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Voluntary sustainability standards to cope with the new European Union regulation on deforestation-free products: A gap analysis

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ABSTRACT

The European Union Deforestation Regulation (EUDR) has been recently adopted to fight deforestation and forest degradation associated with the trade of forest-risk commodities, including cattle, cocoa, coffee, oil palm, rubber, soya, and wood. Operators must exercise due diligence (i.e., information collection, risk assessment, and risk mitigation) to ensure these commodities and their products are deforestation-free and produced in accordance with relevant legislation. In recent decades, Voluntary Sustainability Standards (VSS) have been adopted in the private sector to promote sustainable and deforestation-free supply chains. The EUDR recognizes certification and other third-party verified schemes as supporting tools for risk assessment during the due diligence procedure. However, questions persist regarding the extent to which these schemes can assist operators in assessing compliance with the EUDR. This study addresses these concerns by developing an assessment framework to evaluate the suitability of VSS schemes in covering the due diligence requirements established in the EUDR. The assessment of five major agricultural and forestry VSS schemes against this framework revealed both potentialities and limitations in covering these requirements. Most of the indicators from the framework were at least partially covered. Nevertheless, the assessed schemes fell short in providing a comprehensive prohibition of deforestation and forest degradation. They also presented variable coverage of the relevant legislation outlined in the EUDR, as well as deficiencies in their systems to assure compliance with the standards. Overall, this study indicates that VSS schemes can be incorporated as elements of due diligence systems but are insufficient to demonstrate compliance with the EUDR.

1. Introduction

Agricultural expansion is widely recognized as the primary direct driver of deforestation in tropical regions (Hosonuma et al., 2012; Curtis et al., 2018; FAO, 2020; Pendrill et al., 2022). Globalization and trade liberalization have heightened the vulnerability of forests in agricultural frontiers, as international demand intensifies the deforestation pressure on tropical countries, added to the effects of domestic demand (Meyfroidt et al., 2013; Franco-Solís and Montanía, 2021; Hoang and Kanemoto, 2021; Mammadova et al., 2022). Globally traded commodities that substantially contribute to deforestation in tropical areas are labelled as forest-risk commodities (FRCs) and encompass cattle, palm oil, soybeans, coffee, cacao, and forestry products (i.e., timber and wood-based products), among others. The extent of their individual contributions fluctuates across countries and regions (Henders et al., 2015; Pendrill et al., 2019). While deforestation embodied in FRCs is mainly driven by domestic demand, the global market also play a key role. Though the statistics differ across different sourcing regions, more than one quarter of deforestation embodied in FRCs was attributed to international trade between 2005 and 2013 (Pendrill et al., 2019; Pendrill et al., 2022). The European Union (EU) stands out as the second largest importer of deforestation embodied in the international trade of FRCs (Cuypers et al., 2013; Wedeux and Schulmeister-Oldenhove, 2021).

Building on growing concerns and on experience acquired with previous policies, the EU Deforestation Regulation (EUDR) was adopted in 2023 to tackle the deforestation driven by the EU's consumption (European Commission, 2023a; Berning and Sotirov, 2023). The EUDR advances the EU's transnational policy framework to address deforestation, which formally started in 2003 with the EU Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan (Sotirov et al., 2022). The FRCs included in the EUDR are cattle, cacao, coffee, oil palm,

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natural rubber, soya, and wood. The political momentum for deforestation-free products enabled the EUDR's agenda-setting, and the final text is a compromise solution shaped by different core beliefs and interests of actors participating in its development (Berning and Sotirov, 2024). Some other consumer countries significantly contributing to deforestation embodied in FRCs have also endorsed policies to regulate their market, such as the United States (US) and the United Kingdom (UK), while other relevant players are not inclined to adopt this strategy, such as China (Gent et al., 2022; Vasconcelos et al., 2024).

The EUDR repeals the EU Timber Regulation (EUTR), which was adopted in 2010 to prohibit the placing of illegally harvested timber on the EU market, and therefore only addressed deforestation partially (European Commission, 2010; European Commission, 2021). The EUDR has expanded the EU's regulatory framework from wood-based products to several other commodities which largely drive deforestation worldwide. Furthermore, it closes some important loopholes from the EUTR, while also introducing additional challenges to enterprises and control authorities (Köthke et al., 2023). Although the Regulation will start to apply on 30th December 2024, some studies have identified possible barriers to its effective implementation (e.g., Cesar de Oliveira et al., 2024) as well as possible side effects it may have (e.g., Vasconcelos et al., 2024).

In parallel, the private sector has also endorsed sustainability commitments related to the production and trade of FRCs (Lambin et al., 2018; Grabs et al., 2021; CDP, AFi, 2022). In this scenario, Voluntary Sustainability Standards (VSS) are one of the main family of policy and marketing tools used for achieving deforestation-free supply chains (Bager and Lambin, 2022; Dermawan et al., 2022; Ellis and Weatherer, 2022). VSS specify requirements for producers, traders, manufacturers, retailers, and service providers across a wide range of sustainability metrics (UNFSS, 2013), and are commonly covered by an assurance system (e.g., verification and certification schemes).

VSS emerged and proliferated in the last few decades as non-state market-driven governance systems, developing and implementing environmentally and socially responsible management practices (Cashore, 2002; Marx and Depoorter, 2021). The number of VSS and the land covered by them have increased significantly, even though they still cover only a small share of the global agricultural land (Tayleur et al., 2017; Meemken et al., 2021; UNFSS, 2022). Nevertheless, they are remarkably relevant for some of the commodities covered by the EUDR. For example, VSS cover somewhere between 25.8 and 45.3% and 22.8–37.6% of the land cultivated with coffee and cocoa, respectively (Willer et al., 2022).

The EUDR, as its main feature, requires that operators[1] exercise due diligence to ascertain that products are deforestation-free and produced in accordance with relevant legislation in the country of production. Due diligence is a sequential procedure that includes information collection, risk assessment, and risk mitigation (OECD, FAO, 2023). Complementary information on compliance with the EUDR requirements provided by certification or other third-party verified schemes is one of the criteria outlined in the EUDR for risk assessment. In this context, some organizations affected by the EUDR have claimed for a higher recognition of these schemes. They argue that credible schemes already have well-established no-deforestation criteria, assurance systems, and product traceability in place (CAOBISCO et al., 2022; COCERAL et al., 2022; ClientEarth, 2022; EuroCommerce, 2022; RSPO, 2022).

Nevertheless, it is unclear if VSS schemes and other voluntary supply chain initiatives are effective in preventing deforestation and forest degradation (Lambin and Furumo, 2023) and to integrate human rights and environmental aspects associated to deforestation processes within the sustainability governance of global supply chains (Schilling-Vacaflor and Gustaffson, 2024). Studies investigating schemes certifying oil palm (Carlson et al., 2018; Gatti et al., 2019; Heilmayr et al., 2020; Vander-Wilde et al., 2023), coffee (Takahashi and Todo, 2013; Rueda et al., 2015; Dietz et al., 2021; d'Albertas et al., 2023), soy (Meijer, 2015; Garrett et al., 2016), and wood (Miteva et al., 2015; Heilmayr and Lambin, 2016; Blackman et al., 2018; Tritsch et al., 2020), for example, show variable outcomes. In general, existing literature provides mixed and limited evidence regarding the effectiveness of VSS in systematically promoting deforestation-free commodities, and several studies often point out to not significant impacts (Defries et al., 2017; Ingram et al., 2020; Traldi, 2021; Rubio-Jovel, 2022; Di Girolami et al., 2023) or even ineffectiveness (Panwar et al., 2023). Therefore, previous research indicates that VSS are insufficient for achieving zero deforestation on their own but could still be important elements of a policy mix combining different approaches and instruments to reach sustainability targets (Lambin et al., 2014; Barton et al., 2017; d'Albertas et al., 2023). Policy instruments targeting different actors and addressing multiple goals across several policy sectors and levels can potentially fill governance gaps and promote a mutually reinforcing framework (Gulbrandsen, 2004; Azevedo et al., 2017; Lambin et al., 2018; Milhorance et al., 2020; Marques and Eberlein, 2021). For example, VSS are highly complementary to the Sustainable Development Goals (SDGs) agenda, which could offer opportunities for public-private interactions and policy complementarity (Lambin et al., 2014; Schleifer et al., 2022).

Few studies have explored the interplay between VSS and EU policies (Marx, 2018), and there is currently a significant gap regarding to which extent they can cover the requirements established in the EUDR. A study conducted on behalf of the European Commission found that certification and verification schemes in the forestry sector offer substantial assistance to operators striving to fulfil their due diligence responsibilities for compliance with the EUTR, although several deficiencies and vulnerabilities were identified (Preferred by Nature, 2021). However, new studies are necessary to account for the new commodities and regulatory elements introduced by the EUDR, and, this way, provide detailed evidence to resolve the debates revolving around the interplay between VSS and this Regulation. Some efforts already exist to analyse the current alignments with EUDR requirements. The Roundtable on Sustainable Palm Oil (RSPO), for example, has conducted a gap analysis vis-à-vis the EUDR, identifying the differences between its standards and the requirements from the Regulation (RSPO, 2023a). Boev and van Gelder (2023) have benchmarked VSS operating in the soya market, but the criteria used in their study considers other initiatives beyond the EUDR. Overall, this type of assessment is still scarce in the literature, which limits the conclusions on the extent to which VSS can help operators to cope with the due diligence requirements establish in the EUDR. Furthermore, a harmonized tool that allows a systematic assessment of VSS in relation to the EUDR is – to our knowledge – not yet available.

The main objective of this study is to assess to which extent VSS providing third-party verified certification schemes for FRCs within the EUDR scope might help operators to meet the due diligence requirements from the Regulation. Given the novelty of the topic and the exploratory nature of this study, we aimed to focus on the development of a robust methodological framework for VSS assessment against EUDR requirements and test it on a selection of VSS rather than performing a systematic review of all potentially available VSS covering FRCs within the scope of EUDR. In this context, the objectives of this study are: 1) to develop a methodological framework to assess VSS under certification or other third-party verification scheme against EUDR requirements; 2) to apply this framework to five selected VSS in order to identify gaps in their requirements and inform possible future developments and improvements; and 3) analyse whether or not these VSS are sufficiently aligned with EUDR to act as proof of compliance.

[1] According to the EUDR definitions, 'operator' means "*any natural or legal person who, in the course of a commercial activity, places relevant products on the market or exports them*" (EUDR, Article 2, point 15).

2. Material and methods

2.1. Assessment framework

Article 3 of the EUDR requires that relevant commodities and products can only be placed on the EU market or exported if they are deforestation-free and produced in accordance with relevant legislation in the country of production. Moreover, operators must exercise due diligence to ascertain that relevant commodities and products comply with Article 3. Annex 1 provides definitions of some relevant concepts adopted by the EUDR and having a central role within this study.

Based on these requirements, we built an assessment framework to determine if VSS schemes can deliver assurance and provide information to operators for compliance with the EUDR. The framework builds on the requirements for due diligence laid down in Articles 9, 10 and 11 of the Regulation, as well as the definitions laid down in Article 2. Previous studies dealing with similar topics, but not directly addressing the EUDR, were consulted and used as references when constructing the framework (e.g., Hinkes and Peter, 2020; Greenpeace, 2021; Preferred by Nature, 2021). This framework has also been peer-reviewed by experts in forest and agricultural policy to whom a draft version of the framework has been presented to collect feedback and recommendations.

The hierarchical framework defined by Lammerts van Bueren and Blom (1997) was used to break down the overall goal into parameters that can be managed or assessed. Therefore, the framework was structured into 3 principles broken down into 8 criteria, and 24 indicators. Each indicator has its own set of verifiers and guidelines for conducting the assessment. The three overarching principles of the framework are described below. A short version of the assessment framework containing principles, criteria, and indicators (i.e., verifiers and guidelines not included) is presented in Table 1, and the full version is reported in Annex 2.

The three principles are:

- ***Principle A: Requirements that commodities and products are deforestation-free and produced in accordance with legislation.***

Principle A aims at determining if schemes present requirements that characterize standard-compliant material as deforestation-free and produced in accordance with relevant legislation, according to items (g) and (h) of Article 9(1) of the EUDR. Guidance is grounded on definitions provided in Article 2, where the concepts of deforestation-free and relevant legislation are provided, as well as other relevant definitions.

- ***Principle B: Requirements for information traceability and risk management in the supply chain.***

Principle B first investigates the traceability of information production and commercial transactions required for due diligence, defined in items (a) to (f) in Article 9(1). Subsequently, it investigates traceability systems adopted by the schemes and the risk of mixing with products of unknown origin or produced in areas where deforestation or forest degradation has occurred or is occurring, as outlined in item (j) of Article 10(2). Risk assessment and risk mitigation requirements according to Article 10(2) and Article 11(1) of the EUDR were considered.

- ***Principle C: Scheme structure, assurance system and transparency.***

Principle C does not refer to EUDR requirements, but rather provides criteria and indicators to assess scheme reliability in providing information to assess Principles A and B. This includes consistency between standards of different levels, assurance of internal compliance, requirements for conformity assessment bodies, as well as requirements for transparency and corruption. This examination is relevant because schemes can have strong requirements but might fail to deliver impacts

Table 1
Principles, criteria, and indicators of the assessment framework.

Principles and criteria	Indicators
Principle A. Requirements that commodities and products are deforestation-free and produced in accordance with legislation	
A.1 Requirements for deforestation-free commodities and products	**A.1.1** The scheme presents a clear prohibition of deforestation and forest degradation
	A.1.2 The definitions of forest, deforestation and forest degradation match or encompass the definitions from the EUDR
	A.1.3 The scheme presents a cut-off date for deforestation and forest degradation that is equal or previous to 31st December 2020
A.2 Requirements for commodities and products produced in accordance with legislation	**A.2.1** The scheme presents a clear requirement for production in accordance with the relevant legislation in the country of production
	A.2.2 The applicable legislation encompasses all the categories specified in the EUDR
	A.2.3 The scheme requires that subcontractors operate in accordance with legislation
Principle B. Requirements for information traceability and risk management in the supply chain	
B.1 Information traceability	**B.1.1** The scheme requires a mandatory traceability system
	B.1.2 The scheme requires that information on production and commercial transactions are recorded and kept for at least five years
B.2 Risk management of supply chain	**B.2.1** The scheme provides mechanisms to assure that standard-compliant material is segregated from other sources
	B.2.2 The scheme requires that material from other sources is deforestation-free
	B.2.3 The scheme requires that material from other sources is produced in accordance with the relevant legislation in the country of production
	B.2.4 The scheme requires adequate measures for risk assessment and risk mitigation
Principle C. Scheme structure, assurance system and transparency	
C.1 Consistency between international and national/regional level standards	**C.1.1** The scheme presents consistency between international and national/regional standards
C.2 Requirements for compliance assurance by verified parties	**C.2.1** The scheme requires that verified parties have adequate policies, controls, and procedures for compliance assurance
	C.2.2 All documentation for compliance with the scheme must be kept for at least five years
C.3 Requirements for conformity assessment	**C.3.1** Non-compliance with deforestation-free and legality requirements prevents compliant status
	C.3.2 Conformity assessment is conducted by a legal, impartial, and qualified organization
	C.3.3 The scheme requires periodic checks or re-assessment of verified parties
	C.3.4 Conformity assessment has minimum requirements for information sources and sampling strategies for assuring effective auditing
	C.3.5 The scheme provides mechanisms to assure compliance by all members under a group verification
C.4 Transparency and corruption	**C.4.1** The scheme makes publicly available the full requirements for verified parties and conformity assessment bodies

(*continued on next page*)

Table 1 (*continued*)

Principles and criteria	Indicators
	C.4.2 The scheme makes publicly available the status of verified parties **C.4.3** The scheme makes publicly available a summary of audit reports that contains methodology and main findings, including non-compliances **C.4.4** The scheme presents policies, controls, and procedures to identify and manage risk of corruption

because of weak implementation, inadequate monitoring and enforcement, and lack of systems to avoid fraud (Greenpeace, 2021).

2.2. Data collection and analysis

This research relies on qualitative data collected through desk research and document analysis. This included information that was publicly available from the schemes, such as standards, guidance and interpretation documents, policies, procedures, databases, reports, and any other documents deemed as relevant to assess an indicator. The full list of documents used for each scheme and their current versions is reported in Table S1 within Supplementary materials.

Schemes were assessed against each indicator based on the respective guidelines and verifiers within the framework. Each indicator was classified according to levels described in Table 2, representing to which extent schemes cover indicators of the framework. The assessment of a single scheme consisted of filling a checklist reporting the outcome for each indicator, based on the evidence collected from the document analysis. Then results were summarized at principle and criterion levels.

2.3. Selected VSS schemes

ISEAL Alliance membership was defined as the baseline for selecting VSS schemes. ISEAL is an international non-profit organization created in 2002 to codify best practice for the design and implementation of social and environmental standards initiatives (Loconto and Fouilleux, 2014; ISEAL, 2021). It provides guidance and support to standard-setting initiatives addressing social and environmental concerns and represents an alternative – though largely complementary – system to industry-lead standard setting systems.

Table 2
Possible outcomes of coverage of the indicators in the assessment framework.

Outcome	Description	Example
Fully covered (FC)	There is enough evidence to conclude that the scheme fully covers the indicator.	Standard states that forest conversion into agriculture is not allowed. Therefore, indicator A.1.1 is fully covered.
Partially covered (PC)	Evidence indicates that the scheme only partially covers the indicator, not fully addressing the requirements detailed in the verifiers/ guidelines.	Standard includes land use rights, environmental protection and third parties' rights as relevant legislation, but do not address trade and customs regulations. Therefore, indicator A.2.2 is partially covered.
Not covered (NC)	Evidence indicates that the indicator is not covered by the scheme.	The scheme does not disclose any information or documents related to audits of verified parties. Therefore, indicator C.4.4 is not covered.
Not applicable (NA)	Indicator does not apply because the subject does not fall within the scope of the scheme.	The scheme does not present standards adapted to the national/regional level. Therefore, indicator C.1.1 is not applicable.

Selecting only ISEAL-member VSS ensures the sample is consistent in terms of reference guidelines and standards for VSS setting, thus making comparison more robust. Given the exploratory nature of this study we decided to focus on a preliminary set of VSS to develop and test the methodological framework. The scope in terms of VSS might be expanded and additional standards might be included in future research.

The selection process considered: a) members setting standards for at least one of the relevant commodities from the EUDR, b) members that are part of a third-party verified scheme, and c) members with a significant part of their operations in countries with high deforestation risk. From this examination, five schemes were selected[2]: Fairtrade International (cocoa and coffee), Forest Stewardship Council (FSC) (wood and natural rubber), Rainforest Alliance (cocoa and coffee), Roundtable on Sustainable Palm Oil (RSPO) (oil palm), and Round Table on Responsible Soy Association (RTRS) (soya). As a result of the approach adopted in this study, schemes covering cattle were not included. A summary of the selected schemes and their initiatives to address the EUDR is provided in Table 3, and the extent of implementation of these schemes is summarized in Table S2.

3. Results

In this section, we first provide a summary of the results obtained from applying the assessment framework to the selected VSS schemes. Then, we detail our findings for each Principle (A, B, C), addressing each criterion in sequence according to the framework.

3.1. Summary of the application of the assessment framework

Fig. 1 provides a snapshot of the results obtained from the application of the assessment framework to the selected schemes. Overall, all schemes covered at last partially the indicators from Principle A, though significant gaps for compliance with the EUDR were identified. Moreover, four out of the five schemes did not cover three indicators from Principle B. Schemes covered at least partially most indicators from Principle C, with a couple of exceptions.

Schemes: Fairtrade = Fairtrade International; FSC = Forest Stewardship Council; Rainforest = Rainforest Alliance; RSPO = Roundtable on Sustainable Palm Oil; RTRS = Round Table on Responsible Soy Association. Outcome: FC = fully covered, PC = partially covered, NC = not covered, NA = not applicable.

FSC was the scheme with the highest proportion of fully covered indicators (58.3%), followed by RTRS (45.8%), Rainforest Alliance (41.6%), and Fairtrade and RSPO (both with 37.5%). The proportion of partially covered indicators varied between 37.5 and 50% across schemes. Only FSC did not present any indicator classified as not covered, while this outcome represented 16.7% of the indicators for both Fairtrade and Rainforest Alliance, and 12.5% for both RSPO and RTRS (Fig. 2).

Schemes: Fairtrade = Fairtrade International; FSC = Forest Stewardship Council; Rainforest = Rainforest Alliance; RSPO = Roundtable on Sustainable Palm Oil; RTRS = Round Table on Responsible Soy Association. Outcome: FC = fully covered, PC = partially covered, NC = not covered, NA = not applicable.

3.2. Principle A

Results for criterion **A.1** showed that most schemes are limited in providing deforestation-free products. Two factors contributed to this

[2] Global Coffee Platform (GCP), Sustainable Agriculture Network (SAF), GLOBALG.A.P., and Leaf Marque are also standard-setting organizations members of ISEAL, but they were not assessed in this study for not meeting the inclusion criteria.

Table 3
Selected VSS schemes, their certification scopes, and their initiatives to address the EUDR.

Scheme	Scope	Main initiatives and measures adopted/initiated to align with EUDR requirements
Fairtrade International	General standards for the certification of sustainable farming (small scale producers, hired labour organizations, contract production). Specific standards for cocoa and coffee with additional requirements. Trader standard for supply chain certification.	The standard for coffee production has been updated to require that producers have not cause deforestation to convert land into agricultural production areas since January 1st, 2014 (Fairtrade, 2024). A new programme has been created "*to scale up satellite monitoring of forested areas and farms to all certified cocoa and coffee producer organizations globally*" (Fairtrade, 2023a).
FSC	Standards for the certification of sustainable forest management (individual organizations, group certification, SLIMF). Standards for chain of custody certification.	The *FSC EUDR Aligned* programme has been created to support compliance of FSC-certified products with the Regulation. From June 2024, FSC will provide a set of integrated tools so standards are fully compatible with the EUDR, and companies can meet the legal obligations (FSC, 2024).
Rainforest Alliance	2020 Rainforest Alliance Certification Program. The Sustainable Agriculture Standard is divided into farm requirements and supply chain requirements.	The scheme is working on identifying adjustments to ensure that systems and tools in place can support EUDR needs for farmers and companies (Rainforest Alliance, 2024).
RSPO	Standards for the certification of sustainable palm oil production (principles and criteria, independent smallholder). Standards for supply chain certification.	RSPO has conducted a gap analysis with the EUDR and identified the key actions needed to facilitate compliance. These include adding new definitions, aligning methodologies, reviewing audit guidance, and deleting exceptions, for example. Based on the findings, RSPO has started to review its process, standards, and technical tools (RSPO, 2023a).
RTRS	Standards for the certification of responsible soya production (soybean production and biofuels). Standards for chain of custody certification.	No initiatives towards alignment with the EUDR made public were found.

Fig. 1. Summary of results of the application of the assessment framework to the selected VSS schemes.

outcome: (i) the fact that selected VSS establish requirements that prohibit deforestation and forest degradation only for certain types of forests or lack such requirements for all certification scopes and commodities, therefore not covering all cases to which the EUDR applies, and (ii) the fact that selected VSS present exceptions in which deforestation can occur in compliance with the standards.

As for the first point identified, FSC requires that organizations do not convert natural forests or High Conservation Value (HCV) areas to plantations or to non-forest land use, nor transform plantations on sites directly converted from natural forest to non-forest land use. Management units do not qualify for certification if conversion occurred after December 31st, 2020 (FSC, 2023a).

Rainforest Alliance presents a requirement prohibiting conversion of natural forests and other natural ecosystems into agricultural production or other land uses from January 1st, 2014 (Rainforest Alliance, 2023a).

In the P&C standard, RSPO requires that land clearing since November 2005 has not damaged primary forests or any area required to protect or enhance HCV. Furthermore, land clearing since November 15th, 2018, should not damage HCV or High Carbon Stok (HCS) forests (RSPO, 2018). For the Independent Smallholder (ISH) standard, new planting since November 2019 should not replace HCV and HCS forests (RSPO, 2019a).

RTRS forbids the conversion after 2009 of areas from Category 1 from the RTRS maps (i.e., areas critical for biodiversity where stakeholders agree there should be no conversion of native vegetation). Whenever these maps are not available, conversion of native forests, riparian vegetation, natural wetlands, steep slopes, and legally protected areas is prohibited. Moreover, the scheme forbids the conversion of any natural land after 2016 (RTRS, 2021).

Only Fairtrade's requirements did not present the same trend.

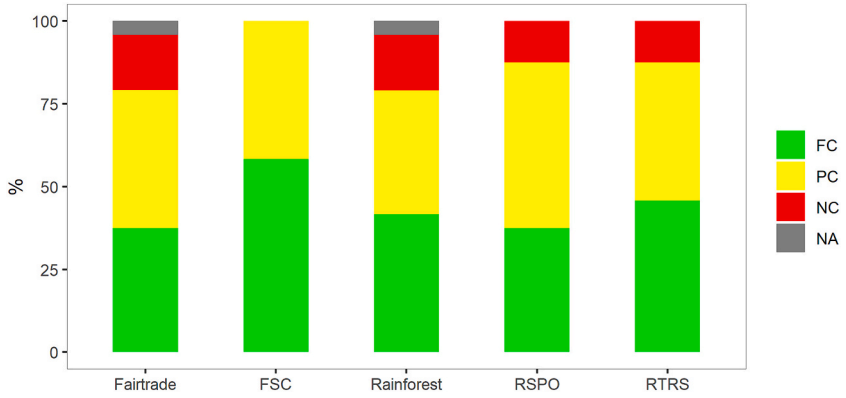

Fig. 2. Percentage of indicators classified under each outcome by VSS scheme.

Fairtrade requires that members under the Small-scale Producer Organizations (SPO) standard do not cause deforestation from July 1st, 2019 (Fairtrade, 2019). On the other hand, members under the Contract Production (CP) and Hired Labour (HL) standards are only required to avoid negative impacts on protected areas (Fairtrade, 2011 and 2014). However, the commodity-specific standards for cocoa and coffee solve this problem, as they require that members have not caused deforestation or degradation in primary or secondary forests, protected areas and areas of HCV or HCS to convert land into agricultural production area (Fairtrade, 2021; Fairtrade, 2023b). This applies from December 31st, 2018, for cocoa and from January 1st, 2014, for coffee.

As for the second point identified (i.e., exceptions to deforestation prohibition), Rainforest Alliance allows farms to get certified when minor conversion has occurred after the cut-off date, seeing it comprises not >1% of farmland or than 10 ha, whichever is smaller. Conversion is also allowed to maintain or expand infrastructure essential for farm or processing operations, if appropriately justified and not surpassing 1% of the certified area (Rainforest Alliance, 2023a).

In the case of FSC, conversion is allowed when it: a) affects a very limited portion of the management unit (i.e., not exceeding 5%), b) will produce clear, substantial, additional, secure long-term conservation and social benefits in the management unit, and c) does not damage or threaten HCVs, nor any sites or resources necessary to maintain or enhance HCVs (FSC, 2023a).

For RSPO, clearing of <10 ha is not considered new land clearing within existing certified units (RSPO, 2019a). Finally, RTRS allows a minimal level of conversion if it accounts for 5% of the total size of the farm or less, but no >20 ha (RTRS, 2021). Conversion is also allowed in the cases of legal obligation or verifiable emergency (e.g., construction of roads, transmission lines, firewalls).

Another limiting aspect is the mismatch between the definitions used by the schemes and by the EUDR for forest, deforestation, and forest degradation. Finally, although the requirements are not fully prohibiting deforestation and forest degradation, all schemes presented a cut-off date previous from the one adopted in the EUDR.

For criterion **A.2**, most indicators were partially covered, meaning that gaps for a comprehensive assurance of compliance with legislation were identified. In the case of Fairtrade, the SPO standard requires that there are no indications that members violate national legislation on the topics covered by the standard (Fairtrade, 2019). On the other hand, the CP, HL, and Trader standards did not present specific requirements for compliance with legislation (Fairtrade, 2011, 2014, and Fairtrade, 2015).

For FSC, the P&C standard requires that organizations comply with all applicable laws, regulations and nationally ratified international treaties, conventions and agreements (FSC, 2023a). In the Chain of Custody (CoC) standard, FSC requires that organizations comply with all applicable timber legality legislation (FSC, 2021a). Rainforest Alliance requires that certificate holders comply – at the farm level – with applicable laws within the scope of the standard, prevailing the stricter rule (Rainforest Alliance, 2023a). At the supply chain level, certificate holders are required to comply with applicable laws in relation to specific topics (Rainforest Alliance, 2023b).

For RSPO, the P&C standard requires compliance with all applicable local, national, and ratified international laws and regulations (RSPO, 2018). In turn, the ISH standard requires assurance of legality, respect for land rights and community wellbeing (RSPO, 2019a). In the case of RTRS, the standard for producers requires awareness and compliance with applicable local and national legislation (RTRS, 2021). RSPO and RTRS do not require compliance with legislation in their standards for supply chain and CoC, respectively (RSPO, 2020a; RTRS, 2011).

Furthermore, requirements for compliance with legislation are often not extended to subcontractors for all certification scopes (i.e., production level – farming and forest management – and supply chain level). In the case of FSC, the requirements from the P&C standard are extended to all the organization's management activities, but the CoC standard only covers the handling of the outsourced material (FSC, 2021a and FSC, 2023a). Fairtrade and RTRS were found to extend only the requirements for labour conditions to subcontractors at the production level (Fairtrade, 2019; RTRS, 2021). For RSPO, only the P&C standard requires that all subcontractors comply with legal requirements (RSPO, 2018). In turn, Rainforest Alliance requires that subcontractors comply with the applicable requirements set in both the farm and the supply chain standards (Rainforest Alliance, 2023a; Rainforest Alliance, 2023b).

Coverage of the eight categories of relevant legislation outlined by the EUDR was variable across schemes and across certification scopes. Item (h) – i.e., tax, anti-corruption, trade and customs regulations – was the gap most commonly reported. Standards at the production level addressed relevant legislation more extensively when compared to standards at the supply chain level.

3.3. *Principle B*

For criterion **B.1**, all schemes require a mandatory traceability system for handling certified products, while also detailing the traceability systems allowed and their respective rules. On the other hand, not all information required for due diligence was covered by the schemes. The main gap identified was the geolocation requirement[3] established in the

[3] According to the EUDR definitions, 'geolocation' means the "*geographical location of a plot of land described by means of latitude and longitude coordinates corresponding to at least one latitude and one longitude point and using at least six decimal digits; for plots of land of more than four hectares used for the production of the relevant commodities other than cattle, this shall be provided using polygons with sufficient latitude and longitude points to describe the perimeter of each plot of land*" (EUDR, Article 2, point 28)

EUDR (Article 9, point d).

Rainforest Alliance requires that geolocation data of the farms is registered, and that products sold as certified can be traced back to the farm (Rainforest Alliance, 2023a). However, this does not include the date or time range of production. RSPO allows to trace palm oil back to a single mill (RSPO, 2020a). However, this means the entire supply base of that mill, and the date or time range of production is not mentioned either. Other schemes did not provide any level of geolocation traceability.

For criterion **B.2**, all schemes presented options for traceability systems where certified products are kept separated throughout the whole supply chain, and therefore are not mixed with material from other sources (e.g., segregation, identity preserved). On the other hand, all schemes allowed, to some extent, the mixing of certified and non-certified input materials under certain traceability systems (e.g., mass balance, book and claim, credit). In these cases, the mix can be sold as certified, if sales with a certification claim do not exceed the amount of product initially purchased as certified – also considering a conversion factor to a processing stage if applicable.

The key issue lies on the lack of systems to control the social and environmental attributes of the non-certified material entering the supply chain of certified products. Therefore, there is an inherent risk that products managed under such traceability systems are associated with deforestation and non-compliance with legislation. This concern applies to cocoa certified by Fairtrade and Rainforest Alliance, as well as products certified by RSPO and RTRS (RTRS, 2011; Fairtrade, 2015; RSPO, 2020a; Rainforest Alliance, 2023b; Rainforest Alliance, 2023c).

While FSC also allows mixing certified and non-certified material, the scheme has a system, namely Controlled Wood (CW), to assure that non-FSC-certified wood does not come from unacceptable sources (e.g., illegally harvested wood, wood harvested in violation of traditional and human rights, and wood from forests being converted to plantations or non-forest use). FSC sets requirements for enterprises supplying CW and requires that organizations sourcing CW for their operations conduct due diligence (FSC, 2006; FSC, 2017). As a downside, the CW system has similar exceptions as those from the P&C standard, presented for criterion **A.1**. Nevertheless, compliance with relevant legislation is covered, and the risk assessment and risk mitigation approaches are close to EUDR requirements.

3.4. Principle C

Criterion **C.1** does not apply to Fairtrade and Rainforest Alliance. In the case of FSC, the international P&C standard must be locally adapted and there are clear procedures to grantee the consistency across standards at different levels. The main documents in this area are a) the process requirements for the development and maintenance of National Forest Stewardship Standards (FSS), b) the international generic indicators, and c) the structure, content and local adaptation of generic forest stewardship standards (FSC, 2009a, 2009b, and FSC, 2023b). However, small inconsistencies related to compliance with national legislation still exist across FSS. For example, the list of applicable legislation mapped in the National FSS for Brazil and Chile (top-2 countries with the highest deforestation risk associated with wood products imported by the EU between 2005 and 2017, see Pendrill et al., 2020) has significant differences and results in different levels of coverage of applicable legislation (FSC, 2005; 2013). In the case of RSPO and RTRS, requirements relevant for this study are consistent across National Interpretations (NIs) (RSPO, 2019b; RSPO, 2020b; RTRS, 2022; RTRS, 2023).

For criterion **C.2**, only FSC fully covered both indicators (FSC, 2014, 2020, 2021a, and FSC, 2023a). In the case of Fairtrade, the implementation of an internal control system only applies to 2nd and 3rd grade organizations, and 1st grade organizations with >100 members (Fairtrade, 2019). For Rainforest Alliance and RTRS, gaps related to internal management systems were identified (RTRS, 2011; RTRS, 2021; Rainforest Alliance, 2023a; Rainforest Alliance, 2023b). Rainforest Alliance and RSPO also fell short on the keeping records of evidence for compliance, requiring only 4 and 2 years, respectively (RSPO, 2020a; Rainforest Alliance, 2023a; Rainforest Alliance, 2023b).

For criterion **C.3**, all schemes require that conformity assessment is conducted by a legal, impartial, and qualified organization. However, checks by a third party are not guaranteed to occur at regular intervals no longer than 12 months. Most schemes required a wide range of information sources for conducing conformity assessment including document analysis, field inspection and stakeholder consultation. Only Fairtrade does not include gathering information from external stakeholders during audits (Fairtrade, 2023c; FLOCERT, 2023).

The key issue identified for this criterion was the use of soft mechanisms to handle violations of the standards. The evidence collected suggests that conducting deforestation, forest degradation, or non-compliance with legislation, does not result in certificate suspension, cancelation of withdraw. Instead, non-conformities (NCs) with the requirements can be addressed by the implementation of corrective actions established by the conformity assessment body. The loss of a certificate is only expected to occur when corrective actions are not implemented within the established timeframe, which varies across significance levels (minor and major NCs) and across schemes, or in specific cases, such as reoccurrence of five major NCs within a principle for RSPO (RTRS, 2012; RTRS, 2014; RSPO, 2020c; FSC, 2021b; FSC, 2022; Fairtrade, 2023d; Rainforest Alliance, 2023d). This increases the risk that certified products do not comply with the EUDR.

For criterion **C.4**, the main gap identified was that Fairtrade and Rainforest Alliance do not provide a public summary of audit reports. Other schemes publish summaries on their website, or on the website of the conformity assessment body, which contain NCs found during the audits. However, these reports only apply to the production level (e.g., farming and forest management), not covering the supply chain level. Apart from this, all schemes made publicly available all the standards and other relevant documents, as well as a list of certificate holders that include certificate status. Most schemes have policies to address corruption, as well as policies, procedures, and channels to handle grievances, complaints, and appeals.

4. Discussion

In this section, results from the implementation of the assessment framework are discussed first (4.1) and then recommendations and management implications are presented (4.2).

4.1. Application of the assessment framework

4.1.1. Prohibiting deforestation and forest degradation

Schemes were found to prohibit deforestation and forest degradation mainly for natural forests, protected areas, HCV and, or HCS. Although this clearly results in a gap for compliance with the EUDR, which does not make any distinctions between types of forests, the magnitude of this gap is not clear.

Since forest protection regimes have been shown to be insufficient to stop deforestation (Wolf et al., 2021), schemes addressing protected areas could further reinforce their conservation (Loveridge et al., 2021). However, addressing protected areas alone would result in a significant gap, since only approximately 21% of the world's forests are under some form of legal protection (WRI, 2023). Building on this, some VSS have expanded the concept of valuable areas in need of specific management and protection regimes far beyond formally protected areas. A relevant example is provided by HCV.

The HCV framework was developed by FSC in 1999 to protect areas with exceptional ecological attributes, ecosystem services and social functions (Jennings et al., 2003). HCV categories are: HCV1- Species Diversity, HCV2- Landscape-level ecosystems and mosaics, HCV3- Ecosystems and habitats, HCV4- Critical ecosystem services, HCV5-

Community needs, and HCV6- Cultural values (FSC, 2023a).

Several schemes created for the certification of agricultural commodities widely produced in the tropics, such as palm oil, soya, sugar, and cocoa, have also incorporated the HCV framework into their VSS. However, HCV forests can represent only a portion of the entire forest area contained within a country or region. For example, Maesano et al. (2016) reported that HCV cover 66% of Italy's forest area. In Gabon, Austin et al. (2017) estimated that 73% of the country's area is classified as HCV, representing 76% forest carbon stocks. Leijten et al. (2020) found that HCV forests cover 65% of the world's forest area and 73% of tropical forests.

While the HCV framework can be an important tool to improve natural resources management, the fact that HCV coverage is limited to a part of the total forest area of a country can led to gaps in forest conservation of forests falling outside HCV categories (Senior et al., 2015; Areendran et al., 2020; Leijten et al., 2020; Abbasnezhad and Abrams, 2022). The protection of HCV linked to large landscape-level forests, for example, was found to allow agricultural expansion at the expense of small forest patches that have relevant conservation value in agricultural landscapes (Edwards et al., 2012). The rationale of identifying, managing, and monitoring HCV seems to be aiming to conserve and enhance valuable areas rather than avoiding deforestation or deforestation *tout-court*.

Conversely, the HCS approach seems to provide wider coverage of the total forest area. For example, Leijten et al. (2020) found that HCS forests ($\geq$ 35 tC ha^{-1}) cover 80% of the world's forest area. This value decreased to 68% when a higher threshold was considered ($\geq$ 75 tC ha^{-1}). Austin et al. (2017) estimated that 80 and 87% of Gabon's area is classified as HCS when considering 188 and 75 tC ha^{-1} as thresholds, covering 93 and 99% of forest carbon stocks, respectively. Nevertheless, limitations can be identified also for HCS. For example, areas not considered as HCS forests can still be classified as forests according to the EUDR. The HCS Approach Toolkit, which is adopted by RSPO, defines >35 tC ha^{-1} as the threshold to classify HCS forests (Rosoman et al., 2017). Classes not falling into HCS forests include scrub (15–35tC ha^{-1}), and open land (<15 tC ha^{-1}). However, the definition of scrub accounts for scattered pioneer tree species, and occasional patches of older forest (Rosoman et al., 2017), which could still qualify as forests for the aims of the EUDR in the cases where the thresholds are met (i.e., land spanning >0.5 ha, with trees higher than 5 m, and a canopy cover of >10%).

It is challenging to find information on the proportion of forest that is protected against deforestation and forest degradation in relation to the total forest area within the land certified by the assessed VSS according to their respective approaches. As an example, HCV in the Adria-Balkan region cover between 11 and 35% of FSC-certified forests (FSC Adria-Balkan Region, 2022a, 2022b, 2022c; FSC Adria-Balkan Region, 2022d). However, figures for other countries where FSC operates are not reported in an aggregated way, but rather in the individual Forest Management (FM) reports, which makes their assessment more challenging. RSPO provides maps of probability for HCV1–3 for several countries, which would allow some level of assessment (RSPO, 2023b). However, the figures of HCV and HCS in relation to total forest area are not directly reported by the scheme.

In summary, previous research indicates considerable room for forests not being classified as HCV and HCS, increasing the risk of non-compliance with the EUDR for schemes adopting these approaches. Another aspect to consider is that schemes for agricultural commodities do not address the conversion of planted forests into cropland and focus only on natural forests.

Besides not covering all forests, schemes also present exceptions allowing deforestation and forest degradation. For Rainforest Alliance, RSPO, and RTRS, instances of deforestation are attached to remediation measures. RSPO, for example, requires that certificate holders apply a remediation and compensation procedure when land clearing occurred without an adequate HCV-HCS assessment. This approach has been adopted to increase the inclusion of oil palm growers that would otherwise not qualify for certification (RSPO, 2015).

On the other hand, no exceptions are allowed by the EUDR, which prohibits deforestation and forest degradation completely after the cut-off date. In fact, remediating deforestation cannot deliver the same conservation value as preserving existing forests. Attributes of restored forests (e.g., species composition, structure, and carbon stock) do not match those from mature forests or would take a long time to recover (Sekercioglu, 2012; Sayer et al., 2017; Trujillo-Miranda et al., 2018; Romanelli et al., 2022). The same applies for remediating forest degradation as defined by the EUDR, since attributes of forest plantations do not match those from primary and naturally regenerating forests, especially for tropical biodiversity (Barlow et al., 2007; Bremer and Farley, 2010; Guillaume et al., 2018; Hua et al., 2022).

4.1.2. *Covering relevant legislation and violation of the standards*

Most schemes fell short in covering all relevant legislation as defined by the EUDR, especially when considering both the production and supply chain levels. Since the list is quite extensive, one might argue that gaps were bound to be observed. In this study, the identification of such gaps – though to different extents – for each of the selected schemes could support operators in identifying the main areas to develop further investigation.

Results also indicated soft mechanisms to handle violations of applicable requirements, which could potentially lead to the maintenance of valid certificates for certificate holders conducting deforestation and forest degradation, as well as transgressing national laws. This concern is supported by empirical evidence provided by previous studies. Halalisan et al. (2016) analysed NCs with FSC standards in five European countries (Bosnia and Herzegovina, Estonia, Romania, Slovenia, and UK), based on public summaries of audit reports from 31 FM certificates. In total, 253 NCs were identified, from which 60.8% were from Romania. NCs with Principle 1 (Compliance with laws) constituted 8% of the NCs identified.

Buliga and Nichiforel (2019) analysed NCs with FSC standards in Romania between 2008 and 2017, based on 108 public summaries of audit reports from 27 valid and three terminated FM certificates. They found 468 corrective action requests (CARs) issued by certification bodies for certification, re-certification, and surveillance audits. 54% of the identified NCs generating the CARs represented a violation of laws, especially related to harvesting operation.

Trishkin et al. (2019) investigated NCs with FSC standards in Northwestern Russia between 2011 and 2015. The number of FM certificates grew from 29 in 2011 to 69 in 2015 and, in total, 101 minor NCs with Principle 1 were identified, representing between 4 and 9% of NCs in the analysed period. In turn, 13 major NCs with Principle 1 were identified, representing between 1 and 9% of all NCs within the period. Overall, 6.1% of the NCs identified in all the analysed years were related to Principle 1.

Bishop and Carlson (2022) analysed a timeseries of annual audit reports for RSPO, covering two-thirds of all certified oil palm growers in Indonesia. In total, 1767 NCs were identified from 262 reports, issued for 114 certified growers. From this number, 104 (5.9%) NCs were linked to laws and regulations, the fourth most frequent subject. Furthermore, 60.6% of these were classified as minor NCs, while 39.4% were classified as major. This value is most likely an underestimation, as laws and regulations are also a component of other themes analysed (e.g., employment). These studies suggest that breaches in requirements for compliance with legislation are not rare. Therefore, it is critical that operators acknowledge this vulnerability.

4.1.3. *Traceability*

From all the information that operators must collect, one of the key challenges for schemes would be to implement a system that allows to trace relevant commodities back to the plot of land used to produce them, as well as the date or time range of production. Traceability to

farm is possible, as several companies from agricultural sectors have already been implementing such systems (Zu Ermgassen et al., 2022). RSPO currently provides traceability to mill and its supply base – which is generally located within 50 km from the mill due to the need to process the palm oil fruit quickly – and intends to enhance this system in the next few years to achieve traceability to plantation (CAOBISCO, FEDIOL, IMACE, EPOA, RSPO, BASP, 2022).

Moreover, new technologies can support the implementation of systems to satisfy EUDR requirements, such as the recent applications of blockchain for traceability in agriculture and forestry (Demestichas et al., 2020; Mirabelli and Solina, 2020; He and Turner, 2022; FSC, 2023c). On the other hand, regulatory gaps can be barriers in the adoption of new technologies (De Filippi et al., 2022), and the disclosure of farm geolocation data to EU-based operators can be undermined by regulatory frameworks in producer countries (European Coffee Federation, 2022). Smallholders may face technical and financial barriers when adopting new technologies, thus ultimately suffering an increased divide with larger producers (FAO, IPA, 2023). At the same time, public disclosure of traceability data may result in disclosure of sensitive business data about the supply chain that companies, regardless their size, might not be willing to share.

The level of detail required by the EUDR can be highly challenging to implement in supply chains with high complexity levels and dominated by smallholders (Renier et al., 2023). The European Coffee Federation (2022) highlights that one single coffee shipment can contain material from 4500 different individual locations. Therefore, the exclusion of groups with low technical and financial capacities to adapt to the new rules continues to be one of the main concerns for an equitable implementation of the EUDR, ultimately resulting in unfair (or, at least, disproportionate) conditions/burdens for smallholders (CAOBISCO, FEDIOL, IMACE, EPOA, RSPO, BASP, 2022; Grabs et al., 2021; Fairtrade, 2022; Zhunusova et al., 2022). Overcoming these barriers for smallholders is important for the success of deforestation policies such as the EUDR, as well as other international initiatives. Cesar de Oliveira et al. (2024) highlight the need of financial support and technical assistance for smallholders for the promotion of deforestation-free value chains in Brazil, especially for the cattle sector.

Finally, while providing traceability to the plot of land used to produce the commodities is a challenging task, alternative (or complementary) approaches with higher feasibility were found to be inadequate for supporting operators with EUDR obligations, such as mass balance and similar systems for Fairtrade, Rainforest Alliance, RSPO and RTRS. According to Mol and Oosterveer (2015), most schemes certifying agricultural commodities offer segregation systems, however mass balance and book and claim systems represent a high market share for several schemes, including many of those addressed in this study.

4.2. Recommendations and management implications

The results presented in this study are limited to the schemes assessed and are not meant to be generalized to VSS and certification schemes at broad. Moreover, these results are limited to the use of secondary data collected in publicly available documents. Thus, the assessment is based on the written set of requirements laid down in the standards and not on actual performance of the selected VSS schemes. Future studies could target interviews with experts, scheme personnel, and certificate holders as an extra layer of information for this assessment, considering the on-the-ground implementation of the standards.

The assessed schemes addressed, at least partially, most of the indicators from the framework. Nevertheless, several limitations and deficiencies in fulfilling EUDR requirements were identified. Therefore, operators must be cautious when incorporating these schemes into their due diligence systems (DDS). For instance, operators should acknowledge limitations in requirements pertaining deforestation and forest degradation. This includes their limitations in covering all forests, as well as the exceptions allowed by the schemes. Additionally, operators would need to fill the gaps to address all relevant legislation as established by the EUDR. NCs identified during audits should also be investigated as potential sources of non-compliance. Furthermore, operators must take careful note of the traceability system employed to handle the relevant commodities.

Nevertheless, these schemes can still facilitate the implementation of the EUDR. With their presence in high deforestation-risk regions (Tayleur et al., 2018), and well-established assurance systems, these voluntary initiatives can provide on-the-ground information periodically assessed by an independent third party. Gathering this type of information would be considerably challenging for EU-based operators (Marx, 2018). Furthermore, most of the schemes have public available databases and reporting systems that allow disclosure of relevant information, making data monitoring and scrutiny possible for many stakeholders. The current scenario resembles previous discussions with the EUTR, where forest certification was not recognized as a green lane for assurance of wood legality, but operators have widely included FSC as part of their DDS (Dieguez and Sotirov, 2021).

This study provides important insights for schemes striving to change their systems to adapt to the EUDR, and some key recommendations can be derived from our findings. Schemes should enhance their criteria for a comprehensive prohibition of deforestation and forest degradation. This means removing constraints which result in a limited forest protection, as in the case of FSC (natural forests and HCV), Rainforest Alliance (natural forests and other natural ecosystems), RSPO (primary forests, HCV, and HCS), and RTRS (Category 1 from the RTRS maps). This also means removing exceptions which allow deforestation and forest degradation to occur, which applies to all schemes previously mentioned. To guarantee that relevant requirements are aligned to the EUDR, the schemes should also ensure that their definition of forest, deforestation, and forest degradation match or encompass the definitions adopted in the EUDR, which was only observed for Fairtrade.

Schemes should expand their requirements to cover all relevant legislation outlined in the EUDR. Schemes should also ensure that these requirements are applicable to both production and supply chain tiers, as well as to subcontractors. These gaps were observed in all assessed schemes, although to different extents.

Schemes should maintain ongoing alignment between international and national standards, as well as across different certification scopes. For example, the list of applicable legislation is not always consistent for FSC across different national standards. Another example is the lack of requirements to prohibit deforestation across all certification scopes for Fairtrade. Although the specific standards for cocoa and coffee are currently addressing this gap, the certification scopes with weaker requirements (CP and HL) will present significant gaps in the face of a future expansion of the EUDR to other commodities.

Schemes should address the source of conventional material entering the supply chain, as they can be associated with deforestation. MB systems dominate the market of several certified commodities (Mol and Oosterveer, 2015), representing a risk for the supply chain. All assessed schemes should also strengthen their strategies for dealing with NCs, as current practices increase the risk of certified products associated with deforestation and forest degradation. Finally, schemes should provide public summaries of audit reports for all certification scopes. This applies to Fairtrade and Rainforest Alliance (not providing a public summary of audit reports), and, to lesser extent, to FSC, RSPO, and RTRS (not providing a public summary of audit reports for all certification scopes).

These recommendations are proposed to enhance the support that these schemes can offer operators in achieving compliance with the EUDR. It should be noted that compliance with the EUDR falls beyond the primary scope of targeted VSS and, therefore, they are not obligated and might not be inclined to adopt these suggestions. However, recent developments reveal a trend towards adaptation. As earlier mentioned, some VSS have already identified their gaps in relation to the EUDR and started working to make sure their requirements are aligned with the

Regulation. Therefore, this study should be considered under the lenses of the dynamic nature of VSS.

Fairtrade has introduced a new requirement for coffee producers and is developing a monitoring system to assess deforestation risk (Fairtrade, 2023a; Fairtrade, 2024). FSC is developing a programme tailored to align its standards and procedures with the EUDR, addressing gaps in the requirements for no-deforestation and no-degradation, geolocation, traceability, and risk assessment and risk mitigation procedures (FSC, 2024). Rainforest Alliance is studying adjustment needs (Rainforest Alliance, 2024). No public commitments to adapt to the EUDR were found for RTRS, but a recent benchmark considered the scheme as the most prepared to demonstrate compliance with the EUDR among schemes operating in the soya market, but relevant gaps were still identified in several areas, especially traceability (Boev and van Gelder, 2023).

RSPO has conducted a gap analysis and found outcomes similar to some findings reported in this study (e.g., different definition of forest, no transfer of legality information through the supply chain, insufficient traceability to the plot of land) (RSPO, 2023a). However, our research provides a more systematic analysis and adopts a broader scope, going beyond a vis-à-vis analysis between EUDR and VSS. In particular, the aspects linked to *Principle C – Scheme structure, assurance system and transparency* are not addressed by existing studies and gap analysis, nevertheless they are pivotal to safeguard the reliability of the information provided by voluntary schemes. Our findings indicate the challenging need of a systematic change in the assessed VSS schemes, including documented requirements, as well as improving implementation, enforcement, and transparency for operators along the supply chain.

5. Conclusions

The assessment of five major agricultural and forestry VSS schemes revealed multiple shortcomings in covering EUDR requirements. Therefore, although these schemes encompass a comprehensive framework for ensuring sustainable commodity production and trade, their effectiveness in fulfilling the specifications of the EUDR is limited in various aspects.

The inadequacy and variability of VSS schemes in meeting the EUDR requirements reflects the fact that standards were created previously to the Regulation, under different contexts, objectives, actors, and priorities. Furthermore, a secondary legislation is expected to clarify the EUDR and provide the implementation norms to operationalize it. Therefore, the final role of VSS schemes in this context is still to be defined and it is not possible to draw conclusive statements on this at this implementation stage of the EUDR.

Nevertheless, the inclusion of these schemes in DDS developed to achieve compliance with the EUDR is supported by the large coverage of indicators from the assessment framework, wide adoption in some agricultural sectors, familiarity in the market, and provision of verified on-the-ground information. In summary, operators can potentially integrate these VSS in their DDS, while understanding that they do not serve as direct paths to achieve compliance with the EUDR.

From a more general perspective, wicked problems like deforestation and forest degradation are unlikely to be addressed via a single policy or regulation. The setting of an appropriate policy mix, encouraging direct or indirect cooperation between public and private actors, might represent the most effective – and possibly the most efficient – approach. In this perspective, a combination of command-and-control and voluntary tools might provide a proper ground for the development of public-private partnerships aiming to promote responsible agriculture and forest management, and conservation of the World's forests.

Furthermore, a regulatory framework pushing for stricter social and environmental requirements can exert positive pressure in the VSS arena, indirectly encouraging the selection of credible VSS aligned with the EU's objectives, while discouraging the adoption of lax voluntary systems. Indeed, the EUDR does not stay in the vacuum, rather it is directly or indirectly linked to many other policies and regulations currently under development (or recently approved) that will try to make "environmental declarations" more reliable, verifiable and robust (European Commission, 2022; European Commission, 2023b).

CRediT authorship contribution statement

Luiz Henrique Elias Cosimo: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mauro Masiero:** Writing – review & editing, Validation, Supervision, Project administration, Methodology, Conceptualization. **Aynur Mammadova:** Writing – review & editing, Validation. **Davide Pettenella:** Writing – review & editing, Validation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Annex 1
Key concepts and their definitions according to the EUDR.

Concept	Definition
Relevant commodities	Cattle, cocoa, coffee, oil palm, rubber, soya, and wood.
Relevant products	Products listed in the Annex I of the EUDR that contain, have been fed with or have been made using relevant commodities (e.g., raw hides and skins of cattle).
Deforestation-free	Deforestation-free means: (a) that the relevant products contain, have been fed with or have been made using, relevant commodities that were produced on land that has not been subject to deforestation after 31 December 2020; and (b) in the case of relevant products that contain or have been made using wood, that the wood has been harvested from the forest without inducing forest degradation after 31 December 2020.
Forest	Land spanning >0.5 ha with trees higher than 5 m and a canopy cover of >10%, or trees able to reach those thresholds in situ, excluding land that is predominantly under agricultural or urban land use.
Deforestation	Conversion of forest to agricultural use, whether human-induced or not.
Forest degradation	Structural changes to forest cover, taking the form of the conversion of: (a) primary forests or naturally regenerating forests into plantation forests or into other wooded land; or (b) primary forests into planted forests.
Relevant legislation	The laws applicable in the country of production concerning the legal status of the area of production in terms of: (a) land use rights; (b) environmental protection; (c) forest-related rules, including forest management and biodiversity conservation, where directly related to wood harvesting; (d) third parties' rights; (e) labour rights; (f) human rights protected under international law; (g) the principle of free, prior and informed consent (FPIC), including as set out in the UN Declaration on the Rights of Indigenous Peoples; (h) tax, anti-corruption, trade and customs regulations.
Operators	Any natural or legal person who, in the course of a commercial activity, places relevant products on the market or exports them.
Traders	Any person in the supply chain other than the operator who, in the course of a commercial activity, makes relevant products available on the market. Non-SME (small and medium enterprises) traders are also considered operators for the aims of the EUDR.
Due diligence	According to Article 8, due diligence includes: (a) collect information, data and documents needed to fulfil the requirements set out in Article 9; (b) adopt risk assessment measures as referred to in Article 10; and (c) adopt risk mitigation measures as referred to in Article 11. Relevant products should only be placed on the EU market or exported when the operator exercises due diligence and finds no or negligible risk of non-compliance with the EUDR.

Annex 2

Assessment framework.

Principle and criterion	Indicator	Verifiers/Guidelines
Principle A. Requirements that commodities and products are deforestation-free and produced in accordance with legislation		
A.1 Requirements for deforestation-free commodities and products	**A.1.1** The scheme presents a clear prohibition of deforestation and forest degradation	Deforestation-free means: (a) that the relevant products contain, have been fed with or have been made using, relevant commodities that were produced on land that has not been subject to deforestation after 31st December 2020, and (b) in the case of relevant products that contain or have been made using wood, that the wood has been harvested from the forest without inducing forest degradation after 31st December 2020. Thus, the scheme shall present a clear prohibition of deforestation (or other equivalent prohibition that incorporates deforestation, e.g., prohibition of all land conversion into agriculture) and, when applicable, forest degradation. Note that the EUDR does not include any exceptions, such deforestation conducted legally, or agricultural land implemented on area deforested by natural events.
	A.1.2 The definitions of forest, deforestation, and forest degradation match or encompass the definitions from the regulation	As presented previously, the requirement for deforestation-free commodities and products is built on the concepts of deforestation and forest degradation: (a) forest means land spanning >0.5 ha with trees higher than 5 m and a canopy cover of >10%, or trees able to reach those thresholds in situ, excluding land that is predominantly under agricultural or urban land use. (b) deforestation means the conversion of forest to agricultural use, whether human induced or not. (c) forest degradation means structural changes to forest cover, taking the form of the conversion of: (a) primary forests or naturally regenerating forests into plantation forests or into other wooded land; or (b) primary forests into planted forests.
	A.1.3 The scheme presents a cut-off date that is equal or previous to December 31, 2020	Thus, besides presenting the prohibition of deforestation and forest degradation, it is important that these concepts match the concept adopted by the EUDR to assure compliance with it. Some other terms are further defined in the EUDR if further analysis is necessary (e.g., agricultural use, primary forest, plantation forest, planted forest). December 31, 2020, is defined as the cut-off date for compliance with deforestation-free requirements. This means that relevant commodities and products shall not originate from land subjected to deforestation or forest degradation after this date. Schemes shall present a clear cut-off date for deforestation and, when applicable, forest degradation, that is equal or previous to the one adopted by the regulation.
A.2 Requirements for commodities and products produced in accordance with legislation	**A.2.1** The scheme presents a clear requirement for production in accordance with the relevant legislation in the country of production	Relevant legislation of the country of production means the laws applicable in the country of production concerning the legal status of the area of production. This will be addressed as legality requirements in short. Country of production means the country or territory where the relevant commodity or the relevant commodity used in the production of, or contained in, a relevant product was produced.
	A.2.2 The applicable legislation encompasses all the categories specified in the regulation	Relevant legislation considers: (a) land use rights; (b) environmental protection; (c) forest-related rules, including forest management and biodiversity conservation, where directly related to wood harvesting; (d) third parties' rights; (e) labour rights; (f) human rights protected under international law; (g) the principle of free, prior and informed consent (FPIC); and (h) tax, anti-corruption, trade and customs regulations. Thus, even when the previous indicator is covered, the specificity of the spheres of legislation that are required by the standards should also be investigated. Evidence of requirements for relevant legislation can

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Annex 2 (*continued*)

Principle and criterion	Indicator	Verifiers/Guidelines
		include, but are not limited to, the following topics (based on international documents, as well as adapting the contents adopted by Preferred by Nature, 2021): (a) land use rights: land tenure rights, including customary rights as well as management rights; (b) environmental protection: pollution control (air, water, soil), use of pesticides/ herbicides, soil erosion, waste management, assessment of environmental impacts, sustainable use of resources, protected areas, biodiversity; (c) forest-related rules: concession licenses, management and harvesting planning, harvesting permits, timber harvesting regulations, protected sites and species; (d) third parties' rights: customary rights, free, indigenous and traditional peoples' rights, communities' rights; (e) labour rights: e.g. as set out in the International Labour Organization (ILO) Declaration on Fundamental Principles and Rights at Work; (f) human rights protected under international law: e.g. as set out in the International Covenant on Economic Social and Cultural Rights (ICESCR), and the International Covenant on Civil and Political Rights (ICCPR); (g) the principle of free, prior and informed consent (FPIC): as set out in the United Nations Declaration on the Rights of Indigenous Peoples; (h) tax, anti-corruption, trade and customs regulations: classification of commodities and products, offshore trading, export/import licenses, tax payment.
	A.2.3 The scheme requires that subcontractors operate in accordance with legislation	Subcontractors are understood by this framework as a third party contracted to perform any stage of production or processing of the commodities and products. To assure that commodities

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Principle and criterion	Indicator	Verifiers/Guidelines
		and products are in fact produced in accordance with legislation, subcontractors, or equivalent, should also be checked against the legality requirements laid down in A.2.1 and A.2.2.
Principle B. Requirements for information traceability and risk management in the supply chain		
B.1 Information traceability	**B.1.1** The scheme requires a mandatory traceability system	ISO 9000:2015 (Quality management systems – Fundamental and vocabulary) defines traceability the ability to trace the history, application, use and location of an object. Thus, this indicator addresses the presence of a mandatory traceability system, usually under the terminology of chain of custody standards, that allows tracking product information from production to consumption. Besides the previously mentioned information that operators need to collect to address deforestation-free and legality requirements, operators also need to collect, organise and keep for five years the following information relating to the relevant commodities or products: (a) a description, including the trade name and type of the relevant products as well as, in the case of relevant products that contain or have been made using wood, the common name of the species and their full scientific name; (b) the quantity of the relevant products; (c) the country of production and, where relevant, parts thereof; (d) the geolocation of all plots of land where the relevant commodities that the relevant product contains, or has been made using, were produced, as well as the date or time range of production; where a relevant product contains or has been made with relevant commodities produced on different plots of land, the geolocation of all different plots of land shall be included; (e) the name, postal address and email address of any business or person from whom they have been supplied with the relevant products;
	B.1.2 The scheme requires that information on production and commercial transactions are recorded and kept for at least five years	

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Principle and criterion	Indicator	Verifiers/Guidelines
		(f) the name, postal address and email address of any business, operator or trader to whom the relevant products have been supplied. Furthermore: (a) geolocation means the geographical location of a plot of land described by means of latitude and longitude coordinates corresponding to at least one latitude and one longitude point and using at least six decimal digits; for plots of land of more than four hectares used for the production of the relevant commodities other than cattle, this shall be provided using polygons with sufficient latitude and longitude points to describe the perimeter of each plot of land; (b) plot of land means land within a single real-estate property, as recognized by the law of the country of production, which enjoys sufficiently homogeneous conditions to allow an evaluation of the aggregate level of risk of deforestation and forest degradation associated with relevant commodities produced on that land; Thus, the scheme should provide mechanisms to assure that the abovementioned information on production and commercial transactions are officially registered to assure traceability throughout the supply chain, as well as a record-keeping time at equal or higher than the one required in the regulation.
B.2 Risk management of supply chain	**B.2.1** The scheme provides mechanisms to assure that standard-compliant material is segregated from other sources	Producers and suppliers might work with multiple sourcing of commodities and products, not only including material verified by the scheme. To maintain the claims for products under the standard, the scheme must require that standard-compliant material is kept segregated from material of other sources throughout the supply chain. This shall include clear and effective measures that are documented and reviewed periodically to prevent material from other sources from entering the supply chain of standard-compliant material. The scheme should require the use of appropriate inventory methods and documented controls to ensure segregation.
	B.2.2 The scheme requires that material from other sources is deforestation-free	Only applicable when mixing standard-compliant material with material from other sources is allowed. When mixing is allowed, the final product contains both material that complies standard requirements, as well as material from other sources, potentially non-compliant with the same requirements. In this case, the scheme shall require that the material from other sources entering the supply chain is compliant with the same deforestation-free requirements and guidelines laid down in items A.1. Thus, the requirements for material from other sources must be checked against indicators A.1.1, A.1.2 and A.1.3. These could be covered in a separate standard or integrated in a due diligence requirement for materials from other sources, for example.
	B.2.3 The scheme requires that material from other sources is produced in accordance with the relevant legislation in the country of production	Only applicable when mixing standard-compliant material with material from other sources is allowed. In the same way, the scheme shall require that material from other sources entering the supply chain is compliant with the same legality requirements and guidelines laid down in items A.2. Thus, the requirements for material from other sources must be checked against indicators A.2.1, A.2.2 and A.2.3. These could be covered in a separate standard or integrated in a due diligence requirement for material from other sources, for example.
	B.2.4 The scheme requires adequate measures for risk assessment and risk mitigation	To assure that indicators B.2.3 and B.2.3 are met, beyond present requirements the scheme shall also present mechanisms to assure compliance. In this case, the scheme shall require that risk assessment and risk mitigation procedures are implemented. Although these procedures might encompass several aspects, here the focus will be to on deforestation-free and legality concerns to match requirements from the regulation. Relevant risk assessment measures include: (a) the deforestation risk of the relevant country of

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Principle and criterion	Indicator	Verifiers/Guidelines
		production or parts thereof; (b) the presence of forests in the country of production or parts thereof; (c) the presence of indigenous peoples in the country of production or parts thereof; (d) the consultation and cooperation in good faith with indigenous peoples in the country of production or parts thereof; (e) the existence of duly reasoned claims by indigenous peoples based on objective and verifiable information regarding the use or ownership of the area used for the purpose of producing the relevant commodity; (f) prevalence of deforestation or forest degradation in the country of production or parts thereof; (g) the source, reliability, validity, and links to other available documentation of the information collected to evaluate compliance with deforestation-free and legality requirements; (h) concerns in relation to the country of production and origin or parts thereof, such as level of corruption, prevalence of document and data falsification, lack of law enforcement, violations of international human rights, armed conflict or presence of sanctions; (i) the complexity of the relevant supply chain and the stage of processing of the relevant products, in particular difficulties in connecting relevant products to the plot of land where the relevant commodities were produced; (j) the risk of mixing with relevant products of unknown origin or produced in areas where deforestation or forest degradation has occurred or is occurring; (k) any information that would point to a risk that the relevant products are non-compliant; (*continued on next column*)

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Principle and criterion	Indicator	Verifiers/Guidelines
		(l) complementary information, which may include information supplied by certification or other third-party verified schemes. Relevant risk mitigation measures include: (a) requiring additional information, data or documents; (b) carrying out independent surveys or audits; (c) taking other measures pertaining to information collected to evaluate compliance with deforestation-free and legality requirements.
Principle C. Scheme structure, assurance system and transparency		
C.1 Consistency between international and national/regional level standards	**C.1.1** The scheme presents consistency between international and national/regional standards	Only applicable for schemes that are locally adapted or internationally endorsed. Some schemes have international standards that are locally adapted. During this process, requirements might suffer some level of alteration. This aspect is also very relevant for schemes that are developed locally and endorsed internationally. Thus, it is important that schemes present mechanisms that assure consistency between different levels, so social and environmental features attached to the scheme are equivalent for all verified parties, especially those features related to the EUDR requirements. These mechanisms can be related to guidelines on the local adoption of the standards or requirements for endorsement. Evidence can also be collected from comparing international and national/regional versions for the requirements relevant to this framework.
C.2 Requirements for compliance assurance by verified parties	**C.2.1** The scheme requires that verified parties have adequate policies, controls, and procedures for compliance assurance	The scheme must require that verified parties have adequate internal policies, controls and procedures to assure compliance with the standards. Thus, investigation should assess if schemes require an affective assurance of compliance with the standard claimed by the organization or farmer/groups. Requirements include, but are not limited to, model risk management practices, reporting, record-keeping, internal control and compliance management, appointment of a compliance officer at management level, (*continued on next page*)

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Principle and criterion	Indicator	Verifiers/Guidelines
		independent audit function to check the internal policies, controls and procedures. It should also be required the existence of personnel with sufficient qualifications and competencies to consistently and effectively implement scheme requirements. These policies shall be periodically reviewed. Organization means a company, corporation, firm, enterprise, authority or institution, located inside or outside the community, or part or combination thereof, whether incorporated or not, public or private, which has its own functions and administration. This definition is adopted from EU Regulation No 1221/2009 (eco-management and audit scheme - EMAS).
	C.2.2 All documentation for compliance with the scheme must be kept for at least five years	When it comes specifically to record-keeping, all evidence used to demonstrate compliance should be kept for at least five years. With this, evidence for compliance with Principles A and B are kept and can be accessed when needed.
C.3 Requirements for conformity assessment	**C.3.1** Non-compliance with deforestation-free and legality requirements prevents compliant status	Even when the scheme fully covers criteria A.1 and A.2, it is essential that a non-compliance with any of these requirements prevents parties to be considered as standard-compliant. This could mean that parties are not eligible, or identification of non-compliance leads to suspension/withdraw of the standard-compliant status. Otherwise, commodities and products might be claimed as standard-compliant and yet not be deforestation-free and legally produced. For examples, for certification schemes this would mean that these are faced as mean major non-compliances, and parties are non-eligible for certification, or certificate is suspended.
	C.3.2 Conformity assessment is conducted by a legal, impartial, and qualified organization	The scheme must make clear what are the requirements that a third-party conformity assessment body must meet to be suited for performing audits. The ISO/IEC 17065:2012 standard (Conformity assessment — Requirements for bodies certifying products, processes and services) and the ISO/IEC 17021–1:2015 standard (Conformity assessment — Requirements for bodies providing audit and certification of management systems) can be

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Principle and criterion	Indicator	Verifiers/Guidelines
		used as the baseline. For these aims of this indicator and consistently with ISO/IEC 17065:2012: a) conformity assessment bodies should be required to be a legal entity, or a defined part of a legal entity, formally registered as such in the country of operation, which is legally responsible for all its certification activities. b) conformity assessment bodies should be required to demonstrate that personnel involved in the certification process are competent to perform their functions. ISO 19011:2018 (Guidelines for auditing management systems) defines competence as the demonstrated personal attributes and demonstrated ability to apply knowledge and skills. c) conformity assessment bodies should be required to operate in impartiality, identifying and managing risks on ongoing basis. ISO/IEC 17065:2012 defines impartiality as the presence of objectivity, which in turn means that conflicts of interest do not exist, or are resolved so as not to adversely influence the activities of the body. Furthermore, basic definitions to be considered, according to ISO/IEC 17000:2020 (Conformity assessment — Vocabulary and general principles), are: (a) conformity assessment is the process of demonstrating that requirements specified in these standards are fulfilled is called. (b) audit is the process for obtaining relevant information about an object of conformity assessment and evaluating it objectively to determine the extent to which specified requirements are fulfilled. (c) conformity assessment bodies are bodies that perform conformity assessment activities, excluding accreditation. Besides internal controls conducted by the verified parties, it is also important to have

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Principle and criterion	Indicator	Verifiers/Guidelines
		periodic third-party checks to assure compliance. Drawing on EU Regulation No 607/2012 (Implementing Regulation for the EUTR), checks by third-parties shall be conducted at regular intervals no longer than 12 months.
	C.3.3 The scheme requires periodic checks or re-assessment of verified parties	Besides internal controls conducted by the verified parties, it is also important to have periodic third-party checks to assure compliance. Drawing on EU Regulation No 607/2012 (Implementing Regulation for the EUTR), checks by third-parties shall be conducted at regular intervals no longer than 12 months.
	C.3.4 Conformity assessment has minimum requirements for information sources and sampling strategies for assuring effective auditing	Several sources can provide evidence to conformity assessment. The main sources of evidence used in audits include document analysis, field inspection and stakeholder consultation. Thus, a combination of all of them is necessary to provide enough evidence on the compliance when it comes to Principles A and B. Moreover, because agricultural and forest production under schemes usually occupy large areas, it is customary to conduct on-site audits based on sampling. The scheme must assure robust sampling strategies for conducting audits, such as based on square footage or number of farms/facilities/forest management units.
	C.3.5 The scheme provides mechanisms to assure compliance by all members under a group verification	Only applicable when group verification is allowed. Group verification is proposed by some schemes an alternative to make standard-compliance accessible to smallholders. However, with more verified parties at play, the risk of non-compliance might increase. Thus, it is important that the scheme includes measures to assure compliance by all group members within the same scope. Evidence from this can be taken from the requirement of an effective group management, with clear objectives and responsibilities, as well as the strategy used for conformity assessment, such as sampling strategies.
C.4 Transparency and corruption	**C.4.1** The scheme makes publicly available the full requirements for verified parties and	It is essential that the public can have online access to which are the requirements that verified parties are being

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Principle and criterion	Indicator	Verifiers/Guidelines
	conformity assessment bodies	checked against, as well as the requirements for those organizations performing the audits.
	C.4.2 The scheme makes publicly available the status of verified parties	Interested parties should have means to evaluate if a standard-compliant claim is valid. This could be achieved by making publicly available online a full and up-to-date list of verified parties, including their status as valid, expired, suspended etc. This could also be achieved through public online search by using the organization name, an individual code or an equivalent identifier, where up-to-date status can be checked by any person.
	C.4.3 The scheme makes publicly available a summary of audit reports that contains methodology and main findings, including non-compliances	It is not uncommon that standard-compliant status can be achieved without full compliance with all requirements because, to a certain extent, some non-compliances can usually be addressed after verification. Thus, it is essential that at least a summary of audit reports is publicly available online containing methodology and non-compliances found, so that interested parties can have access to information and verify if non-compliance with deforestation-free and legality requirements have been identified during audits.
	C.4.4 The scheme presents policies, controls, and procedures to identify and manage risk of corruption	Corruption, i.e., dishonest or fraudulent conduct, might lead to inadequate standard-compliance status. This conduct increases the risk that commodities and products are not deforestation-free and legal. The scheme should have anti-corruptions policies in place to identify and mitigate the risks of corrupt activities in the standard-setting organization, as well as in conformity assessment bodies and verified parties. These include channels and procedures for receiving and handling complaints.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.forpol.2024.103235.

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