies must implement strategies to minimise these risks. This could involve gathering supplementary data or information. Operators must establish and enforce policies, controls, and procedures to effectively mitigate and manage non-compliance risks. This applies to companies in high-risk countries.

[7] According to the European Union Deforestation Regulation (EUDR), Small and Medium-sized Enterprises (SMEs) are defined based on specific criteria related to their size and economic impact. While the EUDR itself might not provide a distinct definition, SMEs are generally classified in the EU context based on the following criteria (European Commission, 2003)
- **Micro-enterprises:** Employ fewer than 10 people and have an annual turnover or balance sheet total not exceeding €2 million.
- **Small enterprises:** Employ fewer than 50 people and have an annual turnover or balance sheet total not exceeding €10 million.
- **Medium-sized enterprises:** Employ fewer than 250 people and have an annual turnover not exceeding €50 million or a balance sheet total not exceeding €43 million.

Box 2.2. On due diligence statements
(Art 9 - (European Parliament and the Council of the European Union, 2023)

a. Description (trade name, type of relevant product);
b. Quantity;
c. the country of production and, where relevant, parts thereof;
d. the **geolocation of all plots** of land where the relevant commodities that the relevant product contains or has been made using were produced, as well as the date or time range of production;
e. the name, postal address and email address of any business or person **from whom** they have been supplied with the relevant products;
f. the name, postal address and email address of any business, operator or trader **to whom** the relevant products have been supplied;
g. adequately conclusive and **verifiable information** that the relevant products are deforestation-free;
h. adequately conclusive and verifiable information that the relevant commodities have been **produced in accordance with the applicable legislation of the country of production**, including any arrangement conferring the right to use the respective area for the purposes of producing the relevant commodity.

2.3 Cut-off date

The EUDR specifies 31 December 2020 as the cut-off date for commodities and products not conforming to the Regulation, prohibiting their entry into or exit from the EU market
Essentially, coffee, palm oil and their derived products obtained from land affected by deforestation or forest degradation after this date are prohibited from import into the EU (Council of the European Union, 2023). Consequently, operators must conduct due diligence to gather the geographic coordinates (or latitude and longitude for geolocation) of all land plots where relevant commodities are produced (Council of the European Union, 2023). By providing the geographic coordinates of the agricultural plots, the land use can be remotely verified using satellites, and forest loss can be determined. Figure 2.1 shows the global map of forest cover for Colombia in 2020 from the EU forest observatory mapping. The global map of forest cover was created by combining available global datasets (wall-to-wall or global in their scope) on tree cover, tree height, land cover and land use into a single harmonized, globally consistent representation of where forests existed in 2020.

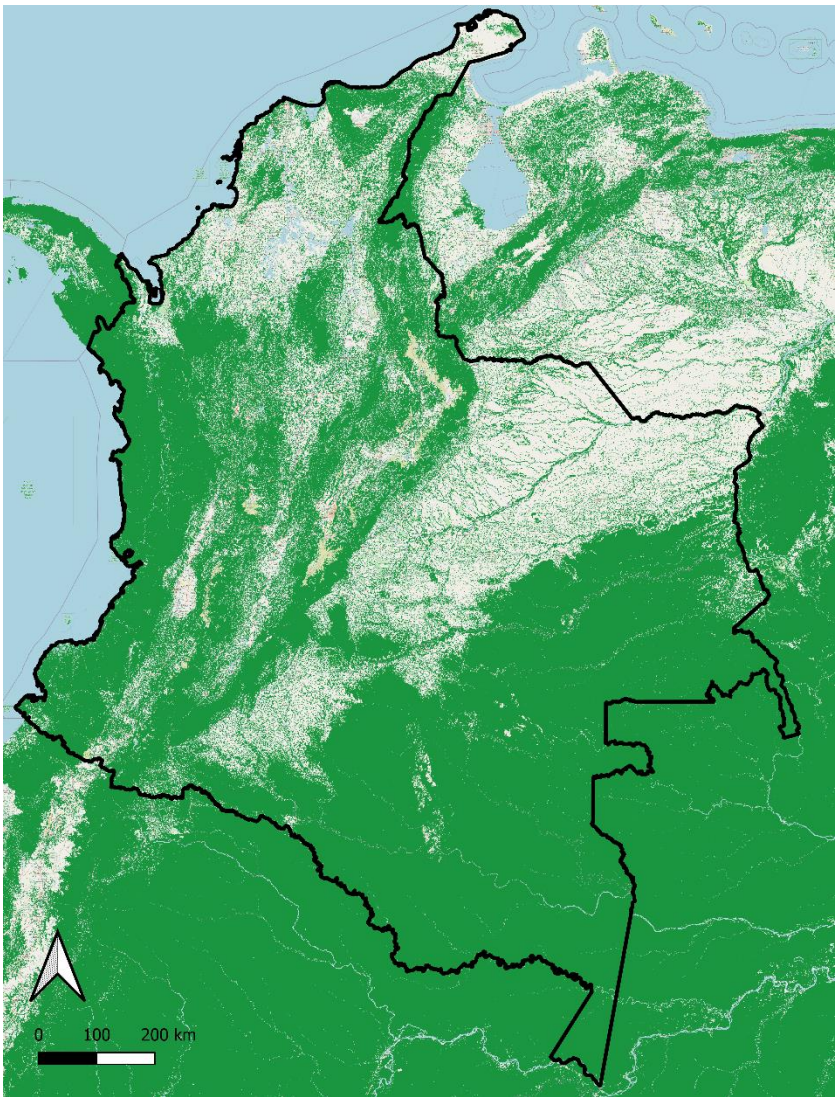


Figure 2.1 *Global map of forest cover for the year 2020 in Colombia*
Source: European Commission (2024a); Joint Research Centre (2023).

2.4 EU Observatory on deforestation

The role of the EU Observatory on deforestation is to enhance monitoring and transparency
The EUDR introduced the establishment of the EU Observatory on deforestation (European Commission, 2024a), designed to streamline access to value chain information for public entities, consumers, and businesses, offering easily comprehensible data linking deforestation, forest degradation, and global forest cover alterations to EU demand/trade for commodities and products. Its primary objective is to support the enforcement of this Regulation by providing scientific evidence concerning global deforestation and forest degradation, as well as related trade activities, in collaboration with competent authorities (Council of the European Union, 2023). The EU Observatory aims to enhance the monitoring of forest cover changes while considering human rights and balancing environmental conservation and business interests.[8]

The EU regulation applies specific definitions to forests, deforestation, forest degradation and agricultural plantations, which may differ from (legal) definitions used in the producer's countries
Article 2 of the EUDR gives the definitions applied to the regulation (See Box 2.3), which differs from Colombia's relevant definitions. Concerning coffee production, these definitions imply that all coffee

[8] The EUDR, Corporate Sustainability Reporting Directive (CSRD) and the Corporate Sustainability Due Diligence Directive (CSDDD) are interconnected as part of the EU's broader strategy to promote sustainable and responsible business practices, with an emphasis on human rights, environmental protection, and corporate accountability.

plantations, even when grown in an agroforestry system that meets the structural requirements for the forest, are considered deforestation when conducted in land that used to be a forest. The definition of forest degradation in the EUDR refers to structural changes in forest cover and does not specify changes that include agroforestry. As soon as the forest is used for agricultural production, including coffee agroforestry, this is considered deforestation (Naranjo et al., 2023). The definitions of 'forest' used in Colombia and the definition used by the European Union shown in Box 2.3 have critical differences: the latter considers forest an area covered by trees with a density of 10%, while for the former, the density is lower. This discrepancy can generate problems in preparing for and applying EUDR requirements.

Coffee and palm oil agroforestry need to be accurately identified on forest cover maps, which means current deforestation and deforestation risk assessments are unreliable

Depending on the land cover map used, some agroforestry systems are shown as forests. This is because resolutions are low, data are missing, land use cover from satellite images has not been verified, and highly shaded agroforestry systems are difficult to identify via high-resolution imagery interpretation. Many have not been ground-verified (Bolívar-Santamaría and Reu, 2021; Daniel et al., 2018; Reymondin and Bunn, 2019). This is incongruent, and this cartographic problem is common not only in Colombia but also for other commodities produced in agroforestry systems (Ingram et al., 2024).

Insights on Deforestation Monitoring from IDEAM's SMByC and the Global Forest Watch

The Forest and Carbon Monitoring System (SMByC) by IDEAM (Colombian Institute of Hydrology, Meteorology and Environmental Studies) is a tool designed to monitor and protect Colombian ecosystems from deforestation. By utilising high-resolution images from Sentinel, Landsat, and Planet Scope satellites, SMByC can pinpoint areas affected by deforestation, providing detailed multi-temporal analyses. This system allows for near-real-time reporting through weekly and quarterly updates, offering insights from as far back as 2000 (Ministerio de Ambiente y Desarrollo Sostenible, 2021). In contrast, the Global Forest Watch (GFW) platform provides a global perspective on forest loss and cover. It relies on lower-resolution satellite imagery from the Global Land Analysis Discovery (GLAD) initiative and offers data from 2001, including real-time deforestation alerts. While GFW excels in tracking global trends, IDEAM's SMByC is more precise for national-level assessments, making it invaluable for understanding specific risks and deforestation patterns in Colombia. IDEAM has published the official land cover map for Colombia 2020, which not only has forest but also other uses/cover (ArcGIS, 2024).

Box 2.3. EUDR and Colombian forest and deforestation definitions

Key definitions in the EUDR (Council of the European Union, 2023):

Deforestation: Conversion of forest to agricultural use, whether human-induced or not.

Forest: Land spanning more than 0,5 hectares with trees higher than 5 metres and a canopy cover of more than 10% or trees able to reach those thresholds in situ, excluding land that is predominantly under agricultural or urban land use.

Agricultural use: Use of land for the purpose of agriculture, including for agricultural plantations and livestock.

Agricultural plantations: Trees in agricultural production systems, such as fruit tree plantations, oil palm plantations, olive orchards, and agroforestry systems, when crops are grown under tree cover. It includes all plantations of the relevant commodities other than wood. Agricultural plantations are excluded from the definition of 'forest'.

Deforestation-free: (a) that the relevant products contain, have been fed with or have been made using, commodities that were produced on land that has not been subject to deforestation after 31 December 2020, and (b) in case of relevant products that contain or have been made using wood, that the wood has been harvested from the forest without inducing forest degradation after 31 December 2020.

Relevant definitions in Colombia IDEAM (Colombian Institute of Hydrology, Meteorology and Environmental Studies:

Deforestation: Definitive elimination of forest cover for other uses.

Natural Forest: Adopted by Colombia under the Kyoto Protocol, understood as land occupied mainly by trees that may contain shrubs, palms, bamboos, grasses and lianas in which tree cover predominates, with a minimum canopy density of 30%, a minimum canopy height of 5 metres and a minimum area of 1 hectare. Excluded from this definition are non-natural tree cover such as forest plantations, stands of trees planted mainly for agricultural production such as fruit tree plantations or other permanent crops, trees planted in agroforestry systems and areas of vegetation that do not meet the above characteristics.[1]

Agroforestry System: A form of production that combines forest species with agricultural species and/or livestock production areas, with a spatial temporal distribution of trees in the production system that clearly indicates their introduction as a forestry component.

3 What characterises the Colombian context?

Colombia aims to combat deforestation and promote sustainable growth

The ways in which oil palm and coffee are grown and traded in Colombia mean that the context is important to understand, particularly the key actions, verification, risks, and what is needed for successful traceability implementation. The Colombian government established an 'agricultural frontier' in 2018 to stop the expansion of farms into wilderness areas; put in place zero-deforestation agreements with the palm oil, dairy, meat and cacao industries through Tropical Forest Alliance (TFA); and implemented a 'green growth policy' to transition to a forest economy, green businesses, and the bioeconomy. In December 2020, Colombia's National Planning Department (DNP) published the national policy for the control of deforestation and sustainable forest management (CONPES 4021); the proposed policies are executed through the allocation of resources and the implementation of specific measures by the relevant government entities, following an established plan and timetable. It is proposed as an intersectoral, multidimensional and systemic strategy to deal with deforestation while growing the economy. The CONPES 4021 encompasses work from the ministries for the environment, defence, agriculture, justice and technology, agencies for land and environmental licences, state prosecutors, the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) and the National Parks Authority. The IDEAM is the forestry authority in Colombia, which, in coordination with the Ministry of Environment and Sustainable Development, operates the Forest and Carbon Monitoring System (SMByC) to generate annual official information monitoring forest cover and deforestation, giving early warnings for deforestation, and to estimate carbon stocks and GHG emissions related to natural forests. In 2021, the 'Coffee, Forest and Climate' agreement was signed between public and private actors, led by the Ministries of Environment and Agriculture, together with NGOs, international cooperation, research centres and coffee exporting companies. The agreement highlights the vital role of the coffee sector in Colombia, emphasising the critical role of tropical rainforests, biodiversity and conservation in addressing global climate change. The objectives of the agreement are to promote sustainable production and livelihoods of farmers, encourage the sustainable intensification of coffee production systems and contribute to the protection and restoration of Colombia's forests (MinAmbiente & MinAgricultura, 2021). This chapter describes the characteristics of the Colombian context and details aspects of the two value chains, starting with coffee and then palm oil.

3.1 Coffee sector in Colombia

Colombia's coffee sector drives social and economic development

Coffee is the most important crop for the country and a vital driver of the Colombian economy, representing about 15% of the agricultural GDP (ICO, 2023). Colombia is the third-highest coffee producer in the world by volume, behind Brazil and Vietnam (ICO, 2023). Furthermore, in the last 10 years, exports of Colombian green coffee have doubled, supported by increased production. Almost 27% of Colombian green coffee is exported to the EU, while 6% of the coffee imported by the EU comes from Colombia. In terms of social impact, the coffee sector in Colombia is characterised by the overwhelming predominance of smallholder farmers, with an average field of 1.5 hectares. More than 552,000 Colombian families derive their livelihood directly from coffee production and generate 2.5 million jobs (Redacción El País, 2024). Women play an essential role in the industry, heading approximately 30% of coffee farms (FNC, 2022b) and carrying out coffee work that does not involve the handling of dangerous products or the handling of loads (OIT, 2022). Coffee growers associated with the National Federation of Coffee Producers (National Federation of Coffee Growers, the Federación Nacional de Cafeteros, FNC) (FNC, 2024b), besides participating in the democratic elections to represent the FNC at local levels, can obtain a 'coffee grower ID', called Cédula Cafetera,[9] used to exercise their rights as associates of FNC.

[9] Traditional cedula: identification document with which the coffee grower acquires the rights of being a member of the sector association. These include participating in elections for the local growers' representatives, as well as to grant these rights to his or her spouse or permanent partner or to one of his or her children. Smart cedula differs from the traditional cedula by giving access to a bank account with preferential rates at a national bank, the Banco de Bogotá (FNC, 2024a).

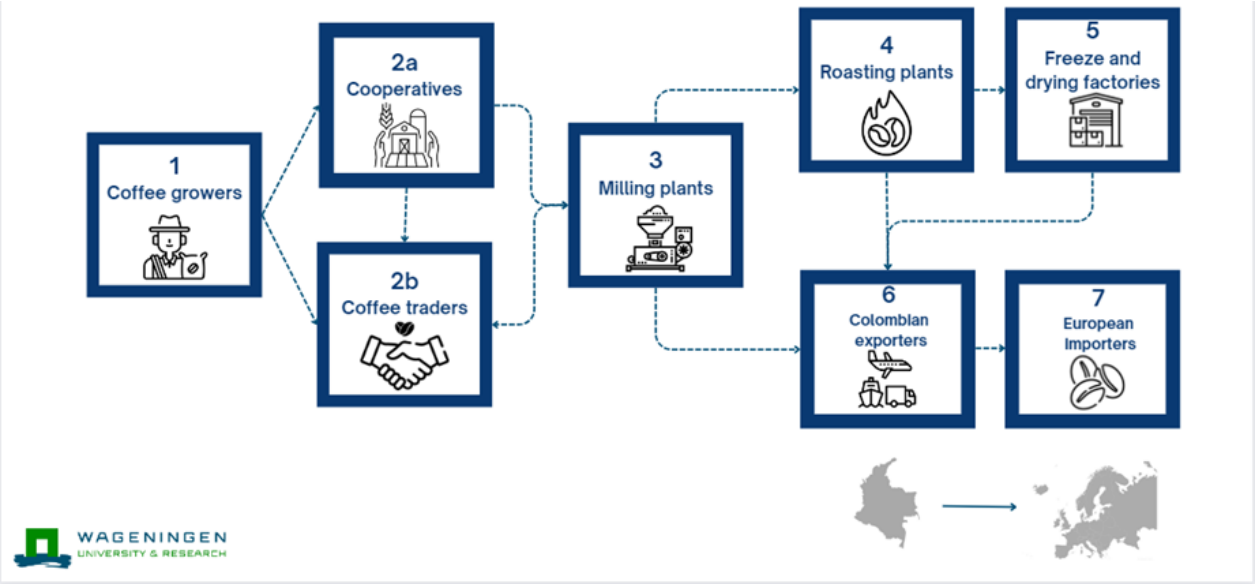


Figure 3.1 *Coffee value chain in Colombia*
Source: Own elaboration based on interviews, information obtained in the study and European Coffee Federation.

Mapping pathways to understand the dynamics of Colombia's coffee value chain

The coffee value chain, represented in Figure 3.1 above, starts at the farm level, where farmers produce, harvest and process dry coffee that is then sold either directly to cooperatives or to intermediaries. Some cooperatives have their own milling plants, while others rely on third parties for the milling process. Afterwards, the coffee can be sold to roasting companies that may further process the product (themselves or with third parties). However, milled green coffee usually reaches exporters and the importing countries. Cooperatives buy different volumes of coffee from many producers, combining different origins of coffee beans during milling, making coffee traceability difficult. Speciality coffee, on the rise in Colombia and worldwide, may be an exception to such a challenge, as the production of speciality coffee is limited by nature, as the product needs to comply with several specific characteristics, making it easier to trace along the chain.

The National Federation of Coffee Producers' information system (SICA) is key for EUDR compliance

The FNC is starting to address the requirements of the EUDR at the management level. The FNC operates a coffee information system (SICA) that, if properly managed and integrated with other information, should advance the coffee sector's readiness to comply with EUDR. This system contains details of the 552,000 coffee-producing families, of which around 360,000, or 65%, are associated with the FNC. The SICA includes information such as farm name/s, location/s, cooperative affiliations, total number of trees, hectares, and other relevant details. In addition, the SICA features a geo-referenced map displaying plots and their characteristics, such as planting dates, tree distances, row spacing, and crop density. Data collection and updates of the SICA are carried out by FNC extension services, which regularly visit coffee producers nationwide. Aggregated data in the database serves as an essential decision-making tool across various sectors, including productivity, social welfare, environmental concerns, and infrastructure development. For example, the geographic information system helps Cenicafé (the National Coffee Research Centre) monitor crop pests and diseases. FNC also utilises information from the SICA to plan crop renewal promotion initiatives and to organise gender programs. Thanks to the SICA, FNC already has access to substantial data on coffee farming in Colombia, which could help the sector comply with EUDR requirements (see Figure 3.2).

FNC has determined that SICA's value for traceability, especially for EUDR geolocation compliance, is critical for the industry

To support EUDR compliance, FNC has launched an IT service to share plot information with exporters. This system will also share critical data such as the date of crop establishment. The SICA service's characteristics are summarised in Box 3.1.

Concerns within the sector arise from the stringent traceability requirements, which cannot currently be met with existing tools

Entities such as Analdex (National Association for External Trade) and Asoexport (National Association of Coffee Exporters) advocate for advancing the implementation of the coffee information system to meet market demands and regulatory requirements, ensuring the industry's sustainability.[10]

Box 3.1 Key SICA characteristics to support EUDR implementation (FNC, 2024)

- The +552,000 coffee growing families are registered in SICA, regardless of whether or not they are 'federally registered'.
- 100% of the coffee growers registered in SICA have geo-referencing of their coffee lots.
- On 31 August 2024, the FNC enabled the Coffee Regulation Platform (a platform administered by the FNC and constantly used by all exporters), through which ALL exporters registered and authorised to export coffee can access the georeferencing of their production chains.
- To share information on coffee growers with exporters, the FNC must have prior authorisation from the coffee grower (Habeas Data).
- Since July 2024, the FNC Extension Service has obtained 50,000 authorisations and plans to obtain 100,000 more by the end of the year, reaching a goal of 93% of all Colombian coffee growers. To date we have 72%.
- To date, more than 30,000 coffee growers have been informed in EUDR, work carried out by the FNC's extension service.

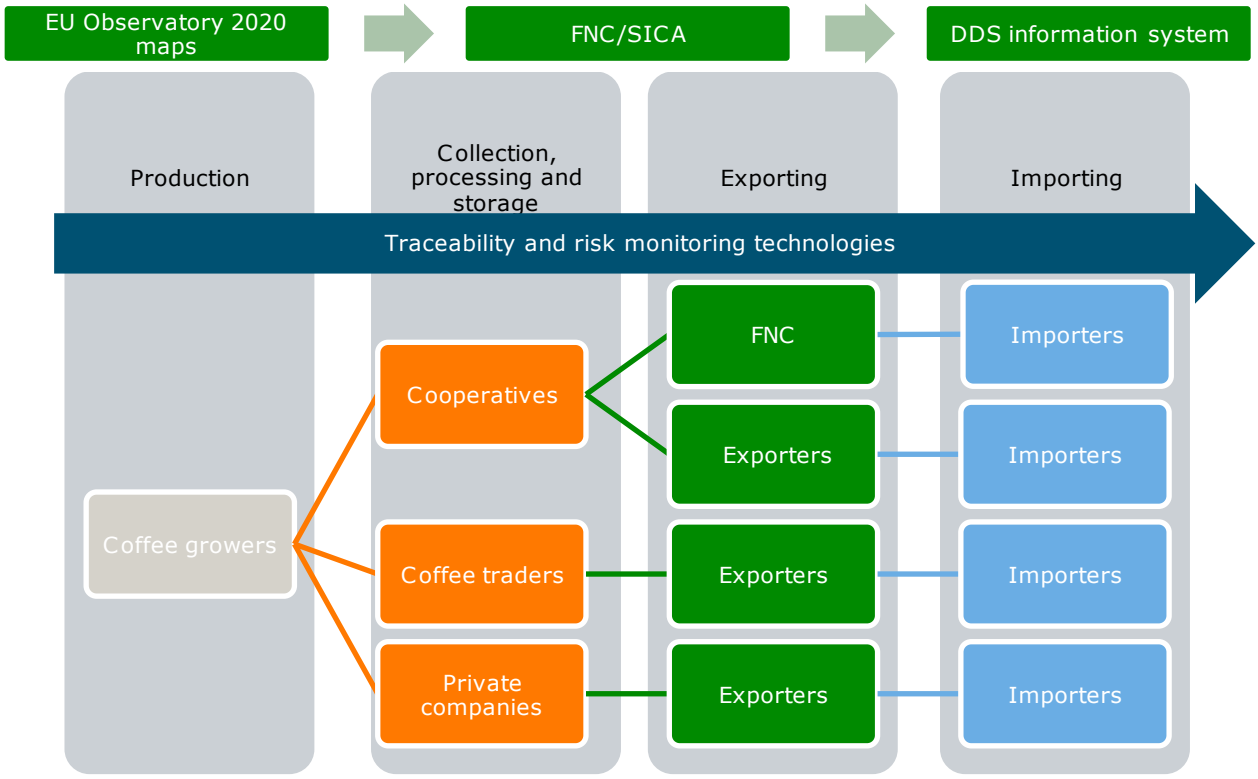


Figure 3.2 *Key actors and data in the coffee value chain to ensure traceability*
Source: Own elaboration based on interviews and information obtained in the study.

[10] https://federaciondecafeteros.org/wp/eudr-pacto-verde-europeo/.

Successful pilots on EUDR compliance have been implemented

The Department of Huila, with support from the European Delegation in Bogotá and FNC, became the first in Colombia to receive training on the EUDR, targeting Municipal Coffee Committees, which are now responsible for passing this knowledge on to coffee growers. Within the framework of this pilot, FNC/SICA and IDEAM carried out an analysis of Deforestation Free Coffee with the aim of aligning IDEAM's concepts with the EUDR. The results and methodology can be replicated and scaled up at a national level and to other sectors. As a result of the pilot, in April 2024, the first shipments of deforestation-free Colombian coffee, were sent to Europe, with the FNC validating purchase and milling lots through SICA. The SICA allows the verification of plantation age based on regeneration dates and controls for false deforestation alerts. This centralised information system enables farm identification and data verification with the EU Observatory's deforestation maps. At the end of the pilot, coffee was confirmed to be deforestation-free by cross-referencing farm coordinates with 2020-2023 land cover change data from Global Forest Watch. Following shipments on 24 and 29 April, around 40,000 kg of deforestation-free coffee arrived in Europe (FNC, 2024c).
The EU Delegation aims to replicate these training sessions and apply the insights gained to other regions and supply chains, including oil palm and cocoa.

However, the coffee sector still faces significant internal and external traceability challenges

The Colombian coffee sector faces several challenges in implementing traceability. At the collection and processing, there is a need for standardisation in processing plant integration to ensure a reliable system, which currently does not extend to soluble, ground, milled coffee, or products containing coffee. Coordination with Colombian and international exporters is essential to understand the EUDR's impact on farmers. There is concern that Colombia might avoid the EU market in the future, as Europe is already not a primary export destination. Effective data sharing is critical for assessing the EUDR's impact on those outside the FNC system. At the same time, questions remain about who should manage this data and how certification systems address it, especially given the EUDR's focus on the private sector. Land registries pose challenges for monitoring and accountability, and differences in forest and agroforestry definitions between the EU and Colombia must be resolved to align Colombian law with the EUDR.

Box 3.2 Challenges for traceability in the Colombian coffee sector.
Own elaboration based on interviews and information obtained during the study.

Collection and processing
- Standardisation of traceability processes in processing plants for to have sectoral wide reliable traceability
- Traceability is not yet implemented for soluble, ground and milled coffee, and exported products that contain coffee
- Alignment and coordination with Colombian and international exporters to provide chain wide understanding of how the EUDR will affect farmers.

Market
- Risk that Colombia avoids EU market due to EUDR as Europe is NOT main export destination Data sharing and open data is key for an effective traceability system and assessing the impact of the EUDR on those not participating in the FNC system

Data
- How is traceability system data managed and by whom? Who has access to the data? How are certification systems addressing this? An exclusive role of the private sector (as EUDR aims).

Land
- Property and land registry represent a challenge and could affect monitoring and accountability.

Forest and agroforestry definitions
- The differences EU and Colombian definitions of forest, coffee agroforestry and coffee under shade (see Box 2.3) need to be resolved to ensure alignment between Colombian law and EUDR.

Overcoming traceability challenges and equity concerns in coffee export

The main challenge identified by the exporters interviewed is the difficulty of ensuring traceability along the coffee value chain. Coffee is bought from many producers; for example, a milling machine can receive coffee from 15,000 producers. A shipping container can be filled with coffee from up to 200 producers, and there needs to be clarity on the monitoring and accuracy of the recorded information. Internet connectivity is

limited in many regions and can hinder information sharing at the farm level. Exporters also claim the EUDR can be unjust towards specific categories of farmers. Areas with the highest rates (or risk) of deforestation were often affected by illicit mining or cultivation. Should the communities of these areas engage in coffee production to regularise their position, they will be included in international commerce (i.e. European Union) for their products.

3.2 Palm oil sector in Colombia

Commitments to sustainability in the palm oil sector

Growing realisation of the impact of palm oil expansion into forested areas led to a voluntary agreement between the public and private sectors, government members, support organisations, and the palm oil sector, led by TFA in 2017. The agreement aimed to maintain the positive trend of the reduction in deforestation related to palm oil, as well as to prevent possible deforestation caused by future expansion of the crop. In fact, in 2023, Fedepalma revealed that 99% of the area cultivated with oil palm in Colombia was free of deforestation, based on data from 2011 to 2023 (Fedepalma, 2023b). Colombia's Sustainable Palm Oil Programme (APS Programme) was created by Fedepalma in 2018 to consolidate sustainable palm oil production, contributing to their national and international recognition and the SDGs' achievement. In 2021, the APS Programme was further formalised as the Corporación Aceite de Palma Sostenible de Colombia (APSColombia). The organisation launched the Aceite de Palma Sostenible de Colombia Protocol, whose value proposition is based on 10 principles covering environmental, social and governance sustainability practices, which Fedepalma and Cenipalma (the Oil Palm Research Centre) promoted. This initiative allowed Colombia to position its palm oil as unique and differentiated worldwide. The association's main objective is to provide palm growers and stakeholders with a scheme for validating and verifying processes and products of sustainable origin.

Colombia is the largest producer of certified palm oil in Latin America and the fourth-largest palm oil producer in the world

In Colombia, 596,217 ha are cultivated with palm oil by more than 7550 producers, 75% of which are small-scale producers (with less than 20 ha). It is estimated that 191,000 jobs depend directly or indirectly on the sector, 82% of which are formal jobs. In 2023, Colombia exported about 27% of its crude palm oil, mainly to Brazil (21%), the European Union (20%), Mexico (16%), the Dominican Republic (11%) and the United States (8%). Exports have increased on average over the past decade to account for about 40-45% of Colombia's total palm oil production. Nonetheless, exports have descended and stabilised to 25%-30% in the last 3-4 years. There are 74 palm nuclei/milling plants in the country, critical figures in the sector, as they facilitate communication and collaboration between companies and growers (from small to large). In addition, Fedepalma, the National Federation of Oil Palm Growers, provides knowledge, support, information and technical assistance to growers through the palm nuclei, the last especially by Cenipalma. The palm oil value chain in Colombia, illustrated in Figure 3.3 below, encompasses several stages. Oil palm producers nationwide sell to different palm nuclei based on their location. These can have their milling plants or act as collectors and aggregators. Palm oil is extracted through pressing and milling processes, generating by-products such as palm kernels and shells. These different extraction products can be exported as such or as further refined (Fedepalma, 2020, 2021, 2022a, 2023a).

The National Database of the Palm Cadaster is essential for EUDR compliance

Since 2009, Cenipalma has been working on structuring the National Database of the Palm Cadaster, and the areas planted with oil palm in Colombia called Geopalma and is updated and incorporated regularly. It is consolidated in two phases: identification of planted areas, called Physical Cadaster, and incorporation of agronomic data at plot level (planting date, density, owner), called Agronomic Cadaster (Rincón-Romero et al., 2022). Due to the complexity of the crop and the environment, this work has required years of effort. It is already at an advanced stage and is constantly being updated and revised. By 2022, 65% of the geographic and agronomic data collection had been completed. Fedepalma is a key actor and the Palm Cadester and important tool for traceability in the sector (see Figure 3.4).

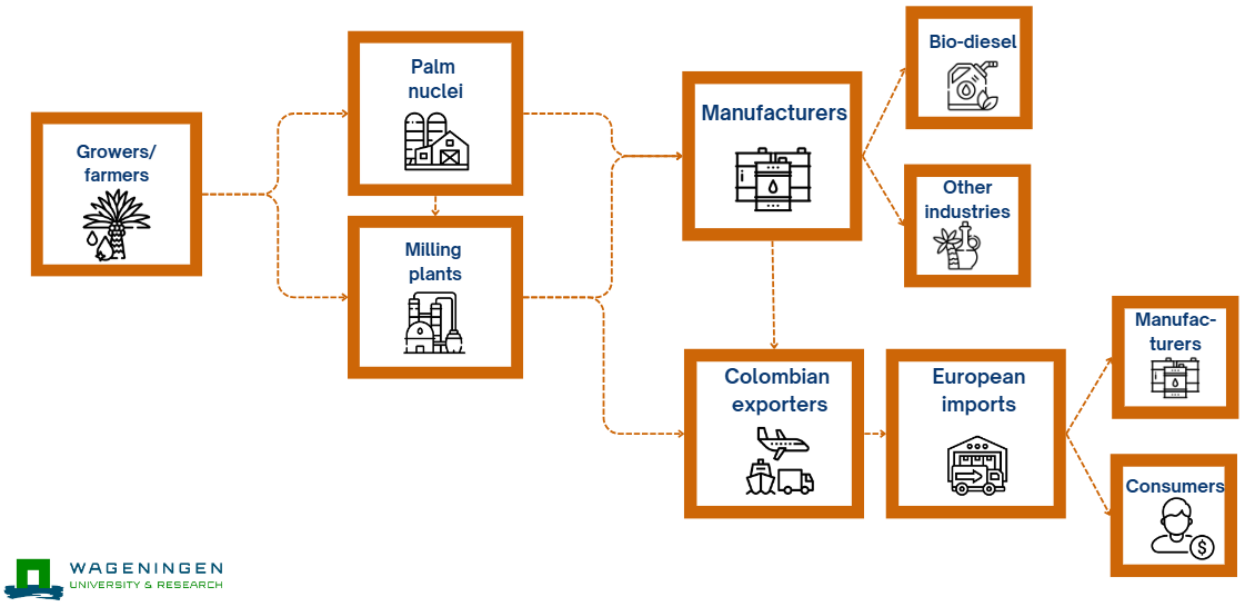


Figure 3.3 *Palm oil value chain in Colombia*
Source: Own elaboration based on interviews and information obtained during the study.

Partnerships with technology providers use satellite imagery and geospatial analysis to monitor land use changes and detect deforestation

In partnership with IDEAM and Satelligence, Fedepalma has developed a leading deforestation monitoring of the industry. Satelligence[11] provides almost real-time data collection and analysis, allowing Fedepalma to monitor palm production continuously. This real-time monitoring enhances the accuracy and timeliness of traceability information, ensuring immediate detection of any deviations from sustainable practices. In early 2023, the Sustainable Origin Accelerator for Palm Oil (SOAPS) programme was implemented as a partnership between Solidaridad and Satelligence, with the support of GIZ Colombia and the Ministry of Foreign Affairs, to achieve Zero Deforestation commitments, traceability and monitoring of palm oil crops. Satelligence created a complete picture of forests and land use in key palm oil production areas. Information from ESA and NASA satellites was used to create the maps (Satelligence, 2022). By building on IDEAM's baseline and monitoring for 2011-2021 and Satelligence advanced technology, monitoring of deforestation is not only more precise but also takes into account the Colombian context and Colombian entities' first-hand information.

The readiness of the palm oil sector is high compared to other commodities regulated by the EUDR

Fedepalma has been participating in roundtables since before the EUDR was published to identify gaps and protect producers' interests. In addition, in the last few years, to improve the crop's reputation and the sector's sustainability, Fedepalma has developed several initiatives to collect precise and updated qualitative and quantitative information on palm oil plantations and palm oil nuclei. This resulted in the creation of the SISPA Plus system. The most recent update offers public and general data on, amongst others, the location of oil palm crops in the country, the production and marketing of oil palm products, national and international price statistics for oil palm products and their main substitutes, as well as statistics on foreign trade in oils, fats, cakes and oilseed meals, among others (SISPA, 2024). Fedepalma also has access to additional information, which is only available internally due to data protection agreements. Furthermore, APSColombia applies a verification scheme that includes most of the legal compliance with EUDR. SISPA Plus is complementary and will help traders with the availability of the sector's general information and context.

[11] Satelligence is a technology and data analytics company that uses digital geolocation tools to monitor palm oil production and plantations. This technology helps accurately track land use changes, detect deforestation, and ensure that palm oil is produced in compliance with environmental regulations.

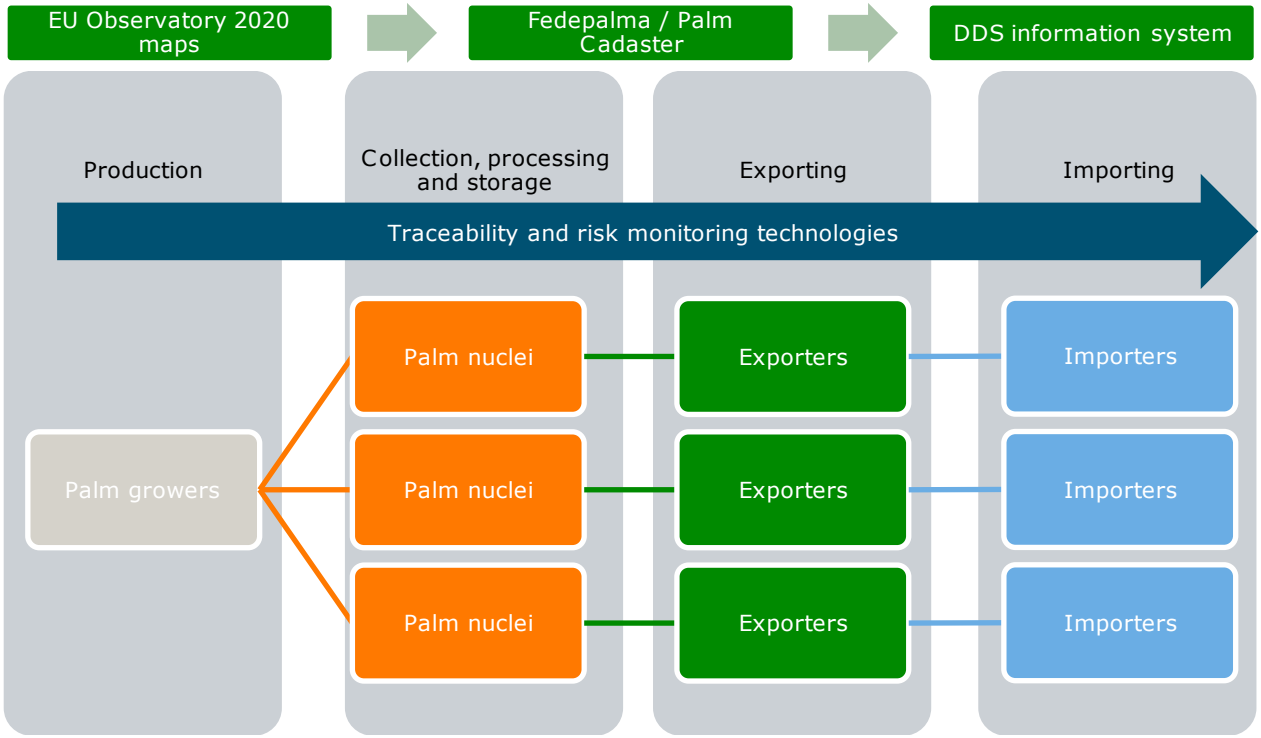


Figure 3.4 *Key actors and data in the palm value chain ensure traceability*
Source: Own elaboration based on interviews and information obtained during the study.

Global market competition creates challenges for Colombian palm oil traceability
A summary of challenges is listed in Box 3.3. The palm oil market is highly competitive, with palm oil from Colombia easily substitutable with products from countries like Malaysia and Indonesia. Competition is driven by price and regulatory compliance, particularly in the European market. While the current export focus on crude palm oil simplifies traceability, shifting towards value-added products could increase the complexity and costs of traceability,[12] and the main challenge in traceability is still from the crop to the mill. Certification poses another challenge due to its high costs, making it difficult to trace non-certified farmers and assess labour conditions. Alternatives like APSColombia are less costly and could be complemented with financial support programmes and subsidies for smallholder verification. Certification standards need revision to meet European regulatory requirements (EURD). Furthermore, bottlenecks such as limited access to critical traceability data, such as the geolocation database managed exclusively by Fedepalma, further complicate traceability efforts. Fedepalma has recognised the value of this information and is moving towards giving access to key stakeholders, mills and exporters. According to the 2022 management report (Fedepalma, 2022a), exports to the European Union were 45% and have decreased to 20%. The notable decrease compared to 2023 can be attributed to the fact that more Colombian exporters are seeking 'easier' and closer markets, such as Brazil and Mexico.

3.3 Pioneering traceability solutions in Colombia

Colombian initiatives illustrate the role of digital technologies in linking producers, consumers, and stakeholders promoting sustainability and accountability
Several initiatives which commenced before the EUDR was implemented, show the potential of blockchain technology in enhancing transparency, traceability, and consumer trust. Briefly described in Box 3.4 IBM Food Trust and FarmerConnect demonstrate how blockchain can be leveraged to provide detailed, immutable records of product journeys from farm to consumer, allowing companies like Nestlé and Juan Valdez to foster greater consumer engagement by sharing the stories and origins behind their products. Similarly, Logyca's collaboration with Fedepalma shows how traceability models in agricultural sectors ensuring that every step

[12] At the moment most of the processing for value added products take place in very few industrial sites.

in the production process is documented and accessible. Overall, digital technology aids in connecting producers, consumers, and stakeholders, driving both sustainability and accountability.

Box 3.3 Challenges for traceability in the Colombian palm oil sector.
Source: Own elaboration based on interviews and information obtained during the study.

Production
- Geolocation of palm crops is provided voluntary by producers. National efforts to extent coverage.

Market
- Palm oil origin is easily substitutable and has many competitors (Malaysia, Indonesia, etc.)
- The competition is mainly on price; for the European market, it is on the possibility of conforming to regulations (EURD).
- Since most exports to the EU are crude oil, there are fewer steps to track. However, it is possible that more value-added products in Colombia would be promoted, and in that case, traceability requirements and costs would also increase.

Certification
- The certification process is expensive.
- Non-certified farmers are complicated to trace.
- Assessing working conditions and respect for workers' rights is not part of the EUDR but is part of the EU's Corporate Sustainability Due Diligence (CSDD).
- Colombian certification standards need to be revised to meet EUDR obligations.

Bottlenecks in the palm oil system
- Limited sharing of data relevant to traceability, e.g. the current geolocation database of palm oil farms (Catastro Palmero) is only managed by Fedepalma and cannot be accessed by other users.

Box 3.4 Learning from other initiatives in Colombia

IBM Food Trust: This *blockchain*-based platform is used in the food industry. An immutable blockchain is used to track every step in the value chain. Companies can participate to share and access product traceability information, including coffee farming details. In 2020, Nestlé included its Zoégas coffee brand. By scanning the QR code on the packaging, consumers can follow the coffee from growing sites to the Zoégas factory in Helsingborg, Sweden (Agronet, 2020).

FarmerConnect: FarmerConnect is a platform that uses *blockchain technology* to trace the origin of coffee. It allows producers to record information about their crops and consumers to access that information via QR codes on coffee packages. This platform seeks to connect consumers directly with farmers. In 2020, Farmer Connect and IBM announced 'Thank My Farmer,' a mobile app that lets consumers know the origin of their coffee (IBM, 2020).

Juan Valdez: With technologies such as *Blockchain* and the *Internet of Things*, a pilot of physical and documentary traceability of coffee was developed with producers in Meta and Santander to highlight the transparency of the processes throughout the value chain. Digital content, including virtual reality, was created for 20 producers in these departments to connect the final Juan Valdez consumer with the producers and stories behind each cup of coffee (FNC, 2022a).

Logyca: Logyca makes design and implementation of traceability models for agro-industrial network. In 2022 the National Federation of Oil Palm Growers (Fedepalma), through the Colombian Sustainable Palm Oil Program (APSColombia) and the sectoral marketing team, promoted a traceability model for the oil palm agroindustry. Logyca aims to facilitate strengthening of the processes and technologies through which Palm Tree Nuclei record and conserve information about their production cycles (El Palmicultor, 2022).

4 What are traceability technologies?

Traceability technologies are critical in designing, implementing, and monitoring effective solutions to combat forest loss and promote more sustainable agricultural production and food systems

The following examples show how traceability technologies have been used to track the origins and movement of commodities, ensuring transparency and accountability across value chains, including coffee and palm oil (Fripp et al., 2023). This section highlights various technologies available for traceability, detailing their uses, applications, and the pros and cons observed during implementation. It's essential to recognise that more than technology alone may be required for comprehensive traceability and that combining different traceability technologies and collaboration among key value chain actors is often necessary. Many of these technologies are used together to establish robust traceability pathways. While some technologies primarily focus on tracking post-harvest transportation, others monitor forest cover changes without covering subsequent stages. Current technologies, thus, have not addressed all deforestation concerns. Additionally, field verification is crucial to ensure the accuracy and effectiveness of these technologies (Ingram et al., 2024).

Limitations of technology in ensuring traceability and accountability

Traceability technologies aid in enhancing transparency and accountability within value chains. However, regardless of the technologies used, there are inherent advantages and disadvantages. For instance, using satellite data and blockchain technology alone does not guarantee that coffee is sourced from deforestation-free areas. Any stage involving human input, such as ledger entries or transferring beans from plant to bag, introduces the potential for errors. Almost all the technologies are costly and have high energy requirements. Therefore, it is essential to acknowledge that technology alone cannot fully address these challenges.

4.1 Geospatial data

Global positioning system (GPS) technology can be used to create polygons showing the exact location of farms and processing facilities, it can also be used to track trucks transporting products. Combined geospatial data can provide insights into land use, environmental conditions (TechnoServe, 2023), and transportation routes, ensuring transparency in the value chain (Fripp et al., 2023). GPS coordinates can be triangulated to check their accuracy and ensure the absence of deforestation in the agricultural plot. This is recognised as Polygon mapping. These polygons are a valuable tool for various purposes, including value chain management (TraceX, 2023). Then, it is possible to compare them with satellite deforestation maps to verify the information (Rainforest Alliance, 2023a) This enables the registration of farms and monitoring of potential expansions over time, which could potentially impact forested areas. GPS and geospatial technology is commonly used to map farms by commodity traders e.g. in the cocoa sector and as part of voluntary certification standards.

Uses/application

Several businesses already use this technology to locate their production area so that products can, for example, be certified for a particular area. It is often used with other technological tools that, for instance, collect and transfer product information (Blockchain and RDFI). It is used to improve the traceability of the timber value chain (Pearson et al., 2023); cocoa (IDH et al., 2021), and palm oil (Unilever, 2020) Companies such as Meridia, Satelligence, Openatlas, and NGOs are offering services which combine the use of GPS, geospatial, and satellite imagery to implement traceability and transparency for EUDR.

Pros and Cons

The EUDR requirement for field polygons has made this technology almost mandatory. GPS tools enable efficient farm localisation, with the added benefit of being accessible through smartphones, reducing the reliance on specialised equipment. However, mapping using GPS encounters technological challenges and

limitations. Obtaining reliable GPS data may be challenging in certain regions, for example, in valleys or areas with low connectivity. A hurdle for traceability at the farm level lies in ensuring the accessibility of tools for collecting and transmitting GPS traceability data across the value chain, thereby enhancing monitoring effectiveness.

4.2 Satellite Imagery

Satellite imagery can be used to monitor land use changes, deforestation, and other environmental impacts in commodity production areas. This helps identify sustainable and responsible sourcing practices (Reiche, 2023). One of the main advantages of satellite monitoring is the ability to acquire sequences of images over time, also known as time series. These data facilitate the tracking of gradual changes in forest cover and help to distinguish between temporary (e.g. seasonal) and permanent changes (Jelas et al., 2024). The data that satellites collect on the forest status can be processed and analysed to build conservation strategies (de Wilde, 2023).

Uses/application
The capture of satellite images can take place as a country's initiative, as is the case in Brazil with Real-Time System for Detection of Deforestation (DETER), which was launched to monitor the state of the Amazon rainforest (Assunção et al., 2023). Satellite imagery, together with geospatial and GPS technology, is used to map field boundaries of farms and protected areas by commodity traders (e.g. in the cocoa sector) and as part of voluntary certification standards. Organisations in the cocoa sector collect satellite information, such as in Ivory Coast, where the Cocoa & Forests Initiative uses satellite imagery and monitoring of areas and plots provided by Satelligence (Satelligence, 2024) to support cocoa farmers to meet the requirements of the EUDR.

Pros and Cons
Although satellite images can be valuable allies in demonstrating cases of deforestation, there are some technological limitations to consider. High-resolution images may only be available for some regions or may be expensive. Thus, the risk is to miss small-scale deforestation activities. In addition, areas with much forest are often covered by clouds that prevent clear sight of the forest; however, multiple satellite data sources can be combined to mitigate against this, such as using radar that can penetrate cloud cover or multiple spectral sources to increase the chance of cloud-free images. The data collected must be processed and stored for analysis, which requires energy-intensive dedicated infrastructure (de Wilde, 2023). This which are more expensive and less accurate - can also be used to create polygons. Finally, countries, farmers and or traders must combine satellite and ground data. To date, many traders, companies and certification standard organisations are reluctant to share such data, citing commercial confidentiality and sensitivity, and data privacy as reasons. This technology needs to be combined with other technologies, such as the localisation of farmers and the identification of products from each farm, to help demonstrate deforestation after introducing the law and overcoming the technical challenges.

4.3 Barcoding and RFID (Radio-Frequency Identification)

Barcodes and RFID tags can be attached to bags, containers, or coffee and palm oil pallets. The tag contains the commodity information (e.g. farm, producer, location) and can be read by appropriate readers. They can be scanned at various points in the value chain, allowing for real-time tracking of products (Tan and Sidhu, 2022). The warehouse receiving the commodities should be able to read the tag and add its identification in a modular way to build information. The warehouse can be divided into zones with different IDs to process commodities from different producers (e.g. certified and non-certified) (Gandino et al., 2007).
The primary distinction between RFID and barcodes is that RFID systems offer greater automation in the identification process.

Uses/application
Barcoding and RFID are already used in the agrifood sector to identify the origin and the quality of products in the value chain (Costa et al., 2013; Gautam et al., 2017), but recently, the need to increase the traceability of supply has prompted several manufacturers to rely even more on this system.

Pros and Cons
RFID technology provides the advantage of easy identification of product information. RFID is more accurate than barcodes, which require more human operations, which increases the likelihood of errors (Hadi et al., 2019). On the other hand, RFID can be more complex and expensive to implement. To make it automatic, facilities (e.g. readers and information transmitters at the entrance of the warehouses) are needed, which entails costs. The entire value chain must adopt the system to have a history of information from producer to consumer. In collection centres, a spatial and temporal organisation is required to separate goods to maintain the tag's uniqueness. Moreover, this system only works when the goods are in the bag. Therefore, it is impossible to assess what occurs before the collection and in case the bag is unpacked. Furthermore, it is not always easy to guarantee that the data remains in its original state permanently, ensuring its integrity and reliability (Kraft and Kellner, 2022).

4.4 Blockchain (or FairChain)

Blockchain technology enables a distributed ledger system that records every transaction or movement of products along the value chain. The collection of traceability information is completed by each actor involved in the chain, e.g. the grower, the inspector, the packaging operator and the retailer. Each participant in the chain can access and add or remove data to the blockchain, and participants can see who added data, creating a transparent and immutable record (Bager et al., 2022; Debicki and Guzman, 2020). At the end of this process, a two-dimensional code is usually generated (QR code), which the consumer can scan to obtain information on the product traceability (Liao and Xu, 2019).

Uses/application
In 2018, Walmart and Carrefour launched pilot projects using blockchain technology to improve the transparency of their value chains. Walmart uses blockchain technology to track more than 25 food products, while Carrefour monitors seven food value chains (Carrefour, 2021; Hyperledger Fabric, 2021). Moyee Coffee tracks its coffee value chain from the Jimma region in Ethiopia using Blockchain, which it believes contributes to creating a fairer value chain with data underpinning the higher prices they pay to contribute to farmer's living income. In textiles, DIBIZ offers real-time traceability and visibility, which can be inclusive of smallholders and offers secure information sharing, facilitating monitoring/control, real-time data acquisition, transparency, and visibility throughout the value chain (Agarwal et al., 2021).

Pros and Cons
Blockchain technology provides transparency among all involved parties and facilitates reliable data collection. This technology allows peer-to-peer transactions to occur transparently and without an intermediary like a bank or a middleman. Eliminating a central authority enables the restoration of trust between producers and consumers, which can reduce the transaction costs in the agrifood market (Xiong et al., 2020). A big advantage that blockchain has over other technologies (barcode and RFID) is that it creates an integrated system with all the data collected at different stages of the supply chain linked to each other. Fraud and malfunctions can be reported in real time, increasing the reality of the system. Blockchain technology can be implemented using open-source frameworks or dedicated software for the agrifood sector. While it's possible to manage a blockchain independently, it is often essential to rely on companies that provide software for data traceability. These companies offer user-friendly interfaces and advanced tools managed by experts who can also offer support, provide statistical insights, and detect potential issues. However, this service can be expensive and in accessible for farmers due to the infrastructure required (e.g., internet connection and a smartphone or similar device) in the countries where commodities are most commonly sourced (Kraft and Kellner, 2022). Furthermore, the costs for small farmers are often very prohibitive (Astill et al., 2019). It is also not always clear who 'opens the chain' and if that person has a smartphone to do so. Another problem with the blockchain system is that there is no

harmonisation regarding what data types to collect. This can create confusion and make creating a comprehensive, integrated system difficult.

Blockchain technology is still solving some challenges, among them the complexity of implementation and the high energy costs of maintaining a real-time ledger. Another is the cost for data collection can be for stakeholders, especially for farmers who may need to be sufficiently educated for this operation and subsequent costs related to collecting the necessary data are substantial after the initial setup.
The additional costs related to training staff to use and operate Blockchain can also drain resources (CBI - Ministry of Foreign Affairs, 2022).

4.5 QR Codes and Mobile apps

QR code or Quick Response code is a two-dimensional square-shaped barcode used to store information or data. QR codes allow real-time updates on the product. Its storage capacity enables it to contain a considerable amount of information and encode multiple types of data such as product origin, type of cultivation, state of preservation, storage location, and other information that can be used to recreate the history of the product. As with barcodes and RFID, the QR is assigned to a bag, which can build information about the product until consumption at each step of the chain. They are generally placed on final product packaging, giving consumers instant access to information about the product's origin and journey (Rotsios et al., 2022).

Uses/application
QR codes can help communicate product characteristics to the final consumer. That is why they are often used on product packages with special certifications so that consumers can verify the information. Examples are speciality coffees (MTPAK COFFEE, 2021) or organic food (FAIR CLIMATE FUND, 2021). QR codes are used to trace batches of cocoa from the farm plot to buyers (COOKO, 2024). They can also be combined with the blockchain system to collect and communicate information gathered during the process (Van Duijnen Koffie, 2023). Examples are (Minespider, 2024), a traceability platform for mining and raw materials; (TrusTrace, 2024), which specialises in fashion and footwear; and (Tilkal, 2024), which collaborates with different brands in the food value chain.

Pros and Cons
QR codes can store a lot of information and are very easy to generate and read with simple tools like smartphones. This offers the benefit of fostering interaction by presenting videos or images related to the product and its characteristics to the end consumer. QR codes don't require dedicated infrastructure or a specialised reader. However, similar to RFID and barcodes, this system cannot ensure a complete guarantee for deforestation-free products. Because information must be added by scanning the codes at each stage of the process, preventing tampering is challenging. The validity of the information stored in the QR code extends only as long as the product remains within the original bag (TechnoServe, 2023).

4.6 IoT (Internet of Things)

This term refers to the network of connected physical devices that collect and exchange data in real-time over the Internet. IoT sensors can be installed at various points in the value chain. They can have different purposes, all of which are critical to the efficiency of the value chain. These sensors (can use AI technologies to) monitor various aspects of the production area, such as temperature, humidity and other environmental factors. Geo-localisation can be added to these during production, transport, and storage. These data help to ensure product quality and integrity during transport and storage (Tana and Sidhu, 2022).

Uses/application
IoT technologies are regularly utilised in smart farming, enhancing the efficiency of agricultural practices by reducing the need for labour-intensive tasks. Using smart sensors, networks, and other technologies such as drones can benefit various practices such as irrigation, fertilisation, weed management, plant growth

monitoring, and crop disease management (Boursianis et al., 2022). IoT in agriculture can integrate different data streams, providing large-scale data analysis and event detection, ensuring efficiency between processes (Kamilaris et al., 2016). It can aid monitoring of yields, quality, processing and logistics, forecasting, and harvesting (Morchid et al., 2024). In certain circumstances, it is also used to improve the efficiency of the value chain, as in the case of the platform (Trace Coffee Beans, 2024), which combines IoT with the Blockchain to ensure the traceability of speciality coffee.

Pros and Cons
Continuous monitoring and real-time analysis of transmitted data have great potential to improve over time. Advantages of IoT in smart agriculture, including superior efficiency, expansion, reduced resources, cleaner method, agility, and product quality improvement (Morchid et al., 2024). Smart farming is slowly becoming popular, especially in wealthier areas of the world with good internet coverage. Applying to crops such as coffee, oil palm, or cocoa is sub-optimal because these plantations are typically situated in rural areas where reliable internet access is not guaranteed. Furthermore, databases and servers capable of storing and processing information are necessary. Moreover, there are concerns regarding the privacy implications associated with using these technologies. The interconnected nature of multiple networks and sensors could increase the likelihood of compromised sensitive information (Morchid et al., 2024; Weber, 2015). Disadvantages include high cost, lack of standardisation and low in the field mobility, energy intensive.

4.7 DNA Barcoding

DNA barcoding is a molecular system that allows scientists to identify specific species by comparing short genetic markers in the sample DNA with reference sequences (Guldiken et al., 2021). DNA barcoding can help identify geographical origins or cultivation specifications, providing valuable information on product quality (Gorini et al., 2023). This tool can therefore be very useful to verify the specific characteristics of certain products in which of location of production determines not only the quality of the final product but also the price of the good, as is the case with olive oil or wine (Ganopoulos et al., 2013; Mezzasalma et al., 2017). This is used both for food safety reasons and to avoid scams in the trade. This could also apply to products that do or do not come from deforestation areas.

Uses/applications
DNA barcodes have some applications for the identification and traceability of mammals, such as cattle, pigs, and lambs (Galimberti et al., 2013; Zhao et al., 2020). They can also be used to trace the origin of many imported products, such as coffee, palm oil, cocoa and other food (Fanelli et al., 2021). Wageningen University & Research has developed a DNA-based system called (Timtrace, 2024) to verify the geographical origin of wood, thus preventing illegal trading (Bosmali et al., 2021). DNA markers have been used to detect pollutants in coffee production to prevent the mixing of Arabica and Robusta coffee beans. Lafargue et al. (2022) investigated the application of DNA barcoding to shed light on the interconnected issues of modern slavery and deforestation within the cocoa industry, thereby uncovering previously obscured facets of the value chain. Although this tool has several applications in commerce, its specific use for fighting deforestation is not yet widely adopted.

Pros and Cons
DNA barcoding can be crucial in combating food fraud and enhancing traceability in the food value chain (Gorini et al., 2023). DNA barcoding is increasingly becoming popular for detecting alterations in food thanks to characteristics such as speed, reliability, sensitivity and specificity (Nehal et al., 2021). The main limitation of the barcoding method is that it relies on reference libraries of barcodes for taxonomic identification of sequences, which may be incomplete or need to be created in the case of specific studies for comparison (Nehal et al., 2021). For broader adoption of DNA barcoding, addressing the challenges of sample preparation, DNA extraction, database completeness, and access to appropriate reference materials is crucial. In addition, continued advances in DNA sequencing technologies are essential to improve the accuracy, efficiency and reliability of DNA barcoding methodology (Gorini et al., 2023). Another area for improvement is the significant cost involved in the analysis, raising questions about who would bear these expenses. DNA barcoding is not yet widely applied, currently being a fairly costly niche technology for high value products. Therefore, viewing this technology as a viable option for extensively tracking coffee flows is challenging.

5 What can we learn from the implementation of traceability systems?

Experiences worldwide in timber, cocoa, and other agricultural products provide valuable lessons for coffee and oil palm traceability in Colombia

Notable examples include the EU Geographic Indication and Timber Regulations, Tony's Chocolonely Cocoa, the statutory national Indonesian and Malaysian Palm Oil Standards and voluntary sustainability certification standards. By examining these cases, we identify best practices and shared challenges to enable more effective and resilient implementation of traceability systems within the Colombian context, summarised in Box 5.1.

Box 5.1 Lessons from other traceability systems

Source: Own elaboration based on interviews and information obtained during the study.

Importance of monitoring and enforcement

- Robust monitoring systems and follow-up on controls, including prosecution, are essential to avoid undermining legitimate producers and to differentiate between authentic and illegal products.
- Implementation needs to be supported by enforcement and criteria and indicator-based tools.
- Effective, proportionate, and dissuasive penalties and sanctions are needed and critical for compliance.

Colombian stakeholders, including the state, should consider how consumers and consumer countries are engaged

- Consumer (country) preferences for deforestation free commodities will play a role in uptake beyond the EU.
- Traceability systems that provide transparency can build consumer trust.

Issues to raise with the EU

- Consistency in applying the EUDR across EU member states will be important such that exports of Colombian products to different EU member states will be handled uniformly.
- Cooperation between Colombia and the EU, and between 'third' countries, especially those producing the same commodities, is important for exchange on what's working and not in implementation and solutions to address problems.

Ensuring coordination in the value chains

- Coordinating the traceability system, the EUDR requires means aligning EU and Colombian regulatory frameworks and technological standards.
- Standardisation of national traceability processes requires coordination between the multiple stakeholders, especially for smallholder farmers.
- Resistance to new traceability methods should be expected, especially if it conflicts with traditional practices and established systems in the value chain, particularly by small farmers and businesses for which such systems can seem daunting; providing examples of how to implement traceability systems can help overcome this challenge.
- Combining and aligning technologies, such as geospatial, certification, and the Internet of Things, can be effective ways of implementing traceability systems.
- With revisions, existing private sector, collective and statutory traceability systems can help implement the EUDR.

Transparency, legitimacy and incentives

- Transparency of competent authorities and all parties involved in the traceability system in third countries such as Colombia and in the EU is important for legitimacy.
- Incentives to participate in traceability systems, especially in producing countries such as Colombia, are critical aspects of efficiency and adoption.

5.1 EU Geographic Indication

Global protection through geographical indication systems (GI).
As part of the EU's system of intellectual property rights, products registered as having a geographical indication (GI) (see Box 5.2) are legally protected against imitation and misuse within the EU and in non-EU countries where a specific protection agreement has been signed. Each EU country's competent national authorities take measures to protect the registered names within their territory. This includes describing the product and *geospatial data* to map a defined and agreed geographic area from which it is produced. Authorities should also prevent and stop the unlawful production or marketing of products using such a name. Non-European product names can also be registered as GIs if their country of origin has a bilateral or regional agreement with the EU that includes the mutual protection of such names. Various products (such as wine, food and spirit drinks) in several countries outside the EU, such as Cameroon, South Africa and Colombia, have been protected. Two geographical indications apply to Colombian coffee: Protected denomination of origin (PDO) and protected geographical indication (PGI), which are further distinguished by the European Union seal that ratifies this recognition.

Box 5.2 Geographical indications and their legal protections

A geographical indication (GI) is an intellectual property right. It protects the name of a product from a specific geographical origin to preserve its qualities and reputation to its origin. According to the EU GI legal framework, GI protection distinguishes between a 'protected designation of origin' ('PDO') or a 'protected geographical indication' ('PGI') depending on how strong the link between the qualities of a product and its geographical origin is. For example, how much of the product's raw materials must come from the area or how much of the production process must occur within the specific region.

Geographical Indications (GI) provide lessons on traceability

1. **While GIs can significantly boost economic benefits for producers and consumers, experiences indicate that monitoring the value chain is critical**. GIs add value to products associated with a specific region (Ingram et al., 2020). However, if a market is inundated with unauthorised GI products that are not monitored and controlled, this diminishes the value of authentic GIs and undermines the economic advantages for legitimate producers. GIs thus rely on a functioning value chain traceability system.
2. **Implementing traceability for GI products varies across channel models is influenced by consumer preferences and the associated costs**. Market power and diverse production methods can further complicate the standardisation of traceability processes. Differentiating between authentic and unauthorised GI products can be challenging due to complex value chains and the involvement of multiple stakeholders, necessitating tailored traceability solutions, especially for smallholder farmers.
3. **Resistance to new traceability methods often arises from traditional practices and established systems within the GI value chain**, indicating the importance of getting all value chain actors on board and understanding the traceability system.
4. **Coordinating traceability for GI products in global markets involves navigating diverse regulatory frameworks and technological standards**. Addressing privacy and data security concerns is crucial for gaining stakeholder trust in these traceability systems, ensuring that GI products' integrity and economic potential are maintained (European Commission, 2024b; TraceX, 2024b).

5.2 Tony's Chocolonely cocoa bean to bar traceability

Tony's Chocolonely is pioneering traceability in the cocoa sector
Tony's Chocolonely became a front-runner in traceability within the cocoa sector, revolutionising the industry with its Sourcing Principles for traceability in 2012. The company utilises 100% traceable cocoa in its chocolate, claiming to know precisely where it comes from. They aim to achieve fully transparent bean-to-bar traceability, encompassing the beans' origin, flow, and quantities. This transparency is leveraged to create a fairer value chain built on direct connections that foster responsibility and accountability while ensuring that farmers receive a fair trade premium and an additional premium for their work (Tony's Chocolonely, n.d.).

Tony's Chocolonely employs a software system called BeanTracker, which was developed with ChainPoint technology

BeanTracker digitally logs data from cooperatives to chocolate production, offering a monitoring tool for every step in the value chain. This uses *blockchain* and *geospatial data* that allows the company to track the beans through the value chain at any moment, ensuring comprehensive oversight and fostering a more equitable and transparent cocoa industry. All value chain members on this shared value chain platform are connected and enter data about incoming 'bean voFlumes', 'beans volumes in stock' and 'bean volumes going out'. This allows the company to know from which cooperative the beans in each container come in Ghana and Cote d'Ivoire, working slightly differently concerning the governmental regulations for cocoa exports (Tony's Chocolonely, 2024).

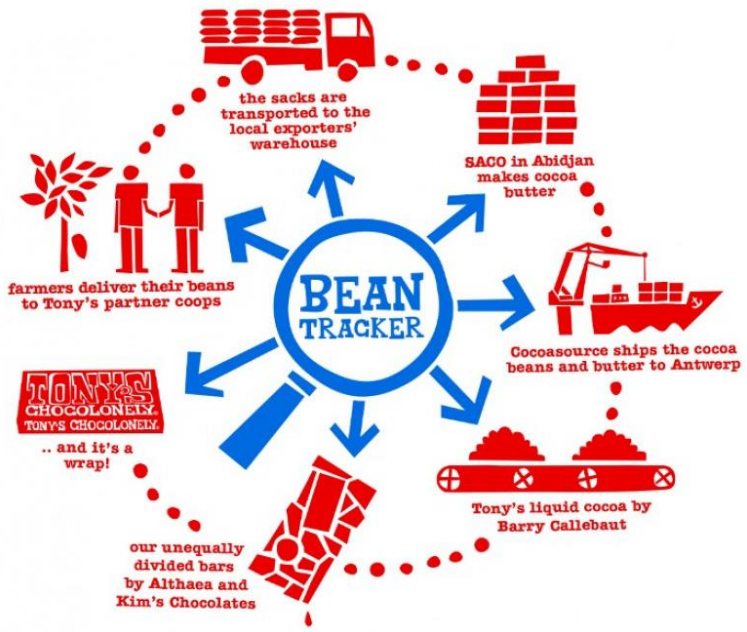


Figure 5.1 *Tony's Chocolonely supply chain system*

BeanTracker builds a comprehensive Bean-to-Bar Traceability

Generally, farmers deliver cocoa beans to the cooperative's warehouse, where the beans are put into sacks. These sacks are then transported by truck to the exporter's warehouse. In Ghana, the exporter is Cocoa Merchants Ghana Limited (CML), while in Ivory Coast, it's either Ecookim or Ocean. The international exporter CocoaSource arranges sacks of cocoa beans to be loaded into containers at Tema, Abidjan, and San Pedro ports and shipped to Antwerp. Ocean and Ecookim also supply beans to SACO in Abidjan, which produces cocoa butter and ships it to Europe. In Antwerp, the sacks of beans are stored in large warehouses until Barry Callebaut uses them to make couverture chocolate (liquid chocolate) for Tony's Chocolonely. This couverture chocolate is then sent to Althaea and Kim's chocolate factories, where the chocolate bars are made and wrapped. The cocoa beans are kept physically separate throughout the process to ensure traceability. The company manages the flow of beans and funds using a 'Tony's premium' via the BeanTracker system. This system links various data sources in the chain, and includes *geospatial data*, to monitor the origins of the cocoa and the conditions for the farmers who grow it. Tony's Chocolonely's goal was to make BeanTracker a scalable solution to lead systemic change by implementing an industry standard for bean-to-bar traceability. By collaborating with Barry Callebaut, the world's largest cocoa processor, they aim to take full responsibility for the entire value chain, setting a precedent for transparency and accountability in the cocoa industry (Tony's Chocolonely, 2024).

Tony's Chocolonely exemplifies how small businesses can implement traceability by integrating technology and transparency, gaining consumer trust and setting standards other companies can follow

Tony's Chocolonely's early experience with cocoa bean-to-bar traceability offers several valuable lessons:

1. **Traceability is feasible for small and large Businesses:** This case demonstrates that traceability is achievable even for small businesses. Tony's Chocolonely's success disproves the notion that traceability is too complex or costly for small companies, suggesting that if a small company can implement effective traceability and remain profitable, larger companies can do so.
2. **Integration of geolocation with certification and other technologies**: Tony's Chocolonely effectively combined geolocation data with certification and other technologies to ensure comprehensive traceability. This integration provides a model for how different technological tools can work together to enhance the traceability of products from source to consumer.
3. **Transparency and consumer reactions:** The company's commitment to transparency has resonated positively with consumers and is a major aspect of its marketing. Such transparency has built trust and drives consumer preference for ethically sourced and traceable products, highlighting the commercial benefits of being open about supply chain practices (Tony's Chocolonely, 2024).

5.3 EU Timber Regulation

The EU Timber Regulation (EUTR) has operated since 2013 and is a forerunner of the EUDR

The EUTR aims to ensure sustainability by ensuring that timber is legally harvested. The EUDR differs from the EUTR in its emphasis on broader commodity coverage and more stringent transparency and traceability requirements, including geo-location evidence to trace the origin of products and annual public reporting on the implementation of Due Diligence. Similar to the EUDR, operators are those who first place timber and timber products on the EU market. The EUTR requires the implementation of a due diligence system to ensure timber is not illegally harvested timber for import into the EU. This is often very costly and time-consuming. While the EUDR appears to address some of the gaps in the traceability of exported raw materials in the EUTR, it creates even more considerable additional burdens for enterprises and control authorities (Köthke et al., 2023).

Evaluations of the EUTR highlight the need for more substantial penalties, better coordination, transparency, support across all EU Member States and incentives for third countries

In an evaluation of the EUTR by WWF in 2019, and a review for the European Commission, several key lessons regarding the implementation of the EUTR were identified (WWF, 2019). Overall, the EUTR was found to fall short of its goal of stopping the trade in illegal timber products within the EU market, with an emphasis on aiding SMEs and enhancing cooperation with supplying countries. Lessons relevant to the EUDR include that:

1. **Effective, proportionate, and dissuasive penalties and sanctions are needed,** including criminal and high financial penalties, as they are critical for ensuring compliance. Follow-up on control results and prosecution and addressing substantiated concerns by third parties were also essential.
2. **Cooperation within and between countries, alongside full implementation** in both origin and EU countries, was necessary for the regulation's success.
3. **Transparency of competent authorities** was highlighted as a vital part of making the EUTR effective.
4. **EU-level consistency in the application of the EUDR will be important.** Actions concerning the EUTR needed to be taken across all Member States, as discrepancies and differences in implementation were found, and better coordination at the EU level was required. The EUTR's obligations applied to all company sizes, but large companies adapted more quickly than SMEs, which faced disadvantages due to lower economies of scale. Civil society organisations played a crucial role in evidence gathering. The Commission was advised to support implementation through measures to promote compliance, such as establishing a communication platform, developing guidance, promoting cooperation with third countries, and encouraging the sharing of experiences and best practices.
5. **Incentives to participate in traceability systems, especially in producing countries, are critical**. Incentives for producers to participate and producer countries to establish nationwide systems to verify and demonstrate compliance with the EUTR requirements were lacking in the EUTR, contributing to its

slow adoption in many 'third' countries. Given vocal resistance from several countries[13] to the EUDR this is a pertinent lesson (WWF, 2019).

5.4 Certification standards for palm oil, coffee and other commodities

Traceability is a core aspect of third-party, auditable sustainability standards such as Fairtrade, Rainforest Alliance and the Roundtable on Sustainable Palm Oil (RSPO)

The traceability requirements in voluntary certification standards aim to show and verify the provenance and the producer of a commodity and promote the environmental and socio-economic sustainability of certified commodities. These three standards include requirements to map the source (farm plots) and trace commodities as they pass the value chain to consumers (Fairtrade International, 2023; Rainforest Alliance, 2023b; RSPO, 2022), and third party independent auditing aims to promote legitimacy and transparency. There are four main approaches used in these standards: (1) Product Segregation refers to physically separating certified and non-certified materials throughout the entire chain; (2) Identity Preserved identifies the ingredient or product to a single farm or farm group; (3) Mass balance and (4) book and claim models allow physical certified and non-certified ingredients to become mixed during warehousing, shipping and manufacturing processes. In Colombia, Alianza Team, Bio D, Del Llano Alto Oleico, Fedepalma, Grupo Hada, OleoFlores, Solidaridad and RSPO signed a declaration 'Colombia compra aceite de palma sostenible' (Colombia buys sustainable palm oil) in 2022 promoting the support, purchase, and promotion of sustainable palm oil, aiming to further increase the 28% of oil palm production in Colombia that was certified sustainable palm oil (CSPO) in 2022 (Fedepalma, 2022b; Solidaridad Network, 2021).

RSPO and Rainforest Alliance certifications provide tools and systems — like automated risk assessment maps for deforestation — enabling companies to provide information needed for EUDR compliance and risk assessments

Farmers can select specific criteria that align with EUDR requirements in the Rainforest Alliance Certification Platform (RACP). Farm Certificate Holders who choose these criteria cannot use allowances for 'minor conversion' of land to agricultural use after the EUDR cut-off date. Certification standards provide supporting evidence for EUDR compliance for companies because traceability is the backbone of certification. By 30 December 2025, all value chain stakeholders — including producers, importers, manufacturers, brands, and retailers who source Rainforest Alliance Certified cocoa or coffee through Identity Preserved or Mixed Identity Preserved value chains — will have the option to identify farm Certificate Holders who have selected the EUDR criteria in the RACP. Users can choose to access the data (including precise geodata) needed to support compliance with their EUDR obligations. The Fairtrade Coffee Standard was revised in 2022 to strengthen deforestation prevention, monitoring, and mitigation and now meets and, in some areas, exceeds the EUDR requirements (Fairtrade International, 2024). For oil palm, there are some gaps but RSPO certification aims to help certified companies meet EUDR conditions (RSPO, 2018). Some large traders also have their own producer/supplier data management systems into which certification data are integrated.

Certification in agricultural production, particularly for farmers in the global South, poses challenges and limitations. One significant drawback is the financial burden on producers

Certification costs include registration fees, auditing expenses, and often higher operational costs due to the need for changes in production systems to meet certification standards (Donovan et al., 2020; Hutabarat et al., 2018; Haggar et al., 2012), on top of the bureaucratic efforts required to obtain and maintain certifications. In the global North, the supply of certified products frequently surpasses demand, leading to an imbalance that can impact the profitability of certification for producers (Meemken et al., 2021). This imbalance is particularly challenging for small, unorganised farmers who often require support from external organisations to navigate the certification process and achieve compliance. There are also technical challenges associated with certification. One notable issue is the risk of overlap and inaccuracies in farmers' data points, often caused by inaccurate GPS locations and outdated cartographic bases. This problem has been reported by both the scientific community and service providers like Meridia, SCS and Satelligence, highlighting the potential for errors in farm data that could affect the reliability of certification systems.

[13] For example Indonesia (The Jakarta Post, 2024), Malaysia, Argentina and Brazil (Viergever, 2024).

Another significant concern is the uncertain ownership of farmer-product data within certification systems and among traders. This raises ethical issues regarding who controls and benefits from the data (Singh et al., 2022). Finally, it is important to acknowledge that certification, like many other systems, is partially fraud-proof. The potential for fraudulent activity exists, undermining the credibility and effectiveness of certification as a tool for ensuring sustainable and ethical production practices.

Traceability is already used in oil palm certification standards

National statutory sustainability certification approaches for oil palm in Indonesia (ISPO), Malaysia (MSPO), and international voluntary sustainability standard RSPO all emphasise value chain traceability to control the flow of certified oil palm products from primary producers to product manufacturers. Several value chain approaches are employed to ensure traceability and sustainability in oil palm. These aim to improve the sustainability of palm oil production and ensure that the supply chain remains transparent and responsible. These standards monitor different stages of the value chain, such as oil palm growing, palm oil milling, storage, transport, refining, and manufacturing, to the end product. These standards aim to ensure that sustainable practices are maintained throughout the entire chain, promoting environmental and social responsibility in the production and distribution of palm oil.

RSPO's PalmTrace Program: This *blockchain* type program facilitates the tracking of certified oil palm products from mills to refineries. Certified members of the Roundtable on Sustainable Palm Oil (RSPO) register their physical sales and processing activities for palm oil, palm kernel, and its fractions under four value chain models. PalmTrace includes a marketplace feature and allows for off-market deals through the Book and Claim system for RSPO Credits.

ISPO and MSPO Standards: Both the Indonesian Sustainable Palm Oil (ISPO) and Malaysian Sustainable Palm Oil (MSPO) frameworks incorporate traceability as a core principle using *blockchain*. Under ISPO, companies are mandated to implement either a segregation or mass balance system to trace the sources of Fresh Fruit Bunches (FFB) and identify their suppliers. Smallholders are required to provide information regarding their sales, pricing, and the identities of their buyers (companies or mills). MSPO introduced the MSPO Trase102 platform, which consists of four modules: Certification, Logo Usage, Complaints and Grievance, and Traceability to enhance transparency and accountability within the value chain, enabling better tracking of sustainable practices. Despite 90% of planted areas being certified under the Malaysian Sustainable Palm Oil (MSPO) scheme, larger players like Sime Darby have developed traceability systems, which are seen as more straightforward and integrated. In Indonesia, two different agencies developing separate standards and guidelines have created confusion among companies, complicating compliance efforts.

Protocol APSColombia: Available since 2022, The Colombian Sustainable Palm Oil Protocol (APSColombia) is a step-by-step, accessible verification system designed to ensure the application of key sustainability principles and best practices at every stage of palm oil production. APSColombia, was created to reach high sustainability standards with lower costs. It recognises progress in achieving sustainability goals while reinforcing the commitment to responsibly sourced palm oil. The protocol is administered by the APSColombia Corporation, an independent, multi-stakeholder organisation dedicated to ensuring transparency and credibility in the implementation of the scheme (APSColombia, 2024).

The way that sustainability certification systems currently work offers several key lessons for the EUDR

1. **Existing private sector, collective and statutory traceability systems are being revised to help implement the EUDR.** All the major voluntary sustainability standards are providing add-ons to enable their standards and systems to provide data to meet EUDR requirements. Certification standards, national governments, the EU are advised to communicate publicly about how existing systems are aligned with the EUDR, also systems proposed or run by the government, traders and cooperatives.
2. **Implementation needs to be supported by enforcement** while various sustainability certifications and tools include criteria and indicators capable of supporting the production of sustainable, deforestation-free products, effective implementation and enforcement are critical.
3. The multiplicity of oil palm systems suggests that linking the **mechanisms underlying traceability, particularly geospatial and producer information, with potential investors and incentives might provide incentives** for smallholders to implement a traceability system, as they often face challenges in accessing resources and support (European Forest Institute, 2022).

6 What are the key actions, verification, and risks for traceability?

Implementing the EUDR requires understanding the actions of different value chain actors, verification steps and risks

To understand the roles and responsibilities of different value chain actors, how these are linked to verification required by the EUDR and the risks associated with these actions, a general overview of the traceability process is described in Figure 6.1 below. A traceability system enables the documentation and tracking of products throughout specific stages of production, processing, and distribution. EUDR requires operators placing relevant products on the EU market to provide diligence statements demonstrating compliance. Essentially, the regulation mandates that operators and traders gather geographic coordinates of the land plots where commodities are produced. This level of traceability is crucial to verify that no deforestation has occurred in those specific locations.

Actions, verification, and risks in the value chain start at the production location

Starting at production, according to the EUDR, a farmers' responsibility is to ensure their farm is delocalised and to pass the information on to the buyer (Publications Office of the European Union, 2023). However, operators must verify land boundaries to ensure the land is used for its legal purpose: agriculture. Colombia has defined the agricultural frontier (UPRA) as the land that's suitable and legally compliant for agricultural activities. The frontier excludes areas such as forests, natural reserves, and indigenous and Afro-descendant land. This means that a plot under this area is legally considered as for agricultural use, regardless of the ownership rights.

To ensure integrity in deforestation-free value chains, identification and audit systems should be implemented from the point of collection, processing and storage

At the time of collection, the plot needs to be identified as deforestation-free using officially available databases, such as the EU Forest Observatory (EU Forest Observatory, 2024) and cross-checking with local databases (i.e. SICA, Palm Cadastre, IDEAM and UPRA) to correct for false positive deforestation alerts. Structural characteristics between the forest canopy and coffee agroforestry require attention to measurement resolution. At this point, proper separation of the products throughout the process is crucial and should be supported by the appropriate record-keeping and trust-building among actors. An audit system must be in place to maintain transparency between farmer organisations and companies. Various technologies, such as RFID/Barcode/QR codes, Blockchain, and certification systems, can be utilised. Risk mitigation is crucial to minimise database errors, fraud, and the mixing of deforestation-free and non-deforestation-free products. The above should continue when commodities are manufactured and stored. Information should be accessible and transparent so that all operators and traders can verify and prove the information is correct.

Operators should ensure compliance in the exporting phase and record the required due diligence for regulatory adherence

Following the collection, manufacturing and storage, the exporting phase must ensure a clear identification of the products. Furthermore, in this phase, operators are required to submit the verification of the information for the due diligence compiling with the Deforestation Due Diligence Statement Registry (DDS information system) (European Commission, 2024e). The Information System (IS) is an information technology system (IT system) that contains the due diligence statements submitted by operators and traders to comply with the requirements of the Regulation. Further verification is advised. The information system will be operational by entering the Regulation application and will provide users with the functionalities listed in Art. 33(2) of the Regulation (European Commission, 2023).

The EUDR obligations apply to importers. Importers must declare that the components of the products they are importing have not contributed to the deforestation of agricultural land that has been deforested after the 'cut-off date'

This means that importers should demonstrate the origin of the raw materials via due diligence requirements. Upon import, importers should provide precise geographical information about the relevant agricultural land, with satellite images and GPS coordinates that must have been verified by operators along the value chain. A due diligence statement is a key document that importers are required to submit under the EUDR (European Commission, 2024e). It acts as a formal declaration that the imported products meet deforestation-free standards. This involves thorough documentation, including raw material sourcing, geolocation data, and verification procedures. More than just a formality, the due diligence statement is a legal obligation that ensures companies are accountable. Importers must maintain accurate, up-to-date records, making them available for review by authorities. This is essential for promoting transparency and affirming a commitment to ethical sourcing (TraceX, 2024a).

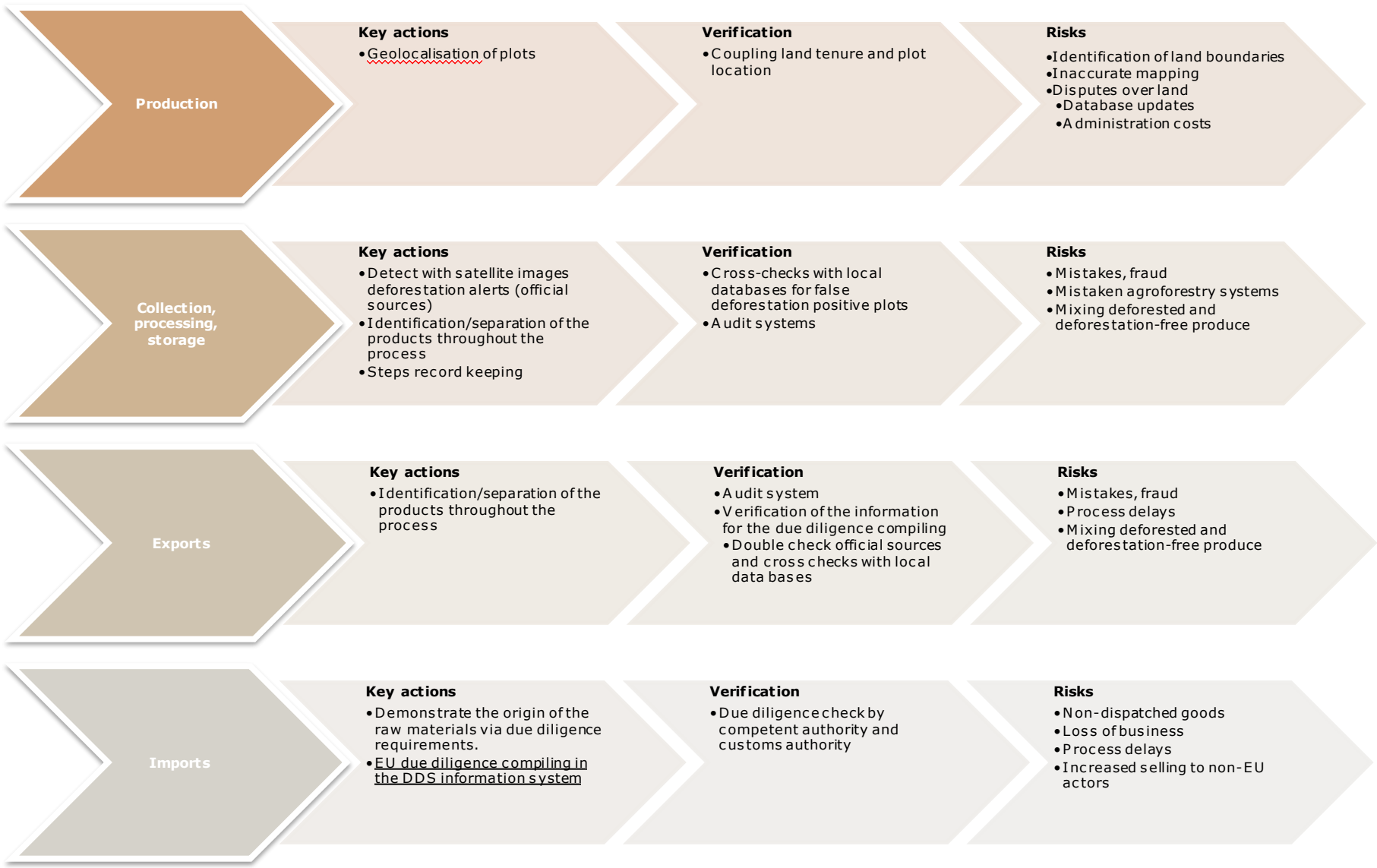


Figure 6.1 *Key actions, verifications and risks for traceability*

Source: Own elaboration based on interviews and information obtained during the study.

7 What is needed for successful traceability implementation in Colombia?

Opportunities and responsibilities in implementing the EUDR
Implementing the EUDR will undoubtedly lead to systemic changes and significantly impact major commodity-exporting countries, including Colombia. Whilst the regulation is foreseen to create some negative impacts, it also presents a global opportunity to create a more traceable, safer, and fairer system for workers and producers, especially for actors and countries who already aim for high sustainability standards in commodity production. System changes take time and concerted action. In this section, we review the roles and responsibilities for the main actors mentioned in the previous chapters, to implement traceability systems and the fair use of technology that leaves no one behind.

7.1 Governments

Continued dialogue
Between Colombian government and the EU is critical to find opportunities on how to meet the EUDR and ensure transparency. These dialogues need to include the most impacted groups, such as smallholders and farmers, to maintain strong trade relations with and assist both nations in their transitions (World Economic Forum, 2023; World Resources Institute, 2024b).

Facilitating technology and data sharing
Government agencies and other decision-makers are responsible for creating an environment conducive to introducing technologies and their dissemination throughout the territory. This, in practice, can be done by ensuring data dissemination amongst value chain actors and providing secure platforms for its exchange. Platforms must be safe and regulated to encourage data sharing, a status that can be obtained through legislation or a voluntary code of conduct. Data-sharing regulations must address the ownership, portability, use, scope and limitations of data collection and sharing. All the stakeholders in the value chain must be informed and comfortable with data sharing for traceability (World Resources Institute, 2024a).

Data standardisation for effective traceability and blockchain implementation
Data standardisation is essential for farmers, with technology providers and researchers playing important roles in ensuring information is used effectively, equitably and ethically. Blockchain traceability offers several implementation advantages, but standardised data is needed to ensure seamless communication across the value chain. Uniformity allows for the consolidation of information, facilitating a standard due diligence process for the EUDR portal. Different actors recording methods without standardisation can cause confusion and information loss. Furthermore, it can slow down the dissemination and application of the technology itself, preventing it from reaching its full potential (World Resources Institute, 2024a). It is also essential for governments to collect and provide official data on land use, land use change, rural property registration, land tenure and trade. Such data are crucial for a reliable monitoring system, creating ownership and accountability, and avoiding land use issues in later years. Another aspect that can facilitate government-level data collection and management is the creation of farmer IDs. These also can eventually be linked to the geospatial information provided for the EUDR to have a nationwide record of the location and extent of farms.

Promoting technology adoption through innovative financing and collaborative partnerships
New financing models such as blended finance initiatives, data monetisation, and data-driven microcredit provision must be developed to facilitate technology adoption. Coordination between public and private entities and cooperatives willing to test and adapt new technology products is essential. In this case, governments can act as a bridge between technology providers and farmers, enhancing farmers' confidence and willingness to engage in these new practices (World Economic Forum, 2024).

7.2 Farmer's organisations

The vital role of farmers' organisations in implementing traceability

Farmers' organisations, such as FNC and Fedepalma, and sectoral cooperatives that unite multiple farmers have been crucial in addressing the new regulation (Melati et al., 2024). However, they could become even more significant in expanding the traceability system. These organisations function as social and economic networks, creating horizontal and vertical relationships between farmers. In this way, they make an integrated system within complex food chains by bringing together a diverse range of actors (CGIAR, 2014). A solid structure and an organised network allow effective management and rapid adaptation to new conditions, whether regulations or crisis events (Giagnocavo et al., 2017). Organisations are therefore crucial for creating this structure, which is also based particularly on relationships of trust.

Accessing and sharing information based on trust

Cooperatives and organisations help overcome the barriers farmers may face in accessing information and services, especially digital ones. In some contexts, illiteracy among farmers may be prevalent. Consequently, agricultural cooperatives play a key role in disseminating the information necessary to implement a tracking system. Additionally, they are crucial in data collection and management, as well as in presenting the data to members in accessible formats (Duffield and Christian, 2024). The trust and local presence of these organisations help overcome a significant barrier. Farmers may be reluctant to share personal or farm information with third-party data collectors. Different stakeholders have identified such reluctancy as the main issue in obtaining geolocated data, as smallholders often fear that the information will be used for other purposes, such as tax collection. However, they will be more willing to share it with cooperatives when well-informed and knowledgeable about its use. Therefore, cooperatives must have data management and processing protocols that ensure the confidentiality and privacy of farmers (Duffield and Christian, 2024). This approach enables the formation of a more robust system that supports the expansion of traceability systems.

Data representation and management for farmers' interests

Farmers' organisations should have a register of information on farmers. This data should be accessible to the farmers but should only be shared with third parties with their written consent. This approach bridges the gap between the demands of new regulations and the needs of farmers. By representing a collective group of farmers, cooperatives have a stronger voice in the discussions about developing a traceability system that protects farmers' interests and generates valuable trend information (Duffield and Christian, 2024). This information can inform cooperative planning and future negotiations with bigger companies or international organisations. Also, it's possible that by representing a large group of activities, they can get convenient deals on software and new technologies to be applied within the network. This will improve the standardisation and harmonisation of data within the industry. This approach allows for better protection of farmers excluded from large private supply chains. Creating a more reliable system that manages geospatial data from farms ensures data uniqueness and protection, reduces confusion, and minimises the effort required from farmers in data transmission, all while maintaining data ownership.

7.3 Private sector

Corporate implementation of traceability in value chains

Companies operating in Colombia are responsible for producing the necessary export documents and completing due diligence requirements (see Chapter 2). They are thus key in implementing technological systems that enable traceability. Some companies have already implemented such systems (see chapter 4), providing examples for others on how to meet the EUDR.

Leading on technologies and bearing costs

Many of the larger coffee and palm oil companies, such as Cargill (Cargill, 2023) and Wilmar (Wilmar, 2023), have traceability systems — typically based on specialised software which are often coupled with voluntary sustainability certification. Data are provided by supplying farmers who agree to engage in the traceability process. This creates a network based on trust and economic transactions to collect data. This information

flow can be two ways, such that good agricultural practices and advice can also be disseminated to farmers or farmer organisations. Companies often bear the some of the costs of traceability and transparency, given the challenges many small farmers face in accessing such software, data systems, technology, technical and financial capacity to meet monitoring and reporting requirements. Opportunities include companies giving greater access of such back to farmers who often provide a significant proportion of the original data, both at individual and aggregated scale, such as production, yield, and sales prices (World Resources Institute, 2024a).

Companies can work together to create a fairer and more transparent system

Pre-competitive collaboration can support traceability when different companies source commodities from the same landscape (Hinkes & Peter, 2020). Pooling common data can help identify high-priority and high risk areas and coordinate actions among farmers and buyers to prevent deforestation before it happens. For this to be possible, companies must agree to share highly sensitive data on plots in a way that respects proprietary farm data and protects farmers' privacy. This happened in West Africa, where WRI joined forces with the World Cocoa Foundation and 19 major cocoa and chocolate companies to collaborate against deforestation (World Resources Institute, 2024a). Although such collaborations are not currently prioritised, motivation to protect the environment can stem from corporate foresight or external factors like the new EUDR.

Certification offers an entry point for compliance for companies

As discussed in chapter 3, traceability is key component in certification standards and can be seen as complementary, sharing many aims with the EUDR. RSPO, Rainforest Alliance and Fairtrade all conducted an analysis of how they support the EUDR and gaps. All revising their standards to enable certified companies to use certification as a mechanism to show compliance and provide evidence of their compliance with EUDR requirements—and at little or no additional cost, using the tools and systems such as automated risk assessment maps for deforestation to provide companies with complementary information for compliance and risk assessments. Certified farmers can also select specific criteria that align with EUDR requirements, such as in the Rainforest Alliance Certification Platform (RACP).

7.4 Different pathways for traceability

Multiple actors work towards the same common goal

No single type of actor or technological solution currently exists for a traceability system for products to be exported into the European market. Whilst there is a shared, common goal of export to the EU, the ways to achieve it may differ. These solutions complement each other and take account of different contexts (chapter 2). For implementation to be effective, there is no single pathway; a mix of technologies and actor integration is needed to support different compliance (e.g. Corporate Systems, Certifications or via National Stakeholder Collaborations) (Figure 7.1). For certified farmers and for those already part of corporate value chains, geolocalisation can be easily implemented or has been done, making them part of a system that can be traced. For others, especially for small farm holders, national stakeholder collaborations are needed to geolocate them and include them in the key data bases (e.g., SICA and Palm Cadastre). Clarification and additional guidance from the EU on EUDR can help create a more cohesive system that avoids disparities between different countries.

Figure 7.1 *Pathway combination integrating technologies and stakeholders in the coffee and palm oil value chains to establish a successful traceability system for exporting products to the EU*
Source: Own elaboration based on interviews and information obtained during the study.

Different pathways involving actors and technologies are essential to establish an effective traceability system, but standardisation is key

Blockchain appears the system most capable of unifying the different stages of the value chains for due diligence. However, it must be seen as something other than a standalone solution to this issue. This is due to its limitations, such as high software costs, connectivity challenges, and the need for data harmonisation, which complicate recording everything within a single system. Furthermore, it is essential to recognise that other technologies and practices, even if less integrated or connected, make data collection less ambiguous and more transparent over time. Additionally, there is a need to establish new databases containing geospatial locations of farms, which serve as the foundation for the entire data collection process required for EU export compliance. This technological advancement must be supported by infrastructure improvements to enhance coverage and connectivity, a responsibility that falls on the state. Furthermore, the development of new apps and software with intuitive interfaces can make these technologies more accessible, potentially increasing their adoption and helping to reduce costs. By promoting clarity and alignment across industries, standardisation supports an effective and reliable traceability system, which is vital for quality control, safety, and trust along the value chain.

8 Conclusions and recommendations

The six main questions are answered here, and recommendations for implementing the EUDR in Colombia's palm oil and coffee value chains are provided in the boxes.

8.1 What are the critical implications of the EUDR for Colombian palm oil and coffee? (Chapter 2)

The EU Deforestation Regulation (EUDR) aims to combat global deforestation and forest degradation by creating a traceable value chain

The EUDR requires that operators and traders adhere to EUDR guidelines, which include a benchmarking system to assess compliance in producing countries based on deforestation rates, agricultural expansion, and production trends. The risk level assigned through this benchmarking determines the Regulation's due diligence requirements. Commodities and products that do not meet the EUDR criteria by December 31, 2020, are banned from the EU market. Polygon mapping is the first step in traceability but is a major challenge due to several factors: the country's geography makes it difficult to reach remote farms to carry out polygon' verifications physically; low level of standardised polygon mapping standards and technology owned or operated by farmers; the large number of smallholder farmers, many of whom are not aware of the EUDR requirements as many sell to small traders to the EU. Land ownership is another challenging factor, as it is possible that the boundaries demarcated by producers are not reflected in legal deeds, the land cadastre, and that the land is not formally owned, complicating the traceability process and giving rise to errors in monitoring or fraud. Producers without clear tenure rights may bear the burden of the costs associated with traceability systems and certifications, ultimately exacerbating their exclusion from profitable markets (McDermott et al., 2023).

Forest maps and definitions are not aligned

Coffee and palm oil, particularly when they are produced in agroforestry systems, are often difficult to detect on maps. There is a risk that the maps used by the EU observatory do not accurately reflect the actual distribution of forests and agroforestry in Colombia. This means that deforestation and deforestation risks and maps of the baseline 2020 year are unreliable. This raises important questions regarding the measurement accuracy of land cover, especially forested land, and the potential misrepresentation of land use. The EU regulation uses specific definitions that differ from those used in producing countries. In the case of Colombia, deforestation has other drivers and deforestation hotspots are not the main origins of cocoa and coffee exports. It's very important to take the national context into account, as well as consider a possible regional analysis and differentiation. It's not the same risk you have from the Caribbean region, with a long agricultural tradition and agricultural land, then the Amazon region.

Risk of excluding Colombian farmers from the EU market

Farmers with accurate geolocation information may find it easier to prove the sustainability of their practices and origin of their products and thus sell to the EU. However, farmers may be inadvertently excluded from the European market as a result of the EUDR, especially smallholders; those who are not members of groups or linked to traders or certification organisations which can demonstrate compliance with sustainability standards which are supporting mapping and traceability systems; and those who do not have geolocated farms. These factors can diminish their bargaining power with larger enterprises. Furthermore, although operators should anticipate varying levels of scrutiny based on their country's classification, there is a limit to the preparation that can be conducted while the implementation of the EUDR is still in the process of being established nationally. A resulting risk is that EU-based importers may avoid supply chains or specific producer countries deemed 'high risk', preferring lower risk (i.e. already deforested countries) which could reduce access of Colombian farmers to the EU market. Additionally, the regulation may create market barriers that distort competition, making it additionally challenging for some producers to access the EU market.

Risk of 'spillover'' to non-EU markets hindering sustainability efforts

There are significant concerns regarding leakage or spillover,[14] particularly when coffee and palm oil overlap with forest areas, which is exported to countries with less emphasis on a product's deforestation footprint, such as the United States and China. On a global level, such a redirection of trade severely undermines efforts to curb deforestation and promote responsible sourcing. When products produced under less strict environmental regulations enter these markets, it creates a scenario where unsustainable practices can thrive without accountability. The absence of stringent checks allows for continued deforestation, negatively impacting ecosystems and communities dependent on these resources. There is also a concern that EU legislation could inadvertently drive the production of raw materials for domestic consumption, or coffee intended for non-EU markets, into forested areas, exacerbating deforestation.

Box 8.1. Recommendations on critical elements for implementing the EUDR

1. **Supporting coffee and palm oil farm polygon mapping via the current national initiatives (SICA and APSColombia)** A realistic timescale (which may take several years) for different stakeholders to conduct polygon mapping and integrate the details, lining farm to farmer identification in a coordinated national system, is strongly recommended. Operators could engage with importers, presenting their proposed traceability systems to build confidence. Conversely, importers are encouraged to engage up their value chain to aid their supplies to meet the requirements.
2. **The benchmarking process should consider Colombian forest and deforestation definitions.** The differences in the definitions of forest and agroforestry classifications must be addressed by the EU with the Colombian government. Therefore, aligning institutional monitoring by the EU Observatory and Colombian authorities is crucial for effective compliance and monitoring with the EUDR.
3. **Alignment of forest maps and definitions is needed for production in agroforestry systems.** As the EU observatory may not accurately distinguish between forests and agroforestry systems it is recommended that stakeholders verify the status of individual farms through organisations like IDEAM and the SMByC, ensuring that current mapping data accurately reflects the land use, and mapping data is also verified on the ground.
4. **Balancing traceability with restoration, reforestation and afforestation involving coffee and palm oil.** It is recommended that Colombian actors discuss with the EU and with other producer countries affected by the EUDR how the EU can support and incentivise, rather than penalise land restoration, agroecology, and reforestation projects involving coffee, oil palm and other commodities regulated by the EUDR.

8.2 What characteristics of the Colombian context are key factors for EUDR implementation? (Chapter 3)

Colombia's coffee and palm oil sectors are a driver of social and economic development but face significant challenges to implement traceability throughout their value chains

Despite Colombia's zero deforestation agreements in 2018 and the CONPES 4021, remote sensing and mapping indicate that deforestation continues and that agricultural commodities, including cattle, continue to be among the drivers, apart from more systemic issues of poverty, unclear land tenure, increasing population, and weak law enforcement, among others (UNDP et al., 2021). The EUDR is an externally driven, unilateral trade based regulation from outside of Colombia that has similar aims, albeit focussing on seven commodities. Meeting the requirements of the EUDR will be challenging due to the large number of small farmers, the many pathways and actors, the complex logistics in both value chains, and the costs of traceability. The National Federation of Coffee Producers' information system (SICA) and the Palm Cadaster and APSColombia are key elements to achieve EUDR compliance. While successful pilots have been implemented, exporters highlight the difficulty of scaling to all farmers and maintaining full traceability as obstacles to compliance.

[14] Leakage, or spillover, happens when unsustainable production shifts from one region or producer to another (Alix-Garcia and Gibbs, 2017). Leakage can happen when reducing the environmental impact of one commodity leads to increased harm from another (Newton et al., 2013).

The many smallholder farmers who are not organised may bear disproportional costs of implementation and changes to comply with the EUDR

The efforts to improve traceability in Colombia in the oil palm and coffee sectors, combined with ever-wider technology dissemination, could be expanded to include more farmers and buyers, especially aiming to reach the many smallholders who are not in groups or certified. The question of who will bear the costs remains unresolved. There are possibilities to achieve traceability systems without burdening farmers, but organisations and institutions must create a cohesive network. More coordination and collaboration are required among commercial actors in the value chain, including the government, to ensure that Colombian products are exported to the EU. This approach will also enable farmers who are not members of organisations or who are hesitant to engage in collective action to still participate in value chains and be able to secure exports of their products.

Box 8.2 Recommendations on the Colombian context

1. **Strengthen communication channels within and between agricultural and forest sectors.** In the palm oil sector, palm nuclei help better address producers. However, most cooperatives and independent exporters active in the coffee sector are not interconnected, rendering it difficult to exchange information. Encouraging affiliation with sector associations like Fedepalma and FNC would be a good initiative to exchange experience successfully and share regulatory update.
2. **Keep expanding SICA and Palm Cadaster Coverage and updates to ensure comprehensive data collection and integration across the entire value chain**. Develop standardised data entry and reporting protocols to ensure consistency and reliability of information across different systems. This will facilitate easier data sharing and verification processes. Implementing a unique identification such as Cedula (citizen ID) is key in standardising information currently contained in different systems.
3. **Review national deforestation trade and forest policies.** Colombian trade and forest policies may require revision to enable compliance with the EUDR, which could be time consuming and costly. Non-compliance however could lead to trade bans, affecting revenue and employment. An alternatives is bilateral negotiating with the EU for more national alignment, as occurred in the VPAs, or multilaterally in trade (geographic or commodity based) groups.

8.3 Which traceability technologies can aid EUDR implementation? (Chapter 4)

Geospatial data, satellite images and blockchain technologies can help in designing, implementing, and monitoring forest risk and loss, and tracing production

Combining traceability technologies such as geospatial data, satellite images, barcodes, and blockchain to track the origins and movement of commodities can help establish robust traceability pathways. A mix seems necessary as there is not one technology that has been used to cover all requirements, with some focussing on tracking post-harvest transportation, others monitoring forest cover changes without covering subsequent stages. Monitoring and controls, and field verification are crucial to ensure the accuracy and effectiveness of technologies.

Box 8.3 Recommendations on traceability technologies

1. **Implement unique identification mechanisms and scale up the use of Cedula to standardise traceability.** Using the Cedula (citizen ID) as a unique identifier within traceability systems can standardise and streamline information flows and ensure accurate tracking of products from farm to export. However robust data protection measures are needed to safeguard farmers' personal information.
2. **Promote technology adoption through innovative financing.** Create and implement financing mechanisms such as blended finance initiatives and data-driven microcredit. These models can lower the financial barriers to technology adoption for operators in the agricultural value chain.

8.4 What can we learn from other traceability systems? (Chapter 5)

Experiences with Geographical Indication (GI) indicate monitoring, and consumers are key
While GIs can significantly boost economic benefits for producers, the consumer market and value chain need to be monitored so that diminishes the value of authentic GIs, as it undermines the economic advantages for legitimate producers. Implementing traceability for GI products varies across channel models is influenced by consumer preferences and the associated costs. Resistance to new traceability methods often arises from traditional practices and established systems within the GI value chain. Coordinating traceability for GI products in global markets involves navigating diverse regulatory frameworks and technological standards. Addressing privacy and data security concerns is crucial for gaining stakeholder trust in these traceability systems, ensuring that GI products' integrity and economic potential are maintained.

Pioneers in cocoa value chain traceability Tony's Chocolonely exemplify how traceability can be achieved through integrating technology and transparency, gaining consumer trust and standard setting
Traceability is possible in small and large businesses. It can be achieved by integrated geolocation with Certification and Other Technologies, which relies on transparency and consumer reactions. The company's commitment to transparency has resonated positively with consumers and is a major aspect of its marketing. This transparency builds trust and drives consumer preference for ethically sourced and traceable products, highlighting the commercial benefits of being open about supply chain practices.

Lessons from the EUTR highlight the need for penalties, coordination, transparency, and support across all EU Member States, aiding SMEs and good cooperation with third countries
Effective, proportionate, and dissuasive penalties and sanctions are needed, including criminal and high financial penalties. Follow-up on control results and prosecution and addressing substantiated concerns by third parties are also essential. Cooperation within and between countries, alongside full implementation in both origin and EU countries and transparency of competent authorities, are vital, alongside EU-level consistency in applying the EUDR**.**

Experiences from sustainability certification systems are cost- and burden-sharing, which need to be balanced by incentives and enforcement
One significant drawback is its additional financial burden on producers, despite incentives such as higher prices and certification premiums. On the positive side, traceability is a core aspect of third-party, auditable sustainability standards such as Fairtrade, Rainforest Alliance, and the Roundtable on Sustainable Palm Oil (RSPO). These systems provide tools and systems that give companies the information needed for EUDR compliance and risk assessments. In the private sector, collective and statutory traceability systems are being revised to help implement the EUDR. Implementation needs to be supported by enforcement, and while various sustainability certifications and tools include criteria and indicators capable of supporting the production of sustainable, deforestation-free palm oil, effective implementation and enforcement are critical. The multiplicity of oil palm systems suggests that linking the mechanisms underlying traceability, particularly geospatial and producer information, with potential investors and incentives might provide incentives.

Box 8.4 Recommendations from experiences with other traceability systems

1. **Dialogue with the EU**.
   - Consistency in the application of the EUDR across EU member states so that exports of Colombian products to different EU member states will be handled uniformly.
   - Cooperation between Colombia and the EU, *and* between 'third" countries, especially producing the same commodities, is important for exchange on what's working and not in implementation and solutions to address problems.
2. **Ensure coordination in the value chains**
   - Coordinating a traceability system to meet EUDR requirements means aligning EU and Colombian regulatory frameworks and technological standards.
   - Agreeing which stakeholders will ensure standardisation of traceability processes nationally and per commodity by coordinating between the multiple stakeholders, especially for smallholder farmers.
   - Combining and aligning technologies – such as geospatial, with certification and internet of things, can be effective ways of implementing traceability systems.
   - With revisions, existing private sector, collective and statutory traceability systems can help implement the EUDR.
3. **Transparency, legitimacy, and incentives**
   - Transparency of competent authorities and all parties involved in the traceability system in third countries such as Colombia and in the EU is important for legitimacy.
   - Provide incentives for different stakeholders to participate in the traceability system, for example reduced taxes, providing back information on mapping, prices or benchmarking production data.

8.5 What are the key actions, verifications, and risks for traceability? (Chapter 6)

Traceability and transparency alone are not solutions, but they are essential for enabling value chain actors to make informed decisions that impact forest loss

Independent verification is necessary for ensuring system credibility. Achieving traceability and transparency in commodity value chains is feasible but requires additional investment. Governments should create a well-resourced policy environment that supports traceability and transparency, especially given the complexities of value chains like coffee. Investments are often ongoing, necessitating continued funding. Practical approaches must consider the needs of smallholders. Significant data gaps persist, particularly in areas with many smallholders, making it critical to ensure data accessibility and usability. Investments are needed to address these gaps (World Resources Institute, 2024a).

Uncertainties and implications for stakeholders

Significant uncertainties surround the implementation of the EUDR, primarily due to the lack of publicly available guidelines and benchmarking data. These uncertainties carry potential implications for various stakeholders, including the need for a mix of technologies to support different pathways within the supply chain. Ensuring continuity of technology and data is crucial, mainly through using unique identifiers for farmers that are widely perceived by national stakeholders as legitimate and embedded in national legal and policy systems. A focus on standardising processes is essential, as compliance with local legislation is a legal requirement. At the same time, EUDR diligence becomes a commercial necessity.

Box 8.5 Recommendations on key actions, verifications, and risks for traceability.

1. **Monitor changes in market shares for products sold to the EU and to communicate any shifts attributed to avoiding EU compliance.** Evaluating the costs and benefits of implementing the EUDR within Colombia's value chains is critical, particularly concerning prices, incomes, and the equitable distribution of these costs across the value chain. Furthermore, the regulation may drive a shift from high-risk production areas to markets outside the EU, potentially increasing the costs associated with risk mitigation.
2. **The government could ensure that *all* operators in the chains are engaged in developing traceability systems,** including intermediaries, farmers organisations and representatives, exporters and importers are engaged to ensure compliance and record the due diligence.

8.6 What is needed for a successful traceability implementation? (Chapter 7)

Enhanced stakeholder engagement and dialogue

Involvement of all stakeholders along the chain is highly recommended, particularly in the public and private sectors. The Ministry of Agriculture and the Ministry of Commerce have been discussing the mechanisms and challenges to complying with the Regulation with associations such as FNC, Asoexport, and Fedepalma. All exporters and importers should also be involved, and ways found to engage with 'solo' farmers who are not organised into groups. IDEAM (the Institute of Hydrology, Meteorology and Environmental Studies) and the Ministry of Environment can support with technical solutions when required. Certification standards

Focus on inclusivity

Implementing traceability systems and regulations like the EUDR raises several potential implications and uncertainties for various stakeholders. For cooperatives, a significant challenge lies in effectively reaching unorganised farmers who may need more awareness or resources. Smallholders risk being left behind or excluded from the EU market if they need help understanding the EUDR requirements, managing associated risks, or utilising necessary technologies. The costs related to data collection and management can be prohibitive, particularly for smaller producers. This creates trade-offs regarding the equitable distribution of costs and benefits, where smallholder farmers and non-landowners may struggle compared to larger enterprises and plantation companies.

Data standardisation for effective traceability and blockchain implementation

Data standardisation is essential to ensure information is comparable, used effectively, equitably and ethically and to allow seamless communication between value chain stakeholders. Governments data on land use, land use change, rural property registration, land tenure and trade is crucial for a reliable monitoring system, also to avoid land use issues. Farmer IDs will play a key role here and can linked to geospatial information provided for the EUDR to have a nationwide record of the location and extent of farms. Blockchain traceability systems offers advantages for standardising and sharing such data.

Box 8.6 Recommendations for a successful traceability implementation

1. **Support group and cooperative initiatives**. Encourage and support cooperatives in exploring and implementing new technologies. Cooperative structures can serve as effective platforms for collective technology adoption, sharing risks, and benefits among members.
2. **Empower farmers and seek opportunities.** Tracking the pathways used to facilitate exports to the EU is essential for organising and empowering unorganised or isolated farmers who are not included in corporate systems and cooperatives, and appear at more risk of being excluded from the EU market due to their lack of knowledge and ability to implement geolocalisation requirements needed for operators to comply with the EUDR.
3. **Facilitating technology and data sharing, including via standardisation.** Government agencies, private sector and producers associations (FNC and Fedepalma) can create a conducive environment to introducing and disseminate technologies and data required amongst value chain actors and providing secure platforms and rules for data and technology use and exchange, such as making clear requirements which will create standardisation.
4. **Promoting technology adoption through innovative financing and collaborative partnerships**. New financing models such as blended finance initiatives, data monetisation, and data-driven microcredit provision can be developed to facilitate technology adoption. Coordination between public and private entities and cooperatives willing to test and adapt new technology products is essential.

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Annex 1

#	Product	Type of org	Organization	Website	Meeting date	Mission/Functions/Description/ Main responsibilities	Interest/benefit/opportunities or relation with the project
1	Coffee	Civil society	Tropical Forest Alliance	https://www.tropicalforestalliance.org/ https://www.solidaridadsouthamerica.org/ https://acuerdocafebosqueyclima.com/	12-7-2023	Leader of zero deforestation agreements	Support cross-sectoral communication to comply with zero deforestation agreements
2	Coffee	Private	Profound	https://thisisprofound.com/	29-6-2023	Consultancy company	They have conducted coffee studies and have contacts with other value chains
3	Coffee	Private/public	FNC-Caldas committee	https://federaciondecafeteros.org/wp/	23-8-2023	A committee that represents the producers of the region, part of the FNC	They seek to boost the commercial efforts of the coffee producers it represents
4	Coffee	Private/public	FNC	https://federaciondecafeteros.org/wp/	11-10-2023	National-level representation of coffee producers	As FNC they are interested in participating and contributing to everything related to the EUDR in order to support producers and projects in their efforts to comply with the regulation
5	Coffee	Private/public	FNC	https://federaciondecafeteros.org/wp/	9-7-2024	National-level representation of coffee producers	Participation in the validation process, the findings of the report are reviewed and updated
6	Coffee	Civil society	Solidaridad	https://solidaridadlatam.org/	23-1-2024	ONG	Promote projects and support coffee producers
7	Coffee	Private	Cooperative de Manizales	https://www.cooperativamanizales.com/WebSite/	19-9-2024	Coffee sales and collection points	They seek to be safe point of sale for producers and a reliable one for buyers
8	Coffee	Private	SUCAFINA COLOMBIA S.A.S.	www.sucafina.com	3-11-2023	Coffee trading company. They have presence in Africa, Asia and Latin America (Brazil, Peru, Mexico and Colombia).	They have the vision of being the most important sustainable coffee export company. They work closely with cooperatives and associations which will be affected by EUDR. They work with different certifications for Nespresso, Starbucks, etc.
9	Coffee	Private	SKN CARIBECAFÉ LTD	https://skncaribecafe.com/	10-11-2023	Coffee export leaders, they own farms for export, they are associated with 17 export companies, 2 additional service companies and 19 associated import companies.	They are very interested in identifying which are the best technologies for traceability for the EUDR. They have several projects related to the sustainability of the coffee production

#	Product	Type of org	Organization	Website	Meeting date	Mission/Functions/Description/ Main responsibilities	Interest/benefit/opportunities or relation with the project
10	C/P	Knowledge instituion	CIAT - International Center for Tropical Agriculture	https://alliancebioversityciat.org/	8-11-2023 (contact 2) 15-11-2023 (contacts 3 &4)	Research about agricultural value chains	They conducted previous studies acquiring knowledge about the coffee and palm oil sector
11	C/P	Public	MinCIT		11-12-2023	Public entity	Cross-cutting knowledge of initiatives
12	Palm	Private/public	Fedepalma-sispa	https://sispaplus.fedepalma.org/Default	14-7-2023	Manage the digital platform to show total numbers of production, price and international trade	They have defined the palm crops' polygons, but based on the new law, they will start to have the polygons of the fields. They are using satellite images with high resolution to identify specific areas. The project is in charge of the geomatic area in Fedepalma
13	Palm	Private/public	Fedepalma	https://fedepalma.org/	3-8-2023	Association of plantain producers, supporting the sector from the technical and commercial point of view	To support affiliates in complying with the regulation, have carried out initiatives with *finnaciación del fondo palmero*
14	Palm	Private/public	Fedepalma	https://fedepalma.org/	25-6-2024	Association of plantain producers, supporting the sector from the technical and commercial point of view	Participation in the validation process. They have interest in the project for the development of the law in palm oil sector. The findings of the report are reviewed and updated
15	C/P	Public	EU delegación	https://www.eeas.europa.eu/delegations/colombia_es?s=160	19-2-2024	EU delegation in Colombia	They want to know about current initiatives and are willing to participate in the process of such initiatives
16	C/P	Public	EU delegación	https://www.eeas.europa.eu/delegations/colombia_es?s=160	2-7-2024	EU delegation in Colombia	Participation in the validation process, the findings of the report are reviewed and updated

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Rapport 2025-037

De missie van Wageningen University & Research is 'To explore the potential of nature to improve the quality of life'. Binnen Wageningen University & Research bundelen Wageningen University en gespecialiseerde onderzoeksinstituten van Stichting Wageningen Research hun krachten om bij te dragen aan de oplossing van belangrijke vragen in het domein van gezonde voeding en leefomgeving. Met ongeveer 30 vestigingen, 7.700 medewerkers (7.000 fte), 2.500 PhD- en EngD-kandidaten, 13.100 studenten en ruim 150.000 Leven Lang Leren-deelnemers behoort Wageningen University & Research wereldwijd tot de aansprekende kennisinstellingen binnen haar domein. De integrale benadering van de vraagstukken en de samenwerking tussen verschillende disciplines vormen het hart van de unieke Wageningen aanpak.