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The Cost of Cocoa: Tracing Deforestation and EUDR Non-Compliance in Nestlé's Sourcing Strategy

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Abstract - English

Every kilogram of chocolate we consume comes with a hidden cost: forest degradation, especially in West Africa. In Ivory Coast, forests cover 2 million hectares of land, almost 90% less than in the 1960s (Kouadio and Singh, 2021), with cocoa cultivation responsible for 37% of deforestation in protected areas (Kalischek et al., 2023). Starting at the end of 2025, the EU Deforestation Regulation (EUDR) will require companies to prove that cocoa imported into the EU market is not associated with recent forest loss. This is to put pressure on downstream players like Nestlé.

This thesis examines Nestlé's cocoa suppliers from Ivory Coast and how they align with EUDR compliance. By combining public trade and deforestation data from Trase with Nestlé Cocoa Plan disclosures, we estimate historical deforestation exposure and project future risk under three scenarios, based on different sourcing and land-use strategies, up to 2026.

Results show that with no compliance from traders, 89.4% of Nestlé's cocoa could remain indirectly sourced and untraceable by 2026. In this case, deforestation exposure could reach 176,000 hectares and cause annual losses of over €300 million due to cocoa being confiscated at the EU border. On the other hand, a stronger push towards traceability and low-impact suppliers could cut that exposure by half. The analysis provides a data-driven method to assess compliance risk and highlights the role that a good procurement strategy has in managing both environmental and financial outcomes.

Title: “The Cost of Cocoa: Tracing Deforestation and EUDR Non-Compliance in Nestlé's Sourcing Strategy”

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Keywords: Cocoa, EUDR, Deforestation, Traceability, Nestlé, Ivory Coast, West Africa.

Abstract - Portuguese

Cada quilograma de chocolate consumido tem um custo oculto: a degradação das florestas, especialmente na África Ocidental. Na Costa do Marfim, restam 2 milhões de hectares de floresta — quase 90% menos do que na década de 1960 (Kouadio e Singh, 2021) — e o cultivo do cacau responde por 37% da desflorestação em áreas protegidas (Kalischek et al., 2023). A partir do final de 2025, o Regulamento da UE sobre desflorestação (EUDR) exigirá que as empresas provem que o cacau importado para a UE não esteja ligado à perda recente de florestas. O objetivo é pressionar atores a jusante, como a Nestlé.

Esta tese analisa os fornecedores da Nestlé na Costa do Marfim e seu alinhamento com o EUDR. Com dados públicos da Trase e divulgação do Plano de Cacau da Nestlé, estimamos a exposição histórica à desflorestação e projetamos o risco futuro em três cenários, baseados em estratégias de abastecimento e uso do solo até 2026.

Os resultados indicam que, sem ação dos comerciantes, 89,4% do cacau da Nestlé continuará com origem indireta e não rastreável até 2026. Isso pode expor 176 000 hectares à desflorestação e gerar perdas anuais acima de 300 milhões de euros devido ao confisco na fronteira da UE. Já o incentivo à rastreabilidade e fornecedores de baixo impacto pode reduzir essa exposição pela metade. A análise propõe um método para avaliar o risco de conformidade e reforça a importância de estratégias eficazes de aquisição na gestão ambiental e financeira.

Título: “O custo do cacau: rastrear a desflorestação e o incumprimento da EUDR na estratégia de provisionamento da Nestlé”

Autor: Carlotta Verona

Palavras-chave: Cacau, EUDR, Desflorestação, Rastreabilidade, Nestlé, Costa do Marfim, África Ocidental.

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Introduction

Cocoa production is one of the main drivers of deforestation in West Africa. At the same time, demand for cocoa continues to grow, and the majority of buyers still rely on fragmented and opaque supply chains. The European Union's Regulation on Deforestation-free Products (EUDR), that will enter in force at the end of this year 2025, sets a new legal standard: all cocoa entering the EU market must be traceable back to a plot of land that was not deforested after 2020. This law introduces new compliance risks for manufacturers of chocolate—along with 6 other commodities—that source from countries with weak traceability systems and a long history of practices causing forest degradation.

The first part of this thesis gives an overview of the Regulation, followed by an analysis of the cocoa market in West Africa and the pressures it faces. We then examine Nestlé, one of the world's largest chocolate producers, and its cocoa procurement strategy. The focus is on Ivory Coast and Ghana, where the company sources most of its beans. In both countries, cocoa farming has been expanding into forested areas, including protected zones and national parks. A first analysis investigates the tradeoff between sourcing in Ivory Coast versus Ghana. This is referred to as Scenario Analysis I. Then, by linking Nestlé's disclosures with public data, we built a dataset of Nestlé's cocoa volumes and then matched it to departmental-level deforestation exposure from Trase to estimate the impact of individual suppliers. From there, we modelled how a company like Nestlé could meet compliance by 2026: under different assumptions about both sourcing strategy and land-use practices, three scenarios were computed. This is referred to as Scenario Analysis II. A final assessment, called Economic Loss Modelling, looks at the financial impact of non-compliant cocoa by linking untraceable volumes to potential losses from confiscated supply. This approach provides a business-relevant model for anticipating regulatory risks and quantifying environmental impact linked to sourcing decisions.

The manuscript is divided into six sections. Section 1 reviews the key literature; Section 2 presents the market analysis; Section 3 then outlines the research questions; Sections 4 and 5 describe the data and the methodology used. Section 6 presents the results, interpretation, and limitations. Please note that Sections 5 and 6 follow a three-part structure in order to

investigate Scenario Analysis I, Scenario Analysis II, and Economic Loss Modelling separately.

1. Literature Review

The liberalisation of trade and business has encouraged the growth of global supply chains; an estimated one-third of agri-food exports are now traded within global value chains (FAO & BASIC, 2020). While the act of deforestation takes place at specific locations upstream in the supply chain, downstream firms and suppliers play a critical role in ensuring that the risk of deforestation is addressed within the commodity supply chains from which they source.

1.1 Concerns connecting agriculture and deforestation

Agricultural expansion is the main driver of almost 90% of global deforestation (FAO, 2022), with land-use change linked to population growth, economic development, and evolving consumption patterns (Geist & Lambin, 2002). As incomes rise, dietary preferences shift away from staple crops toward higher-value foods such as meat, dairy, fruits, vegetables, and processed products, thereby intensifying pressure on land and forest resources (Geist & Lambin, 2002).

The production of food is the primary cause of biodiversity loss globally (Benton et al., 2021) and, as highlighted in *The State of the World's Forests 2024*, the conversion of forests and other natural ecosystems into agricultural land leads to habitat destruction, fragmentation, and degradation, resulting in declines in species richness and ecosystem functionality (FAO, 2024). This transformation not only threatens the survival of countless species but also undermines the ecosystem services that forests provide, such as carbon sequestration, water regulation, and soil fertility, which are essential for sustainable agriculture and human well-being.

Empirical studies have consistently identified a small group of commodities such as cattle meat, oil palm, cereals and soybeans, and forestry products as major contributors to deforestation (Pendrill et al., 2019). However, it is the mode of production, not the commodities themselves, that links these supply chains to forest degradation. As such, international responses have increasingly adopted commodity-specific approaches, combining public regulation, private sector commitments, and multi-stakeholder

partnerships. Initiatives such as the Amazon Soy Moratorium and the Cocoa & Forests Initiative in Côte d’Ivoire and Ghana exemplify collaborative efforts to decouple agricultural production from deforestation, while supporting sustainable livelihoods and forest restoration.

1.2 Regulatory Efforts on Deforestation

Many efforts are being made to break the link between commodity production and deforestation. For the past two decades some international initiatives have set targets mainly by 2020 (see Table 1), but meeting them was challenging. These commitments have at least pushed companies involved in production, trade, or in buying deforestation-linked commodities in general, to start taking action.

Date	Organisation / Initiative	Commitment
2008-2015	UN Framework Convention on Climate Change – REDD, then REDD+, Framework	Activities to reduce emissions from deforestation, sustainable management of forests, and conservation of forest carbon stocks in developing countries.
2010	Consumer Goods Forum (network of retailers, manufacturers and service providers)	Zero net deforestation in membership’s supply chains by 2020 in key commodities.
2012	Tropical Forest Alliance (global partnership of governments, companies, civil society, Indigenous Peoples, local communities, and UN agencies)	Reduction in tropical deforestation associated with the sourcing of commodities. Promotes regional multi-stakeholder initiatives.
2014	New York Declaration on Forests (over 200 national and local governments, companies, and civil society, community and Indigenous Peoples’ organisations)	At least halve the rate of loss of natural forests globally by 2020, strive to end natural forest loss by 2030; support private-sector goal of eliminating deforestation from production of agricultural commodities by no later than 2020; significantly reduce deforestation derived from other economic sectors by 2020.
2015	UN Sustainable Development Goals	SDG 15.2: “By 2020, promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation globally.”
2020	Consumer Goods Forum Forest-Positive Coalition of Action	Coalition of major companies aiming to support deforestation- and conversion-free enterprises. Commodity-specific roadmaps for action.
2021	COP26 Glasgow Leaders’ Declaration on Forests and Land Use (signed by 141 countries)	“Work collectively to halt and reverse forest loss and land degradation by 2030 while delivering sustainable development and promoting an inclusive rural transformation”.
2021	COP26 Forest, Agriculture and Commodity Trade (FACT) Dialogue Roadmap for Action (statement by 27 governments)	Promotes trade of agricultural commodities while protecting and sustainably managing forests. Includes indicative actions on trade development, smallholder support, traceability, and transparency.

Table 1. International initiatives against deforestation. Source: OECD/FAO (2023).

But in recent years, as part of the EU's commitment to terminate global forest loss, the Commission has introduced the EU Regulation on Deforestation-free Products, known as EUDR, to minimize the European Union’s contribution to global deforestation and degradation through its consumption and trade of specific agricultural and forest-based commodities (Regulation (EU) 2023/1115).

1.2.1 Overview of the Regulation

Regulation (EU) 2023/1115 establishes an harmonized legal framework to ensure that specific commodities placed on or exported from the EU market are not associated with deforestation or forest degradation. The regulation covers seven high-risk commodities such as cattle, cocoa, coffee, palm oil, soy, wood, and rubber, along with their derived goods. These may only enter the EU market if they are demonstrably deforestation-free and produced in compliance with the relevant legislation of the country of origin. To this end, the regulation imposes mandatory due diligence obligations on operators and traders, including data collection, risk assessment, and the adoption of risk mitigation measures where appropriate (Regulation (EU) 2023/1115).

1.2.2 Compliance and Enforcement

To facilitate traceability and enforcement, operators are required to submit due diligence statements via a centralized EU information system, with plot-level geolocation data indicating the land on which the commodities were produced. These submissions feed into a country benchmarking system designed to categorize countries according to their deforestation risk, which determines how rigorous the checks on their exports need to be. Non-compliance with the regulation can lead to significant consequences, including financial penalties, market exclusion, and disqualification from public procurement and funding mechanisms. Although the regulation entered into force on 29 June 2023, its application has been delayed to allow time for stakeholders to prepare: large operators must comply by 30 December 2025, while micro- and small enterprises have time until 30 June 2026 (European Commission, 2024; World Economic Forum, 2025).

1.2.3 Application to the Cocoa Sector

In the cocoa sector, the regulation introduces strict traceability and legality criteria with direct implications for major producing countries, particularly Ivory Coast and Ghana. Cocoa beans and derivative products such as cocoa paste, butter, powder, and chocolate, must be proven to be both deforestation-free and legally produced. This includes ensuring that no cocoa has been sourced from land deforested after the 31st of December 2020. This date is referred to as the ‘cut-off date’ by the commission, and later in this paper also. Operators must provide precise geolocation coordinates for each production plot and demonstrate compliance with both EU and domestic legal standards. Although the initial implementation date for importers was set for 30 December 2024, following complaints

from trading partners, it has now been postponed to 30 December 2025 to allow businesses and authorities additional time to adapt systems and ensure readiness. Some pressures are still coming from countries that are asking to simplify the rules further, and to delay the application date again (Reuters, 2025). EUDR requirements necessitate significant changes in corporate supply chain management, including improved traceability systems, segregation of compliant and non-compliant cocoa, and strong engagement with suppliers.

2. Supply Chain Pressures in West African Cocoa

Understanding the implications of the EU deforestation regulation requires examining two key dimensions of the cocoa value chain. First, production, that is highly concentrated in Ghana and Ivory Coast, where crop failures are limiting output. Second, that major cocoa companies are central in shaping supply chain practices and influencing regulatory design (FAO & BASIC, 2020).

2.1 Ghana and Ivory Coast

Ghana and Ivory Coast together produce more than 60% of the world's cocoa supply, making them central to the functioning of the global cocoa value chain (Kouadio & Singh, 2021). However, both countries are experiencing a sustained decline in production capacity, limited by structural and environmental constraints. The causes are ageing plantations, limited access to farm inputs, and chronically low yields, combined with increasing exposure to climate change, of which unpredictable rainfall and the spread of crop diseases are severely eroding productivity (Yao et al., 2025).

2.1.1 Ivory Coast

Ivory Coast (Côte d'Ivoire) alone accounts for nearly half of global cocoa output, but sustaining this level of production has become increasingly difficult. Average yields declined by 27% in a span of 22 years, from about 0.70 t/ha in 2000 to 0.52 t/ha in 2022/23 season (FAO, 2025). The trend continued this past season arriving at just 0.39 t/ha in 2023/24, driven by factors such as the proliferation of the *Phytophthora* pod rot (black pod) disease (Suh & Molua, 2022), and the dominance of monoculture systems. In response to yield decline, farmers are expanding into forested zones: cocoa is now linked to over 37% of deforestation in protected areas, with 30% of national cocoa cultivation

occurring within these areas (Kalischek et al., 2023). Deforestation has clearly become a widespread routine practice among farmers in the country, and forest monitoring and enforcement remain ineffective. This expansion poses a critical threat to biodiversity, especially in a country where over 90% of original forest cover has already been lost (Kouadio & Singh, 2021).

2.1.2 Ghana

Ghana faces similar challenges, though on a smaller scale. Average productivity remains around 568 kg/ha (FAO, 2025), while farm-level investments and access to modern agricultural inputs is limited. Though Ghana's deforestation footprint from cocoa is lower than Côte d'Ivoire's, it is still significant: 13.5% of forest loss in protected areas is linked to cocoa farming, with 7% of national cocoa area located within these zones (Kalischek et al., 2023). Ongoing inefficiencies in the sector still push farmers to expand into forested areas instead of improving yields on existing land.

2.2 Commercialization Companies and Civil Society

To understand how EUDR compliance will evolve once it becomes applicable at the end of this year, it is essential to look at the role of downstream actors in the cocoa supply chain. Commercialization companies, such as Nestlé, Mars Wrigley, Mondelez, and Ferrero, hold substantial market power through their control over sourcing strategies, prices, and certification demands (Euromonitor, 2023). Their operational and procurement decisions on how and where to source cocoa have a direct impact on farmer behavior and land use on the ground. At the same time, civil society organisations such as Fairtrade International, Rainforest Alliance, and the VOICE Network, help push for higher sustainability standards and more transparent supply chains. Through groups like the Cocoa Coalition, in which the participating companies are Ferrero, Hershey, Mars Wrigley, Mondelez International, Nestlé, Toms Group, Tony's Chocolonely, and Unilever, it shows that these actors are not only reacting to regulatory obligations but are actively influencing implementation.

Another relevant characteristic worth studying is connected to the market dynamics that are reshaping the cocoa supply chain. Three interlinked factors are putting pressure on producers and downstream actors, such as: i) rising prices, ii) steady global demand, and a iii) growing supply deficit. These trends encourage land expansion and make it harder to achieve deforestation-free sourcing.

2.2.1 Rising Prices

Cocoa prices have increased dramatically over the past two years, reflecting both structural constraints in supply and speculative responses to future shortfalls. According to ICCO data, prices on international markets have nearly quintupled between 2022 and 2024, reaching unprecedented highs (ICCO, 2025a), as appears in Figure 1. At the time of writing this report, the highest peak reached is 11,443 €/tonne. This price spike is primarily driven by production slowdowns in Côte d’Ivoire and Ghana due to the factors explained in the previous section.

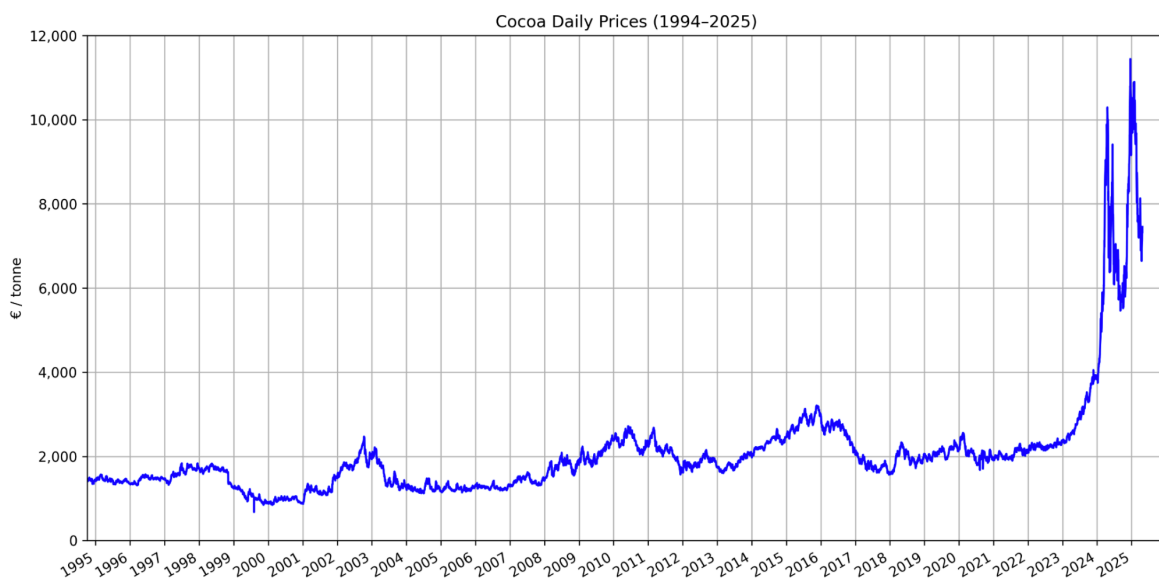


Figure 1. Average quotations on ICE Futures Europe (London) and ICE Futures US (New York) for cocoa beans. *Source: ICCO, 2025a.*

While high prices could, in theory, incentivize sustainable investments in producing countries, in practice they risk incentivizing additional expansion of cocoa cultivation into forested areas, particularly where land tenure is weak and enforcement capacity is limited.

2.2.2 Persistent Demand

Despite rising prices, global demand for cocoa products remains overall robust. Although recent figures indicate a slight decline in grindings—down of 5.4% in Europe and of 0.52% in Asia in Q4 2024 (European Cocoa Association (ECA), 2025; Cocoa Association of Asia (CAA), 2025)—this contraction is modest compared to price increases, suggesting that cocoa consumption is relatively price inelastic. Demand remains especially strong in emerging markets, like the Asian one, and among premium product segments, increasing

long-term pressure on production zones. As consumption patterns shift and diversify, demand for traceable and sustainably sourced cocoa in Europe continues to grow, adding further challenges to supply chain compliance.

2.2.3 Supply Deficit

The combined effect of constrained supply and resilient demand causes a global supply deficit. In 2024, the largest deficit that the cocoa market has seen in over 60 years happened. This imbalance amounted to 441 thousand tonnes (ICCO, 2025b) missing from grinding facilities, resulting in losses in stocks of chocolate products. The results of this market tightening primarily impacts final consumers and the environment.

In fact, consequently to the price spike, overall final consumer expenditure augmented. The average retail unit price of chocolate confectionery products increased from \$17.3 per kg in 2022 to \$19.8 per kg in 2025 (ICCO, 2025c), impacting customers. On the environment, a deficit means a tightening of available volumes and increased pressure on land conversion, that raises the likelihood of non-compliant cocoa entering global markets. This mechanism will continue unless robust monitoring and traceability systems are put in place.

3. Research Statement

In light of the current cocoa market situation and the upcoming EUDR compliance deadline, this research poses questions regarding the level of compliant cocoa that confectionery multinationals have sourced since 2021 and how much they will be affected by the European Regulation. A market analysis was done to narrow down this research to a singular company with clear disclosures of suppliers, of sourcing countries, and of production volumes, allowing for a deep analysis and precise results. The company chosen is Nestlé, among the biggest chocolate companies in the world, with an overall revenue of \$108.13 billion in 2022.

As a result, the scope of this research is to understand the impact of Nestlé's sourcing portfolio strategy on deforestation pressure in West African countries, and to understand the consequences of the EUDR. This problem statement substantiates itself in the following 3 research questions:

- RQ1: What is the current deforestation impact of Nestlé in Ivory Coast and Ghana?

- RQ2: What will be the impact of Nestlé cocoa on Ivory Coast forests for the next production seasons and for different sourcing strategies?
- RQ3: What will be the economic loss impact of the EUDR on Nestlé's EU market?

To answer these research questions, we gathered data from state-of-the-art supply chain mapping models for agricultural commodities as the basis of our work, along with market observations from organizations, companies and governments, in order to create projections under different sourcing scenarios. Our historical analysis is restricted to the period between 2019 and 2021, due to a lag of four years needed in deforestation assessments. Therefore we will quantify projections covering the subsequent 5 years, meaning between 2022 and 2026.

4. Data

4.1 Data Collection

This analysis began with an extensive review of publicly available datasets related to deforestation, with the goal of identifying the most suitable data source for tracking commodity-linked deforestation—specifically cocoa, in the context of the European Union Deforestation Regulation (EUDR). Among the datasets initially explored was the globally recognized Global Forest Watch (GFW), developed by the World Resources Institute (WRI). GFW offers comprehensive global monitoring of tree cover loss, primary forest loss, and overall forest degradation. However, despite having conducted a Cocoa Deforestation Risk Assessment, GFW has not yet made this cocoa-specific data publicly available.

Given the nature of this thesis, that focuses not only on forest loss, but also on the responsibility of actors along the cocoa value chain, it was necessary to base the analysis on a dataset that could link deforestation events directly to supply chain actors, therefore tracing the whole production line from smallholder farmers in West Africa, to grinding facilities, and finally to multinational corporations selling chocolate products in European supermarkets. This requirement led to the adoption of Trase trade mapping data for cocoa agriculture as the primary data source, by Guye et al. (2024, Version 1.1). This data uses a

generalised supply chain mapping approach called Spatially Explicit Information on Production to Consumption Systems (SEI-PCS), to link products and supply chain actors with specific areas of production, and associated sustainability risks. Its key advantage lies in its granularity, both geographically (down to the department level) and at the supplier-level, identifying specific exporters and traders. For Ivory Coast and Ghana, Trase offers cocoa-specific trade flows with estimates of deforestation exposure over a 15-year period (Trase (a); Trase (b)). Trase methodology combines satellite-based deforestation data with shipping and customs records to estimate the cumulative deforestation associated with cocoa exports by country, region, and trader.

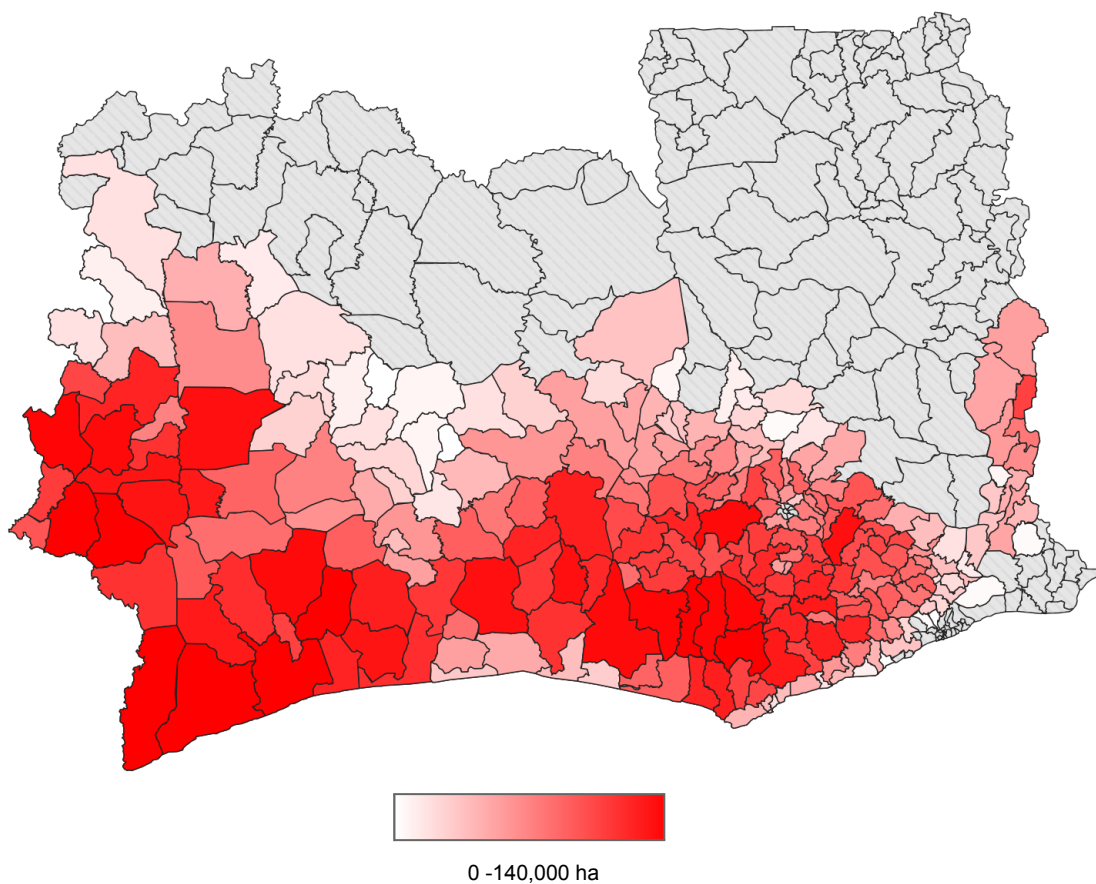


Figure 2. Departmental-level 15-year deforestation exposure (ha) associated with 2021 cocoa production in Ivory Coast and Ghana

In parallel, market data was collected to understand cocoa production and demand trends. Most official figures are sourced from the International Cocoa Organization (ICCO), which provides data on global cocoa production, grindings, daily prices, and surplus/deficit balances. This data was aggregated into a structured format to visualize long-term trends.

To better understand global cocoa consumption and usage patterns, complementary data was also sourced from the European Cocoa Association (ECA) and the Cocoa Association of Asia (CAA). These organizations publish regional figures on cocoa grindings, which are essential to visualize changes in cocoa demand and link them back to origin countries.

Lastly, to evaluate the exposure of specific corporations to the EUDR compliance, this analysis includes a case study on Nestlé. The company's cocoa sourcing practices were examined using publicly disclosed information, especially data from the Nestlé Cocoa Plan reports. This program was developed in partnership with the Rainforest Alliance, International Cocoa Initiative, and the KIT Institute. It outlines Nestlé's commitments to sustainable sourcing but could help estimate Nestlé's potential exposure to non-EUDR-compliant cocoa entering the EU. More details regarding data aggregation and calculation in the Methodology chapter.

4.2 Discussion on Data Availability

This analysis focuses on Ivory Coast and Ghana, not only due to their central role in the global cocoa supply but also because they are among the few countries for which reliable, high-resolution cocoa plantation data is available. Mapping cocoa-driven deforestation remains challenging elsewhere, mostly due to the difficulty of collecting precise and updated plantation polygons and linking them to forest loss.

Only a few studies have been successful in doing so, like Kalischek et al. (2023), Abu et al. (2021), and Schneider et al. (2023), that used deep learning on satellite images combined with ground validation to produce detailed cocoa plantation maps for both countries. These are static probability maps, so they don't capture yearly expansion into forests or protected areas, they still offer a robust static probability estimate of cocoa cultivation areas, relative degradation and deforestation.

Based on this plantation data, Trase was able to allocate cocoa production volumes to individual departments using weighted averages derived from the cocoa area probability maps. The corresponding deforestation exposure was then calculated using forest loss data from the European Commission's Joint Research Centre (JRC) Tropical Moist Forests (TMF) dataset. Trase's methodology assumes that forest degradation—defined as the conversion of undisturbed forest to non-forest—linked to cocoa occurs within a 15-year window before the initial cocoa export, accounting for the average four-year maturation

period between planting and export. That is why, in this analysis we will refer to the “15-year deforestation exposure” or simply “deforestation exposure”.

While Kalischek et al. (2023) were able to link 360,000 ha of forest loss in protected areas to cocoa in Ivory Coast and 26,000 ha in Ghana, these maps are not publicly available. As a result, even though departmental-level estimates are possible and reliable, the lack of open-access plantation-deforestation maps remains a limiting factor for more granular or dynamic assessments.

5. Methodology

This chapter outlines the methodology used for the two scenario-building analyses, and the estimation of economic loss, to address the research questions introduced in Section 3.

5.1 Historical Analysis: Nestlé

To assess Nestlé’s impact on forest degradation in Africa, we first needed to map historical records on volumes and its supply chain structure. While Nestlé does not publicly report its total cocoa purchases, it provides annual figures for the volumes sourced under its sustainability initiative, known as the Nestlé Cocoa Plan. Launched in 2009, the Cocoa Plan has the objective of ensuring that all cocoa sourced is either Rainforest Alliance certified or verified through Nestlé’s own mass balance scheme. According to its 2023 sustainability report, around 85.5% of Nestlé’s cocoa is certified (Nestlé Global, 2023a). At present, KITKAT is the only brand in their portfolio using 100% certified beans. The Rainforest Alliance’s “mass balance” certification means that an equivalent volume of certified cocoa is purchased to match the amount used in the product, though it may not come from the same farms.

It is common for chocolate manufacturers to split their production between “sustainable” and “conventional” cocoa, often sharing data only on the sustainable portion. As of 2019, Mondelēz, Nestlé, and Mars have the highest shares of conventional, often non-certified, cocoa (Voora et al., 2019).

Again, there is no equivalent information available for cocoa volumes sourced outside of the Cocoa Plan, so this analysis relies entirely on data derived from the program reports. From years 2019 to 2023, Nestlé reports not only the percentage sourced through the plan,

but also how much this volume is. Based on the ratio, it is possible to estimate the company’s total cocoa purchases for those years. We were also able to deduct data for 2017, 2018, and 2024 from other reports, for example from non-financial disclosures.

The resulting dataset spans from 2017 to 2024, which is a consistent and robust foundation to do forecasting over time.

Secondly, to understand from which countries Nestlé sources the most, we rely on the list of countries and their corresponding percentages, as reported in the Nestlé Cocoa Plan reports. At this stage, a key assumption must be introduced in order to estimate sourcing volumes per country. Since the Nestlé Cocoa Plan distributes its volumes across countries according to specific percentages—figures that vary only slightly year by year—we assume that the remainder of Nestlé’s cocoa sourcing, which falls outside of the Cocoa Plan, follows the same country distribution. While not ideal, this assumption is needed to build a complete picture of Nestlé’s sourcing over time. In the absence of detailed country-level data, it offers a reasonable approach for this analysis. Chapter 6.2.2 will revisit and examine this assumption in more detail, highlighting its implications and limitations. The full breakdown of Nestlé’s sourcing portfolio, as estimated through this method, is presented in Table 2.

Nestlé sourcing from	Historical					Projected
	2019	2020	2021	2022	2023	2024-2026
Ivory Coast	72.6 %	72.4 %	69.5 %	63 %	55 %	55 %
Ghana	8.2 %	7.8 %	8 %	7 %	7 %	7 %
Cameroon	1.1 %	1.1 %	3 %	4%	3 %	3 %
Nigeria	-	-	-	2%	5 %	5 %
AFRICA	81.8 %	81.4 %	80.4 %	76 %	70 %	70 %
Brasil	3.1 %	3.9 %	6 %	11 %	13 %	13 %
Ecuador	10.6 %	8.6 %	7 %	7 %	11 %	11 %
Mexico	0.8 %	1.5 %	1 %	2 %	0.4 %	0.4 %
Venezuela	0.3 %	0.2 %	1 %	0.4 %	0.3 %	0.3 %
Dominican Republic	-	-	1 %	2%	2 %	2 %
Peru	-	-	-	-	0.2 %	0.2 %
LATAM	14.8 %	14.2 %	15.6 %	20 %	27 %	27 %
Indonesia	3.4 %	4.4 %	4 %	4 %	3 %	3 %
ASIA	3.4 %	4.4 %	4 %	4 %	3 %	3 %

Table 2. Producing countries and relative shares of Nestlé volume

The next step was to identify the names of Nestlé’s supplier companies operating in Ivory Coast. Suppliers are typically categorized as ‘tier-1’ and ‘tier-2’, and for Nestlé, we have access to both lists for the year 2023. These lists were cross-referenced with the Trase

dataset, where tier-1 suppliers are referred to as ‘trader groups’. Major suppliers were identified, like Cargill and Barry Callebaut—large multinational companies active in multiple countries and exporting different commodities. On the other hand, no matches were found for Nestlé’s tier-2 suppliers in either of Trase categories ‘trader group’, ‘logistic hub cooperative’, or ‘exporter’. Tier-2 suppliers are usually cooperatives or local exporters that operate further upstream in the chain, for which reliable information is harder to obtain. As a result, all cooperatives and exporters linked to the relevant tier-1 suppliers in Trase dataset were included in the analysis.

Additionally, the analysis assumes that the share of each tier-1 supplier in Nestlé’s portfolio reflects their market shares at national level. Nestlé’s total cocoa volume sourced from Ivory Coast was therefore allocated proportionally based on these shares.

Finally, deforestation exposure was estimated. Trase data makes it possible to link trader volumes to specific departments of production, offering a spatial breakdown of cocoa sourcing within the country. However, the raw data reflects deforestation exposure at the market level. To isolate Nestlé’s exposure, we used localized deforestation rates. From the national dataset, we calculated yearly deforestation intensity (hectares per tonne) for each trader, disaggregated by department. This approach ensures to keep track of the specific impact of each actor. Based on these adjusted rates, then the adjusted cocoa deforestation exposure associated with Nestlé was calculated as follows:

$$\text{Deforestation exposure of Nestlé (ha)}_{y,t,d} = \text{Deforestation Rate (ha/t)}_{y,t,d} \times \text{Volume sourced by Nestlé (t)}_{y,t,d}$$

where y = year,

t = trader group,

and d = department of production.

Here deforestation exposure is intended as the cocoa production area that overlaps with the loss in undisturbed tropical moist forests for the 15-year period that begins 19 years before the target year. It means that 4 years have passed between the first deforestation and the first cocoa harvest. This methodology was reviewed in section 4.2.

5.2 Scenario Analysis I: Shifting Sourcing Countries

The first scenario analysis has the aim to assess Nestlé’s cocoa deforestation impact in its two biggest sourcing countries in Western Africa, and to explore how much this exposure may have been reduced by sourcing more in one country than the other. The two countries put into comparison are Ivory Coast, main cocoa source for both Nestlé and the world, and Ghana, third Nestlé sourcing country in 2019-2020 and second in 2021. In 2023, Nestlé sourced from there respectively 185,570 and 23,618 tonnes of cocoa, meaning 55% and 7% of its total supply.

The data used was Trase 2019-2021 deforestation exposure in Ghana and Ivory Coast (Trase (a); Trase (b)). Deforestation exposure follows the same methodology as the other Trase dataset (Guye et al., 2024), reviewed in section 4.2. Similar the methodology above, to retrieve cocoa deforestation exposure associated with Nestlé cocoa, we used the shares of cocoa sourced from both countries in those years, as following :

$$\begin{aligned} \text{Deforestation exposure of Nestlé (ha)}_{c,y} = \\ \text{Deforestation Rate (ha/t)}_{c,y} \times \text{Total Volume sourced by Nestlé (t)}_y \\ \times \text{Nestlé Sourcing Share (\%)}_{c,y} \end{aligned}$$

where c = sourcing country

and y = year.

Then sourcing scenarios were computed by tweaking the sourcing share in each country to be between 0 and 100%, and computing the respective sourced volumes and deforestation exposure.

A cap was considered to assess the feasibility of extreme cases—i.e. 100% sourcing in that country—but results show that Nestlé total volumes could be accommodated entirely by both countries, since Ivory Coast produced five times more the volumes needed by Nestlé, while Ghana two times.

5.3 Scenario Analysis II: Reducing Impact in Ivory Coast

The second scenario analysis tries to answer RQ2 by forecasting deforestation exposure up to 2026 according to different sourcing strategy scenarios. In particular, we explored how

changes in *indirect sourcing ratio* and *deforestation intensity* could influence deforestation linked to each trader in Nestlé's portfolio.

This sparked from limited temporal cover of available forest degradation insight and the need to assess repercussions of the upcoming European Regulation on Deforestation-Free Products (EUDR) on companies, whose effect is strictly related to a company's sourcing strategy, meaning the choice of suppliers. In fact, traders in the cocoa supply chain are the link between companies and smallholder farmers, and are responsible for the traceability of cocoa beans. This is crucial because a collaboration with reliable farmers assures that cocoa is first of all traceable, and by traceable we mean being able to retrieve the exact farm area (in technical terms, polygons), and ensure that they employed deforestation-free farm practices. Most of the time, this is not possible, and companies end up with huge shares of 'indirectly' source volumes coming from high deforestation intense farms. This, in front of the EUDR regulators, is a clear punishable practice and will result in that product to be confiscated and the company taxed, all because of its poor procurement choices.

Indirect Sourcing Ratio

By indirect sourcing ratio we indicate the share of cocoa indirectly sourced from middlemen called "pisteurs", who collects cocoa from villages and small farmers, amass it, and then sell it to traders/suppliers. This way, there is no track of the specific farm where the stock came from, and is therefore untraceable. We have found that in 2021, 55.5% of Nestlé's Ivorian supply was indirectly sourced, and almost 62% the year before. It is in the company's best interest to reduce this ratio. For this reason, we built 3 scenarios that might reflect a change in Nestlé's procurement management in the future:

1. Business-As-Usual (BAU) scenario: Nestlé's suppliers continue to work with the same farmer groups and therefore the *indirect sourcing ratio* stay the same as 2021 levels.
2. Optimistic scenario: Nestlé's suppliers actively try to lower their *indirect sourcing ratio* by -9.7% each year, ensuring a better compliance for EUDR.

3. Pessimistic scenario: Nestlé's suppliers do not comply and prefer to buy from middlemen rather than directly from farmers. For this reason, the *indirect sourcing ratio* increases by +9.7% each year.

Variances in indirect sourcing ratio explored in the scenarios are based on the actual observed change from 2020 to 2021: -9.7%. In the optimistic scenario, we believe this huge improvement to be replicable also the years after, reaching unprecedented low levels of indirectly sourced cocoa. On the other hand, in absence of compliance, it becomes easier for traders to purchase from middlemen rather than directly from farmers. For this reason, we view a potential +9.7% increase in indirect sourcing ratio as a realistic pessimistic scenario, and could in fact be even worse. Changes in indirect sourcing ratio are applied to the singular supplier operating in that department.

Deforestation Intensity

Deforestation intensity is defined as the ratio between deforestation exposure associated with cocoa produced in a certain area, and the volume of this cocoa, hence it is measured in hectares per tonne. In 2021, cocoa destined for Nestlé production was cultivated on land associated with 161,988 hectares of forest cleared between 2002-2017. Deforestation intensity that year amounted to 596 ha/kt, meaning that to produce one kilo of cocoa beans, an area of almost 6 square meters was converted into cultivation from undisturbed forest. In 2019 this value amounted to almost 7 square meters per kilo. In particular, a visible decrease in deforestation intensity is observable after the EUDR cut-off date in December 2020 (Figure 3), signaling that an effort was made to increase the share of deforested-free and compliant volume of farmed products. On this basis, we believe a further reduction of deforestation intensity is possible, given also that EUDR will now require traders to submit a due diligence statement.

For these reasons, the 3 scenarios also reflect a change in farmer practices in the future:

1. Business-As-Usual (BAU) scenario: farmers continue with current practices and *deforestation intensity* stays the same as 2021 levels.
2. Optimistic scenario: Nestlé's traders are actively trying to source from reliable farmers that ensure *deforestation intensity* to reduce by -11% each year.

3. Pessimistic scenario: Nestlé's traders do not comply and buy from farmer groups offering a cheaper product. These farmers expand their cultivation area into undisturbed forested land. For this reason, *deforestation intensity* increases by +11% each year.

Variances in deforestation intensity explored in the scenarios are based on the actual observed change from 2020 to 2021: -11%. Similar to our assumptions for indirect sourcing, we believe the huge intensity improvement to be replicable over the years after, reaching cocoa production that results in minimal or even zero forest degradation. On the other hand, in absence of a regulation, it becomes easier for farmers to clear forest land to expand cultivation. For this reason, we view a potential +11% increase in deforestation intensity as a realistic pessimistic scenario, and could in fact be even worse.

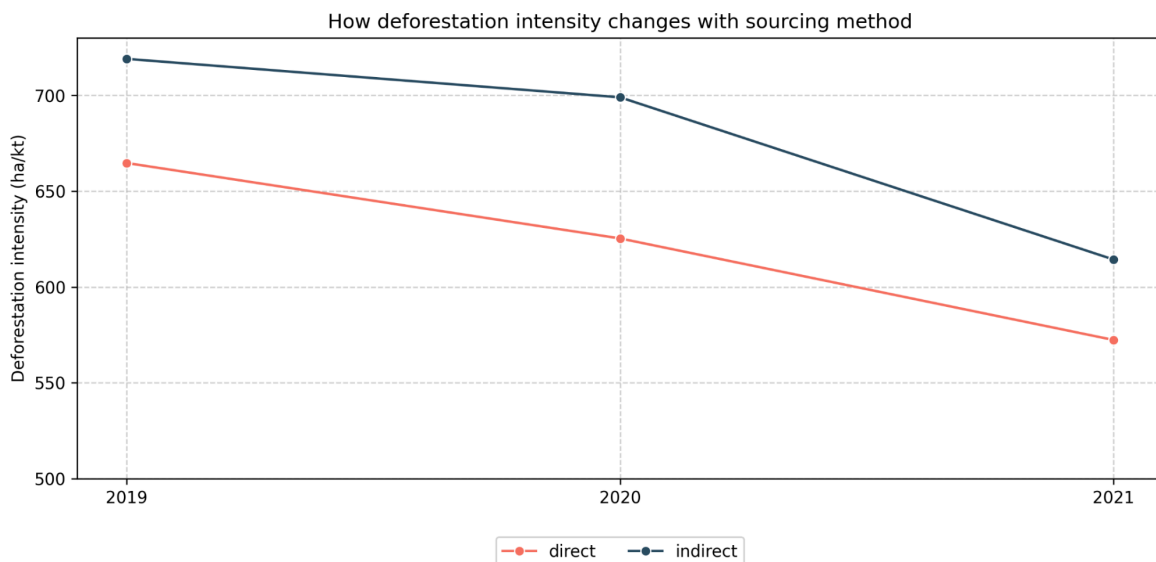


Figure 3. Historical values of deforestation intensity (ha/kt) by sourcing scenario.

Scenario Computation

Onto the actual computing, it is needed to first forecast yearly volume purchased by Nestlé, both total supply and the one coming from Ivory Coast. Since data about total purchased volume is available for years 2017-2024, this value acts as a boundary and scaling factor for individual trader volumes over this period. For the missing years, i.e. 2025, and 2026, we looked at the historical trend and calculated a mean annual decrease rate, which turned out to be -3.53%. Then it was applied to the missing years. To extract supply coming from

Ivory Coast specifically, we assume Nestlé keeps its sourcing ratio for countries constant at the last known value from 2023, due to a lack of updated information. For Ivory Coast, this value is 55%. Subsequent to these calculations, we project Nestlé's cocoa supply from Ivory Coast to be 184 kilo tons in 2024, 178 kt in 2025 and 172 kt in 2026.

Finally, scenarios were computed. The function developed distributes total Ivorian supply among traders according to their market shares in 2021 (last known value) and then applies respective changes in indirect sourcing ratios and deforestation intensity levels for each trader, in each department. In summary, the updated parameters each year will be computed by applying the following factors:

- BAU
Indirect ratio +0% : *indirect_ratio_factor_per_year=1.0*
Deforestation +0% : *def_factor_per_year=1.0*

- OPTIMISTIC
Indirect ratio -9.7% : *indirect_ratio_factor_per_year=0.903*
Deforestation -11% : *def_factor_per_year=0.89*

- PESSIMISTIC
Indirect ratio +9.7% : *indirect_ratio_factor_per_year=1.097*
Deforestation +11% : *def_factor_per_year=1.11*

5.4 Economic Loss Computation

To have an estimation of EUDR concrete effects on the cocoa trade (both of raw material and finished product) entering the European Union market, we tried to quantify the confiscable amount of cocoa beans destined to Nestlé consumption in the EU. We are aware of the lack of disclosure by the company, therefore some assumptions were made. First of all, our Scenario Analysis II projected to 2026 will give us an indication of the potential forest degradation linked to sourcing in Ivory Coast from specific suppliers, but leveraging this exposure to assess economic loss will be challenging. Variables like the precise plots of land in which Nestlé beans are cultivated is not publicly available information, supposed it exists.

In their “Tackling Deforestation” 2021 Report, the company disclosed their intensive effort to map all farmers that are part of the Nestlé Cocoa Plan (NCP): 82% of farms in direct supply chain of Ivory Coast were mapped (75820 farmers out of 92190), and 95% of farms in Ghana (17305 farmers out of 18137) (Nestlé Cocoa Plan, 2021a). From this, we could assume that all farms mapped are also clean from any deforestation, meaning that the land was already converted into plantations. Also, because there is no disclosure about beans indirectly sourced, we cannot assume any of it to be clean. According to this logic, of cocoa sourced through the NCP, 18% of directly supplied volume is to be considered non-compliant, and for indirect supply, we consider 100%. In 2021, the NCP cocoa covered only 50.6% of all cocoa sourced in Nestlé, therefore the rest is to consider non-traceable, therefore non-compliant. According to methodology, we would estimate the share of compliant cocoa to be only 18.8% in 2021, and in 2026, since the NCP coverage grew over the years, the estimate would increase to 33.2%.

More recent evidence shows that Nestlé assessed 42.3% of its cocoa supply chain as deforestation-free in 2023, increasing slightly to 46.4% in 2024 (Nestlé Cocoa Plan, 2023; Nestlé Global, 2024a). Based on these values, we can estimate the share of non-compliant volumes, using the projected total cocoa purchases outlined in Scenario Analysis II (see methodology in the previous section).

Economic loss is defined here as the value of non-compliant cocoa beans entering the European market that would be confiscated under EUDR enforcement. This refers to supply that cannot be processed or sold because it fails to meet due diligence requirements. To evaluate it, we will only consider cocoa destined to the European market, which accounts for 38% of Nestlé’s confectionery sector performance (Nestlé Global, 2024b). The cost of this lost volume is calculated using the yearly average global cocoa bean price (€/tonne), as reported by ICCO (see Figure 1 in section 2.2.1). Due to the sharp price increase in 2023, any confiscated supply after that year becomes significantly more expensive than in previous years.

6. Results and Discussion

6.1 Historical Analysis

6.1.1 Nestlé

Nestlé has been relying on Ivory Coast for more than half of its total chocolate supply, and the Ivorian market has for sure benefitted from this consumption, which represents on average 12% of all cocoa produced in the country. As seen in table 3, Nestlé stocks have been slowly decreasing over the years, registering a decline of 23% since 2017. Evidence of this is also reflected by the slow decline of chocolate production and consumption worldwide, along with the extraordinary spike in prices that weighs down chocolate manufacturers.

	Nestlé							
	2017	2018	2019	2020	2021	2022	2023	2024
Nestlé Cocoa Plan (t)	186,358	198,155	183,361	202,890	198,000	254,000	288,477	298,082
Nestlé Cocoa Plan (%)	42.9 %	49 %	44 %	48 %	50.6 %	68.3 %	85.5 %	88.9 %
Total Cocoa Sourced (t)	434,401	404,398	416,729	422,687	391,304	371,889	337,400	335,300

Table 3. Nestlé sourcing volumes over the period 2017-2024 (all sourcing countries).

In terms of forest degradation footprint, Nestlé sources its cocoa from the south region of Ivory Coast, which is where cocoa plantations concentrate in the country.

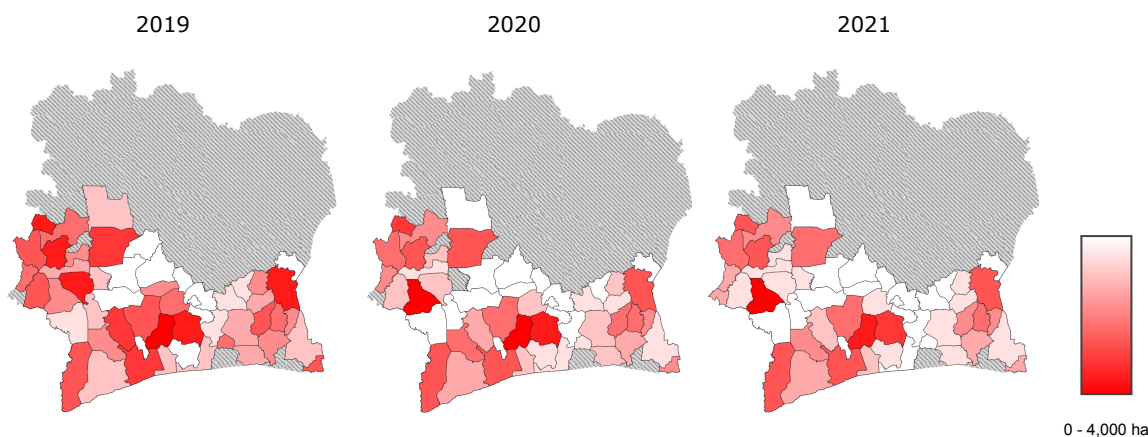


Figure 4. Nestlé deforestation exposure per department - historical data

In 2021, Ivorian cocoa destined to Nestlé factories worldwide can be associated with 0.2 million hectares of deforestation exposure. Although the trend is declining over the years, as possible to see in Figure 4, the area of degraded forest so far is alarming. In particular, the most affected departments are those of San-Pedro, Lakota, and Sassandra.

6.1.2 Suppliers and Traders

Corporate responsibility imposed by EUDR will ultimately fall on suppliers, who then regulate their own network of farmers. Nestlé’s sourcing depends mainly on six major companies: Cargill, OLAM, Barry Callebaut, Sucden, Ecom, and Touton. Among these, Cargill stands out as Nestlé’s largest supplier and is also the one linked to the greatest deforestation (Figure 5).

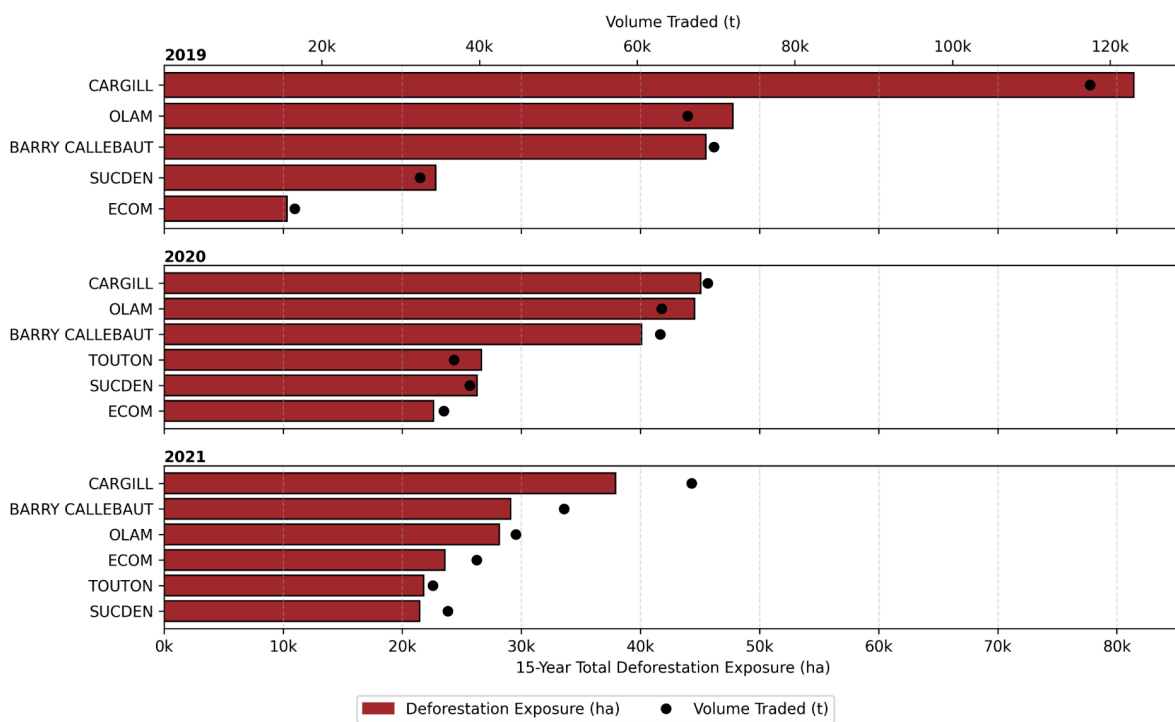


Figure 5. Nestlé’s largest and most impactful Tier-1 cocoa suppliers in Ivory Coast

When compared to the national average, Nestlé’s suppliers show only a minimal reduction in deforestation intensity (i.e. the forest area cleared per ton of cocoa produced). As seen in Figure 6, some of these suppliers still stand out as outliers due to their high deforestation intensity, and that the distribution reflects that of the market, indicating their significant scale and influence.

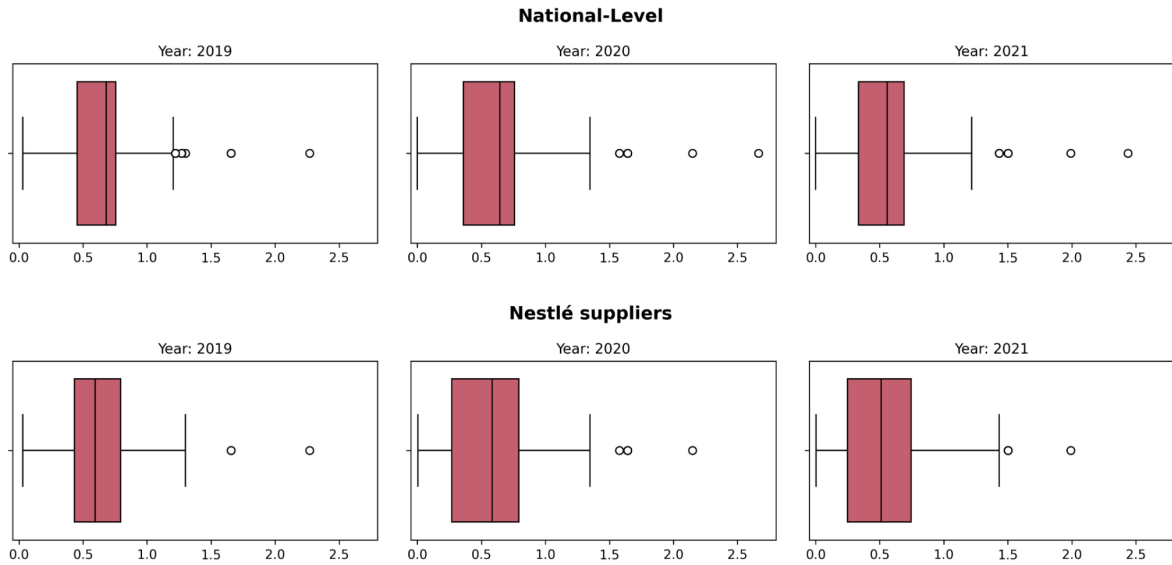


Figure 6. Distribution of deforestation intensity: national-level and focus on Nestlé suppliers

In some cases, traders with similar volumes of cocoa sourcing show significantly different levels of deforestation exposure, and this is based on whether they buy directly from farmers or through middlemen, where the exact origins are unknown. Particularly, as discussed earlier when building scenarios, Nestlé must be especially cautious with certain suppliers like Ecom and Sucden, which source over 80% of their cocoa indirectly (see Figure 7). They operate as the final link in a long chain of middlemen and have very few direct relationships with farmers. In light of EUDR compliance, this is not a good start.

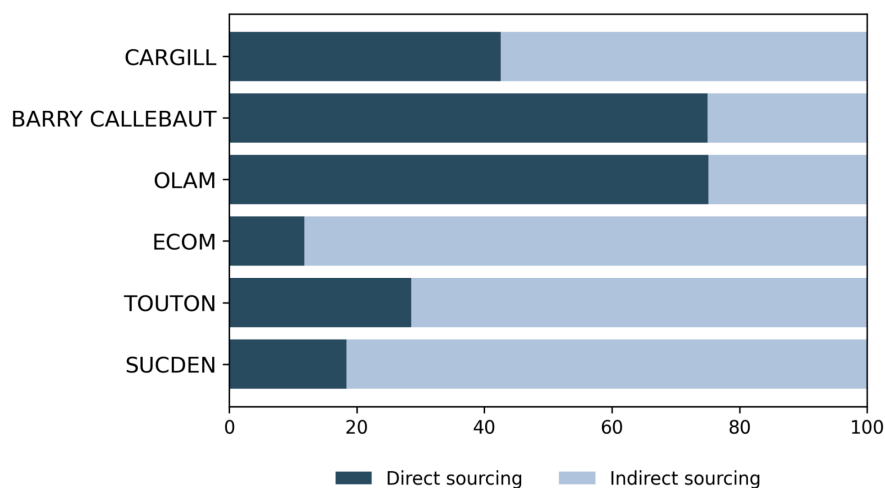


Figure 7. How much of direct/indirect cocoa are trader groups for Nestlé supplying (2021)

6.1 Scenario Analysis I

6.1.1 Results

According to the methodology explained in Section 5, we were able to trace back exact volumes sourced from the two Western African countries and quantify the relative 15-year deforestation exposure for three key years: 2019, 2020 and 2021. If Nestlé were to change its sourcing strategy in those years, the results of such a decision would have had huge repercussions on the forest pressure. In the three years considered in our analysis, Nestlé sourced approximately 8% of its cocoa from Ghana, and around 70% from Ivory Coast, always positioning itself as the number one source. These sourcing levels remained pretty constant over the entire observation period, but what changed drastically was the level of deforestation attributed to these volumes of produced cocoa. In fact, Nestlé's 15-year total deforestation exposure in Ivory Coast decreased by about 29% from 2019 to 2021, from slightly above 230 thousand hectares to 165 thousand. Volumes decreased by only 10%. The same trend is to be seen also in the neighbouring country, as shown in Table 4.

Ivory Coast					Ghana				
Year	% Sourced	Volume (t)	Deforestation (ha)	Deforestation intensity (ha/kt)	Year	% Sourced	Volume (t)	Deforestation (ha)	Deforestation intensity (ha/kt)
2019	72.6 %	302,545	231,461	761	2019	8.2 %	34,172	51,804	1555
2020	72.4 %	306,025	205,423	675	2020	7.8 %	33,125	49,932	1477
2021	69.5 %	271,956	164,825	602	2021	8.0 %	31,304	30,851	985

Table 4. Historical volume and deforestation related to Nestlé cocoa (2019-2021)

The different sourcing scenarios (Figure 8) allow us to visualize the huge impact that a tonne of cocoa coming from Ghana has compared to one coming from the neighbouring country. This difference reflects the yearly deforestation intensity rate. Ghana's deforestation rate was about 1554 ha/kt in 2019 compared to 761 ha/kt in Ivory Coast, basically double the speed of forest degradation. More interestingly, the cut-off date—on the 31st of December 2020—drastically slowed down the deforestation rates in both countries. From this date, all products traceable back to forest degradation might be subject to taxation according to the EUDR. We assumed that traders started to comply and in consequence also farmers reduced their expansion of plantation area.

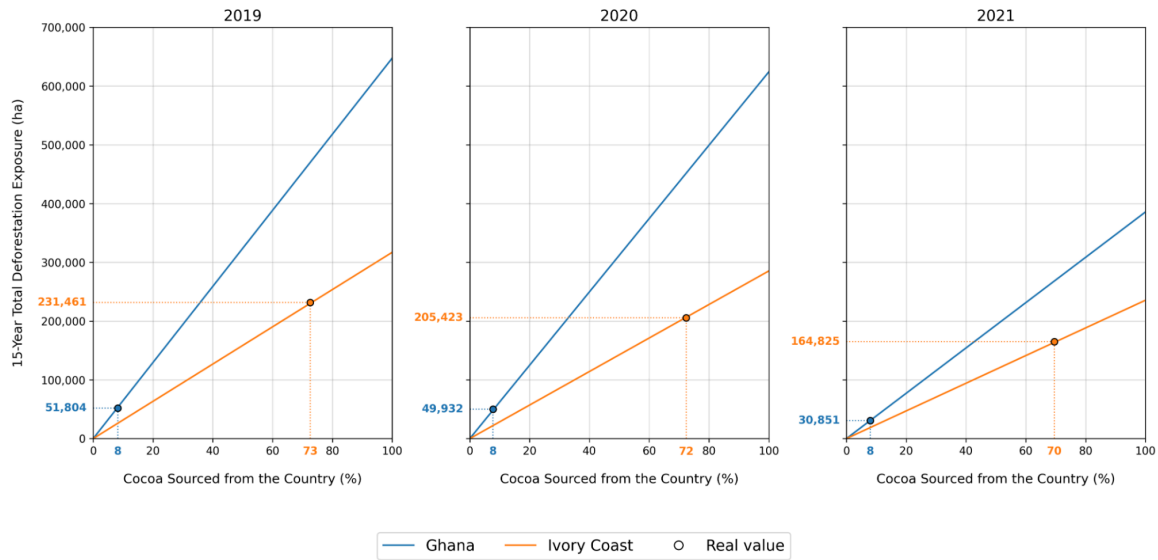


Figure 8. Projected sourcing scenarios: Nestlé dependence on Ivory Coast & Ghana (0–100%)

6.1.2 Discussion

Results show a clear negative trend of supply coming from Ghana, therefore Nestlé should keep limiting stocks bought from ghanese traders. The country already represents a very low percentage of Nestlé's total cocoa, at around 7-8%, but increasing that share would mean higher volumes of non-compliant cocoa. As of 2021, sourcing one tonne of cocoa from Ghana would cause 1.6 times more forest degradation than sourcing that tonne from Ivory Coast. But Nestlé should not only limit its sourcing from high risk areas, but also increase relationships with its Ivorian traders in order to lower deforestation rate even more. Scenario II explores exactly how much this collaboration would need to be in order to arrive at adequate levels the next few years.

6.2 Scenario Analysis II

6.2.1 Results

The second scenario consisted in forecasting production in Ivory Coast and tweaking (1) indirect sourcing ratios and (2) deforestation intensity levels for each trader. So we will first present results from the projections, then from the exploration of the two parameters, and conclude with the scenarios.

Evidence illustrates that future Nestlé sourcing volumes in Ivory Coast are bound to decrease, as Figure 9 suggests. This is due to the country’s persistently low productivity (discussed in section 2.1.1) and a downward trend in Nestlé’s procurement between 2019 and 2023. Like other major chocolate manufacturers, Nestlé has been affected by recent global supply shortages in cocoa production (ICCO, 2025b).

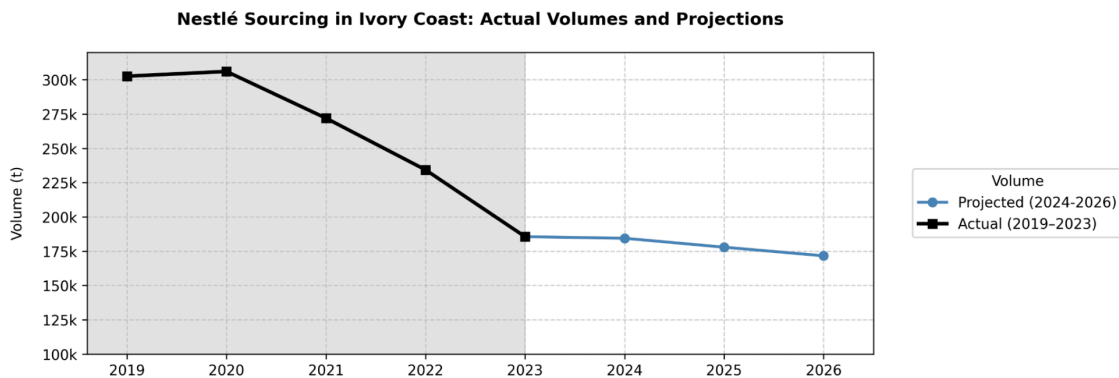


Figure 9. Forecasted 2024-2026 supply coming from Ivory Coast

Next, we projected how much Nestlé will indirectly source according to optimistic (-9.7%) and pessimistic (+9.7%) scenarios. As shown in Figure 10, if the current decreasing trend in indirect sourcing reverses, meaning that traders would have fewer direct partnerships with farmers, in favour of more reliance on middlemen (so called “pisteurs”), by 2026 as much as 89.4% of Nestlé’s cocoa could be indirectly sourced (light blue portion of the bar). This would make it extremely difficult to trace beans back to their specific farms of production and would make it complicated to fill in due diligence statements for the EU’s centralized compliance system. On a positive note, Nestlé could keep pushing for a procurement strategy that favors direct sourcing from farmers to increase traceability, potentially reaching 67% of cocoa directly sourced (dark blue portion of the bar) by 2026. For context, this figure was just 44.5% in 2021. This change could be possible if tier-1 suppliers maintain and increase the positive momentum observed between 2020 and 2021. It is clearly in Nestlé’s best interest to keep raising this percentage and ideally push for even higher levels of direct sourcing over time.

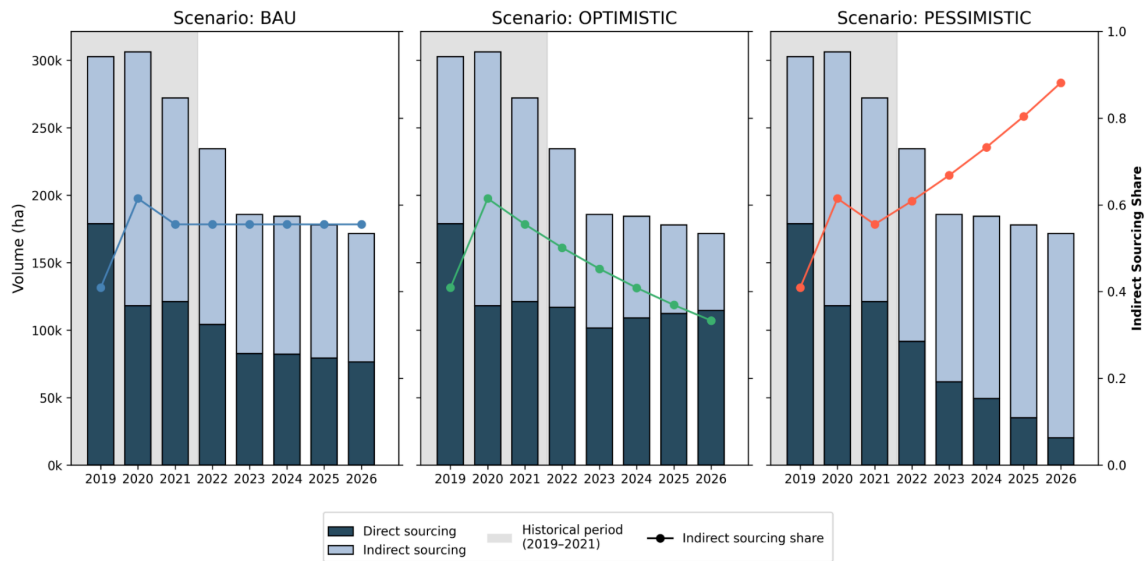


Figure 10. Simulated impact of a $\pm 9.7\%$ variation in Indirect Sourcing ratio by scenario (2022–2026)

Moreover, when projecting deforestation intensity in the future (Figure 11), our optimistic scenario supposes all farmers assume farming practices that are not harmful towards Ivorian forests, protected areas, and national parks. If this was the case, by 2026 deforestation intensity among Nestlé’s suppliers would drop to 327 ha/kt, meaning that farming practices will expand to forest land and degrade an area of about 3 square meters to produce one kilo of cocoa beans. Without improvements in farming practices, that number would stay at a level which is double, to almost 6 square meters per kilo.

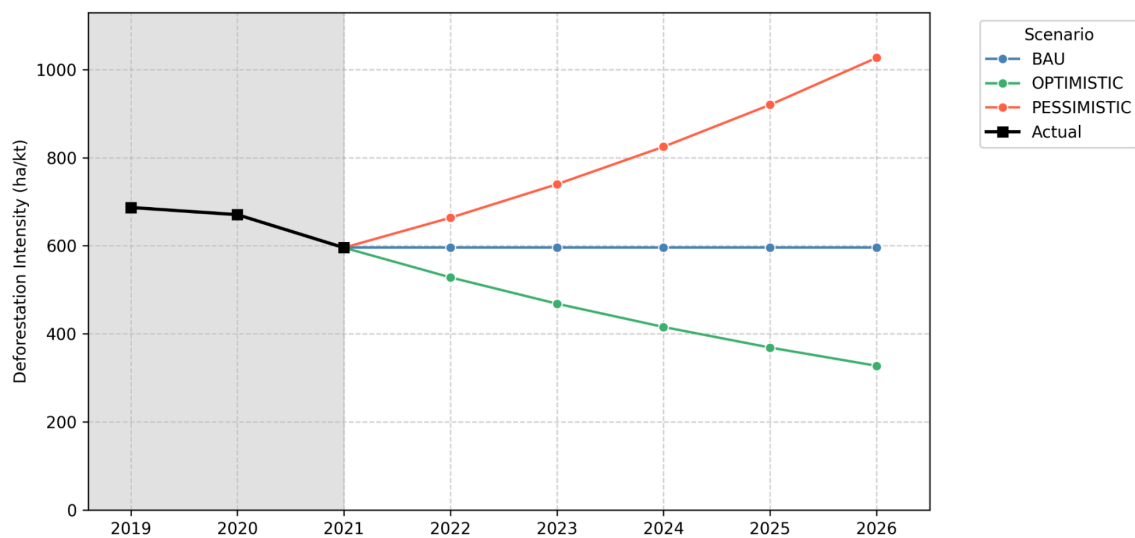


Figure 11. Simulated impact of a $\pm 11\%$ variation in Deforestation Intensity by scenario (2022–2026)

On the other hand, under a pessimistic scenario where farmers do worse than business-as-usual, deforestation intensity could reach 1,027 hectares per kiloton, more than 10 square meters of forest lost for every kilo of cocoa produced.

Finally, we quantified Nestlé’s future exposure to deforestation. Figure 12 illustrates the results. In a business-as-usual scenario, where both the share of indirect sourcing and deforestation intensity remain at 2021 levels, exposure declines in line with cocoa volumes purchased by Nestlé, reaching 102,227 hectares by 2026. Under a pessimistic scenario, where sourcing and land-use practices are not regulated, this figure rises significantly to 176,224 hectares. On the positive side, if Nestlé increases direct sourcing from farmers with low-impact practices, deforestation exposure could drop to just 56,192 hectares, which is nearly half of the baseline estimate. This number corresponds to roughly 562 square kilometers, and would allow Nestlé to be exposed to less risk related to non-compliance of the EUDR.

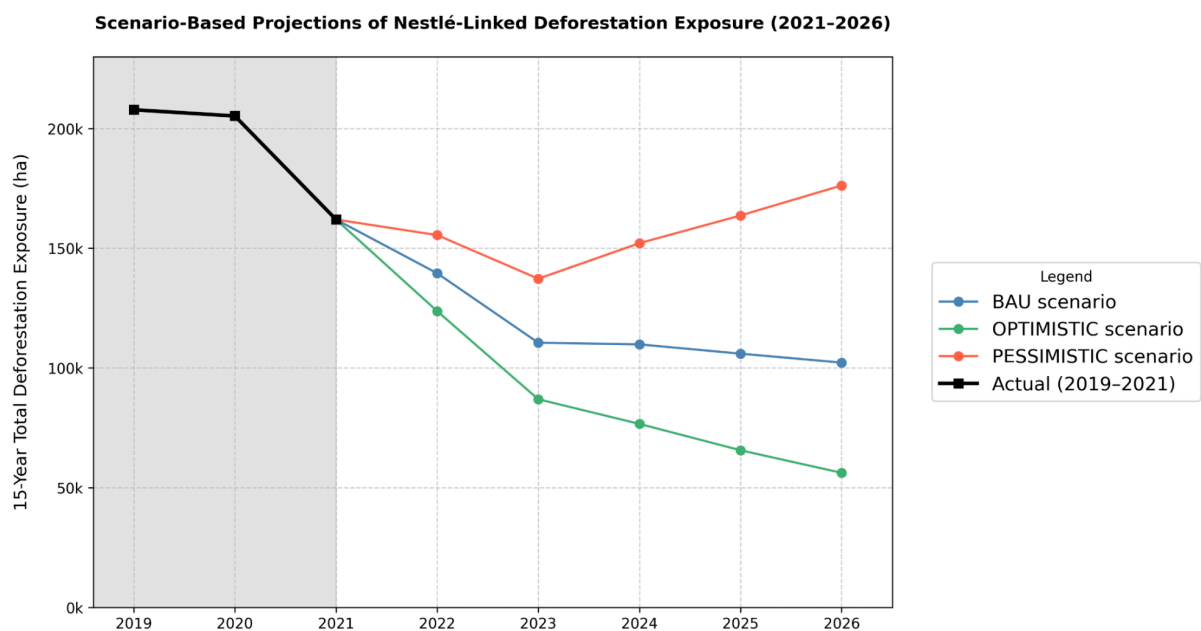


Figure 12. Scenario-based projections of future deforestation exposure linked to Nestlé in Ivory Coast

6.2.2 Discussion

Regarding projections indicating decreasing volumes sourced from Ivory Coast, it is to be noted that the figures (refer to Figure 9) reflect the share of cocoa sourced from the Nestlé

Cocoa Plan in Ivory Coast, that was assumed to be the same also in ‘normal’ cocoa, in order to have an estimate of the total. However, since this share for Ivory Coast has been decreasing rapidly since 2019, from 72.6% to only 55%, we wonder if the volumes in the difference have been somehow removed from the Nestlé Cocoa Plan (NCP) and counted elsewhere, omitting consistent chunks of deforestation in order to look more compliant. Or that it is in fact true that Nestlé actually cut down sourcing from Ivory Coast by 17 percentage points. What we do know for certain is that the Nestlé Cocoa Plan now accounts for almost the entirety of cocoa sourced by the company. Back in 2017, NCP made up just 42.9% of Nestlé’s cocoa purchases, while today that share has reached 88.9%, making the remaining volume of conventional cocoa now very limited. As a result, since our estimates are based on the growth of the NCP, they are to be considered increasingly reliable.

Now, since we hope it is in the company’s interest to pursue compliance, the Optimistic scenario offers a clear and actualizable strategy to reach low levels of deforestation. We believe that reducing indirect sourcing and deforestation intensity by the set levels is a feasible goal, and that Nestlé may have already begun implementing similar strategies to improve compliance with the EUDR. We hope these efforts will continue and also accelerate beyond 2026.

That said, there are reasons for concern. Companies have historically shown limited financial commitment to sustainable sourcing. A 2022 report showed that the Consumer Goods Forum’s Forest Positive Coalition of Action, an informal group of companies including Carrefour, Mars, Mondelēz, Nestlé, and Unilever, invests only 9 million dollars annually in landscape programs, which is less than 0.0128% of the collective annual profit of participating companies (Erasmus et al., 2022). Multinationals could invest more in initiatives like “jurisdictional sourcing”, that imposes commitment to source only from verified areas and provide financial incentives. This shows a broader issue: multinationals have the capacity to do more but often choose not to. Additionally, high cocoa prices continue to add pressure on a governance landscape that is unsustainable.

6.3 Economic Loss

6.3.1 Results

The estimated economic loss shown in Figure 13 peaks at 2025, with 315 million € in damages coming from confiscated non-compliant supplies entering the European market. In 2026, this figure would still reach €304 million if Nestlé fails to improve its traceability efforts and maintains the same levels disclosed in 2024—only 46.4% of direct supply being traceable. The steep increase in 2023 reflects the spike in global cocoa price (€/tonne) that affected the entire market.

When compared to revenues, these losses are substantial. In 2023, Nestlé reported 3,027 billion CHF in confectionery sales within the European market (Nestlé Global, 2023b). Of this, chocolate accounted for 76.6%, amounting to 2,318 billion CHF. In 2022 performance was a bit higher, with 2,337 billion CHF in sales. It is clear that a loss equivalent to 4% of total sales is not sustainable in the long run.

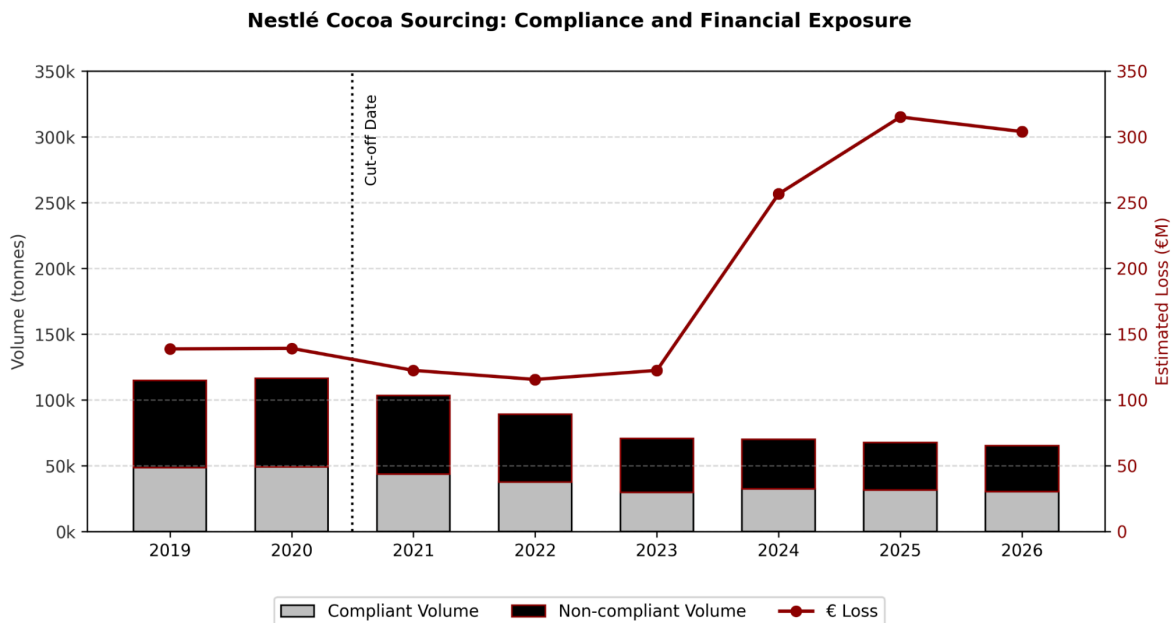


Figure 13. Forecasted economic loss from confiscated non-compliant supply coming to the EU

6.3.1 Discussion

That said, we expect that management and procurement strategies are already shifting in light of the EUDR, avoiding a pure business-as-usual approach. This analysis exemplifies what happens when procurement choices do not change and supplier selection lacks strategic planning: traders continue to rely heavily on indirect sourcing through “pisteurs” and “traitants”, rather than investing in direct relationships with farmers.

An important caveat is that here estimates of non-compliant cocoa are based on Nestlé’s own disclosures regarding their deforestation-free assessments. However, these figures are presented without any clear explanation of the methodology used. Specifically, Nestlé reports that 46.6% of cocoa beans from their ‘primary’ supply chain have been classified as deforestation-free—31.6% assessed via satellite imagery, and 14.8% assessed from the ground. No data or clarification is provided for the ‘secondary’ supply chain, leaving a huge gap in traceability. Also, we do not exclude the existence of a third level of supply chain, usually present in supply chains of similar chocolate companies, like Mars, that stated that *“76% of cocoa we sourced in 2023 is traceable to Tier 3 farm level polygons from first point of purchase”* (MARS, 2025).

However, what is clear is that cocoa remains Nestlé’s weakest performing commodity in terms of deforestation risk. The company claims that 93.5% of its overall sourcing across all commodities is deforestation-free, but this number is heavily weighed down by cocoa. All other commodities in their portfolio—meat, palm oil, pulp and paper, soy, sugar, and coffee—have significantly high scores, with coffee being the lowest at 93% (Nestlé Global, 2024a). This is to show that cocoa continues to be a serious challenge for companies, and that the targets they set are often unachievable in just a few years. Nestlé aims at 100% deforestation-free supply chains for cocoa and coffee by 2025, while not being even at a halfway point. The West African cocoa market still remains opaque and difficult to regulate.

6.4 Discussion: Exploring Other Sourcing Countries

To build a full picture of Nestlé’s deforestation footprint, future research needs to expand beyond Ivory Coast and Ghana to cover all sourcing countries. Based on sourcing volumes, Brazil and Ecuador should be prioritized, followed by Nigeria, Cameroon, Indonesia, the Dominican Republic, and then to other sourcing countries where Nestlé buys less than 1% of its cocoa from.

Ecuador is particularly relevant: since 2023, it accounts for 11% of Nestlé's total cocoa production, and the company has been investing heavily in the region. As reported in their 2022 Cocoa Plan Progress Report, *“Ecuador has become one of our fastest-growing origins and we have been scaling up our activities there”* (Nestlé Cocoa Plan, 2021b). Brazil is also a key area, since it is Nestlé's second-largest cocoa source.

Since the start of Nestlé Cocoa Plan in 2009, most traceability and impact assessments have only focused on Ivory Coast and Ghana. There, the company maps farmers on the ground by walking for thousands of kilometers, they train farmers to good agricultural practices, monitor practice adoption with Rainforest Alliance, and support reforestation efforts. Over 1 million trees have been distributed, and forest restoration initiatives are taking place (Nestlé Cocoa Plan, 2021a).

However, in 2022 Nestlé expanded deforestation assessments to Latin America. Nestlé relied on Global Risk Assessment Services (GRAS) to gather satellite data from 2015-2020 and compare it with protected and at-risk areas, as well as high carbon stock areas. As a result, the risk of cocoa-related deforestation is mainly low and concentrated in specific areas. In Brazil, only 0.5% of sourcing areas were classified as high-risk, across just four municipalities. In Ecuador, the figure is even lower at 0.4%. Moreover, a 2023 study found that Ecuadorian cocoa systems contribute positively to climate mitigation due to high carbon sequestration in biomass, and that cocoa does not seem to be linked to deforestation (Avadí, 2023). There, extractive industries like mining and oil may become a bigger threat to forests than cocoa, due to recent concessions being granted on Amazon land (NICFI, 2020).

That said, replicating this thesis's methodology in other countries presents major challenges. Transparency is a key issue: Nestlé has not disclosed its tier-1 suppliers in Brazil, and the local market remains opaque. With the upcoming EUDR, companies will be required to submit due diligence statements for all cocoa entering the EU, whether raw or processed, and therefore they will partner with satellite data processors like GRAS to meet compliance standards. While this may lead to more supply chain assessments across cocoa-producing regions, the data will likely remain inaccessible to the public.

Conclusion

This thesis presents a structured assessment of how much a company's sourcing strategy directly influences deforestation exposure and regulatory risk in the cocoa sector, using Nestlé as a case study. Results show that Nestlé's reliance on Ivory Coast is declining but remains substantial, and that its suppliers differ in their levels of traceability and environmental performance. While direct sourcing from farmers has the potential to significantly increase traceability and lower their exposure to deforestation, the company's portfolio still heavily relies on indirect supply and opaque sourcing practices.

Scenario analysis suggests that without improvements in procurement, Nestlé's deforestation exposure could reach over 170,000 hectares by 2026, with as much as 90% of its cocoa becoming non-traceable. This puts the company at high risk of EUDR non-compliance, with estimated annual losses of over €300 million in confiscated cocoa. On the other hand, a shift toward verified sourcing and lower-impact farmers could reduce exposure by half and limit financial damages.

Despite Nestlé's public commitments and progress through the Nestlé Cocoa Plan, cocoa remains the company's least compliant commodity. Even though traceability has improved, actual investments in sustainable sourcing and alternative initiatives are still very limited. If companies and their traders continue to rely on middlemen and avoid real engagement with producers, deforestation will persist and compliance costs will rise. Not only that, but the entire system of Ivorian cocoa farming will remain unchanged with farmers earning below the extreme poverty line.

This analysis offers a simple procurement strategy framework in order to minimise a company's exposure to EUDR non-compliance risk. As the regulation will soon enter into force, companies will need to move beyond their "responsible programs" and start using data to manage their supply chain risk properly.

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AI Statement

I acknowledge the use of AI was limited to grammar and writing structure refinement, as well as minor adjustments to the Python code to improve the visual presentation of graphs. No original content or analysis was generated by AI.