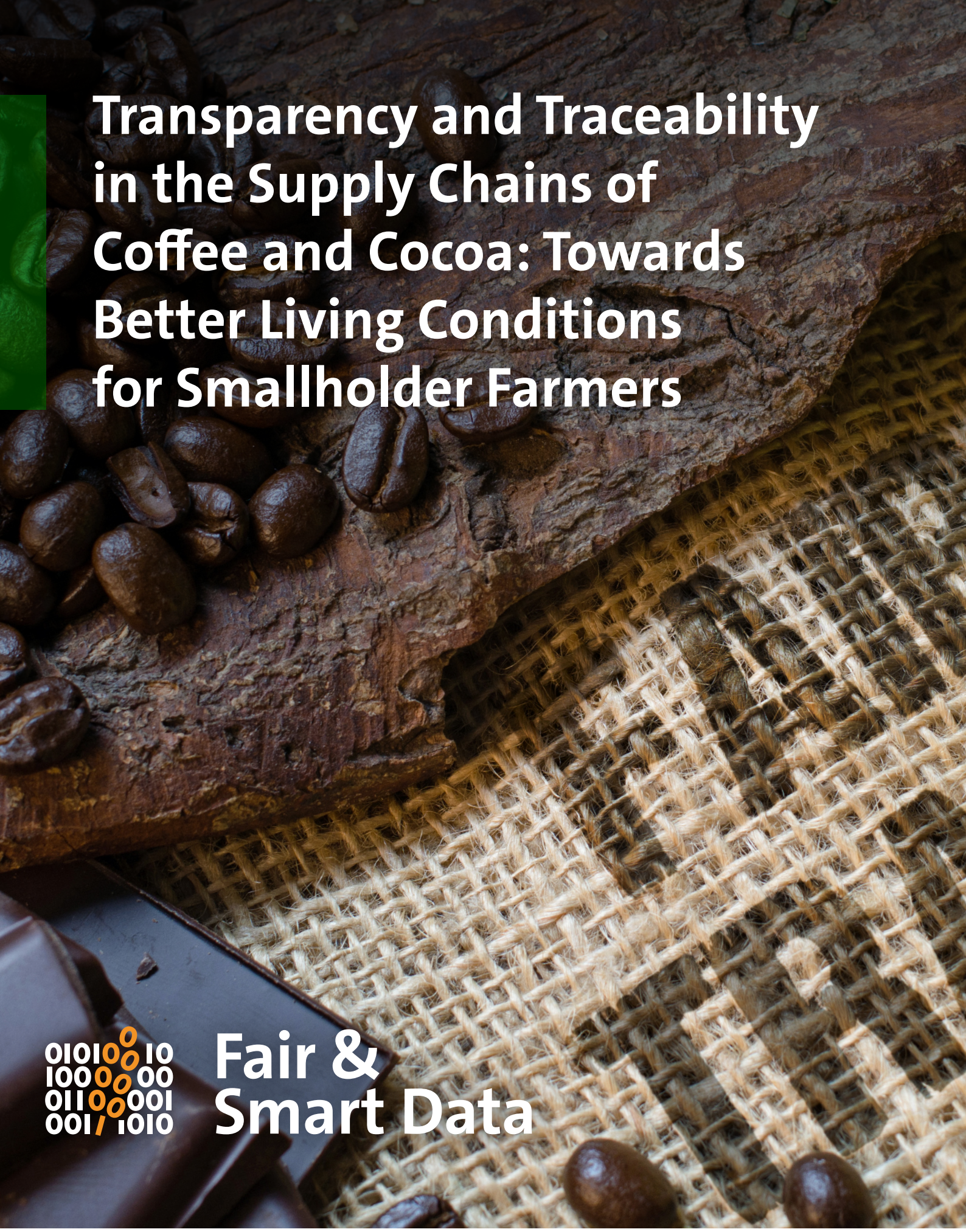
Transparency and Traceability in the Supply Chains of Coffee and Cocoa: Towards Better Living Conditions for Smallholder Farmers



Fair &
Smart Data

Maastricht University

maastrichtuniversity.nl/fsd

ABSTRACT

The cocoa and coffee industries are essential to the global economy, providing livelihoods for millions of smallholder farmers. However, these sectors face economic, environmental, and social challenges with lasting impacts on farmers and their communities. One core underlying problem is the persistent poverty experienced by cocoa and coffee farmers. Although the rising awareness of the negative impacts associated with cocoa and coffee production has generated calls for change from consumers and advocacy groups, it is still hindered by limited transparency in the supply chains of these commodities. Traceability emerges as a potential solution for improved transparency, but its feasibility in the cocoa and coffee industries remains underexplored. Increased transparency and traceability adoption, facilitated by accurate data provision at each level of the supply chain, is an urgent need to improve the living conditions of smallholder farmers. Addressing the root causes of farmer poverty, promoting fair trade practices, and safeguarding human rights are crucial for creating more just and sustainable global supply chains. Achieving this goal requires collaboration among governments, industry leaders, NGOs, and consumers, working together towards a shared vision of a fairer and more prosperous future for the farmers who serve as the backbone of the cocoa and coffee industries.

This report is produced by Fair & Smart Data (FSD), a research project at Maastricht University. For more information visit *maastrichtuniversity.nl/fsd*

Prepared by:

Beatrice Dușmăneanu
Melanie Jeschke

Supervised by:

Sidi Amar

Content

1. Motivation

The cocoa and coffee industries play a significant role in the global economy, with millions of smallholder farmers relying on these crops for their livelihoods (Bermudez et al., 2022; Fairtrade Foundation, 2023). However, both sectors are plagued by environmental and human rights issues that have long-lasting implications for the farmers and their communities. One core underlying problem is the persistent poverty experienced by cocoa and coffee farmers (Fountain & Huetz-Adams, 2022). The financial struggles these farmers face are further exacerbated by the current cost-of-living crisis, making it difficult for them to adopt sustainable practices, improve working conditions, and address environmental and social challenges. In stark contrast to the dire circumstances of smallholder farmers, the companies in the downstream value chain of coffee and cocoa enjoy stable and profitable business operations (Fountain & Huetz-Adams, 2022). With this economic disparity, it becomes imperative for the leading companies in the industry to assume a considerable responsibility in ensuring human rights, due diligence and preventing deforestation within their supply chains.

Increasing global awareness of the negative impacts associated with cocoa and coffee production has prompted collaborative efforts between public and private entities. Consumer-facing companies and their suppliers have made public commitments and formed partnerships to eliminate deforestation and safeguard human rights within their supply chains (Bermudez et al., 2022). Moreover, consumer demand for sustainability has grown substantially (World Economic Forum, 2023), pressuring the industry to respond by offering various sustainability certification options. As a result, companies have increasingly relied on these certification schemes to demonstrate their commitment to sustainable sourcing (Lafargue et al., 2021). These initiatives hold the potential as institutional tools for promoting sustainability by facilitating monitoring, enforcement, and providing economic incentives (Lemeilleur et al., 2015). However, in their eagerness to meet consumer demands, companies often prioritise acquiring certification logos for their products, overlooking the fact that certification schemes can still be susceptible to fraud, lack of transparency, and loss of traceability (Lafargue et al., 2021).

While many companies within the industry have made sustainability commitments and claimed progress, verifying these claims poses a significant challenge (Rothrock et al., 2021). The sustainability claims made by companies regarding their cocoa and coffee products are often misleading. Despite being aware of farmers' harsh realities, such as the prevalence of child labour and the struggle to meet basic needs, some companies continue to promote their products as sustainable. When questioned by non-governmental organisations (NGOs), they defend themselves by pointing to certification from standard-setting organisations or their own sustainability programmes. However, considering the United Nations' definition of sustainability (n.d.) –"meeting the needs of the present without compromising the ability of future generations to meet their own needs"– this would be mere greenwashing. Even when supported by sustainability programmes or certifications, cocoa farming families are still unable to fulfil their essential needs. Furthermore, deforestation resulting from cocoa and coffee production exacerbates the global climate crisis, posing a threat to future generations. Labelling cocoa and coffee from these regions as sustainable disregards the challenges faced by farmers and the broader impact on ecosystems (Fountain & Huetz-Adams, 2022).

In brief, the persistent smallholder farmers' poverty, the disparity between their earnings and the industry profits, and the prevalent greenwashing practices engender a pressing need for increased transparency and traceability in the cocoa and coffee supply chains. By shedding light on the intricacies of these supply chains, we can identify the areas needing improvement and develop strategies that benefit all stakeholders, including smallholder farmers. This report explores the drivers and issues of transparency and traceability in the cocoa and coffee industries in order to enhance farmers' living conditions and address environmental and human rights concerns.

2. Definitions of Main Concepts

Transparency and traceability in the cocoa and coffee supply chains can be powerful tools for positive change. Tracing these commodities' journeys from farm to consumer can provide crucial insights into the conditions under which they are produced.

2.1 Transparency

Supply chain transparency refers to the degree to which information about the production, transportation, and distribution of goods is available to stakeholders throughout the supply chain (Centobelli et al., 2022). Supply chain transparency includes two main elements: visibility and disclosure. In other words, data throughout the supply chain must be accurately identified and collected. Moreover, that information must be communicated both internally and externally at the required or desired level of detail (Harbert, 2020). This includes information about the origin of raw materials, the conditions under which they were produced, the environmental and social impacts of production, as well as the parties involved in the supply chain.

A transparent supply chain allows stakeholders, such as consumers, investors, and regulators, to track the movement of goods and assess the sustainability, ethics, and quality of the products they buy or invest in (Kashmanian, 2017). Transparency can also promote accountability and help to identify and address issues such as human rights abuses, environmental degradation, and fraud. Therefore, many countries are starting to promote transparency in terms of regulations and legislation, using emerging technologies to enhance the accessibility and clarity of the supply chains, particularly in highly competitive, scattered, and complex markets (Centobelli et al., 2022).

2.2 Traceability

Supply chain traceability refers to tracking the movement of goods and information throughout the supply chain, from the very start to the end-use (Norton & Conlon. 2019). Traceability involves collecting data at various supply chain stages, such as the origin of raw materials, transportation and storage conditions, and processing and packaging information. This data is then used to create a traceability system that enables stakeholders to identify the source and history of the products and any issues or inefficiencies in the supply chain (Bechini et al., 2008).

Traceability is essential for several reasons. It can help identify and prevent issues such as fraud, product recalls, and quality control problems. It can also enable producers to demonstrate compliance with regulations and industry standards and help consumers make informed purchase decisions.

2.3 Smallholder Farmers

According to the FAO (2021), smallholders produce around a third of the world's food. There is no consensus in the literature on a definition of smallholder farmers. However, there are common characteristics of smallholder farmers in the definitions available in the literature. Our research group, Fair & Smart Data (FSD), adopts the following working definition of smallholder farmers, which we deem as the most comprehensive: "Smallholders are a vulnerable community[1] of people cultivating small fields of land to feed their families and earn an income, mostly living in rural areas of countries in the Global South with limited access to financial resources and essential infrastructures." The sizes of smallholder farms can differ significantly from one country to another and often reflect differences in their stages of development. (Rapsomanikis, 2015).

1 A vulnerable community is a population within a country with a higher risk of needing humanitarian assistance or being excluded from financial and social services.

3. Drivers for Traceability and Transparency

Increasing traceability and transparency in the coffee and cocoa supply chains can bring various benefits to different actors and society as a whole. These benefits include improved trust and governance for farmer organisations, increased access to loans and grants for national traders and farmer organisations, sustainability and efficiency gains for exporting and grinding companies, reduced corruption and lower costs for regulatory authorities, and enhanced sustainability initiatives and market understanding for manufacturers. All these benefits result in overall market efficiency, improved governance, and adaptive regulations for the entire value chain (Nitidae & Efi, 2021a).

Adapted to the generalised illustration of motivations and drivers of traceability systems by Razak et al. (2021), Figure 1 presents an overview of the drivers for transparency and traceability in the cocoa and coffee supply chains.

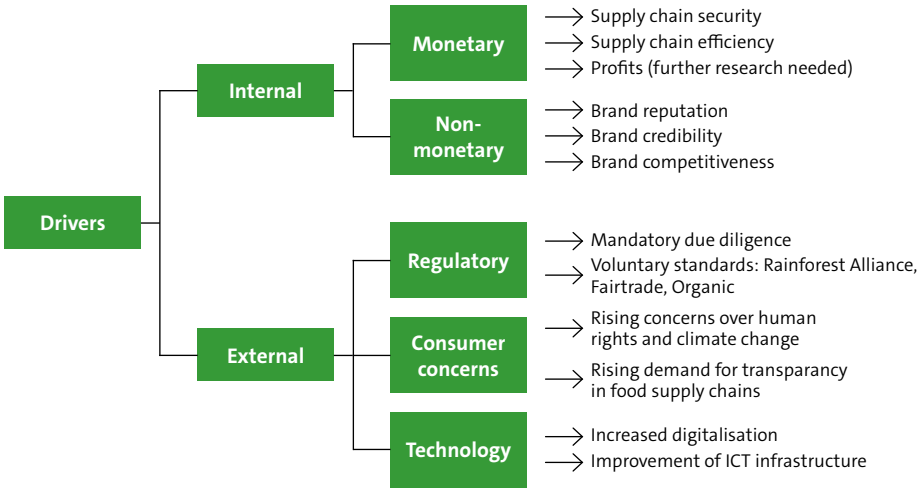


Figure 1. Drivers for transparency and traceability adoption in cocoa and coffee supply chains

3.1 Regulatory Drivers

Besides an improved overview of the supply chain and better business practices, an important external driver for transparency and traceability comes from regulations. For instance, EU countries are developing policies to address issues like child labour and deforestation in supply chains (CBI, 2022a). These policies aim to improve transparency and require companies to ensure their supply chains are free from negative impacts on human rights and the environment.

The forthcoming Due Diligence Act will mandate the traceability of commodities entering EU markets, requiring them to be traced back to the field plot level (Fountain & Huetz-Adams, 2022). This regulatory development is expected to exert pressure on companies and governments of producing countries to fulfil their long-standing promises. The proposed due diligence procedure in the regulation involves three steps: gathering information about the products, conducting a risk assessment, and implementing risk mitigation measures if necessary. Companies must provide a "due diligence statement" confirming compliance or negligible risk before placing the products on the market. These statements will be recorded in a register accessible to enforcement agencies and the public in an anonymised form (Fountain & Huetz-Adams, 2022).

To translate the requirements of the proposed due diligence into implementation, companies have to take the following actions (European Parliament, 2023):

- Integrate due diligence into corporate policies and establish a due diligence system.
- Identify actual or potential adverse impacts.
- Prevent potential adverse impacts and mitigate actual impacts.
- End actual adverse impacts and minimise their extent.
- Establish and maintain complaints procedures.
- Monitor the effectiveness of due diligence policies and measures and publicly report on efforts.

The current regulation has several critical shortcomings. Firstly, it does not require companies to ensure farmers can earn a living income. It is not fully aligned with international standards such as the UN Guiding Principles on Business and Human Rights and the OECD Due Diligence Guidance (ECCJ, 2023). The limitation of the due diligence obligation to "established business relationships" should be revised to ensure companies conduct due diligence throughout their entire supply chain. Efforts should be made to engage with vulnerable groups, including smallholders and indigenous peoples, and gender sensitivity should be incorporated into the proposal (Fountain & Huetz-Adams, 2022).

3.2 Economic Drivers

The economic drivers of companies and some other stakeholders to adopt transparency and traceability in the supply chains are mainly internal and relate to achieving maximum efficiency through the real-time exchange of information. Improved efficiency is meant to reduce transaction costs and risks linked to vertical interactions within the supply chain (Mattevi & Jones, 2016). These internal drivers can be further categorised into monetary and non-monetary market incentives.

Non-monetary drivers refer to the factors that cannot be directly quantified economically and usually do not impact short-to-medium-term profits. Existing literature highlights several non-monetary elements that drive traceability systems, including brand competitiveness, product complexity, and supply chain entry requirements (Resende-Filho & Hurley, 2012; Mai et al., 2010; Mattevi & Jones, 2016). Transparency and traceability systems may be driven by dominant actors within the supply chain when they enforce implementing such systems as a supply chain entry requirement (Sun & Wang, 2019; Heyder et al., 2012). Moreover, supply chain transparency and traceability enable companies to understand better their suppliers' working conditions, allowing them to make more informed decisions about whom they choose to do business with.

Monetary drivers encompass the factors that can be easily measured in economic terms within both the firm and the supply chain (Epelbaum & Martinez, 2014; Canavari et al., 2010). These drivers aim to either increase firm profits or enhance supply chain efficiency. Increased profits are a long-term driver, often initiated by short-term goals like reducing costs and mitigating liabilities associated with supply chain failures, such as recall expenses, financial penalties, and market share damage (Mai et al., 2010; Kayikci et al., 2022). Efficient

tracking and fast exchange of information among supply chain actors are viewed as a value-adding activity that impacts supply chain efficiency positively (Hinkka et al., 2013).

By understanding the full scope of their supply chain and knowing where their products and materials come from, companies can be better prepared to respond to potential risks and take action to mitigate them. Thus, firms striving to enhance their operations and overall efficiency are motivated to embrace transparency and traceability systems. Furthermore, Supply chain security is a significant concern, and the implementation of traceability systems holds the potential to enhance supplier relations and address this issue effectively.

3.3 Social Drivers

Consumers increasingly demand transparency and traceability in the products they buy, particularly regarding sustainability, ethical sourcing, and fair labour practices (El-Warraky et al., 2021). Therefore, companies that can demonstrate transparency and traceability in their supply chains are better positioned to meet these consumer demands, increasing trust in their products and production processes and driving brand loyalty (Razak et al., 2021).

Moreover, voluntary standards and certifications also drive the implementation of transparency and traceability systems (Mol & Oosterveer, 2015). Firms seek such certifications to show supply chain partners and consumers that they adhere to environmental, social, and economic standards.

3.4 Technological Drivers

Digitalisation offers significant benefits in the cocoa and coffee industries, particularly in addressing the growing demand for transparency and traceability. It enables the gathering, monitoring, and information storing throughout the supply chain, facilitating sustainable sourcing, market linkages, productivity improvement, competitiveness, and environmental protection (CBI, 2022a).

Cocoa producers can leverage digital tools to enhance internal processes, decision-making, and farm-level operations. In addition, digital tools allow producers and exporters to share specific product and operation information, increasing access to financing and insurance. Furthermore, technology enables direct connections between small-scale producers and the entire value chain, granting them better market access.

For instance, employing digital tools in traceability can assist in substantiating the origin of products, thereby facilitating access to the EU market and reinforcing a company's position as a trading partner (CBI, 2022a). For cocoa exporters, the Centre for the Promotion of Imports from developing countries (CBI) advises to:

- Consider implementing a (digital) traceability system.
- Clearly define priorities in terms of traceability.
- Develop a well-thought-out strategy for the effective utilisation of traceability tools.
- Explore multiple digital solutions to ensure informed decision-making.
- Determine the most suitable tool for the company before investing in it.

Through traceability, buyers, producers, and consumers can gain access to up-to-date and accurate information, fostering transparency. With the aid of digital tools, supply chain actors can achieve the following:

- Verify the geographical origin of cocoa.
- Link sustainability attributes to specific batches of cocoa and coffee.
- Gather data on certification payments.
- Inform and engage with consumers.

4. Supply Chains of Coffee and Cocoa

In the following sections, we discuss the structures and challenges of coffee and cocoa supply chains and the issues related to implementing transparency and traceability.

4.1 Coffee Supply Chain

Coffee is one of the world's most widely traded commodities, making it a driving factor in the global economy (FAO, 2023). Worldwide an estimated 125 million people depend on coffee for their livelihoods, mostly in middle- and low-income countries (The Fairtrade Foundation, 2023). Coffee is produced in about 80 tropical countries, with an annual production of around 9 million tonnes of green coffee beans (Krishnan, 2017). Production, processing, and marketing of coffee are organised in global value chains. A typical coffee value chain is very complex, involving multiple stages and many stakeholders.

4.1.1 Economic, Social and Environmental Challenges of the Coffee Supply Chain

There are general challenges in the coffee supply chain that can potentially be solved by transparency and traceability. These challenges can be categorised into three main categories: economic, social, and environmental.

Economic. Despite the high price that coffee can fetch on the global market, many farmers receive low crop prices. Farmers earn less than $1 a pound for their beans (Kettler, 2019). In addition to high expenses, farmers struggle to earn a sustainable income and invest in new technology. Due to limited access to credit and technical assistance, farmers cannot easily adopt new farming practices or improve the quality of their crops.

Farmers have limited access to market information and pricing data, hindering their ability to negotiate fair prices for their coffee and make informed production decisions (Samper & Quiñones-Ruiz, 2017). This can lead to lower yields and quality, further reducing their income and competitiveness. For example, to earn a living income, coffee's export price must be $2 per pound for a 4-person farming household in Colombia (Kettler, 2019). This is double the current market price of coffee beans and 43% more than the current Fairtrade Minimum Price.

The volatility of the coffee market has been a continuous problem for decades. Since 2013, the prices have frequently been lower than the cost of production (USAID, 2019). Coffee is a major capital investment. Therefore, farmers usually continue to harvest coffee even when the price is lower than the cost of production. This price uncertainty may hinder appropriate decision-making regarding resource allocation and planning. Moreover, while coffee prices fluctuate, the main production costs, including labour and fertilisers, are rising in all countries.

Social. There are many social issues related to the coffee supply chain, including poverty, child labour, lack of access to basic necessities, and labour shortage induced by youth migration. Most of these issues are side effects of the limited financial resources of farmers.

Most young people in farmer communities see farming as a high-risk and low-status vocation. The hard work and low earnings make coffee farming unattractive for young people. Thus, rural youth increasingly migrate to urban centres for better economic opportunities (Utrilla-Catalan et al., 2022). This leads to a labour shortage in the ageing farmer communities of the coffee sector. The average age of coffee farmers across Africa is 60 years.

Since farmers are not earning enough money to afford labour, children are often used to supplement the labour force on coffee farms, especially during harvest season. Coffee is one of the top 5 agricultural commodities produced by child labour (4C, 2022). Some children work up to 6 days a week and around 8 hours daily, earning less than $5 a day. This can prevent them from attending school and put their health and safety at risk.

Coffee farmers are usually located in remote areas with limited access to infrastructure such as roads, electricity, and telecommunications. This can make it difficult for farmers to access markets, education, and healthcare, contributing to poverty and isolation.

Environmental. The coffee supply chain faces various environmental challenges that significantly impact the ecosystem and sustainability. These challenges include deforestation, biodiversity loss, pesticide use, and wastewater management.

Deforestation is a critical issue within the coffee supply chain (Nguyen & Sarker, 2018) as the expansion of coffee farms often leads to the clearing of forests, destroying valuable habitats and displacing numerous plant and animal species. Deforestation also contributes to climate change by releasing large amounts of carbon dioxide into the atmosphere. The conversion of natural habitats into coffee plantations reduces the diversity of plant and animal species in the affected areas.

Farmers often rely on chemical pesticides to protect crops from pests and diseases. However, excessive and improper use of these substances can have adverse effects on the environment. Pesticides can contaminate soil, water sources, and nearby ecosystems, harming beneficial insects, birds, and other wildlife and potentially entering the human food chain.

Wastewater management is a critical aspect of sustainable coffee production. Coffee processing involves large volumes of water, which can become contaminated with organic matter, chemicals, and by-products (Nguyen & Sarker, 2018). Inadequate management of this wastewater can lead to pollution of nearby water bodies, causing harm to aquatic life and compromising the quality of water resources for local communities.

4.1.2 Structure of the Coffee Supply Chain

Figure 2 presents a visualisation of the coffee supply chain, which involves seven key actors operating in the upstream segment, ranging from farmers to commodity traders. Besides the stakeholders involved directly in the production, others provide assistance throughout the supply chain. Among these are certification bodies, research institutions, aggregation platforms, public bodies, and input and service providers

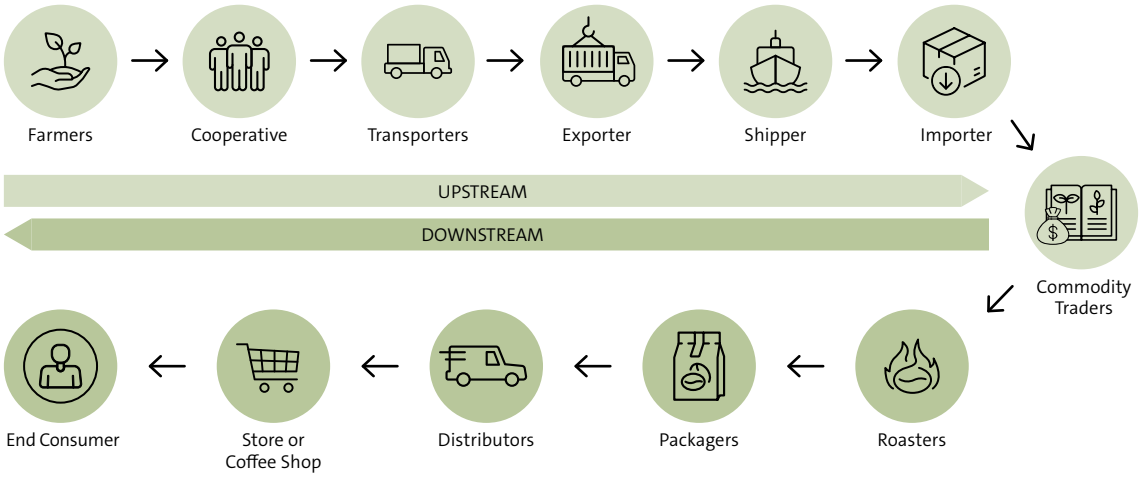


Figure 2. Structure of coffee supply chains

Farmers and Cooperatives. The coffee supply chain originates with farmers, particularly smallholders in tropical regions of Latin America, Asia, and Africa. These farmers play a vital role in global coffee production, responsible for cultivating 70% of coffee beans worldwide (Utrilla-Catalan et al., 2023). Following the harvest, the coffee cherries undergo additional processing, with two main methods: dry processing, which is based on sun-drying the cherries, and wet processing, which includes washing and fermenting the cherries before drying.

Smallholder farmers are in an unfavourable position within the supply chain due to their limited financial resources, remote locations, restricted market access, and lack of connections with international market players. To address these challenges, these farmers can establish cooperatives, a strategic move that allows them to improve their access to resources and capitalise on marketing and business opportunities (Bali et al., 2021). Groups of farmers in proximity come together to form producer organisations or cooperatives, benefiting from their collective size to gain additional bargaining power. Some cooperatives even progress to an advanced level, investing in shared capital, farm equipment, and various communal services, such as education and healthcare.

Smallholder farmers' primary income source stems from selling almost all their produced coffee at the farm gates (UNDP, 2012). When selling their coffee, most farmers opt to collaborate with cooperatives, village collectors, brokers, or exporters within their districts or nearby districts. This approach helps them navigate market access challenges and ensures a more stable income flow.

Exporters. After the coffee beans are prepared for sale, exporters play the crucial role of moving them from the producing countries to the consuming ones. The level of responsibility these exporters hold in the supply chain can vary (Samper et al., 2017). Typically, they provide essential services such as quality storage, timely transportation, and insurance coverage for the coffee during transit. The costs involved in procuring coffee and the risks associated with price fluctuations can be substantial, especially depending on the region and the exporters' long-term commitments to their clients.

Cooperatives often rely heavily on their established partnerships with a single exporter. As a result, there may be limited awareness at the farmer level about the differences in services provided by various exporters. Some exporters are considerably large and financially adept, with access to essential market, financial, and technological resources.

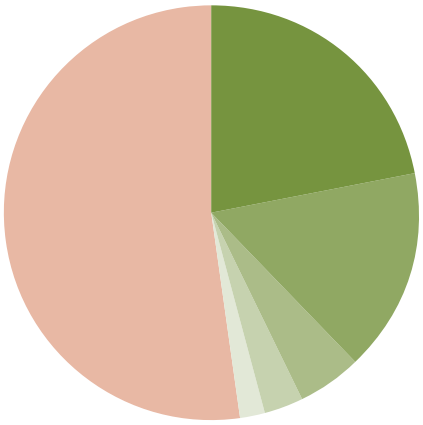
Importers. The downstream coffee value chain is usually developed in consuming countries (Utrilla-Catalan et al., 2022). Once the coffee beans reach their destination country, commodity traders facilitate their buying and selling for importers.

Generally, importers serve as the link connecting the coffee available in the market to the roasters. Their responsibilities encompass a range of services, including procurement, financing, and logistical support for international roasters (Samper et al., 2017). Additionally, they might offer supplementary sensory testing and quality assessment services. Importers are usually financially savvy and often establish partnerships with major financial institutions. It is common for importers to maintain associations with several coffee storage and logistics companies within a country. Furthermore, they have some of the most extensive access to the market, financial resources, and technological tools.

Roasters. Following their production journey, the coffee beans are typically sold to coffee roasters responsible for bringing out their distinct flavours and characteristics through the roasting process. Roasters might also blend different types of coffee beans to create unique and exclusive blends.

The size of a roasting company plays a vital role in determining its influence and market power. Currently, the coffee roasting industry is characterised by increasing concentration, with 5 corporations dominating the global market, as illustrated in Figure 3 (Ghoshray & Mohan, 2021). Given the supply of coffee in the market, these roasters often wield significant bargaining power and enjoy high access to market intelligence, financial resources, and technological tools.

For quality assurance, roasters typically conduct thorough analyses and cup testing to ensure the roast is even and to identify any defects that might have occurred during post-harvest processes (CBI, 2020).



Roaster	Market Share
Nestle	22%
Jacobs Douwe Egberts	16%
Green Mountain	5%
Strauss	3%
Tchibo	2%
Others	52%

Figure 3. Roasters' shares of the global coffee market (Source: Ghoshray & Mohan, 2021)

Retailers and Consumers. Following the roasting process, the coffee beans are packaged and distributed to various channels, including retailers, coffee shops, and sometimes directly to consumers. A handful of concentrated players dominate the retail segment. In the Netherlands, for instance, just 5 retailers, namely Albert Heijn, Jumbo, Lidl, Plus, and Aldi, control a staggering 79% of the market.

Consumers play a critical role in the final stage of the coffee supply chain. They possess the power to shape the entire chain by exerting influence over market demand, making ethical choices, raising awareness, and even engaging in direct trade relationships (ILO, 2020). The choices consumers make, such as the type of coffee they purchase, the brands they support, and the certifications they prioritise, significantly impact the production and availability of coffee varieties. By actively selecting brands that emphasise fair trade, sustainability, and social responsibility, consumers can effectively prompt companies to adopt responsible sourcing practices, support farmers' livelihoods, and reduce the environmental impact of coffee production (CBI, 2022b).

4.1.3 Transparency and Traceability Issues in the Coffee Supply Chain

Information asymmetry between consumers and supply chain actors is a significant barrier to sustainable consumption expansion (Sayogo et al., 2015). In the coffee supply chain, transparency and traceability are essential for providing reliable data, which is crucial in ensuring sustainable and ethical production and trade of coffee. Nonetheless, achieving full transparency and traceability is a challenging endeavour.

The coffee supply chain faces four key challenges concerning transparency and traceability:

Complex and fragmented supply chain. The complexity of the supply chain itself is one of the biggest challenges towards implementing transparency and traceability. Coffee beans pass through multiple intermediaries, including growers, exporters, importers, roasters, and retailers, making tracking their journey from the farm to the cup very difficult.

The long and various handling methods of coffee, tailored to meet specific end-product requirements, result in a complex and opaque process (Alamsyah et al., 2023). Additionally, the coffee production industry has always been characterised by crop fluctuations with slow time to maturity of coffee cherries, knowledge-intensive processes, and high input and investment, contributing to price volatility and delayed returns (Utrilla-Catalan et al., 2022).

Limited Data and Information Sharing. To enhance the availability of information throughout the supply chain and to consumers, it is crucial to obtain reliable and accurate data from all stakeholders involved. However, limited data and information sharing pose significant challenges.

While certain traceability tools exist in some stages of the supply chain (Bateman, 2015), each participant in this intricate system only tracks their particular segment of the journey using their own data logging system. Consequently, information is collected at each point but is not effectively communicated across the supply chain among the different actors. This siloed data management leads to fragmented information throughout the supply chain.

At the farmer level, consistent documentation is difficult for two primary reasons. First, farmers see no value in maintaining documentation other than obtaining a price premium. Without a premium, farmers see documentation as a waste of their time. Second, farmers are reluctant to record information about their products if the documentation process is complicated (Sayogo et al., 2015).

Roasters generally procure their coffee from traders or importers. However, some importers do not want to reveal relevant information. As a result, roasters are often faced with incomplete and inaccurate data regarding the origin of the coffee they purchase, affecting their ability to provide accurate and complete data on their roasted products.

Confidentiality-related legal challenges may slow the process of getting information from each supply chain stakeholder (Kuepper & Kusumaningtyas, 2020). Furthermore, information about commodity chains is often intended for internal use and remains mostly confidential for external parties, including consumers.

Limited Visibility and Accessibility to Smallholders. The third challenge revolves around the inadequate visibility faced by smallholder farmers, predominantly in remote regions with limited access to essential infrastructure like roads, electricity, and telecommunications. The challenging and steep landscapes in which coffee plants flourish further complicate the task of timely visits and assistance to the farmers. This limitation severely hampers the provision of much-needed support and guidance to coffee farmers. Consequently, there exists a significant lack of awareness among farmers regarding the importance and applicability of traceability.

Limited Technology Adoption. Coffee farmers are generally reluctant to adopt new technologies (Hussain et al., 2020). The combination of high costs, inadequate infrastructure, and low digital literacy among farmers contributes to the limited technology adoption in their areas, resulting in a lack of effective traceability measures. This situation makes verifying coffee beans' origin, quality, and sustainability difficult.

Table 1 recapitulates the transparency and traceability challenges in the coffee supply chain.

Transparency and Traceability Challenge	Description
Complex and fragmented supply chain	The coffee supply chain's complexity makes tracking the coffee beans' journey difficult. The coffee beans go through different stages with specific handling mechanisms to meet product requirements, resulting in an opaque process.
Limited Data and Information Sharing	Barriers to data sharing and documentation create challenges in the coffee supply chain. Farmers have limited incentives to document their operations, leading to inconsistent record-keeping. Importers and traders may withhold information, resulting in data gaps for roasters. Legal issues, including confidentiality concerns, further hinder information flow among stakeholders. Consequently, incomplete and inaccurate data undermines the credibility of the tracking efforts in the supply chain.
Limited Visibility and Accessibility to Smallholders	Coffee farmers often reside in remote areas with restricted access to basic infrastructures. These circumstances cause a lack of awareness among farmers regarding the importance and applicability of traceability.
Limited Technology Adoption	Limited technology adoption among smallholder farmers is attributed to high costs, lack of infrastructure, and low digital literacy.

Table 1. Summary of traceability and transparency challenges in the coffee supply chain.

4.2 Cocoa Supply Chain

The cocoa industry relies on an estimated 5 to 6 million farmers worldwide, supporting the livelihoods of nearly 50 million individuals (Bermudez et al., 2022). Approximately 90% of these farmers are smallholders who cultivate cocoa on plots of land less than 5 hectares in size (Voora et al., 2019) in developing countries across Africa, Asia, and Latin America (CacaoNet, 2012). Out of the total production, 70% comes from two African countries – Ghana and Côte d'Ivoire (Voora et al., 2019). The cocoa market is highly concentrated, with only a few trading and processing companies handling significant volumes of cocoa beans (Fountain & Huetz-Adams, 2022). While cocoa serves as a basic raw material for various products, its primary consumption is driven by the chocolate industry, which in 2022 achieved a market size of around $ 127.7 billion, projected to experience a compound annual growth rate (CAGR) of 4.4% until 2028 (Global Chocolate Market Report and Forecast 2023-2028, n.d.). A significant portion of the value and margins is concentrated in the hands of the final actors, namely chocolate brands and retailers, capturing around 70% of the total value and 90% of the total margins from cocoa farmers to end consumers (FAO & BASIC, 2020). Conversely, in the upstream of the value chain, stakeholders engaged in activities ranging from cocoa cultivation to bean exports generate a relatively smaller share, only 18.6% of the total value and less than 7.5% of the total margin (FAO & BASIC, 2020).

4.2.1 Economic, Social and Environmental Challenges of the Cocoa Supply Chain

The cocoa industry faces complex and interconnected issues, encompassing environmental protection, human rights, and farmer poverty. Addressing these challenges requires comprehensive approaches that consider the economic, social, and environmental dimensions of sustainability in cocoa production.

Economic. Both the environmental and social issues in the cocoa industry are deeply rooted in the problem of farmer poverty (Fountain & Huetz-Adams, 2022). Cocoa farmers often live in poverty, and the current cost-of-living crisis further compounds their financial struggles. Farmer poverty serves as a fundamental driver behind nearly every challenge faced in the cocoa sector, and without cocoa farmers earning a living income, achieving sustainability in the cocoa industry becomes an elusive goal (Fountain & Huetz-Adams, 2022). Despite its gravity, current sustainability legislations like the EU Directive on Corporate Sustainability Due Diligence (CSDDD) only vaguely reference farmer poverty, and most sustainability programmes fail to address its causes (Fountain & Huetz-Adams, 2022).

Social. Child labour is a significant issue with an extensively documented history in the cocoa supply chain, particularly in producing countries of West Africa (LeBaron & Gore, 2020). In this context, children are involved in age-inappropriate and hazardous labour practices, violating their rights. The social issues within the cocoa supply chain extend beyond child labour, which often receives the most attention. Families in the cocoa sector face a broad spectrum of challenges, such as limited access to education, inadequate healthcare and sanitation facilities, uncertainties regarding land and tree tenure, violations of labour rights, and gender inequality (Fountain & Huetz-Adams, 2022). Women, in particular, face barriers as both rights-holders and agents for change. They often have limited access to resources, education, and decision-making processes, which impedes their ability to improve their circumstances and contribute to positive change in the industry.

Environmental. A growing number of uncertainties, including climate change (Bunn et al., 2017), the effects of the Covid-19 pandemic (Global Agriculture and Food Security Program, 2021), and geopolitical events such as the ongoing Russian-Ukrainian war (Confectionery Production, 2022a) are challenging the viability of the cocoa sector as they lead to increase in prices and lower yields. In addition to being vulnerable to the effects of climate change, the cocoa sector is also a driver of climate change, as in many parts of the world, cocoa farming is associated with deforestation (Renier et al., 2023). The upward trend in deforestation caused by cocoa production persists mainly due to several factors. These include increasing demand for chocolate, declining production capacity resulting from ageing cocoa trees, insufficient implementation of effective agricultural practices, and the reduction of suitable land areas due to the impacts of climate change (Ashiagbor et al., 2022). These combined factors provide additional motivation to convert forests into farmland for cocoa cultivation, posing a significant threat to preserving remaining forested and protected areas.

4.2.2 Structure of the Cocoa Supply Chain

Similar to the coffee supply chain, the cocoa supply chain involves multiple stakeholders, spanning from cultivation to retail. Once cocoa farmers sell their harvest, local traders, exporters, and processors collect and transport the cocoa, sometimes engaging in local grinding and pressing activities. Subsequently, the cocoa reaches the importing country, where further processing, such as grinding and pressing, may occur before selling it to chocolate manufacturers. The final chocolate products are then distributed to retailers, who sell them to end consumers through supermarkets and stores.

Cocoa production across different countries exhibits variations in the upstream supply chain, with distinct terminology used to refer to the various actors involved. To gain a deeper understanding of the interconnections among actors in the entire cocoa supply chain, a more detailed analysis was conducted on the supply chains of Ghana and Côte d'Ivoire. These two countries were chosen due to their status as the largest cocoa-producing nations, providing valuable insights into the complexities and dynamics of cocoa production at a significant scale.

Supply chain structure in Côte d'Ivoire

In Côte d'Ivoire, the Conseil du Café-Cacao (CCC) fully regulates the cocoa sector (Stoop et al., 2021). CCC is a government institution established to develop a sustainable cocoa and coffee sector, and according to Guichet Unique du Commerce Extérieur (n.d.), its objectives include enhancing productivity, ensuring fair income for producers, and promoting coffee and cocoa consumption domestically and internationally. CCC also sets the farmgate price for cocoa, regulates cocoa prices for subsequent transactions, and issues licenses for cocoa exports (Laven et al., 2016). By fulfilling these functions, the CCC plays a crucial role in the management and growth of the cocoa (and coffee) industry in Côte d'Ivoire.

Farmers. The cocoa supply chain (in both countries) begins with the farmers, as represented in Figure 4 and Figure 5. Cocoa farmers usually take care of cocoa tree planting and maintenance, harvesting, cocoa shelling, fermentation and drying, and farmgate sales. If a farmer is part of a cooperative, they are duly identified and registered.

Middlemen. In Côte d'Ivoire, there are two types of middlemen or small traders: pisteurs (trackers), who are independent traders, and delegues (delegates), who have direct connections with the cooperatives (Renier et al., 2023).

Cooperatives. They are farmer-connect organisations that purchase, collect, and aggregate the farmer's production, and typically they work in the interest of their members. The sale mode depends on the farmer's proximity to the cooperative and capacity to meet the volume requirements. If accessible, the farmers can sell directly to the cooperative; otherwise, they sell through middlemen.

Cooperatives in the cocoa sector can compete with local traders by offering certification premiums for some farmers' production. However, they often face challenges in collecting the entire production due to delayed start of buying cocoa beans, higher operational costs, and limited ability to pay certification premiums for all delivered beans. Moreover, local traders can provide additional services to farmers more efficiently and consistently, such as credit, and advantageous terms for selling or purchasing food crops and inputs, allowing them to maintain a significant market share (Nitidae & Efi, 2021a).

Buying centres. In addition to the cooperatives, in Côte d'Ivoire, there are buying centres that purchase cocoa from pisteurs. Similarly to the cooperatives, they sell it for either local processing or international export (Stoop et al., 2021).

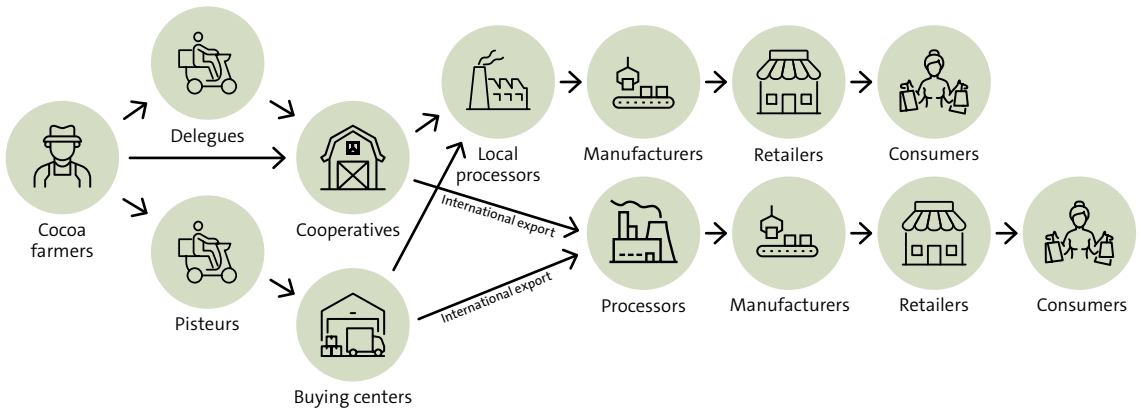


Figure 4. Structure of the cocoa supply chain in Côte d'Ivoire

Supply chain structure in Ghana

In Ghana, where cocoa represents the backbone of the country's economy (Stoop et al., 2021), the Cocoa Board (COCOBOD) regulates the cocoa sector. The board's objectives include promoting value addition and processing, regulating market activities, and supporting the development of the cocoa industry in Ghana (Cocobod - Objectives and Functions of the Board, n.d.). COCOBOD is also responsible for farmgate price setting and quality control at several points in the chain.

Licensed Buying Companies and Produce Buying Company. The cocoa supply chain in Ghana is quite similar to Côte d'Ivoire, the main difference being that instead of cooperatives and buying centres, there are Licensed Buying Companies (LBCs) and a Produce Buying Company (PBC) that buy the cocoa from the smallholders (Stoop et al., 2021). The LBCs comprise a network of purchasing clerks operating at the local or communal level, responsible for buying and collecting cocoa beans and arranging transportation to district warehouses. Large LBCs have hundreds of purchasing clerks operating in over 50 districts nationwide (Nitidae & Efi, 2021a).

Cocoa Marketing Company. The cocoa collected by the LBCs and PBC is transported to the Cocoa Marketing Company (CMC), which operates through three centres nationwide (Owusu & Duah, 2018). The CMC holds significant authority as the sole state-owned subsidiary through which LBCs are allowed to sell their cocoa. Subsequently, the CMC handles the local processing, trading, and export to international traders and processors.

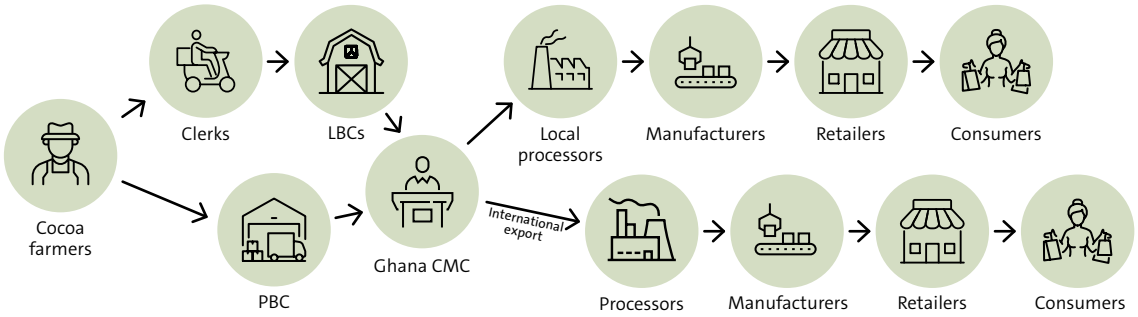
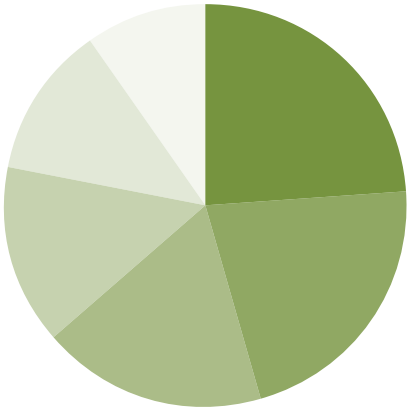


Figure 5. Structure of the cocoa supply chain in Ghana

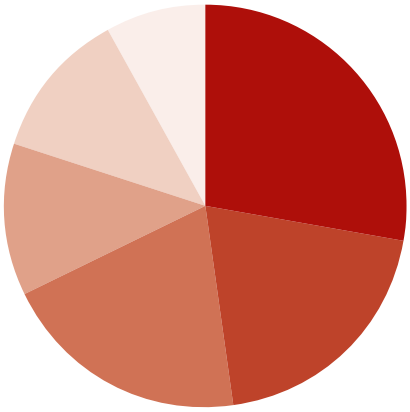
Processors. They carry out the primary processing of the cocoa beans and then export most of them to chocolate manufacturers.

Chocolate manufacturers and retailers. The manufacturers perform secondary processing, where the cocoa product (be it cocoa butter or powder) is transformed into chocolate and other confectionary products and then sold to retailers, who sell it to the final consumer.

The downstream supply chain is very concentrated, as only 6 international processing and trading companies dominate the cocoa bean trade, accounting for approximately 83% of the total trade, and only 8 companies account for 50% of the global manufacturing of chocolate (Nitidae & Efi, 2021b). Moreover, manufacturers and retailers are the ones to gain the highest margins, amounting together to 80 - 90% of the total chocolate price (Bermudez et al., 2022). Figure 6 represents the market share of the biggest traders, processors and manufacturers in the cocoa value chain.



Company	Role	Global trade/sales
Barry Callebaut	Trader, processor	20%
Olam	Trader, processor	18%
Cargill	Trader, processor	15%
ECOM	Trader, processor	12%
Sucden	Trader	10%
Touton	Trader, processor	8%



Mars	Manufacturer	14%
Ferrero	Manufacturer	10%
Mondelez	Manufacturer	10%
Hershey	Manufacturer	6%
Nestle	Manufacturer	6%
Lindt	Manufacturer	4%

Figure 6. Global shares of largest cocoa processors and chocolate manufacturers (Source: Nitidae & Efi, 2021b)

To facilitate a broader analysis of the applicability of traceability tools and systems, a more generalised depiction of the supply chain is illustrated in **Figure 7**. This involves grouping various terms such as "pisteurs", "delegues", or "purchasing clerks" into a common term, namely "middlemen". Similarly, the subsequent stakeholder, typically referred to as "cooperatives" or "licensed buying companies", is represented simply as "cooperatives". Furthermore, despite variations in nomenclature across countries, the term "exporter" is used to encompass all the relevant stakeholders, even if in specific instances, such as in Ghana, this role is fulfilled by the CMC.

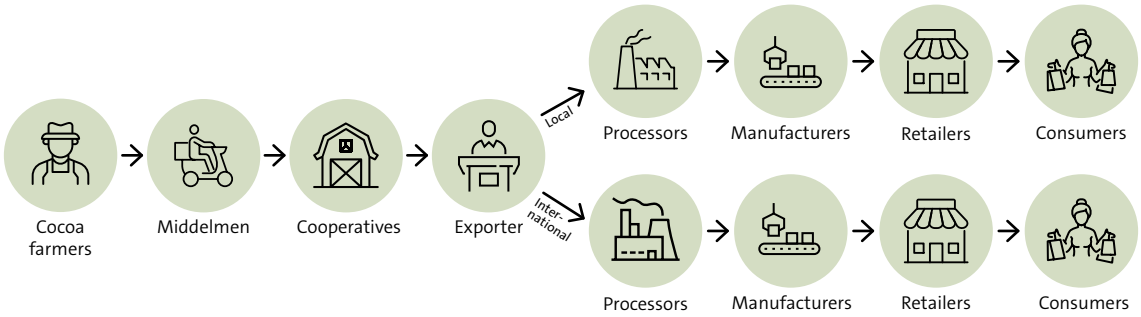


Figure 7. Generalised structure of cocoa supply chains

Achieving transparency and traceability in the cocoa supply chain requires stakeholders' active participation and collaboration. Each stakeholder has a unique role in data provision and ensuring traceability:

- **Farmers** maintain accurate records of their farming practices, including the use of fertilisers, pesticides, and labour conditions.
- **Cooperatives** register farmers, keep documentation on cocoa origin at the farmer level, support cocoa farmers by promoting sustainable farming practices, facilitate access to training and resources, and encourage farmers to improve traceability through proper record-keeping.
- **Traders and processors** establish systems to track the origin of cocoa beans, maintain transparent documentation, and promote fair trade practices.
- **Manufacturers** record the origin and quality of the cocoa beans they receive, maintain chain-of-custody documentation, and implement traceability systems throughout their production processes.
- **Retailers** demand transparency from their suppliers, source certified cocoa, and provide information to consumers about the origin and sustainability of cocoa products
- **Consumers** make informed choices and support initiatives that promote transparency in the cocoa supply chain and drive the demand for traceable and sustainable cocoa.

4.2.3 Transparency and Traceability Issues in the Cocoa Supply Chain

The lack of transparency and traceability is a significant challenge in the cocoa industry and can be attributed to many factors. However, the two main macro factors are insufficient ambition and funding from the industry stakeholders and the absence of supporting legislation in consuming and producing countries. For instance, in Côte d'Ivoire, the national legislation mandates companies to source at least 20% of their cocoa through local exporters. These local exporters, however, often rely on middlemen such as pisteurs and traitants, who either cannot or choose not to provide the necessary traceability information (Fountain & Huetz-Adams, 2022).

Even though the cocoa supply chains differ slightly depending on the actors involved, especially in the producing countries, one thing they have in common is the middlemen (the small traders linking the farmers and the bigger cooperatives). Visibility is missing at the farm and small trader levels, leading to a so-called 'break in the chain' (Lafargue et al., 2021). Subsequently, this break makes specifying the cocoa origin at the farm level quite challenging.

The difficulty of accessing certain farms presents a lucrative opportunity for the middlemen who collect the harvest. However, these middlemen are not inclined to allow external oversight of their operations, resulting in a lack of information or data provision at this crucial stage of the supply chain (Lafargue et al., 2021). Consequently, the companies involved face significant challenges in attaining visibility down to the farm level, hampering their ability to manage the sustainability of their inputs.

In their report, Nitidae and Efi (2021a) state nine critical challenges that limit traceability to the farmer level, such as the presence of multiple plots owned by farmers, the prevalence of sharecropping arrangements, difficulties in accurate identification of farmers, postharvest mixing of cocoa beans, the involvement of multiple buyers, the existence of multiple cooperatives, downstream mixing practices, a lack of supplier loyalty, and the diverse needs and preferences of clients.
Table 2 presents an overview of the main challenges of transparency and traceability in the supply chain of cocoa gathered from different literature sources.

Transparency and Traceability Challenge	Description
Presence of middlemen	Middlemen that are present in most cocoa supply chains lack standardised documentation. Due to their intricate network, there is a lack of transparency which hampers the establishment of first-mile traceability.
Absence of regulations	Regulatory frameworks regarding farmer documentation and supply chain traceability are lacking in cocoa-producing countries, hindering the traceability efforts coming from downstream actors.
Cocoa commoditisation	Specifying the origin of cocoa proves challenging due to its status as a commodified product, which often undergoes mixing and blending throughout the supply chain. This mixing process makes it difficult to maintain traceability and accurately track the specific origins of cocoa beans.
Geographical remoteness	The geographical remoteness of the cocoa production countries poses a significant challenge for the focal firms in the industry, as it limits their visibility across the supply chain and their ability to influence the upstream actors and their practices. With less oversight and control over the supply chain, it becomes harder to establish robust traceability systems and ensure adherence to ethical and sustainable practices.

Multiple plots	Farmers have multiple cocoa plots, some old (deforested long ago) and some younger ones, planted more recently. Farmers may falsely register cocoa from younger plots as coming from older ones to meet sustainability objectives. This makes it difficult to trace cocoa from recently deforested areas and allows farmers to over-report production.
Sharecropping	Numerous cocoa plots are managed by sharecroppers rather than the landowners themselves. As a result, cocoa is sold by multiple individuals, making it difficult to establish a clear link between production and a specific farmer. This omission of sharecroppers and tenants not only impacts farmer income but also has far-reaching implications on their capacity to safeguard the environment, affects the labour rights of sharecroppers and tenants, and runs the risk of policy decisions favouring the interests of farm owners over addressing the challenges faced by those directly engaged in the laborious work.
Identification	In Côte d'Ivoire, the prevalence of duplicate names among people often poses challenges in accurately identifying individuals. Moreover, many farmers lack proper identification documents, and some even possess multiple documents with varying ID numbers and birth dates, further exacerbating the complexities in the identification processes.
Post-harvest mixing	During the process of cleaning and drying the cocoa beans before being bagged, farmers can easily mix beans from different plots, sometimes to achieve the desired quality mix.
Multiple buyers	Farmers often sell their cocoa to multiple buyers instead of delivering their entire production to cooperatives. This decision stems from the financial constraints faced by cooperatives, which rely on funding from traders and cannot afford to purchase beans throughout the entire season. Moreover, the uncertainty surrounding the quantity of beans sold as certified and the fluctuating premiums discourage farmers from entrusting all their production to cooperatives. Consequently, farmers choose to sell to alternative buyers or middlemen who can offer immediate cash when the cooperative lacks sufficient funds to make purchases.
Multiple cooperatives	Farmers often register in multiple cooperatives, primarily to gain access to premium payments and social services. Consequently, this practice results in the duplication of plot registrations and farmer records across various cooperatives, creating difficulties in verifying and tracking their information, especially given the common occurrence of shared names.
Downstream mixing	Cocoa beans undergo additional mixing at different stages in the downstream supply chain. This mixing process aims to achieve homogenised quality, offset weight losses, and fulfil specific client requirements.
Lack of consistency in the supply	Sustaining trade relationships is a complex and time-consuming endeavour. Factors such as market price fluctuations, regional yield variability, quality concerns, delivery timing, and funding limitations can prevent suppliers from fulfilling their commitments. As a result, exporters and processors may resort to engaging new suppliers to meet their contractual obligations, leading to the incorporation of beans with unknown supply information into the supply chain.
Diversity of clients	The chocolate industry displays a growing interest in certified and traceable cocoa products; however, some manufacturers prioritise cost or striking a balance between price and quality over traceability and sustainability. To cater to a wide range of clients and customers, trading companies and chocolate manufacturers offer multiple brands or product categories with varying levels of requirements. To accommodate this diversity, trading companies combine sustainability commitments with an opportunistic procurement approach, making it unlikely for any major company to fully commit to direct procurement and a certified supply chain.

Table 2. Challenges limiting traceability to the farmer level in the cocoa supply chain

The establishment of comprehensive traceability systems from farmer to consumer in the cocoa supply chain is impeded by various existing challenges. Despite efforts to systematically document and track the origin of cocoa, the involvement of multiple actors and the decentralised nature of the supply chain creates significant barriers for downstream stakeholders to specify the origin of cocoa and maintain full transparency accurately.

5. Linking Consumers to Smallholder Farmers

There is a growing consumer interest in understanding the journey of products like coffee and cocoa. Consumers seek transparency and want to make informed purchasing decisions that positively impact the lives of smallholder farmers who produce the products' raw materials. This section analyses the vital link between consumers and smallholder farmers by exploring the data available on each side. Furthermore, a methodology to assess the available data is introduced to help consumers get more information about the origin of their products and make conscious purchasing decisions.

5.1 Farmer-to-consumer Transparency and Traceability

To create a positive impact on the livelihoods of smallholder farmers in the cocoa and coffee sectors, supply chain actors must ensure that the collected data serves the interests of these farmers. This calls for a higher level of transparency and disclosure, providing insights into the realities, challenges, and opportunities farmers face. Achieving a more equitable and democratic information landscape requires collaborative and coordinated efforts. These endeavours should consider the burden on farmers during data collection, encourage the adoption of cohesive indicators for comprehensive assessments, and facilitate inclusive information sharing.

Effective collaborations involving diverse stakeholders in the supply chain have the potential to reduce unnecessary resource expenditure and complexity associated with data collection and sharing. The crucial aspect of this effort is designing an approach that intentionally encourages the active participation of smallholder farmers and cooperatives. Embracing a more inclusive and cooperative approach allows the cocoa and coffee sectors to effectively harness the power of data, addressing smallholder farmers' specific needs and challenges. This approach empowers farmers and enhances the outcomes of data-driven initiatives aimed at improving their livelihoods.

In the current landscape, consumers searching for information on the origin of their coffee and chocolate products often encounter limited details on the packaging and websites. Technology holds the potential to empower consumers by granting them access to the complete journey of their favourite coffee or chocolate. However, there is currently a lack of consumer-oriented software and apps dedicated to that purpose. To bridge this information gap, companies, producers, and regulatory bodies must join forces to prioritise transparency and traceability.

While technology provides the means, a collaborative approach is necessary to establish comprehensive systems that connect the dots and deliver complete product information to consumers. Moreover, existing regulations need to evolve to ensure that consumers can easily access the desired level of information about the products they consume.

5.2 Data Availability at the farm level

Accessing data about cocoa and coffee farmers as a consumer can be quite difficult. Typically, data about farmers is collected and published by international organisations such as the Food and Agricultural Organization (FAO), World Bank, International Coffee Organization (ICO), Specialty Coffee Association (Costa et al., 2013), certification organisations including Fairtrade and Rainforest Alliance, or in academic papers. Nevertheless, non-profit organisations like Lutheran World Relief and Heifer International have noted that despite the abundance of data and information about cocoa and coffee production and supply chains, there is a notable absence of data concerning the vital contributions, challenges, and conditions of smallholder farmers who play a crucial role in these industries. Moreover, the available data is frequently dispersed and not readily accessible.

In recent years, multi-stakeholder initiatives have made efforts to mobilise actors across the coffee and cocoa value chains to collectively identify sustainability objectives and actions, with some initiatives focusing on issues affecting smallholder farmers and cooperatives. However, these efforts have not yet resulted in a more democratic data landscape where data on farmers is readily available.

The search for publicly available data on smallholder farmers' living conditions uncovers several limitations and access barriers. While there are ongoing efforts to collect and store data about coffee and cocoa farmers for various purposes, a substantial amount of this information is not openly accessible. For example, some data may be restricted to specific user groups, such as scientific publications, investment reports, and compliance reports.

Biases in data collection and sharing present further challenges. Some organisations may be reluctant to gather or disclose data on sensitive topics that could potentially reflect poorly on their operations. Alternatively, they might selectively focus on data directly benefiting their interests. As a result, the available data and information offer only a partial picture of smallholder farmers' realities, leading to information asymmetries.

Various data can be available on the farmer's side, offering valuable information to all stakeholders in the value chain of coffee and cocoa, including consumers. Table 3 presents an overview of the different data types available at the farm level.

Type of data	Description
Demographics	Demographic data about the farmers, such as age, gender, education level, and household size, contribute to assessing the social and economic aspects of cocoa and coffee farming communities.
Geolocation	The availability of data on the farm's size and geographical coordinates enables precise location tracking.
Farming practices	Detailed insights into farming practices, including cultivation techniques, irrigation methods, and fertilisers or pesticides, provide valuable information on organic and sustainable farming approaches.
Productivity	Collecting crop yield data facilitates the assessment of productivity and output. Additionally, documenting the cocoa and coffee varieties on the farm helps determine the quality and flavour characteristics of produced beans.
Harvest	Data related to the timing and harvesting methods, as well as the post-harvest processing techniques employed (such as wet or dry processing), can be recorded.
Quality assessment	Some farms may also conduct quality assessments of their coffee beans, utilising cupping tests or other evaluations to determine flavour profiles and grades.

Environmental conditions	Environmental conditions, including altitude, temperature, rainfall, and soil characteristics in the cocoa- and coffee-growing regions, are crucial factors to consider as they directly influence the product quality and the farm's long-term sustainability.
Finance	Financial data, including production costs, revenue, profitability, and access to credit or financing, provides insights into the economic viability of farming operations.
Certification and compliance	Maintaining records related to certifications such as Fair Trade, Organic, Rainforest Alliance, or other sustainability labels allows for tracking compliance and certification processes.

Table 3: Types of data available at the farm level

5.3 Methodology for Relaying Farmer Data to Consumers

Gaining clarity on whether smallholder farmers are being paid adequately and fairly can be challenging for consumers due to the lack of data provision and transparency. In Figure 8, we present a methodology that connects the available data on farmers to consumers. Below is a categorisation of available data and information at various levels:

Product/Company Level:

- Information provided on the packaging related to certifications or labels indicating fair trade, organic, or sustainable practices often implies that farmers are paid fair prices, and the cocoa or coffee is sourced responsibly. In addition, QR codes on the packaging can redirect the consumer to the company's website for more information.
- Some companies provide more detailed information about the product's origin, the agricultural practices involved, and the living conditions of farmers on their websites.
- Companies may also release reports detailing their involvement in improving the livelihood of smallholder farmers. An example would be the premium price some companies offer farmers, often as an additional percentage on top of the regular price while considering a living income benchmark. These reports offer valuable insights into the initiatives, projects, and support extended to farmers, shedding light on fair payment practices and other forms of assistance.

International/Independent Organisations Level:

- Reports and data from international organisations and NGOs provide information on agricultural practices, sustainable sourcing, and fair trade. These organisations often conduct research, set standards, and provide benchmarks for living conditions, income levels, and sustainability in farming communities.
- Independent sources of information, such as scientific studies or assessments conducted by non-profit and academic institutions, may offer insights into smallholder farmers' income levels and overall well-being in specific regions or sectors.

Farmer/Cooperative Level:

- Cooperatives associated with smallholder farmers might offer data or reports on their members' income levels, livelihood improvement programmes, and pricing mechanisms. This information can help assess whether fair payment practices are in place.
- It is essential to note that obtaining specific and accurate information at the individual farmer level can be challenging. Estimations and generalisations are often made due to the complexity of supply chains and the involvement of multiple actors. However, by combining information from multiple sources and considering independent assessments, consumers can better understand a company's sourcing practices and commitment to fair payment for smallholder farmers.

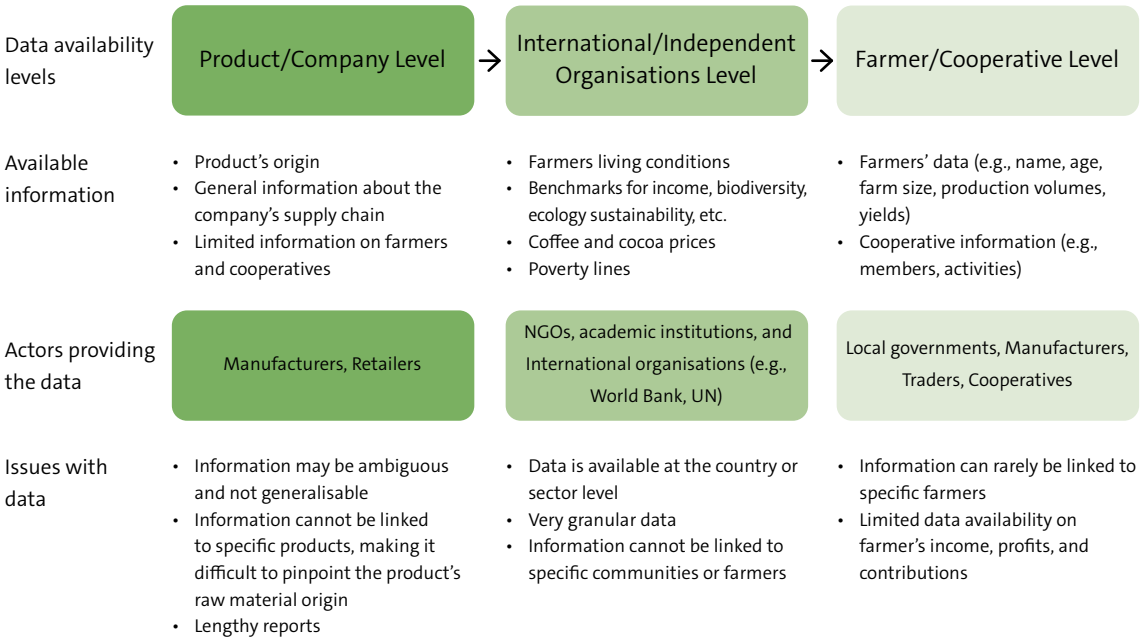


Figure 8. Data levels and linkage methodology

The information accessible to consumers often falls short of providing a comprehensive understanding of the impact of purchasing certain coffee and cocoa products on the farmer communities who cultivate them. Nevertheless, by accessing the three levels of data, one can gain some insights into whether farmers are receiving adequate compensation and whether the production methods employed are sustainable.

6. References

4C. (2022). *Protecting Children's Rights in Coffee Supply Chains*. 4C. https://www.4c-services.org/wp-content/uploads/2022/07/4C.pdf

Alamsyah, A., Widiyanesti, S., Wulansari, P., Nurhazizah, E., Dewi, A. S., Rahadian, D., Ramadhani, D. P., Hakim, M. N., & Tyasamesi, P. (2023). Blockchain traceability model in the coffee industry. *Journal of Open Innovation: Technology, Market, and Complexity*, *9*(1), 100008.

Ashiagbor, G., Asante, W., Forkuo, E. K., Acheampong, E., & Foli, E. G. (2022). Monitoring cocoa-driven deforestation: The contexts of encroachment and land use policy implications for deforestation-free cocoa supply chains in Ghana. *Applied Geography*, *147*, 102788. https://doi.org/10.1016/j.apgeog.2022.102788

Bali, N., Moroda, M. K., & Kumar, S. (2021). Factors Affecting Coffee Value Chain in Cooperative Union: The Case of Multipurpose Cooperative Union Kellem Wollega Zone. *Neeraj Bali, Moga Kana Moroda and Srinivasan Kumar, Factors Affecting Coffee Value Chain in Cooperative Union: The Case of Multipurpose Cooperative Union Kellem Wollega Zone, International Journal of Management*, *11*(12), 2020.

Bateman, A. H. (2015). Tracking the value of traceability. *Supply Chain Manag. Rev*, *9*, 8-10.

Bechini, A., Cimino, M. G., Marcelloni, F., & Tomasi, A. (2008). Patterns and technologies for enabling supply chain traceability through collaborative e-business. *Information and software technology*, *50*(4), 342-359.

Bermudez, S., Voora, V., Larrea, C., & Luna, E. (2022). GLOBAL MARKET REPORT Cocoa prices and sustainability. In *IISD.org*. IISD. https://www.iisd.org/system/files/2022-11/2022-global-market-report-cocoa.pdf

CacaoNet. (2012). *A Global Strategy for the Conservation and Use of Cacao Genetic Resources As the Foundation for a Sustainable Cocoa Economy*. https://www.cacaonet.org/fileadmin/templates/CacaoNet/Uploads/publications/A_global_strategy_for_the_conservation_and_use_of_cacao_genetic_resources__as_the_foundation__Abbreviated_version__1989.pdf

Canavari, M., Centonze, R., Hingley, M., & Spadoni, R. (2010). Traceability as part of competitive strategy in the fruit supply chain. *British Food Journal*, *112*(2), 171-186.

CBI. (2020). *Entering the European market for organic coffee*. CBI Ministry of Foreign Affairs. https://www.cbi.eu/market-information/coffee/organic-coffee/market-entry

CBI. (2022a, November 22). *9 tips to go digital in the cocoa sector*. https://www.cbi.eu/market-information/cocoa-cocoa-products/tips-go-digital

CBI. (2022b). *Which trends offer opportunities or risks in the European coffee market?* Ministry of Foreign Affairs https://www.cbi.eu/market-information/coffee/trends

Centobelli, P., Cerchione, R., Del Vecchio, P., Oropallo, E., & Secundo, G. (2022). Blockchain technology for bridging trust, traceability and transparency in circular supply chain. *Information & Management*, *59*(7), 103508.

Cocobod - Objectives and Functions of the Board. (n.d.). https://cocobod.gh/objectives-of-board

Costa, C., Antonucci, F., Pallottino, F., Aguzzi, J., Sarriá, D., & Menesatti, P. (2013). A review on agri-food supply chain traceability by means of RFID technology. *Food and bioprocess technology*, *6*, 353–366.

ECCJ. (2023, June 1). *EU Parliament gives green light to corporate due diligence law, but still leaves grave loopholes - ECCJ*. https://corporatejustice.org/news/eu-parliament-gives-green-light-to-corporate-due-diligence-law-but-still-leaves-grave-loopholes/

El-Warraky, N., Duran, E., Abreu, G., Burke, K., Waegemans, T., & Leclercq, T. (2021). *Track, trace, trust: The future is transparent*. Accenture. https://www.accenture.com/_acnmedia/PDF-163/Accenture-Consumer-Goods-Reimagined-POV-02-Track-Trace-Trust.pdf

Epelbaum, F. M. B., & Martinez, M. G. (2014). The technological evolution of food traceability systems and their impact on firm sustainable performance: A RBV approach. *International Journal of Production Economics*, *150*, 215-224.

European Parliament. (2023). *Parliament adopts new law to fight global deforestation | News | European Parliament*. https://www.europarl.europa.eu/news/en/press-room/20230414IPR80129/parliament-adopts-new-law-to-fight-global-deforestation

Fairtrade Foundation. (2023). *Coffee Farmers*. Fairtrade Foundation. https://www.fairtrade.org.uk/farmers-and-workers/coffee/

FAO. (2021). *Small family farmers produce a third of the world's food*. Food and Agriculture Organization of the United Nations. https://www.fao.org/news/story/en/item/1395127/icode/

FAO. (2023). *Coffee*. Food and Agricultural Organization of the United Nations. https://www.fao.org/markets-and-trade/commodities/coffee/en/

FAO & BASIC. (2020). *Comparative study on the distribution of value in European chocolate chains*. https://lebasic.com/wp-content/uploads/2020/07/BASIC-DEVCO-FAO_Cocoa-Value-Chain-Exec-Summary_Advance-Copy_June-2020.pdf

farmerconnect. (n.d.). *Our Traceability Platform*. farmerconnect. https://www.farmerconnect.com/products

Fountain, A. C., & Huetz-Adams, F. (2022). *Cocoa Barometer (2022)*. Cocoa Barometer. Retrieved April 3, 2023, from https://cocoabarometer.org/en/

Global Chocolate Market Report and Forecast 2023-2028. (n.d.). Expert Market Research. https://www.expertmarketresearch.com/reports/chocolate-market

Ghoshray, A., & Mohan, S. (2021). Coffee price dynamics: an analysis of the retail-international price margin. *European Review of Agricultural Economics*, *48*(4), 983–1006.

Guichet Unique du Commerce Extérieur. (n.d.). *The Coffee and Cocoa Board*. guce.gouv.ci. Retrieved May 2, 2023, from https://guce.gouv.ci/bcc?lang=en_US

Harbert, T. (2020). *Supply chain transparency, explained*. MIT Management Sloan School. https://mitsloan.mit.edu/ideas-made-to-matter/supply-chain-transparency-explained

Heyder, M., Theuvsen, L., & Hollmann-Hespos, T. (2012). Investments in tracking and tracing systems in the food industry: A PLS analysis. *Food Policy*, *37*(1), 102-113.

Hinkka, V., Främling, K., & Tätilä, J. (2013). Supply chain tracking: aligning buyer and supplier incentives. *Industrial Management & Data Systems*.

Hussain, L. A. S., Inzoli, F., Golinucci, N., Stevanato, N., Rocco, M. V., & Colombo, E. (2020). FEEM Approach to Supply Chain Analysis The coffee sector in Kenya.

ILO. (2020). *Sustainable supply chains to build forward better*. https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---sector/documents/genericdocument/wcms_777245.pdf

Kashmanian, R. M. (2017). Building greater transparency in supply chains to advance sustainability. *Environmental Quality Management*, *26*(3), 73–104.

Kayikci, Y., Subramanian, N., Dora, M., & Bhatia, M. S. (2022). Food supply chain in the era of Industry 4.0: Blockchain technology implementation opportunities and impediments from the perspective of people, process, performance, and technology. *Production planning & control*, *33*(2-3), 301–321.

Kettler, P. (2019). *We love coffee. Are we willing to pay the price?* Fairtrade. https://www.fairtrade.net/news/we-love-coffee-are-we-willing-to-pay-the-price

Kuepper, B., & Kusumaningtyas, R. (2020). *Monitoring the Sustainability Status of the Dutch Coffee Sector: Tracking Progress Beyond Certification*. Profundo. https://www.pbl.nl/sites/default/files/downloads/pbl-2020-monitoring-sustainability-dutch-coffee-market-profundo-3992.pdf

Lafargue, P., Rogerson, M., Parry, G., & Allainguillaume, J. (2021). Broken chocolate: biomarkers as a method for delivering cocoa supply chain visibility. *Supply Chain Management*, *27*(6), 728–741. https://doi.org/10.1108/scm-11-2020-0583

Laven, A., Oomes, N., Tieben, B., & Buunk, E. (2016). Market Concentration and Price Formation in the Global Cocoa Value Chain. *ResearchGate*. https://www.researchgate.net/publication/316924045_Market_Concentration_and_Price_Formation_in_the_Global_Cocoa_Value_Chain/figures?lo=1

Lemeilleur, S., N'Dao, Y., & Ruf, F. (2015). The productivist rationality behind a sustainable certification process: evidence from the Rainforest Alliance in the Ivorian cocoa sector. *International Journal of Sustainable Development*, *18*(4C), 310. https://doi.org/10.1504/ijsd.2015.072661

Mai, N., Gretar Bogason, S., Arason, S., Víkingur Árnason, S., & Geir Matthíasson, T. (2010). Benefits of traceability in fish supply chains–case studies. *British Food Journal*, *112*(9), 976-1002. https://doi.org/http://dx.doi.org/10.1108/00070701011074354

Mattevi, M., & Jones, J. A. (2016). Food Supply Chain: Are UK Small to Medium Sized Enterprises (SME) Aware of Concept, Drivers, Benefits & Barriers, and Frameworks of Traceability? *British Food Juóurnal*, *118*(5), 1107–1128. http://wrap.warwick.ac.uk/75548

Mol, A. P., & Oosterveer, P. (2015). Certification of markets, markets of certificates: Tracing sustainability in global agro-food value chains. *Sustainability*, *7*(9), 12258-12278.

Nitidae & Efi. (2021a). *Traceability and transparency of cocoa supply chains in Côte d'Ivoire and Ghana*. Retrieved March 3, 2023, from https://www.nitidae.org/en/documents?filieres%5B%5D=cacao

Nguyen, G. N., & Sarker, T. (2018). Sustainable coffee supply chain management: a case study in Buon Me Thuot City, Daklak, Vietnam. *International Journal of Corporate Social Responsibility*, *pp. 3*, 1–17.

Nitidae & Efi. (2021b). *Sustainability initiatives in Ivorian and Ghanaian cocoa supply chains: benchmarking and analysis*. https://www.nitidae.org/en/documents?filieres%5B%5D=cacao

Owusu, A., & Duah, H. (2018). The Effect Of Outsourcing Intra-Port Haulage Operations On Productivity: The Case Of Cocoa Marketing Company Limited, Takoradi. *European Journal of Research and Reflection in Management Sciences*, *Vol. 6*(No. 1).

Rapsomanikis, G. (2015). *The economic lives of smallholder farmers*. F. a. A. O. o. t. U. Nations. https://www.fao.org/3/i5251e/i5251e.pdf

Razak, G. M., Hendry, L. C., & Stevenson, M. (2021). Supply chain traceability: A review of the benefits and its relationship with supply chain resilience. *Production Planning & Control*, pp. 1–21.

Renier, C., Vandromme, M., Meyfroidt, P., Ribeiro, V., Kalischek, N., & Ermgassen, E. K. Z. (2023). Transparency, traceability and deforestation in the Ivorian cocoa supply chain. *Environmental Research Letters*, *18*(2), 024030. https://doi.org/10.1088/1748-9326/acad8e

Resende-Filho, M. A., & Hurley, T. M. (2012). Information asymmetry and traceability incentives for food safety. *International Journal of Production Economics*, *139*(2), 596–603.

Rothrock, P., Weatherer, L., Ellis, K., Samberg, L., Donofrio, S., & Calderon, C. (2021). *Trends in the Implementation of Ethical Supply Chains: A 2020 Snapshot of the Cocoa Sector*. https://www.forest-trends.org/publications/trends-in-implementation-of-ethical-supply-chains-cocoa-2020/

Samper, L. F., Giovannucci, D., & Vieira, L. M. (2017). *The powerful role of intangibles in the coffee value chain* (Vol. 39). WIPO.

Samper, L. F., & Quiñones-Ruiz, X. F. (2017). Towards a balanced sustainability vision for the coffee industry. *Resources*, *6*(2), 17.

Sayogo, D. S., Zhang, J., Luna-Reyes, L., Jarman, H., Tayi, G., Andersen, D. L., Pardo, T. A., & Andersen, D. F. (2015). Challenges and requirements for developing data architecture supporting integration of sustainable supply chains. *Information Technology and Management*, *pp. 16*, 5–18.

Stoop, P., Ramanan, N., Geens, H., Lambrecht, A., & Dekeister, S. (2021). *Technical Brief on Cocoa Traceability in West and Central Africa*. C-Lever.org. Retrieved April 2, 2023, from https://www.idhsustainabletrade.com/publication/technical-brief-on-cocoa-traceability/

Sun, S., & Wang, X. (2019). Promoting traceability for food supply chain with certification. *Journal of Cleaner Production*, *217*, 658-665.

UNDP. (2012). *The Market and Nature of Coffee Value Chains in Uganda* https://www.undp.org/sites/g/files/zskgke326/files/migration/ug/UNDPUg_-PovRed_Value-Chain-Analysis-Report-Coffee-2013-Report.pdf

United Nations. (n.d.). *Sustainability | United Nations*. https://www.un.org/en/academic-impact/sustainability

USAID. (2019). *Price Risk Management in the Coffee and Cocoa Sectors*. https://agrilinks.org/sites/default/files/resources/price_risk_management_coffee_and_cocoa_final_report_september_2019.pdf

Utrilla-Catalan, R., Rodríguez-Rivero, R., Narvaez, V., Díaz-Barcos, V., Blanco, M., & Galeano, J. (2022). Growing Inequality in the Coffee Global Value Chain: A Complex Network Assessment. *Sustainability*, *14*(2), 672.

Voora, V., Bermúdez, S., & Larrea, C. (2019). *Global Market Report: Cocoa*. IISD.

World Economic Forum. (2023, January 17). *Consumers want sustainable options. What food producers, suppliers, and retailers can do now*? https://www.weforum.org/agenda/2023/01/consumer-power-net-zero-food-producer-retailer-davos23/