SUSTAINABLE AND RESILIENT VALUE CHAINS SERIES

Deforestation

IISD REPORT

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Sustainable and Resilient Value Chains: Deforestation

December 2025

Written by Rupal Verma, Florencia Sarmiento, and Erika Luna

Photo: iStock

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Executive Summary

Deforestation is among the most urgent environmental challenges in global value chains. It is mainly driven by international trade and growing demand for forest-risk commodities such as soy, palm oil, cocoa, and timber. This report, the first in the sustainable and resilient value chains series from the International Institute for Sustainable Development, explores how supply chain actors, particularly the private sector and voluntary sustainability standards (VSSs), can effectively address deforestation risks while advancing broader sustainability and resilience objectives in global value chains.

Using a four-step framework—Plan/Prepare, Respond, Recover, and Adapt—this report assesses the role of selected VSSs (the Forest Stewardship Council, the Programme for the Endorsement of Forest Certification, the Roundtable on Sustainable Palm Oil, Rainforest Alliance, Fairtrade, ProTerra, and the African Organisation for Standardisation) and companies in transforming forest-risk supply chains. The framework offers a way to understand how different actors engage with sustainability risks by (a) planning and preparing to prevent the risk through risk assessments and early interventions before deforestation has occurred; (b) responding with immediate corrective actions after deforestation has occurred or is suspected to have occurred; (c) recovering by adopting measures to address adverse impacts related to deforestation; and (d) adapting by embedding longer-term changes that improve value chain functioning and reduce the impacts of deforestation and the likelihood of future risks of deforestation occurring. Evidence is drawn from standard documents, desk research, and interviews with standard bodies and companies.

Key Findings

1. Plan/Prepare (prevention) is the strongest and improving fast.

Most standards now contain no-conversion/no-deforestation provisions, ecosystem protection, and risk/impact assessments, with increasing use of geolocation (points/polygons) and satellite monitoring to monitor deforestation. Where present, clear cut-off dates act as strong deterrents. However, geospatial requirements are not present in all VSSs, and not all VSSs require free, prior, and informed consent/social safeguards. Company practice is advancing with farm mapping, alert systems, and risk assessment, but indirect suppliers remain a blind spot.

2. Respond (immediate action) exists, but is often generic, especially in VSSs.

Assurance systems in VSSs trigger audits and corrective action plans when non-compliance is detected. Deforestation-specific corrective action plans are less common in VSSs, and most standards, in theory, do not allow deforestation-associated products to be certified after the allowed cut-off date. Some company sourcing policies pause or halt non-compliant suppliers. However, deforestation-specific corrective action plans, escalation timelines, and indirect supplier coverage vary across companies. Firms that pair monitoring with supplier enablement (training, inputs, transition finance) reduce the risk of smallholder exclusion.

3. Recover (repair harm) provisions are present but can be strengthened.

Recover provisions work when ecological and social remedies are delivered, verified, and disclosed—by both standards and companies. The core elements among the VSSs examined include restoration/rehabilitation of damaged areas and grievance outcomes that trigger remedies. On the company side, recovery is supported via improved farm practices but needs to be tied to supplier re-entry to verified remediation and paired with producer support so that gains persist. This combination repairs harm, reduces the risk of deforestation happening again, and strengthens compliance across the value chain.

4. Adapt (long-term transformation) is emerging but needs to move beyond pilot-level interventions.

Agricultural VSSs increasingly require tree cover on farms and risk-based plans, while forestry standards institutionalize long-term forest management. Beyond requirements, VSSs are also engaging in landscape-/jurisdictional-level action to support adaptation against the risk of deforestation. Company action is shifting toward landscape/jurisdictional initiatives that align sourcing policies with local land-use plans, shared monitoring, and restoration of degraded land. These approaches can reduce future pressure to clear forest land and can therefore build producer resilience, but they require multi-year finance, local incentives, and government buy-in to scale.

Prevention and long-term solutions—Plan/Prepare and Adapt—offer the greatest leverage to reduce deforestation risk and build resilience. A key insight from the report is that no single tool or actor can effectively address deforestation risks. Deforestation is a complex challenge with various drivers across commodities, and addressing it would require a smart mix of measures, including VSSs, financial incentives from public and private actors, and a supportive policy environment. Collaboration among companies, producers, governments, and local communities is necessary to ensure equitable and scalable solutions. At the same time, adopting innovative measures while understanding their impacts and limitations is also key to achieving success in ensuring deforestation-free value chains.

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Abbreviations and Acronyms

AI	artificial intelligence
ARSO	African Organisation for Standardisation
CoC	chain of custody
CAPs	corrective action plans
EUDR	European Union Regulation on Deforestation-free products
FAO	Food and Agriculture Organization of the United Nations
FLR	forest landscape restoration
FPIC	free, prior, and informed consent
FSC	Forest Stewardship Council
GFW	Global Forest Watch
GPS	Global Positioning System
GVCs	global value chains
HCS	high carbon stock
HCV	high conservation value
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
PEFC	Programme for the Endorsement of Forest Certification
PES	payment for ecosystem services
RA	Rainforest Alliance
RSPO	Roundtable on Sustainable Palm Oil
RaCP	Remediation and Compensation Procedure
SRVC	sustainable and resilient value chains
UNEP	United Nations Environment Programme
VSSs	voluntary sustainability standards

1.0 Introduction

1.1 The Concept of Sustainable and Resilient Value Chains

In today's interconnected global economy, value chains play a defining role in shaping not only the economic impacts but also the environmental and social outcomes. In particular, food and agricultural supply chains are increasingly scrutinized for their role in driving sustainability risks, from biodiversity loss and climate change to human rights violations and environmental degradation. With the escalating planetary crises, the need to transform global value chains (GVCs) into engines of resilience and sustainability has become urgent.

This report is the first in a series on sustainable and resilient value chains (SRVCs) that aims to help value chain actors identify, prevent, address, and transform sustainability risks, while delivering positive outcomes for people and the planet. We believe that solving major sustainability challenges requires a smart mix: strong public policy and law combined with effective market-based initiatives that support producers. When these measures complement each other, value chains can evolve toward greater sustainability and resilience rather than shifting risks elsewhere. This series focuses on how value chain tools and instruments, especially voluntary sustainability standards (VSSs), can be harnessed for risk transformation. The series seeks to provide actionable insights across various challenges. Each publication will explore a specific sustainability risk, such as deforestation, biodiversity loss, gender inequality, climate change, or poor working conditions, in key sectors where those risks are most pronounced, particularly in the production stage.

The SRVC series draws on growing evidence that value chain sustainability and resilience are interconnected. Literature shows that sustainable supply chains can deliver long-term economic, environmental, and social value (Ahi & Searcy, 2013; Carter & Rogers, 2008; Cotta et al., 2022) while resilient ones can anticipate, absorb, and adapt to shocks (Ambulkar et al., 2015; Cotta et al., 2022). The literature also reflects the fact that the relationship between sustainability and resilience in supply chain studies is still relatively new and in early development (Fahimnia et al., 2019; Negri et al., 2021). Integrating sustainability and resilience offers a pathway for transforming value chains into platforms for systemic change. This is especially relevant as global policy landscapes shift toward greater accountability and risk management, with emerging regulations and trade rules demanding more robust and transparent supply chain governance.

The SRVC framework (Figure 1) is used in this series and report to analyze how private sector companies can tackle deforestation and use value chain tools such as VSSs to achieve their deforestation-free goals and build SRVCs. The framework, which covers aspects of managing risks and advancing sustainability to build resilience, has four stages:

- **Plan/prepare:** Anticipating and mitigating sustainability risks before they occur, through risk assessments, strategic planning, and early interventions.
  Example: Companies conducting risk assessments across the value chain and tiers to identify deforestation risk exposure; VSSs having no-deforestation rules in their requirements. In some cases, companies may also consider how climate-related factors,

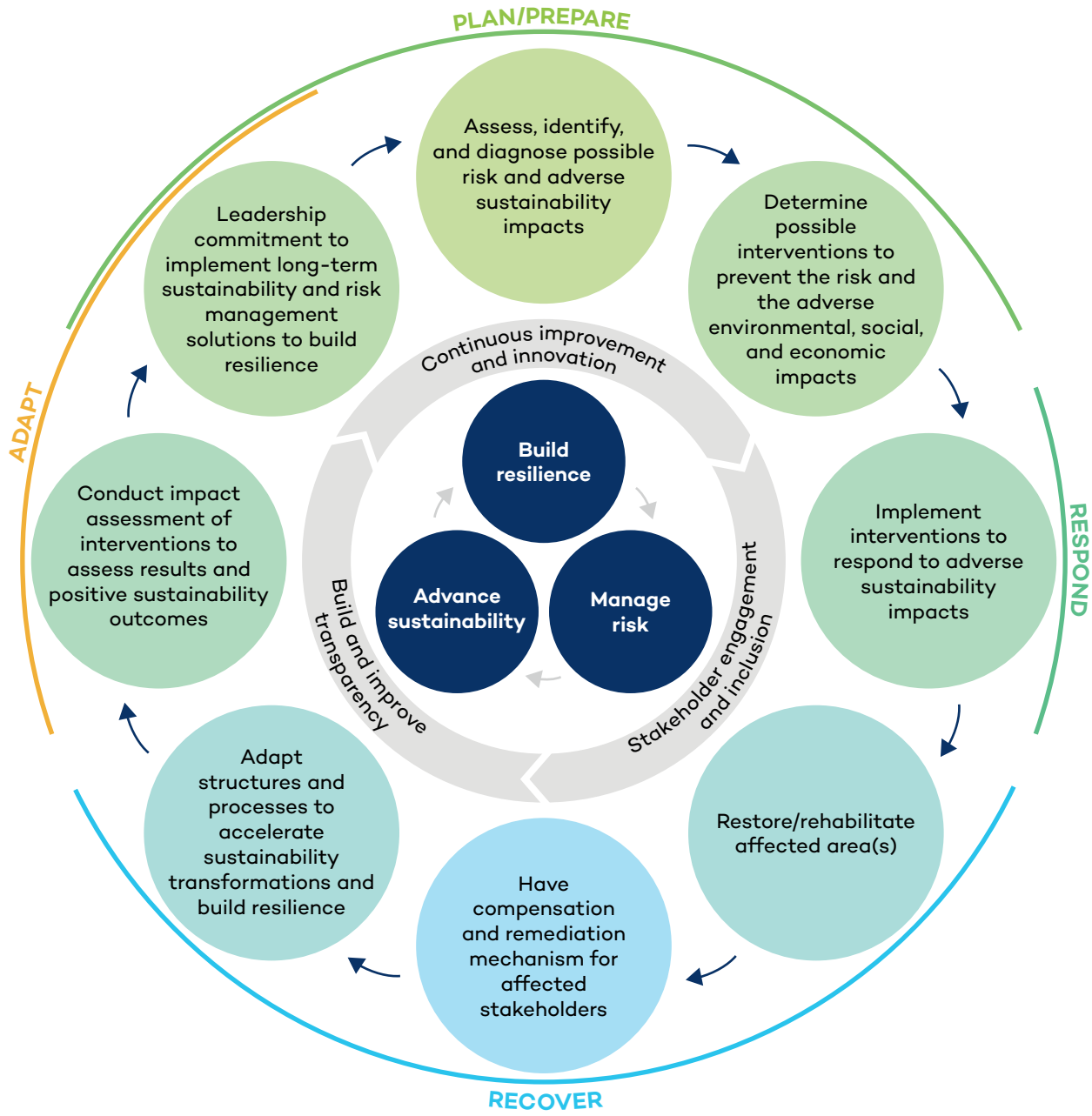
such as drought, can increase deforestation risks and incorporate these into broader sustainability planning so that this does not drive deforestation.

- **Respond:** Taking timely corrective action in response to deforestation when it has happened or when it is suspected to have happened to address the situation, respond, and deliver positive environmental, social, and economic results afterwards.
  Example: Companies perform audits and assessments to understand why deforestation has occurred and set clear consequences, like enforcing sanctions for non-compliance or providing time-bound corrective action plans.
- **Recover:** Implementing restorative measures to address harms, including ecological rehabilitation, compensation, and grievance mechanisms for stakeholders affected by impacts of deforestation. Such restorative efforts can not only repair environmental and social harms but also contribute to long-term resilience by strengthening the capacity of ecosystems and communities to adapt to future shocks, thus "building back better."
  Example: Restoring areas where deforestation occurred by using native and climate-resilient species or building soil health to support recovery.
- **Adapt:** Embedding long-term transformation that can improve supply chain operations, both by preventing future deforestation risks in the long run and by enabling recovery and resilience in landscapes where deforestation has already occurred. Such adaptation promotes sustainability by strengthening resilience, supporting producer capacity, and aligning with broader landscape or jurisdictional approaches.
  Example: Implementing long-term solutions, including landscape approaches and investment in nature-based solutions, that support long-term forest-positive production, such as agroforestry systems.

The Plan/Prepare and Adapt stages can generally be the most effective for mitigating deforestation risk and achieving lasting positive impact—that is, restoring, preserving, and enhancing forest ecosystems while strengthening the resilience of supply chains and local communities.

Practices and measures to address deforestation risks often span multiple stages of this framework, as companies and value chain stakeholders may combine preventive, responsive, and restorative actions depending on context and timing. Actions in one stage can also enable or evolve into the next; for instance, recovery efforts most often create the foundation for longer-term adaptation and transformation.

Figure 1. Framework: Building SRVCs



Source: Authors.

1.2 Report Objectives

This report focuses on deforestation as the first thematic risk area to apply the SRVC framework in sectors where forest loss is most present, particularly in the production stage. Deforestation remains one of the most pressing sustainability risks embedded in GVCs. Agricultural expansion, driven by demand for key commodities such as soy, timber, palm oil, cocoa, and beef, is a primary cause of forest loss worldwide. At the same time, global markets and supply chains also offer powerful entry points for solutions by leveraging standards, company sourcing policies, traceability systems, and incentives to shift production practices

and protect ecosystems. The report applies the SRVC framework and its four stages (Table 1 below) along with an exploratory methodology to identify and illustrate innovative and promising approaches that VSSs and private companies have applied to address deforestation and advance SRVCs. It also highlights gaps in VSSs' requirements and corporate practices, such as limited traceability coverage beyond first tiers in the supply chain and insufficient support for smallholders to collect farm-level data. The report provides recommendations to improve these practices with a view to preventing deforestation and protecting forests.

Table 1. SRVC framework and stages used in this report

Step	When	Purpose
1. Plan/Prepare	Before deforestation (ex-ante)	Anticipatory: Identify and mitigate risks early.
2. Respond	During/immediately after the onset or when deforestation is suspected to have occurred	Reactive: Address ongoing or recent deforestation through timely action.
3. Recover	After deforestation (ex-post)	Restorative: Ecological and social rehabilitation.
4. Adapt	Before *and* after deforestation (both ex-ante and ex-post)	Transformative: Build long-term resilience and redesign systems to prevent recurrence or recover stronger.

Source: Authors.

This report is organized into four sections. Section 1 unpacks the issue of deforestation in the context of global agricultural value chains, outlining key trends, drivers, and challenges related to forest loss and land-use change. Section 2 examines the role of VSSs in addressing deforestation risks across commodities, highlighting both VSS requirements and good practices. Section 3 explores the role of private sector actors in advancing SRVCs to address deforestation, showcasing innovative approaches and tools aligned with the SRVC framework. Section 4 presents conclusions and recommendations, offering practical guidance for VSS organizations and private sector actors to enhance their practices to tackle deforestation in value chains.

1.3 Methodology

This report uses the SRVC framework (Table 1) to assess how VSSs and private sector companies address deforestation in GVCs. Using a four-step process—Plan/Prepare, Respond, Recover, and Adapt—the framework provides a structured way to understand how actors engage with deforestation risks at different stages of supply chain governance. The VSSs were selected for inclusion in this report based on their relevance and adoption in forest-risk sectors, with at least one VSS included in the research linked to one key forest-risk commodity. The company examples illustrate how private sector actors across different commodities work to address deforestation in value chains.

The analysis is based on the following sources:

- document analysis of VSSs' requirements
- desk-based research of private sector strategies to address deforestation and publicly available reports to identify innovative and promising practices
- semi-structured interviews with representatives of VSSs and companies to obtain qualitative insights on implementation challenges, innovative practices, and emerging solutions.

1.4 Research Limitations

While this report highlights promising practices and tools to address deforestation through the SRVC framework, it does not assess the transferability or effectiveness of these measures across all contexts. The analysis is based on selected VSSs, companies, and sources, and findings should be interpreted as illustrative rather than exhaustive. Further research is needed to evaluate long-term impacts, implementation challenges, and the adaptability of these approaches in different production geographies.

2.0 Unpacking Deforestation in the Context of Global Value Chains

Forests cover about one third of the Earth's land surface, housing the majority of terrestrial biodiversity, supporting agrifood systems, acting as critical carbon sinks, and sustaining water cycles (Food and Agriculture Organization of the United Nations [FAO], 2020b, 2022b, 2024b). They also serve as a means of livelihood for many communities worldwide, with more than half of the world's GDP estimated to come from nature and its services (CDP, 2023). They are essential to further the three pillars of sustainability (environmental, social, and economic), yet they are under significant threat. According to the FAO Global Forest Resources Assessment, deforestation totalled 420 million hectares—larger than the size of India—between 1990 and 2020, with an annual loss rate of some 10.2 million hectares from 2015 to 2020, primarily in tropical and subtropical regions (FAO, 2022b; WWF & BCG, 2021). That is down from 15.8 million ha per year in the period 1990–2000 (FAO, 2024b).

There have been stand-alone instances of encouraging progress, however. For example, Brazil reported a 50% decrease in 2023 compared to 2022 in the Legal Amazon[1] (FAO, 2024b). Despite these gains, forests face ongoing threats from climate change and human activities, such as agricultural expansion and unsustainable logging, which drive both deforestation and forest degradation (FAO, 2022b, 2024b; Organisation for Economic Co-operation and Development [OECD] & FAO, 2023).

2.1 Deforestation Trends, Drivers, and Global Trade Impact

Forest degradation affects the quality and resilience of forest ecosystems, but it is most often considered reversible, i.e., forests are expected to regrow. Deforestation, however, is a complete removal of forest cover, involves a change in land use—possibly due to human activities—and causes more severe and irreversible consequences (FAO, 2022b).

Research indicates that drivers of deforestation are not static and vary with time across regions, mainly dependent on political and market shifts (WWF, 2021). Busch and Ferretti-Gallon explored 320 spatially explicit econometric studies from over 24 years and found that deforestation is mainly associated with activities designed to create greater accessibility, such as building roads and cities, and bring higher economic returns, such as agriculture, livestock, and timber (Busch & Ferretti-Gallon, 2023). Commercial agriculture expansion (including cropland expansion, cultivation of soybean and oil palm, livestock grazing, and others) has been identified as one of the leading causes of deforestation, with agricultural expansion accounting for nearly 90% of global deforestation (Busch & Ferretti-Gallon, 2023; FAO, 2020a, 2022a; WWF, 2021; WWF & BCG, 2021). In the Amazon, for example, 70% of deforestation has been driven by land clearing for cattle grazing (Kimbrough, 2023).

[1] Brazil's Legal Amazon is formed by the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, Tocantins, and Mato Grosso and also the municipalities of the state of Maranhão, located west of the 44th Meridian.

Box 1. Defining forests and deforestation: Challenges and implications

The definition of "forest" varies by country, institution, and context (Côte et al., 2018; Lund, 2016; Pulla et al., 2013; Putz & Redford, 2010; Sarmiento et al., 2024). For instance, FAO defines forests as "lands of more than 0.5 ha, with a tree canopy cover of more than 10 percent, which are not primarily under agricultural or urban land use" (FAO, 2001). The UN-Reducing Emissions From Deforestation and Forest Degradation in Developing Countries (REDD) program defines forest as an "area of land spanning more than 0.05 hectares with tree crown cover (or equivalent stocking level) of more than 10 percent with trees with the potential to reach a minimum height of 2-5 meters at maturity in situ" (UN REDD, 2021).

This heterogeneity of forest definitions, including where a forest starts and ends, often influences what constitutes deforestation, creates challenges in mitigating deforestation, and further influences forest conservation and management efforts (Chazdon et al., 2016; Savilaakso et al., 2023). Beyond definition, differences in data collection also play a role. For instance, Global Forest Watch (GFW) records "forest loss" globally, while FAO focuses specifically on deforestation caused by permanent land-use change. GFW includes temporary forest cover changes, unlike FAO, which considers only lasting changes in land use, making direct comparisons difficult (Ritchie, 2024).

A study by BeZero,[2] a leading carbon ratings agency, highlighted the challenge with differing forest definitions (and also for deforestation) using the case of Indonesia and Papua New Guinea. When comparing the data on forest cover, the study found that Indonesia's national assessment overestimated its forest cover by 24.4% compared to that of the FAO definition, 23.4% when compared to the IFORCE dataset, and 1.7% when compared to GFW assessments, in the years 1990–2022. The estimates shared by Papua New Guinea for the same period were closer to FAO's, with FAO overestimating the forest cover by 0.6% while IFORCE and GFW overestimated forest cover by 9.4% and 3.2%, respectively (BeZero Ratings, 2023).

As measures to estimate forest cover are critical to establish and mitigate deforestation, scholars, practitioners, policy-makers, and others have argued that key forest definitions (and related terms) and uniform detection methods must be standardized and adopted.

New data sets from GFW offer fresh insights into the proximate drivers of forest loss. GFW's updated mapping across eight tropical countries—Bolivia, Brazil, Cameroon, Colombia, Indonesia, Malaysia, Peru, and the Republic of Congo—identifies five primary drivers: commodity-driven deforestation, shifting agriculture, forestry, wildfire, and urbanization. While commodity-driven loss remains a major cause, it is highly concentrated in specific hotspots such as Brazil and Indonesia (GFW, 2025). These distinctions highlight the need for place-based interventions in deforestation strategies.

[2] For more information, see https://bezerocarbon.com/about/company, https://bezerocarbonmarkets.com/insights/forest-definitions-matter-an-indonesia-and-papua-new-guinea-case-study

International trade and consumption of agriculture and forest-related commodities further accelerate deforestation, accounting for about a quarter of forest loss in tropical areas, with an indication that increasing forest cover at home often means outsourcing land use—and its environmental impact—to other countries (Pendrill et al., 2019; Ritchie, 2021). Vietnam, for instance, underwent a forest transition, increasing forest cover from 24.7% in 1992 to 38.2% in 2005 (Hoang & Catacutan, 2014). However, this success came at the expense of neighbouring countries through massive timber imports. About 39% of Vietnam's forest regrowth between 1987 and 2006 was effectively "logged" in other countries (Ayers Butler, 2009).

Commodity-driven deforestation has been considered a "direct driver" and one of the biggest causes of deforestation (Curtis et al., 2018; FAO, 2022b; OECD & FAO, 2023; Pendrill et al., 2019; World Economic Forum, 2022). Much of the forest clearing for agriculture has been indicated to be illegal. Illegal logging for timber, for example, is a major concern for many countries and has an estimated annual international trade value of USD 50 billion to USD 157 billion (OECD & FAO, 2023; World Bank, 2019) which was 8%–27% of the export value of all forest products in 2022.[3]

2.2 Combating Deforestation: Initiatives and commitments

Efforts have been made across the globe to decouple commodity production from deforestation and tackle deforestation, underscoring the need for multi-partner engagement. These include policy responses such as REDD+, the European Union Regulation on Deforestation-free products (EUDR), the New York Declaration on forests, and the Glasgow leaders' declaration on forests and land use. Many initiatives and scoring tools have also emerged targeting the actions taken by the private sector, such as the CDP Forest scores, WWF Palm oil scorecard, The Consumer Goods Forum's (CGF's)-Forest Positive Coalition (FPC), and Forest 500.

Despite the growing number of global initiatives, trends on deforestation appear to be improving only slightly recently, with progress limited to specific countries or contexts. This highlights the scale of the challenge and the need for effective tools that can translate high-level commitments into measurable outcomes and support the achievement of deforestation-free value chains. In this context, given the complex and transboundary nature of deforestation risks, actors in GVCs have used VSSs to support their goals of addressing deforestation. The results have been mixed (Cosimo et al., 2024; Ingram et al., 2020; Lambin & Furumo, 2023; Larrea et al., 2021), yet VSSs continue to modify their requirements and upgrade their services to support actors in addressing deforestation.

In Section 2, we present a high-level mapping of selected VSSs' requirements across the four pillars of the SRVC framework. More importantly, we go beyond and illustrate their innovations and initiatives, such as adopting new technologies, that aim to address deforestation. This high-level analysis aims to highlight VSSs' value and their potential to

[3] FAO's state of the world's forests report says global forest product exports amounted to USD 576 billion in 2024. See page 10, Figure 1 here for more information: https://openknowledge.fao.org/server/api/core/bitstreams/bf9ac694-29f7-466c-9187-a24d432e0ccb/content

help value chain actors curb deforestation. This can create benefits for multiple stakeholders: producers that comply gain access to markets and guidance based on VSSs' potential to address deforestation; companies can mitigate reputational and operational risks; and policy-makers can draw on VSSs to inform or enhance their governance or public policy instruments.

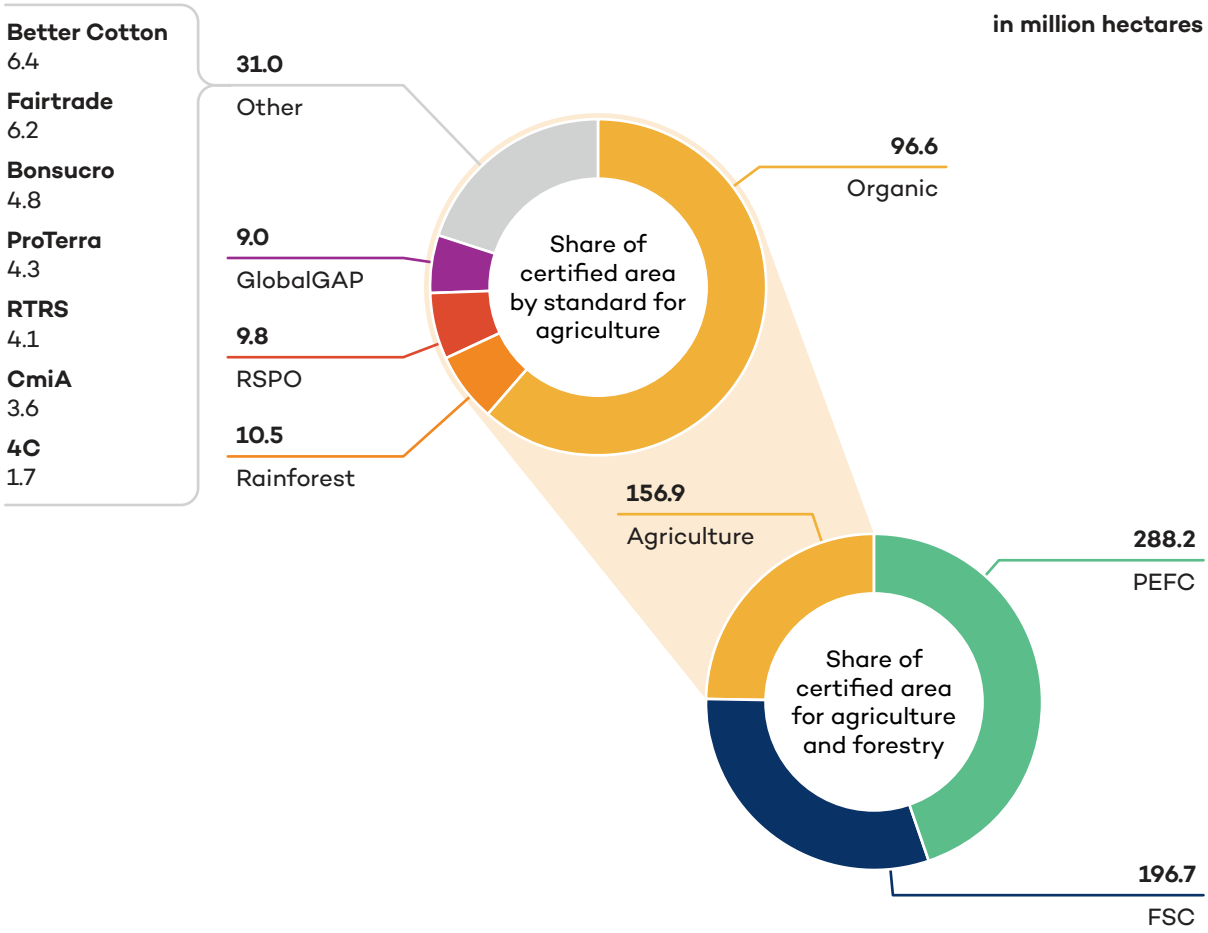
At the same time, it is also essential to underscore that VSSs have limitations and challenges and represent only one part of the solution. Private sector actors are also developing and adopting measures motivated by regulatory requirements, climate commitments, and stakeholder expectations. These include, for example, satellite-based monitoring systems, landscape-level interventions, and jurisdictional approaches that complement or go beyond certification to address deforestation. In Section 3, we illustrate successful and innovative approaches companies are taking to tackle and mitigate the risk of deforestation across GVCs.

Taken together, these perspectives highlight both the progress achieved to date and the opportunities for further improvement in reducing deforestation risks across GVCs. The following sections unpack these approaches in more detail, examining how different innovations are being applied, what contributions they have already made, and what potential next steps could support continuous improvement. By doing so, the report seeks to generate insights that VSSs and value chain actors can build on to effectively address deforestation and advance sustainability and resilience in GVCs.

3.0 How VSSs Help Address and Transform Deforestation Risks While Delivering Positive Results

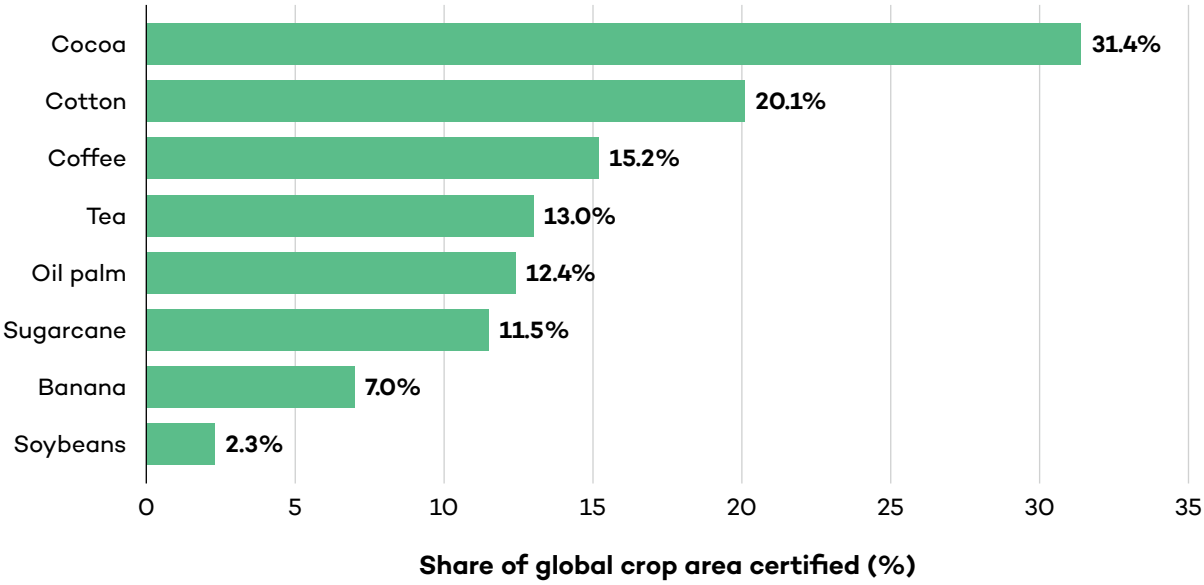
VSSs are defined as "standards specifying requirements that producers, traders, manufacturers, retailers or service providers may be asked to meet, relating to a wide range of sustainability metrics, including respect for basic human rights, worker health and safety, environmental impacts, land-use planning, and others" (United Nations Forum on Sustainability Standards, 2013, p. 4). Most VSSs also provide support systems to help producers meet those requirements and advance sustainable production and consumption of agricultural commodities via training, capacity building, and other supporting measures (Bermúdez & Sarmiento, 2023; Larrea et al., 2021).

Figure 2. Distribution of globally certified agricultural and forestry area by standard 2022)



Source: Authors, based on Kemper et al., 2024.

Figure 3. Minimum harvested area certified by agricultural commodity in 2022



Source: Authors, Kemper et al., 2024.

VSSs have proliferated over the last four decades. Those focusing on forestry encompass larger producing areas (Figure 2) than others. Given their strong presence in sectors closely associated with deforestation, VSSs are well-positioned to contribute more meaningfully to forest protection. They have the potential to help producers and value chain actors anticipate, mitigate, and transform deforestation risks while also advancing broader socio-economic and environmental goals.

To assess this potential, this section analyzes how the requirements of selected VSSs (Table 2) operating in deforestation-risk commodity sectors align with the SRVC framework (Figure 1). It also highlights the good practices they promote beyond compliance requirements to address deforestation. Our sample includes both international schemes (Forest Stewardship Council [FSC], Programme for the Endorsement of Forest Certification [PEFC], Roundtable on Sustainable Palm Oil [RSPO], Rainforest Alliance, Fairtrade, and ProTerra) and a regional standard (African Organisation for Standardisation [ARSO]) to capture differences in governance scope and producer-country context, if any, and to explore if national standards are better aligned with domestic laws, institutions, and enforcement pathways relevant to deforestation. The selected VSSs operate across forest-risk commodities that are key drivers of deforestation, including palm oil, soybean, cocoa, coffee, and timber. The analysis is based on a review of selected VSSs' requirements, desktop research, and interviews with VSS organization representatives.

Table 2. VSSs assessed in the report

Standard	Sector	Standard document referenced
Fairtrade	Cocoa, coffee	Fairtrade Standard for Smallscale Producer Organizations v2.7 Fairtrade Standard for Coffee v2.7 Fairtrade Standard for Cocoa v2.3 Fairtrade Trader Standard v2.0 Fairtrade Standard for Hired Labour v.2.1
Forest Stewardship Council	Forestry	FSC International Standard Principles and Criteria for Forest Stewardship FSC-STD-01-001-V5-2 EN[4]
African Organisation for Standardisation	Forestry	Forestry- Sustainability and Eco-labelling - Requirements (2014)- ARS/ AES 3
Programme for the Endorsement of Forest Certification	Forestry	Sustainable Forest Management, ST 1003 PEFC ST 1003:2018
Rainforest Alliance	Cocoa, coffee	Rainforest Alliance Sustainable Agriculture Standard: Farm Requirements V1.4
Roundtable on Sustainable Palm Oil	Palm oil	RSPO Principles and Criteria for the Production of Sustainable Palm Oil (2018)
ProTerra	All ag commodities except cattle and wood	ProTerra Monitoring and Verification Standard (2023)

Source: Authors.

3.1 Plan/Prepare: Foundation for risk reduction

This section shows how the selected VSSs prevent deforestation before it happens. Table 3 maps each scheme's ex-ante requirements, such as land-conversion safeguards, cut-off dates, and risk/impact assessments, against the SRVC Plan/Prepare indicators.

[4] The assessment refers only to the FSC Principles & Criteria. The Principles & Criteria represent a part of FSC's Standard, but these are expanded through the International Generic Indicators. The indicators provide operable guidance on implementing the broader ambitions outlined in the Principles and Criteria. These are not included in the benchmarking.

Table 3. VSSs' requirement coverage related to Plan/Prepare

Indicators	Fairtrade	FSC	ARSO	PEFC	Rainforest Alliance	RSPO	ProTerra
Risk assessment prior to expansion of business operations/cultivation and infrastructure	✓	✓	✓	✓	✓	✓	✓
Use of high-resolution maps to monitor deforestation rates	✓	✗	✗	✗	✓	✓	✓
Prohibit conversion of forest land (all forest types; high conservation value [HCV] and other critical ecosystems included) to production land	✓	✓	✓	✓	✓	✓	✓
Chain of custody to ensure traceability	✓	✓	✓	✓	✓	✓	✓
Cut-off date for converting land with HCV into production land	✓	✓	✗	✓	✓	✓	✓
Maintain critical ecosystems, such as HCV areas	✓	✓	✓	✓	✓	✓	✓
Criteria for the prevention of deforestation	✓	✓	✓	✓	✓	✓	✓
Ensuring land rights and legal use of land	✓	✓	✓	✓	✓	✓	✓
Criteria on free, prior, and informed consent (FPIC) of local communities	−	✓	−	✓	✓	✓	✓
Verifiable forest management plan targets and their incorporation in the monitoring system	✗	✓	−	✓	−	−	✗

✓ Covered − Partly covered ✗ Not covered

Source: Authors.

The Plan/Prepare category in the SRVC framework focuses on proactive measures that can support in anticipating and mitigating the risk of deforestation in GVCs. Our analysis indicates that while the potential to prevent deforestation may depend on the commodity sector in which a VSS operates, all selected VSSs include some preventive measures against deforestation.

All VSSs have provisions requiring evaluation of potential risks and the screening, scoping, prediction, and mitigation of widespread environmental and social implications before expanding agricultural/forestry operations, with environmental risks most often focusing

on forest-related risks. In PEFC, for example, it is mentioned that "the organization shall consider risks and opportunities concerning compliance with the requirements for sustainable forest management" (PEFC, 2018, page 14).

Further, all VSSs have requirements that restrict or prohibit the conversion of forests[5] and critical ecosystems for production purposes and requirements to maintain and protect HCV or high carbon stock (HCS) value areas (e.g., primary forests, peatlands, and secondary forests with high density). These core requirements are consistently present across all the VSSs examined, indicating that prevention of direct land-use change is widely embedded across standards, though coverage (which forest types, which circumstances) differs by standard.

Cut-off dates for land conversion vary among VSSs analyzed. PEFC, Fairtrade (coffee standard), and Rainforest Alliance set earlier dates (2010, 2014, and 2014, respectively), reflecting stricter baselines, while FSC (2020), Fairtrade Cocoa (2018), and RSPO have more recent cut-off dates (e.g., November 2005 for land clearing that must not have damaged primary forests or areas required to protect or enhance HCVs, and November 2018 for land clearing that must not have damaged HCV or HCS forests). ARSO prohibits forest conversion for agricultural practices but lacks a cut-off date, allowing limited forest conversion under strict conditions. It states that forest conversion to plantations or non-forest land uses is forbidden except when conversion (a) entails a very limited portion of the forest management unit; (b) does not occur on HCV forests; and (c) will enable "clear, substantial, additional, secure" long-term conservation benefits across the forest management unit (ARSO, 2014).

Both approaches—that is, having a strict date and a variable one—have pros and cons for preventing deforestation. A fixed date can, in theory, guarantee that conversion has not occurred after the specified date, but it can exclude areas that had undergone conversion to become part of the VSS's certification process, risking missing the opportunity to halt ongoing or future conversion. On the other hand, a variable date or not having a specific cut-off date can support remediation and improvement of deforested areas and provide flexibility for farmers, but if these rules are not well enforced, they can weaken deterrence against new land-clearing activities.

Some VSSs incorporate technology (e.g., polygon mapping) and use high-resolution maps to monitor deforestation. Fairtrade and Rainforest Alliance require geolocation data for all farms as a certification requirement. In its coffee standard, for example, Fairtrade requires geolocation for 100% of member farms (polygons for farms >4 ha; points for farms ≤4 ha), and requires these data to be used to inform deforestation-prevention plans (Fairtrade Coffee Standard, 2021, p. 17). Rainforest Alliance requires geolocation data for 100% of farm units with the certified crop. Large farms and individually certified farms need to provide a polygon for each farm unit, and small farms in group certification must have at least 35% of farms mapped as polygons and the remainder as points and by second certification audit, all farms need to have polygons (Rainforest Alliance, 2025, p. 25). The ProTerra Monitoring and Verification Standard (MRV) standard mentions that auditors should use satellite imagery

[5] For clarity, "conversion" provisions in our sample apply to all forest types (primary, secondary, natural forests, and tree-covered lands meeting the scheme's definition) and critical ecosystems, where conversion may not be fully prohibited and may be conditioned on prior risk screening.

to assess deforestation and runs annual verification cycles (i.e., assessments and verification statements are annual). RSPO members are also required to submit the concession maps, both certified and uncertified, and to have them made publicly available on RSPO's interactive mapping platform, GeoRSPO.[6] This allows for RSPO's Geographical Information System Unit to actively monitor oil palm grower members' compliance with RSPO P&C 2018 relating to deforestation, no new planting on peatlands, and for fire and hotspot monitoring (RSPO, 2020). However, not all VSSs have requirements that use technology to monitor and prevent deforestation. As technology becomes central to complying with emerging rules such as the EUDR (e.g., plot-level proof of deforestation-free status), integrating accessible technological tools and helping smallholders to use them remains a clear opportunity for VSSs to strengthen their requirements and support the prevention of deforestation.

All standards assessed include criteria related to the prevention of deforestation, either as explicit no-deforestation requirements or addressing conversion under broader forest or ecosystem management provisions. For example, Rainforest Alliance mentions that "From January 1st, 2014, onward, natural forests and other natural ecosystems have not been converted into agricultural production or other land uses" and that "farms preserve all remnant forest trees unless they present hazards to people or infrastructure. Other native trees on the farm are managed sustainably to ensure that the same quantity and quality of trees is maintained" (Rainforest Alliance, 2025, p. 72, 73).

ARSO and Fairtrade do not specifically mention FPIC principles for local communities but have requirements that include related language; for instance, Fairtrade covers that via related environmental risk and land rights clause. FPIC is a critical safeguard for land rights and deforestation prevention as it reduces land-use conflicts and unlawful conversions by requiring prior consent when forests are community-managed or customary lands. Most VSSs also have chain of custody (CoC) models to ensure traceability of certified goods to origin of production, which can help buyers, traders, end users and other value chain actors verify claims such as deforestation-free production. The kinds of CoC models included vary among VSS[7] and are:

- identity preserved/segregated: allow product-level claims because certified volumes remain physically separate.
- mass balance: mixes certified and non-certified inputs but controls credits on paper, so claims are typically volume or supplier-level, not item-specific.
- book-and-claim: enables support for certified production without tracing the physical product.

[6] https://rspo.org/as-an-organisation/tools/georspo/

[7] For more detail on various types of CoC models included in VSSs, see the section Assurance: VSSs implement several activities and procedures to verify whether farmers and operators comply with their criteria in *Voluntary Sustainability Standards, Forest Conservation, and Environmental Provisions in International Trade Policy,* IISD 2021 report, p. 8 onward, available at https://www.iisd.org/system/files/2021-10/voluntary-sustainability-standards-forest-conservation-trade-policy.pdf
Another useful resource on CoC models used in sustainability standards systems is ISEAL's 2025 guide, available at https://isealalliance.org/sites/default/files/resource/2025-07/ISEAL_Chain%20of%20custody%20models%20and%20definitions%202025_V7_0.pdf

Lastly, as part of Plan/Prepare, some standards require producers/forest managers to set verifiable, time-bound targets for maintaining and restoring natural vegetation and forests. From our examined standards, we observe that forestry standards more clearly require verifiable targets and monitoring within forest management plans. For example, FSC requires verifiable targets in the management plan and adaptive monitoring, so results feed back into planning; PEFC and ARSO require stated management objectives, periodic monitoring, and plan reviews (e.g., PEFC 9.1; ARSO 6.3.2, 6.3.6). Among agriculture standards, RSPO requires integrated HCV/HCS management plans with monitoring and a 5-year review cycle. Rainforest Alliance sets farm-level vegetation cover thresholds with annual monitoring and targets when farms fall short. Fairtrade calls for mitigation plans, but targets are not consistently quantified, and ProTerra MRV includes general monitoring rather than target-specific requirements. Targets are typically written into the VSSs' forest management plans, so they are treated as planning commitments (Plan/Prepare), but the evidence of achievement and verification may be reported under Recover.

These findings point to clear opportunities. VSSs can strengthen deforestation monitoring by mainstreaming technologies (e.g., polygon mapping) across all selected standards and ensuring that these technologies are accessible, affordable, and usable by producers, especially smallholders. VSSs can also reinforce requirements such as ambitious cut-off dates that, at a minimum, align with regulatory requirements but can even be stricter. Strengthening CoC and traceability requirements so products can be tracked back to the producing area and screened for any links to deforestation is also key for all VSSs. VSSs can add FPIC and social safeguards because clear rights and consent reduce conflict-driven clearing and land grabs, making producers and communities partners in protecting forests.

Beyond Requirements for Plan/Prepare

Leveraging Satellite Imagery to Prevent Deforestation

Satellite imagery (assessing satellite images of forests, for example, via GFW) has become one of the most used tools to monitor deforestation, with recent advancements allowing for near-real-time data on forest cover and change at specific time intervals and specific areas (Carter et al., 2024; World Bank, 2020). Its strengths are:

- consistent, repeatable monitoring, which means satellites can capture images of the same forests repeatedly in the same way each time, making it easy to compare and spot any changes over time, such as the felling of new trees
- the possibility of early detection of forest loss and potential deforestation hotspots when used in combination with artificial intelligence (AI) and machine learning (Broich et al., 2011; Defries & Townshend, 2001; FAO, 2023; Farmonaut, 2024; WWF, 2018a).

VSSs are adopting these innovative measures to improve forest monitoring, prevent deforestation, strengthen compliance with mandatory regulations for certified entities, and support sustainable forest management. The Rainforest Alliance is one example of a VSS that has operationalized satellite imagery in certification schemes. VSSs are adopting these innovative measures to improve forest monitoring, prevent deforestation, strengthen compliance with mandatory regulations for certified entities, and support sustainable forest

management. The Rainforest Alliance is one example of a VSS that has operationalized satellite imagery in certification schemes. The deforestation risk map is created by overlaying the geolocation data provided by the certificate holder with the Rainforest Alliance deforestation layer, which is created by analyzing deforestation from the cut-off date 2014 until the present, thus giving an indication of possible deforestation that has occurred. RA provides certificate holders and auditors with a risk map report and access to assessment results for each farm unit in a deforestation risk table. Farm units are assigned a risk level, from insignificant (low risk) to significant (high – medium risk). Certificate holders and Auditors must visit the farm units with significant risk to verify if deforestation has occurred or not. Any deforestation or conversion occurring later than 2014 renders a given area or production unit as non-compliant with the Rainforest Alliance Standards and may be cause for non-certification or cancelation. (Rainforest Alliance, 2025; Rainforest alliance, personal communication, 21 November 2025). Thus, satellite imagery can improve the accuracy of detecting deforestation in real time, support risk mapping, and strengthen the audit and compliance process to prevent deforestation.

Another example is Fairtrade partnering with Satelligence to scale satellite monitoring of forested area to all certified cocoa and coffee producer organizations. Producer organizations submit farm geolocation data for all of their members' farm plots, and Satelligence checks the data quality and verifies geolocation. The system then detects if there was any deforestation at farms and if farms are located in or near protected areas, flagging the risk of deforestation (Fairtrade, 2023). Fairtrade-certified cooperatives can use the reports generated under this system and share them with their customers to prove compliance/deforestation-free commodity production (Fairtrade, 2023). This partnership is expected to enable more than 1 million coffee and cocoa farmers who cultivate 2.5 million hectares to access satellite data, manage forests better, and help meet EUDR requirements.

While satellite technology offers valuable tools for identifying deforestation hotspots and forecasting and preventing deforestation, its effective use still faces several challenges and limitations. Reliable monitoring and forecasting of deforestation depend on multi-year, quality-controlled datasets (to build stable baselines and, where used, to train AI models to predict and detect deforestation accurately), the availability of high-resolution imaging, and the ability of value chain actors to use advanced tools and methods that are continuously updated to capture accurate land-use change (Fairtrade, personal communication, March 21, 2025). High-resolution imagery and analytics can be expensive, and smallholders may need financial support to access tools to capture data.

At the farm level, farmers can struggle to collect Global Positioning System (GPS)/polygon data. It can be a difficult process, especially for smallholders, who may lack access to basic technology such as smartphones or mapping apps. This could lead to incorrect data being captured that falsely report deforestation or miss real clearing of forests. Interpreting satellite outputs also requires expertise, and without adequate training, users may misread or misapply results (Rainforest Alliance, personal communication, April 24, 2025; Fairtrade, personal communication, March 21, 2025). Beyond this, technical limitations may also be a challenge. For instance, cloud cover in tropical regions can obscure satellite imagery, and interpreting land-use change often requires careful analysis to avoid mistaking intact forest for cleared land or missing real clearing. However, recent advances in remote sensing are improving reliability.

For instance, real-time change detection techniques, such as the Sentinel-1 Cumulative Sum method, have achieved high accuracy (up to 93%) in identifying forest disturbances with very fine spatial resolution (Ygorra et al., 2024).

For this technology to help prevent deforestation, training and capacity-building programs for farmers, especially smallholders, must be expanded to collect, analyze, and interpret their data.[8] Strengthening farmer support systems, improving data quality, and ensuring wider access to technical expertise would enhance the reliability and inclusiveness of satellite-based monitoring in certification systems. Effective cross-checking of the data, via on-ground audit checks or farmer verification of data, for instance, is also important. Evidence on the effectiveness of this technology is promising for detection and compliance screening, but the impact on actual deforestation rates can be made stronger when satellite monitoring is paired with clear enforcement (cut-offs, suspension/remediation rules), incentives for producers, and transparent reporting.

Tapping Into the Power of Community Forestry

Community forestry is defined as an "umbrella term encompassing collaborative forest management and smallholder forestry" (International Tropical Timber Organization, n.d.). It represents a key approach to preventing deforestation in regions where local livelihoods are tied to forest resources. This collective management seeks to balance forest protection objectives with socio-economic benefits for local communities (FAO, n.d.; Fern, 2021; Natural Resources Canada, 2022).

Some VSSs support such models, recognizing that communities with secure rights and direct incentives are more likely to invest in sustainability practices due to ownership of land and possible socio-economic incentives. One way this can be operationalized is through a forest concession, which "is a contractual arrangement for the temporary allocation of public forest resources by the legal owner of an area (typically the state) to another party (e.g., companies, communities, NGOs [non-governmental organizations])" (Tegegne et al., 2018). When well designed, community concessions can reduce deforestation and deliver socio-economic gains: they help formalize land tenure, as their ownership prompts communities to take care of their land and forests, which lets communities plan long term; it can also help them create diversified income from timber and other forest products (e.g., nuts, resins, honey) and value-added processing; generate local jobs and enterprise opportunities; and improve market and finance access (tenure can unlock credit and contracts) (Profor, n.d.; Sarmiento et al., 2024; Tegegne et al., 2018).

One example of this is Guatemala's Maya Biosphere Reserve, where the government has granted local communities long-term forest concessions (Preferred by Nature, 2021). FSC certification is mandatory for both communities and industry groups to obtain and maintain forest concessions in the reserve, and represented more than 350,000 ha of forest as of 2022 (Cashore et al., 2006; FSC, 2022a; Preferred by Nature, 2021). Rainforest Alliance has also supported about 10 of these concessions by training farmers on methods to generate higher yields on cropland and helping them to develop sustainable business and access markets for

[8] With the type of data and method of collection to be determined.

non-timber forest products such as xaté palm, tree nuts, and FSC-certified timber (FAO and United Nations Environment Programme [UNEP], 2020; FSC, 2022a; Rainforest Alliance, 2022c).

The community-managed Maya Biosphere Reserve concessions have reportedly been successful, and deforestation has remained near zero in the nine original active concessions over the last 20 years, outperforming strictly protected areas such as the Laguna del Tigre National Park (Cuffe, 2016; Rainforest Alliance, 2022b). It is also reported that just 2% of fires in the reserve occur in areas managed by these communities, while this strategy has created 12,000 jobs in more than 100 forest businesses, generating increased timber sales (USD 69.6 million in sales between 2013 and 2021), and supported women farmers and entrepreneurs in the area (Berenger & Morrissey, 2022; FAO & UNEP, 2020; Rainforest Alliance, 2022b). Such initiatives help lower poverty and improve socio-economic conditions in local communities—critical factors for successful deforestation prevention in areas managed or owned by communities. When livelihoods improve, there is less pressure to convert forests for survival.

However, limitations remain in successfully implementing these concessions. One challenge is to establish economically viable community forestry enterprises and market timber and non-timber forest products, so there is continued access to markets (Rainforest Alliance, personal communication, April 24, 2025). The long-term success of such initiatives also depends on intervention design being suited to local contexts, continued access to funding to maintain forest management (such as patrols and fire prevention, monitoring tools, and periodic certification audits), the ability of farmers and organizations in the area to maintain and ensure compliance with certifications if needed (such as FSC in the case of the Maya Biosphere Reserve), government support for tenure rights, and collaboration among all actors—communities, governments, the private sector, and NGOs (Berenger & Morrissey, 2022; FAO & UNEP, 2020; Fern, 2021).

3.2 Respond: Immediate action against deforestation

Respond in the SRVC framework refers to actions taken after deforestation or when there is credible evidence or suspicion of it, to contain harm, correct non-compliance, and prevent further clearing. This differs from Plan/Prepare (pre-deforestation prevention and risk reduction) and Recover (post-event restoration and remediation).

As mentioned in the section on Plan/Prepare, VSSs primarily address deforestation through cut-off dates (a preventive measure), wherein, according to their criteria, in theory, they do not allow for lands deforested after specified dates to be certified. This is the most common mechanism through which VSSs sanction (suspension, decertification or withholding certification) deforestation (based on analysis of VSS requirements and interviews with VSS representatives).

To illustrate how the selected VSSs operationalize response measures for deforestation, we present our findings in Table 4 below. They show the alignment of VSS requirements focusing on audits and corrective actions. In practice, effective Respond measures often trigger or feed into Recover—for example, when corrective actions include replanting for ecosystem restoration.

Table 4. VSSs' requirement coverage related to Respond

Indicators	Fairtrade	FSC	ARSO	PEFC	Rainforest Alliance	RSPO	ProTerra
Audits and assessments to provide corrective action plans (CAPs) to remedy deforestation	− [a]	✓	✗	✓	− [b]	✓	✓ [c]

✓ Covered − Partly covered ✗ Not covered

Source: Authors.

Note: [a] General CAPs, not deforestation-specific; [b] CAPs generally; limited remediation for "minor" conversion; [c] General CAPs; deforestation-specific remedy needed in specific cases.

Certification audits are typically conducted before granting certification (and then at specified intervals, like every 3 years, to maintain certification). When auditors identify non-conformities, VSSs require CAPs to be implemented by producers or certification-seeking entities that specify time-bound corrective measures, verification steps, and sanctions (e.g., decertification) if corrections are not made. In principle, for deforestation, non-compliance with criteria and disrespect of the cut-off date would imply a pause on or cancellation of the certification. However, some VSSs may have CAPs that help producers mitigate deforestation and embed targeted measures to prevent further loss. In cases where CAPs include replanting, rehabilitation, or compensation, those actions transition into Recover and can be tracked until outcomes are verified.

An example is RSPO, which requires members to conduct HCV assessments before new land development. If, in this process, land conversion occurs outside the rules specified by RSPO, growers must complete the RSPO Remediation and Compensation Procedure (RaCP) (see details in the Recover section below) before obtaining RSPO certification. Forestry schemes (FSC, PEFC) run forest management unit or forest management unit-level (a defined forest area with mapped boundaries, a management plan, staff, and operations that a certificate covers) audits, where non-conformities trigger corrective action requests and unresolved issues can lead to suspension/withdrawal. FSC has also implemented a Remedy Framework that applies to organizations linked to past conversion. It requires a remedy roadmap (restoration/compensation, FPIC-based engagement, grievance pathways and others that can lead to recovery, as explained in Recover section below) as a condition for potential reassociation. Most agricultural VSSs employ general CAPs through their audit systems with no specific focus on deforestation. This can be due to VSSs' design, as their general requirements are broader than those for deforestation. However, it could be beneficial to have CAPs specifically addressing deforestation, most importantly for VSSs operating in high-risk areas.

Our findings suggest that immediate responses and corrective action systems remain limited across VSSs, as they do not certify deforested land and therefore may not require any response mechanisms. In other words, the maximum sanction for deforestation is decertification or withholding certification, i.e., exclusion from certified markets. However, some VSSs

offer structured response protocols to address deforestation as it happens through various CAPs and mechanisms. VSSs can strengthen their response frameworks by introducing deforestation-specific CAPs that implement forest-positive measures, such as agroforestry, to ensure deforestation is addressed in real time and that these measures contribute to long-term ecosystem recovery.

Beyond Requirements for Responding to Deforestation

Most VSSs we assessed lack mechanisms for addressing deforestation or recommending corrective action beyond their compliance requirements. This is largely because their core design prohibits certification in deforested areas after specific cut-off dates. For example, FSC has a cut-off date of 2020, beyond which deforested lands are ineligible for certification. VSSs also require regular audits to renew certification, which further limits the possibility of deforestation occurring. Routine audits further deter clearing by enforcing these rules.

However, there is scope to embed a continuous-improvement pathway (as optional recommendations)—for example, allowing applicants or nearby producers to commit to time-bound restoration plans and agroforestry, for instance, for areas that are not in farming plots but around them, even when certification cannot be granted to the deforested plot. This keeps incentives for remediation and recovery from deforestation alive without weakening the no-conversion date requirement. Verified restoration can have other advantages for producers, such as making them eligible for grants, blended finance, or government programs tied to recovery and risk reduction.

3.3 Recover: Building back better

Recover in the SRVC framework addresses damage that has already occurred and focuses on ecological restoration, social remedy, and verification of outcomes. Unlike Respond (immediate responses) and Adapt (long-term transformation), Recover indicators concentrate on addressing the damage and restoring degraded areas. Although most standards have a cut-off date, which in theory makes certification impossible if disrespected, recovery provisions remain essential: they target ecological restoration and social remedy and can protect the surrounding landscape from leakage (when deforestation halted in one place shifts elsewhere rather than actually stopping) or renewed clearing of forests or HCV areas.

Actions taken in response to deforestation can enable recovery (e.g., CAPs requiring restoration of degraded areas), and the actions taken to recover may enable adaptation. To illustrate how the selected VSSs' requirements align with the recovery element of the SRVC framework, we present in Table 5 the coverage of those requirements related to restorative actions such as rehabilitation, grievance mechanisms, and actions that support recovery.

Most VSSs require producers to restore natural areas. Explicit reforestation as a remedy for logging is present for the forestry standards, FSC, PEFC, and ARSO, which require forest operations to have sustainable timber harvesting practices followed by natural or assisted regeneration that may be needed to restore productivity and ecosystem functions.

Table 5. VSSs' requirement coverage related to Recover

Indicators	Fairtrade	FSC	ARSO	PEFC	Rainforest Alliance	RSPO	ProTerra
Efforts (like reforestation) to remedy logging	✗	✓	✓	✓	✗	✗	✗
Habitat/ecosystem restoration/ rehabilitation	✓[a]	✓	✓[b]	✓	✓[c]	✓	✓
Grievance mechanism for affected stakeholders	✓	✓	−	✓	✓	✓	✓

✓ Covered − Partly covered ✗ Not covered

Source: Authors.

Note: [a] In mitigation and prevention plans, so as a preventive measure; [b] Mentioned to include in the forest management plan, so as a preventive measure; [c] Restoration triggered when vegetation cover is below threshold, not deforestation-specific; so as an adaptive measure.

Among the agriculture standards, ProTerra and RSPO support the remediation of deforested land. As per ProTerra standards, the cut-off date is December 31, 2008. However, the standard requires operators to restore forest ecosystems following the guidelines in the ProTerra Procedure for Restoration and Compensation of Deforestation (ProTerra, 2023, p. 8). Under these guidelines, ProTerra acknowledges that it will "consider deforestation that occurred between 1 January 2009 and 31 December 2020, eligible for ProTerra certification if an organization has taken effective actions to restore the area and/or has provided suitable compensation for the lost ecosystems and its values" (ProTerra, 2024). In this case, an organization must prepare a dedicated Restoration and Compensation Procedure for affected lands and submit it to ProTerra for approval. Upon successful implementation, the organization may become eligible for certification.

Similarly, RSPO has put in place a Remediation and Compensation Procedure for past clearance and requires integrated HCV/HCS management plans for conservation areas. RSPO uses RaCP when a grower (certified or non-certified) cleared land without a prior HCV assessment (i.e., non-compliant clearance without prior HCV assessment since November 2005, or without prior HCV-HCSA assessment since November 15, 2018). In brief, the grower must disclose past clearance, conduct a land-use change analysis, and submit a remediation/compensation plan (e.g., on-site restoration) for review by the RSPO Compensation Panel. Certification (or continued certification) proceeds only after the case is approved and the plan is implemented under verification; independent smallholders are treated separately (RSPO, 2015b). As of December 2024, RSPO had approved 356 RaCP cases, leading to remediation and/or compensation covering close to 140,000 hectares, mainly across Indonesia, Latin America, and Africa (RSPO, 2025).

While Fairtrade and RA have provisions for maintaining natural ecosystems, they sit in the Plan/Prepare category (for Fairtrade) or, where they drive long-term production changes

(like in Rainforest Alliance), they fall under the category of Adapt, as they do not set stand-alone, deforestation-specific restoration-as-remedy requirements. For example, RA requires certificate holders to maintain and annually monitor natural vegetation cover and, when farms fall below 10% (or 15% for shade-tolerant crops), to set targets and take actions to restore cover (Rainforest Alliance, 2025, Req. 6.2.3–6.2.4). "Natural vegetation" explicitly includes riparian buffers, in-farm conservation areas, agroforestry vegetation, border plantings/live fences, and—crucially—conservation/restoration areas outside the certified farm for at least 25-year protection, creating a landscape-level restoration pathway around certified farms.

Box 2. FSC remedy frameworks

The FSC remedy frameworks are centred around addressing forest conversion. They apply when a company or its affiliated entities are involved in the conversion of natural forests or FSC Policy for Association violations. Effective July 1, 2023, the frameworks claim to set a standardized, outcome-focused pathway to address conversion and other unacceptable activities as per the FSC standard before the company can be re-associated or eligible for certification. The frameworks require companies linked to past forest conversion or other serious harm to deliver verified ecological restoration/compensation and social remedy (FPIC-based engagement, grievance resolution as per the UN Guiding Principles on Business and Human Rights) (FSC, n.d.-b). Unlike routine audit corrections, remedy frameworks can tackle historic impacts at corporate-group scale, tie actions to mapped impact areas, and require independent verification—helping move beyond prevention to measurable recovery.

This complements FSC's new policy to address conversion, which makes land converted after December 31, 2020, ineligible for certification, while allowing land converted from 1994 to 2020 to proceed to the certification process after remedy. In November 2023, for example, Asia Pacific Resources International Holdings Ltd. Group (APRIL) signed a memorandum of understanding with FSC to initiate a group-wide remedy and association process under the framework. FSC suspended the memorandum of understanding in September 2025 following allegations of violence involving Toba Pulp Lestari, a member of APRIL's corporate group, and an Indigenous community in North Sumatra, Indonesia (FSC, n.d.-a). The case is pending an independent investigation, but it demonstrates the mechanism's use and the scrutiny it applies.

Grievance mechanisms are available across all examined standards. While broad rather than deforestation-specific, they function as an important entry point for social remedy and for triggering corrective actions linked to restoration or compensation. In severe cases, the offenders might be decertified, which can be a strong deterrent for deforestation activities and motivation to implement remediation measures. For example, in FSC, the Mighty Earth group submitted a Policy for Association complaint against Korindo in 2017 concerning large-scale deforestation and HCV destruction. Inability to check for improvements led to FSC's disassociation from the Korindo Group (in 2021) and termination of Korindo's trademark licences with FSC, with requirements set for remedy and independent verification before any future reassociation (FSC, 2022c, 2022b). This case suggests how grievance systems could

function as an entry point to enforce consequences and catalyze recovery actions (restoration/compensation) when deforestation harms are identified. Effective grievance mechanisms can support recovery from deforestation by offering affected communities a formal channel to report issues such as land rights violations or environmental harm, enabling timely remediation and restoration actions.

In summary, while the provision of cut-off dates in VSSs limits the cases needed for recovery, recovery remains necessary to repair damage caused by deforestation, protect wider landscapes, and ensure no new land clearance occurs. Efforts vary based on the VSS and the commodity sector in which it operates. Forestry standards require natural/assisted regeneration after harvesting. To strengthen Recover, standards should tighten assurance around what already exists—require periodic, field-based verification that remediation has been delivered (for instance, based on the forest management plan indicators set up as a part of Plan/Prepare), disclose remediation status and completion, and ensure grievance outcomes consistently facilitate and track ecological/social remedy with proportionate sanctions when remediation fails.

Beyond Requirements for Recover

Carbon-Based Forest Landscape Restoration

Forest landscape restoration (FLR) is an approach used to recover deforested/degraded sites and their functions. In a Recover context, it should be tied to mapped impact areas, a time-bound restoration plan (e.g., species mix, planting density, survival checks), and independent verification (Baskent et al., 2025; FAO, 2022c; Frontiers, n.d.). When restoration is designed and monitored for carbon outcomes, the process is carbon-based FLR and projects may issue voluntary carbon credits. The carbon credits earned may be sold on international and voluntary carbon markets, such as in the framework of the European Union Emissions Trading System (EU-ETS) or international offset markets (Treeck, 2024; World Bank, 2022).

One example of this work among VSSs is Fairtrade, which has developed a carbon-credit standard and certified projects across Burkina Faso, Ethiopia, India, Lesotho, Peru, and Uganda (Fairtrade, n.d.). Under the optional Fairtrade Climate Standard (an add-on to the Gold Standard), producer organizations may implement afforestation/reforestation projects that generate Fairtrade carbon credits with a minimum price and premium. Fairtrade reports more than 833,000 tCO_2e of verified reductions to date and EUR 546,000 in premiums paid to producer organizations (Fairtade, n.d.). Such initiatives can help farmers gain access to the voluntary carbon market, which allows them to earn income through verified carbon credits, enabling restoration of deforested areas, and providing financial incentives to avoid future deforestation (Fairtade, n.d.). When tied to mapped impact areas with time-bound restoration plans and third-party verification, such projects function as Recover (post-event remedy). As a co-benefit, carbon-based FLR can also contribute to adaptation, as restored forests stabilize soils, regulate water, and buffer livelihoods against climate shocks while also adding monetary incentives for farmers, enabling future prevention of deforestation.

While this nature-based solution allows for land restoration and provides socio-economic benefits, there are challenges, mainly because the voluntary carbon market continues to be characterized by relatively low prices and limited demand, which can undermine the financial

sustainability of such projects (Bagwill, 2025; Hamrick & Gallant, 2017; World Bank, 2022). Monitoring, reporting, and verification are costly, and many farmers lack project skills (e.g., restoration design, field data) and market skills (registry enrolment, contracting, pricing, and selling credits), making otherwise strong restoration projects hard to launch and sustain.

Despite the challenges, FLR and carbon-based FLR can be a key market mechanism that can finance restoration, incentivize ecosystem services, and reward producers for supporting deforestation-free and climate goals. For this measure to be replicable and successful, it is essential to expand training and technical support for farmers while ensuring there are guaranteed incentives. As FLR projects have high potential to serve adaptation, integrating carbon-based restoration projects into landscape-level initiatives can also strengthen and support restoration outcomes (Antonioli, n.d.; Gehrig-Fase et al., 2021).

3.4 Adapt: Ensuring long-term sustainability

Adapt in the SRVC framework refers to long-term transformation, such as changes in production systems, landscapes, and business practices, that embed resilience and keep deforestation risks from recurring. Adapt focuses on establishing farming systems that integrate and protect forests (e.g., agroforestry), strengthen livelihoods and climate resilience, and ensure durable, forest-positive outcomes across value chains. To illustrate how the selected VSSs operationalize Adapt, we map a subset of their requirements against indicators (Table 6) that capture this long-term improvement.

Table 6. VSSs' requirement coverage related to Adapt

Indicators	Fairtrade	FSC	ARSO	PEFC	Rainforest Alliance	RSPO	ProTerra
Forest conservation to maintain ecosystem health and long-term sustainability of forests	✓	✓	✓	✓	✓	✓	✓
Long-term objectives to ensure sustainable use of all resources in the forest area	✗	✓	✓	✓	✗	✗	–
Integrating improved farming practices like agroforestry	✓	–[a]	–[a]	✗	✓	✗	✗

✓ Covered – Partly covered ✗ Not covered

Source: Authors.

Note: [a] Multiple-use forest management.

Adapt captures long-term transformation, such as production and management changes that can facilitate forest-positive outcomes. Most of the selected VSSs include requirements for forest conservation that can support ecosystem restoration and improvement in

ecosystem health. Across agriculture standards, Adapt requirements seek to keep trees in farming systems, protect conservation areas with periodic reviews, institutionalize risk-based plans with buyer support, and provide general provisions related to biodiversity protection. For example, RSPO has requirements for HCV/HCS identification and protection, plus an integrated management plan with monitoring and 5-year reviews. ProTerra has requirements to protect legal reserves/conservation areas, and to restore or legally compensate if degraded. These compliance requirements can facilitate resilient landscapes that are less prone to future deforestation.

The forestry schemes (FSC, PEFC, and ARSO) cover forest conservation and have long-term goals that ensure the sustainable use of forest resources. They have requirements related to forest management plans, improvement of forest health, and practices such as silviculture. For example, PEFC requires "that the quantity and quality of the forest resources and the capacity of the forest to store and sequester carbon shall be safeguarded in the medium and long term by balancing harvesting and growth rates, using appropriate silvicultural measures and preferring techniques that minimise adverse impacts on forest resources" (PEFC, 2018, p. 17) and "that health and vitality of forest ecosystems shall be maintained or enhanced and degraded forest ecosystems shall be rehabilitated wherever and as far as economically feasible, by making best use of natural structures and processes and using preventive biological measures"(PEFC, 2018, p. 19). ARSO (forestry) adds practical measures: species identification, preventive biological measures, evidence that the structure of the vegetation is not changing irreversibly, and in-unit conservation areas maintained for future regeneration. These requirements, in theory, facilitate adaptation by ensuring the forest's structure and functions persist.

Some VSSs also integrate sustainable agricultural practices as a structural shift in production practices that can facilitate adaptation. For example, Rainforest Alliance mandates natural vegetation cover, requiring at least 10% of the farm area to be vegetated for farms with non-shade-tolerant crops and 15% for those with shade-tolerant crops, expecting diversified agroforestry for shade crops. Fairtrade mandates risk-based prevention/mitigation plans (with buyer support) that promote agro-ecological practices and agroforestry. Among the forestry schemes, FSC and PEFC encourage multiple-use forest management but do not mention practices such as agroforestry on farms. These nature-based measures can support adaptation by stabilizing soils, regulating water, diversifying income, and maintaining tree cover within production systems, helping landscapes absorb shocks and reducing pressure to convert new forest into agricultural or production lands.

Most VSSs included in our analysis have forest conservation requirements, and forest-based ones have provisions for long-term sustainable use of forest resources. The opportunity is now in ensuring that these provisions are maintained in practice and monitored for their effectiveness—for instance, making sure set-asides are actively managed and periodically checked, with results feeding back into management plans. There is also an opportunity to scale tree-integrated production and other farming practices that can support ecosystem health while ensuring practical producer support (training and accessible finance).

Beyond Requirements for Adapt

Landscape Approaches and Collective Action

Landscape and jurisdictional approaches go beyond plot-level interventions and expand benefits to other areas and stakeholders. These approaches aim to integrate diverse land uses, involve multiple stakeholders, and drive system-wide improvements in forest governance and climate resilience (Reed et al., 2015; Turley, 2016; Waeber et al., 2023; WWF, n.d.). These approaches support adaptation by aligning farms, forests, and public land under one plan, assigning conservation areas, restoration, and climate-smart production so risks do not simply leak to neighbouring areas. Shared governance and monitoring create consistent rules and incentives across actors, unlocking blended finance and enabling landscape-scale buffers (e.g., riparian corridors) that stabilize water, soils, and habitats. In short, they turn isolated practices into resilient combined land-use measures, making the whole system better able to absorb shocks and avoid renewed deforestation.

RSPO is an example of a VSS integrating landscape and jurisdictional approaches. In 2015, RSPO piloted jurisdictional certification in the Seruyan district of Central Kalimantan, Indonesia, to address extensive land-use change at scale in a region where oil palm concessions had driven deforestation. This initiative introduced regional regulations for HCV protection, FPIC, land conflict resolution, and Indigenous rights (Padmanaba et al., 2023; RSPO, 2015a). Corporate actors including Unilever backed these efforts through landscape restoration and sustainable sourcing strategies, such as farmer training, restoration programs, and sourcing commitments (CGF, 2022). As a result, Seruyan completed Stage 1 of the RSPO Jurisdictional Approach, covering policy reforms and mapping smallholders and certified groups across the district as of November 2023 (Sertifikasi Yurisdiksi Kabupaten Seruyan, 2023). In Central Kalimantan, this translated into training for more than 254 smallholders, the certification of 1,000 farmers, and the planting of 23,000 trees (CGF, 2022).

Another example is the work done by Rainforest Alliance. In Cameroon, Rainforest Alliance projects in Mount Bamboutos, Mount Bana, and forests across the country's Western Highlands and South Region have focused on community-based landscape management and inclusive governance, to tackle regulatory, institutional, and knowledge barriers (Rainforest Alliance, 2020). The project seeks to secure legal protection for 7,600 hectares of key biodiversity areas, creating community-led landscape management plans covering 53,000 hectares and promoting sustainable farming practices, such as mulching, tree planting, and integrated pest management, to improve yields, soil health, and watershed protection while offering economic incentives for forest conservation (Rainforest Alliance, 2020).

Rainforest Alliance, together with Olam Ghana, Partnership for Forest, the Ghana Cocoa Board, and the Forestry Commission, has also piloted technology-driven approaches in cocoa forest landscapes in Ghana through the Tech4Communities Hybrid Community-Based Monitoring System using the Forest Watcher Mobile App (Ghana News Agency, 2022; IDH, 2018a; ISEAL, n.d.; Rainforest Alliance, 2019). This project connected fragmented forest reserves to create a corridor spanning more than 12,700 km², safeguarding 97,612 ha of forest reserves, trained more than 9,000 cocoa farmers to digitize farm data, and empowered communities to use mobile and satellite tools for forest monitoring for risk of deforestation

and landscape-level decision making, facilitating long-term resource management (Ghana News Agency, 2022; IDH, 2018a; Rainforest Alliance, 2022a).

These examples and evidence suggest that landscape approaches encourage collaboration across governments, companies, and communities for integrated landscape governance, which can support combining resources to achieve deforestation-related and other sustainability goals (CGF, 2025; IDH, 2018b). They can deliver successful approaches for adapting to the risk of deforestation by ensuring engagement and willingness from multiple actors, providing social benefits to locals, and reducing deforestation pressures through improved agricultural practices, strengthened community governance and ownership, and enhanced livelihoods.

However, given the complexity of such landscape approaches, implementation can be challenging (Waeber et al., 2023). Landscape approaches may take more time to deliver results, making benefits available only in the long term, and scaling beyond the initial pilot area can be difficult because governance is fragmented (overlapping agency mandates, unclear tenure, uneven coordination capacity) and political will varies by district/province (shifting priorities, budgets, and leadership across administrations), which can stall permits, plans, or enforcement (Schütz, 2019; Stickler et al., 2020). The success of these activities also hinges on the absence of other conflicting objectives in the area (e.g., expansion of agriculture) and the willingness of local actors to collaborate (Schütz, 2019). This means that for landscape approaches to be successful and to maintain the interest of local actors, some short-term benefits that the communities can leverage may need to be considered. Keeping the approach and strategy dynamic and allowing for continuous adaptability are also key to ensuring the long-term success of such methods.

While VSSs provide structured approaches to sustainability, private sector actors use other tools as well, adopting complementary forest-risk mitigation strategies across their supply chains. Building on the VSS analysis, the next section explores how companies are responding to deforestation risks through procurement policies, monitoring systems, supplier engagement, and landscape-based initiatives, highlighting innovative practices that contribute to SRVCs.

3.5 Summary

Table 7. How VSSs go beyond compliance requirements

SRVC category	VSS activities outside of compliance requirements
Plan/Prepare	Leveraging satellite imagery to prevent deforestation: Collect farm geolocation to spot clearing early, take action, and prevent future deforestation. Tapping into the power of community forestry: Strengthen community, improve land tenure, governance, and monitoring so local actors take ownership of land and are motivated to prevent conversion and manage forests sustainably.
Respond	Responses are primarily confined to required audits of VSS-compliant practices/establish corrective action plans
Recover	Carbon-based forest landscape restoration: Use voluntary carbon projects to finance site-level replanting/rehabilitation.
Adapt	Landscape approaches for sustainable land management and collective action: Coordinate various stakeholders, such as communities involved, local government, NGOs, and private sector actors, to ensure long-term, forest-positive land use in farming systems.

Source: Authors.

4.0 Private Sector Approaches to Addressing Deforestation

With concerns around deforestation growing in recent years, many companies have publicly committed to eliminating deforestation from their supply chains. For example, 61 meat and soybean purchasing companies (including Ahold Delhaize, Marks & Spencer, METRO, Tesco, McDonald's, Nando's, Unilever, and Walmart) in Brazil have committed to combating deforestation in the Cerrado (WWF, 2018b). In another example, about 1,000 companies disclosed their deforestation management practices through CDP reporting in 2022; this was a 300% increase over 2017 (CDP, 2023).

Little evidence is available on the actions taken to operationalize these commitments, however. The 2024 Forest 500 Annual Report, for instance, highlighted that 63% of the companies had at least one commitment related to forests, but failed to provide any evidence of implementation (Global Canopy, 2024). Further, of the 1,000 firms reporting in CDP and recognizing risks, only 12% monitor their deforestation/conversion footprint, 31% have board-level oversight of forest-related issues, and just 3% are conducting comprehensive forest-related risk assessments, including mapping suppliers (CDP, 2023). This inaction threatens sustainability goals and signals that voluntary action alone may not be sufficient to drive systemic change.

At the same time, some companies are innovating and adopting various techniques beyond sourcing VSS-compliant products, such as satellite monitoring, ecosystem restoration, payment for ecosystem services (PES), nature-based solutions, and landscape-level collaborations, to address deforestation in supply chains. To understand and highlight these innovative and successful practices adopted by the private sector, this section examines how private sector actors operating with deforestation-risk commodities address deforestation practices using the Framework: Building SRVCs (Figure 1). The analysis is based on interviews with selected firms and publicly available information, where each measure is assessed for its contribution to the respective pillar of the SRVC framework and its ability to be used by other actors to meet their goals related to forests.

The company initiatives presented in this section are illustrative examples of approaches used today to address deforestation risk. We have not independently assessed their impacts, reliability, or effectiveness. Evidence is drawn from publicly available sources and interviews. Separate, dedicated research would be required to provide assessment of impacts, effectiveness, and reliability.

4.1 Plan/Prepare: Foundation for risk reduction

Private sector actors typically engage in risk assessment, supplier mapping, incentives for farmers, and traceability investments to prevent deforestation. These early interventions serve as important tools for anticipating and preventing the risk of deforestation and developing strategies to address those risks and the potential adverse impacts of companies' operations. Much of the recent development in preventive strategies is also linked to companies managing

reputation risks and remaining competitive, for instance, by ensuring compliance with mandatory sustainability regulations such as those of the EUDR.

Leveraging Technology for Improving Traceability to Prevent Deforestation

Companies that operate in deforestation-risk commodities are increasingly integrating advanced technologies, such as geospatial tools that, for example, collect farm-level geolocation data or provide high-resolution satellite monitoring for farms, into their supply chains to monitor deforestation risk in or near the farms from which they source. Companies can use platforms such as Global Forest Watch Pro to conduct geospatial analyses, comparing farm locations with satellite data to determine whether specific sites are linked to deforestation. Some platforms also provide near-real-time alerts. By combining real-time data with available contextual information, such as past clearing and protected area maps, they can anticipate where forest clearing is expected to happen or where hotspots exist (GFW, n.d., 2016; Satelligence, 2020; World Resources Institute, 2019). This can support the development of targeted interventions in supply chains.

One example is the use of polygon mapping, where exact farm boundaries are mapped using geospatial coordinates or geolocation. This enables companies to conduct precise deforestation risk assessments by monitoring land use changes at the plot level, using satellite imagery over time through various geospatial analysis tools (ArcGIS Pro, n.d.; Baldwin, 2023; Cox, 2024; *GIS Dictionary,* n.d.; TraceX, 2023). Cargill, for instance, reports having applied polygon mapping across 153,000 cocoa farms in Côte d'Ivoire and Ghana, covering 951,000 acres. Using GFW Pro, Cargill highlights having identified areas of remaining forest, monitored risk of deforestation, and ranked cocoa sourcing structures based on risk, reporting 100% traceability in Ghana and 74% in Côte d'Ivoire (Kolling, 2020). Ferrero reports having applied polygon mapping to assess 460,000 hectares, mapping 200,000 farmers, and reporting 93% traceability to farm level, with 97% of its cocoa supply chain reported as deforestation-free in 2022 and 2023 (Ferrero, 2024c, 2024a).

Polygon mapping can improve product traceability, as having exact farm boundaries (polygons) means companies can link a product to a real place on the map. These polygons are usually given an ID or a number and stored in whatever system the company uses to keep shipment records that contain products produced on the farm whose polygon is collected. As products move through the chain (for example, from farm to mill to processor to buyer), this ID appears on various bills, invoices, etc., making it possible to link shipments back to the originating polygons and allowing for satellite checks with product claims (e.g., deforestation-free), thus supporting product traceability. However, collecting those data may also be resource-intensive. It can also require regular updating for verification, as boundaries may change due to land disputes or expansion, which can make the data invalid. Lastly, as explained above, polygon data alone do not indicate whether deforestation has occurred and need to be analyzed and combined with other information, including satellite imagery monitoring and geospatial analysis tools, such as GFW Pro, to determine if deforestation occurred.

Blockchain is also being used to prevent deforestation. This is a shared tamper-proof digital decentralized database or ledger that stores information about who did what (EU Blockchain Observatory and Forum, n.d.). Companies can record key facts, such as farm ID and geolocation, proof of ownership, harvest date, deforestation-free certificates, product description (e.g., crop, volume) and each custody step, so every move in the value chain is, in theory, traceable (Fraunhofer Institute for Material Flow and Logistics, n.d.; Kaur, 2024; Stopfer et al., 2024; World Economic Forum, 2021). Similarly, Unilever, for example, piloted SAP's GreenToken[9] blockchain tool in Indonesia to source more than 188,000 tonnes of oil palm fruit (Unilever, 2022). GreenToken can be used to manage mass-balance or segregated accounting and can support suppliers to create digital tokens that mirror the material flow of the palm oil at each transaction in the value chain. This means that for every unit of palm fruit/oil that moves along the value chain, a matching digital token is created and passed along the value chain as the material is bought, sold, or mixed. The token allows tracking attributes related to the palm oil's origin (e.g., which supplier/area it came from, sustainability attributes such as deforestation-free production) (SAP, n.d.-a, n.d.-b, n.d.-c; Unilever, 2022). Unilever says the GreenToken tool helped it track, verify and report in near real time the origins and journey that palm oil takes through its long and complex supply chain (Unilever, 2022).

Luker Chocolate, a Colombian chocolate *manufacturer,* for example, expanded traceability in its cocoa supply chains through a partnership with Trusty-Agrifood Supply Chain Management,[10] to create LukerTrace, its traceability platform. They carried out a pilot to integrate blockchain technology into this system, but it was not successful as farmers did not have internet to validate their information into the platform- indicating limitations of this technology (Luker Chocolate, personal communication, November 19, 2025).

Blockchain's advantages include its resistance to tampering as records are securely stored and difficult to alter, and the ability to provide real-time traceability as products pass through value chains, as explained above. However, there are challenges in its implementation as the standards for developing the ledger are not yet fully mature, and the forest industry will need to shift to digitization and automation (e.g., e-documents, GPS locations) to feed into the ledger—barriers that are especially significant in small-holder-dominated and under-resourced areas (FAO & International Telecommunication Union, 2019; Howson et al., 2019; Stopfer et al., 2024). Costs, weak or no Internet connectivity, and limited technological capacity make using blockchain tough in such areas, and if the data entered are poor, even if the ledger is tamper-proof, the results will be poor and not useful, i.e., "garbage in, garbage out." To scale the use of blockchain effectively, companies could align their systems with industry-wide standards, integrate blockchain with other traceability tools (e.g., polygon mapping, satellite imagery), and provide training and support to suppliers in resource-constrained contexts.

These examples illustrate the capacity of the private sector actors to lead the development and use of tools that can improve traceability and strengthen monitoring to prevent deforestation. Technology-based instruments can provide companies with early warnings. However, these solutions are resource-intensive and may come at a higher cost, need advanced infrastructure, and may depend on the ability of producers/supply chain actors to use the technology or

[9] More information on Greentoken is available at https://www.sap.com/products/scm/green-token.html

[10] https://www.trusty.id/

provide necessary data for successful use of the technology. Smallholders in particular may need more support to implement such technologies and provide the information required to monitor and prevent deforestation successfully.

To strengthen and broaden the use of technology for deforestation prevention, companies must work to reduce costs, offer support to actors to implement the technology, and combine technological monitoring with stronger farmer support programs, including training and financial incentives for best practices being implemented by farmers. This will ensure that traceability systems are inclusive and effective in preventing deforestation risks across GVCs.

Financial Support and Incentives for Farmers

Providing financial incentives is one of the strategies to promote sustainable agricultural behaviour among farmers, including preventing deforestation (Oranu et al., 2025; Piñeiro et al., 2020). Financial benefits can motivate farmers to protect forests, as their livelihoods are secure and linked to sustainability outcomes. Most often, these initiatives combine environmental goals, such as addressing the risk of deforestation, with efforts to improve farmers' livelihoods by increasing productivity and their resilience.

One such incentive provided by companies is PES, which is "voluntary transactions in which payments are received for the provision of well-defined ecosystem services" (United Nations Convention to Combat Desertification, n.d.). These financial transfers are made to farmers or landowners and function like other market-based instruments, such as subsidies (Fripp, 2014; International Institute for Environment and Development, n.d.; Sarmiento et al., 2024). For example, under the Cocoa and Forests Initiative program, Ferrero enrolled more than 9,500 cocoa farmers in a PES scheme in Côte d'Ivoire and Ghana, providing them with financial incentives, training, tools, and fertilizers to support deforestation prevention and sustainable land use (Ferrero, 2024c). The scheme was focused more on enabling sustainable behaviour among producers than strictly tying payments to ecological outcomes.

While PES is very promising in terms of incentivizing farmers to reduce deforestation, it may not apply in all situations, such as in areas where land rights/tenure are not well defined or where there is complex local governance that makes it difficult to engage with the right actors and enforce agreements. Thus, social context—like local norms, competing land rules, and trust in implementing institutions—also plays a key role in developing a successful PES program (Intergovernmental Science-Policy Platform on Biodiversity & Ecosystem Services Secretariat, 2017). Evidence of how long PES benefits last is mixed. Some studies indicate that the duration of PES contracts affects benefits, which may only last as long as payments are being provided to the farmers, and that the effects fade once payments stop (Charoud et al., 2023; Kemigisha et al., 2023). To make PES schemes more successful, companies can link them with complementary livelihood support programs (e.g., support with agricultural inputs) and align payments with socio-economic benefits, such as land rights, so benefits can continue beyond the initial contract time.

Another form of financial support is offering producers low-interest loans and financing options tied to sustainability commitments. These financial instruments reward farmers who meet specific environmental criteria, such as maintaining deforestation-free operations, with

favourable credit terms. Favourable credit terms and access to funding help farmers pay the costs associated with better agricultural practices (such as buying new seedlings and setting up agroforestry systems) and create opportunities to add new income streams (e.g., via shade-grown crops) so they are not forced to clear forests to get more land to stay profitable.

An example of this is the Responsible Commodities Facility Cerrado Programme, launched in 2022 by Tesco, Sainsbury, and Sustainable Investment Management to promote the production of deforestation- and conversion-free soy in Brazil's Cerrado region. Under the program, low-interest rate loans are given to medium-sized to large soy farms that commit to zero deforestation of native vegetation. The initial round of this first-of-its-kind financing mechanism was financed via green bonds listed on the Vienna Stock Exchange and purchased by Tesco, Sainsbury's, and Waitrose. The raised funds were allocated as low-interest loans to compliant farmers. In its first year, the Responsible Commodities Facility disbursed USD 11 million in loans to 32 farms, report 42,000 tonnes of deforestation-free soy and conserving some 8,500 ha of native vegetation (CGF, 2023a; Sustainable Investment Management, 2023b). Compliance was continuously monitored and independently verified in each crop cycle (Sustainable Investment Management, 2023a).

Ferrero established Village Savings & Loan Associations in Ghana and Côte d'Ivoire that are essentially self-managed savings groups that help households build savings and access small loans. They report that these associations have enabled income-generating activities and financial access for cocoa producers. Ferrero reported having 1,700 active associations with 46,000 members—72% of whom are women—who saved EUR 3.8 million between 2022 and 2023 and, of that amount, members loaned EUR 2.5 million for various purposes (Ferrero, 2024b). The company reported that almost 27,000 people benefited from financial products and services, and 26% of the farmers received their sustainability premium (paid on top of the commercial price) digitally (Ferrero, 2024b).

Incentive mechanisms have advantages as they improve farmers' access to credit, enabling sustainable investments and reducing their reliance on unsustainable land-use change for income, thereby giving farmers tangible financial benefits to prevent deforestation. However, barriers include the possible exclusion of smallholders who lack formal documentation, challenges in scaling up community-based models such as Village Savings & Loan Associations, and risks of reinforcing inequalities when financial literacy or collateral are prerequisites for participation. The effectiveness of such schemes depends on their design, transparency, equitable access for all producers, and strong monitoring systems that can show measurable conservation outcomes (Fairtrade & KIT, 2024). Ensuring that schemes are designed considering the local context and that smallholder farmers have equal access to these funds and the capacity to implement conservation activities is critical (Bond et al., 2009; Oranu et al., 2025; Piñeiro et al., 2020). Partnerships with local financial institutions and governments could also expand scale and sustainability. This can enhance the potential of incentive mechanisms to prevent deforestation risks across value chains.

4.2 Respond: Accountability and compliance mechanisms

Private sector actors engage in various response strategies that are helpful when deforestation has already occurred. These measures help manage immediate impacts and limit further deforestation, typically once deforestation or its risk has been detected, for example, via monitoring, third-party audits, or media accusations. Companies operating in deforestation-risk commodities respond to deforestation by initiating corrective actions, boosting traceability and transparency, changing suppliers, and shifting to ones committed to avoiding deforestation. Activities that further recovery often follow up/complement response strategies (as illustrated in the section on Recover below).

Strengthening Supply Chain and Sourcing Policies

Strengthening sourcing requirements and supplier engagement policies has become a central strategy for private sector actors to respond to deforestation risks in their supply chains. Many companies have supplier codes of conduct, with monitoring and non-compliance protocols that vary in strictness (Nowicki et al., 2022). When deforestation occurs or companies become aware of such cases, they may fortify these policies and take corrective action or, in some cases, suspend relationships with non-compliant suppliers. Most companies also respond to deforestation by including "no-deforestation" supplier requirements, meaning they source from suppliers not associated with deforestation.

Wilmar International, for instance, a leading palm oil trader, has implemented a No Deforestation, No Peat, No Exploitation (NDPE) policy since 2013. However, following claims by Greenpeace in 2018 that the company was not respecting this policy, Wilmar extended its scope to include third-party suppliers and reports to have halted sourcing from non-compliant suppliers, backed by a public grievance process (Reuters, 2018; Wilmar International Limited, 2018). Companies can use information gathered via satellite monitoring and related technologies to check where deforestation occurred and prepare response actions. For example, Mondelēz International uses satellite monitoring to monitor its palm oil supply chains through Satelligence. As of October 2023, Mondelēz reported coverage of 90% of the palm oil mills from which it sources. When a satellites detects deforestation, Mondelēz starts a "suspend and engage" process for the mill(s) where the alert occurs, so affected suppliers are engaged to collaborate and fix the issue (CGF, 2023b; Satelligence, n.d.). JBS, a major meatpacker from Brazil, is also using satellite technology to enhance supplier compliance by monitoring cattle ranching, a major driver of deforestation. JBS uses satellite imagery, geo-referenced data, and government databases to monitor its direct suppliers and reports having blocked nearly 13,000 potential supplier farms in Brazil that were deemed non-compliant with its deforestation-free sourcing requirements since the program began (JBS, n.d.).

These examples show that sourcing and supplier policies, when supported by robust monitoring technologies, can improve companies' ability to respond to deforestation. The advantages include having clear expectations for suppliers, deterrence via the suspension route, and enhanced verification of deforestation-free sourcing. However, the effectiveness of these policies and actions depends on consistent enforcement across the value chain

and extending the scope to indirect suppliers, transparency in grievance handling, and supporting suppliers and farmers to comply. Poorly designed policies can unintentionally exclude smallholders, as they may not be able to prove deforestation-free commitments due to technological challenges or unclear land tenure, which could deter risk-averse buyers from purchasing from them.

For these policies and initiatives/actions to succeed, companies can integrate them more transparently and put in place complementary measures, such as technical assistance and incentives to help farmers and vulnerable stakeholders overcome deforestation challenges so they are not excluded from value chains.

Conducting Audits in Response to Deforestation

Conducting audits is a key part of managing and mitigating deforestation and a central response measure. An independent audit can help in reviewing a company's sourcing policies and supplier control to check for sustainability risks, e.g., deforestation risks, find the root causes, and suggest corrective action, all of which, if done correctly, increase transparency and accountability across the value chain (Eurofins, n.d.; European Commission, 2019; Global Inspection Managing, 2023; Institute of Environmental Management & Assessment, 2020).

One example of how audits can be used to tackle deforestation is found in Brazil's beef industry through the Terms of Adjustment of Conduct or the TAC da Carne agreement, a legal settlement requiring slaughterhouses to audit cattle purchases and to monitor and verify their suppliers to exclude those associated with illegal deforestation. Companies such as JBS have reported measurable improvements because of this. JBS reported a decline in non-compliant suppliers, reporting only 4% of audited supply chains containing irregularities in 2022, compared to 52% among unaudited companies. In Para, home to Brazil's second-largest cattle herd, JBS reported 3% of non-conformity in cattle purchases, an improvement since a 2020 audit found 32% of its supply came from farms violating environmental regulations, such as those against illegal deforestation (Maisonnave, 2025; Mano, 2025). These audits may have supported reduced sourcing from deforestation-linked farms and helped identify hotspots of non-compliance where further interventions were needed, though the issue of indirect suppliers (cattle through intermediaries) remains a key gap (Amigos da Terra, 2024).

When these audits are conducted independently, they can increase accountability in value chains and support companies in acting against suppliers engaged in deforestation. When combined with clear enforcement measures, such as suspending or remediating non-compliant suppliers, audits can provide a strong deterrent against deforestation.

Audits must, however, be extended to indirect suppliers, as that is where most leakage is expected to occur. Audits often overlook indirect suppliers because audit systems typically trace direct contractual relationships, which do not extend to upstream suppliers lacking formal agreements. Additionally, records are usually incomplete, products are mixed and rerouted through middlemen, and suppliers change frequently, making indirect suppliers fall outside of the audits' verifiable scope. This highlights the need for more comprehensive monitoring systems. Audits can also be cost- and resource-intensive and are susceptible to human error and bias (Global Inspection Managing, 2023). For audits to be a successful

response mechanism, companies should ensure independent third-party organizations conduct them and that the results are combined with other tools, such as satellite monitoring, to capture high-risk areas and reduce human error. Companies can take corrective action based on audits, but they should also strengthen remedy pathways for non-compliant suppliers and give them necessary training and support.

4.3 Recover: Reforestation and ecosystem restoration

The private sector has adopted measures to recover and restore areas where deforestation has occurred. These measures typically involve identifying degraded or deforested areas using technology such as satellite imagery and AI, and implementing restoration strategies—for example, planting native tree species and promoting agroforestry practices.

Promoting Agroforestry Practices

Agroforestry is a widely recognized nature-based solution that, unlike monoculture, integrates trees or woody perennials with crops and/or livestock in spatial or temporal arrangements and provides environmental, social, and economic benefits (FAO, 2025a; High Level Panel of Experts on Food Security and Nutrition, 2017; Nair, 1993; Waldron et al., 2017). Companies are increasingly implementing and promoting agroforestry practices to strengthen resilience in their commodity supply chains as they can support the recovery of degraded lands and, in some cases, lead to successful adaptation.

One example of this is Unilever, which launched its Cocoa and Forests Initiative impact program in Côte d'Ivoire in 2021 to help smallholder farmers adopt agroforestry practices (Unilever, 2024). This combines training on climate-smart practices, such as natural pest control and pruning, with support for community-run nurseries that produce tree seedlings. Unilever says it has distributed and planted 286,277 multi-purpose trees across 2,048 farms under this project as of 2023, trained 16,808 farmers in sustainable cocoa practices, and supported the regeneration and restoration of 8,360 hectares of forest and farmland (Unilever, 2023). The company reports that farmers were trained in the restoration of targeted classified forests and their surrounding buffer zones (Center for International Forestry Research and World Agroforestry, n.d.). They are encouraged to select and plant various species, including shade trees, legumes that improve soil quality, and fruit trees that offer additional sources of income. Diversifying production and improving yields reduces the pressure to expand farmland into forest areas. The initiative also prioritized securing land tenure for farmers (Unilever, 2024), recognizing it as a critical driver of long-term commitment and investment in sustainable practices by fostering a sense of ownership.

Another example is Luker Chocolate, which reports training Colombian farmers in agroforestry techniques, encouraging them to grow other crops such as banana and fruit trees among their cocoa crops and native forest species (Luker Chocolate, 2023). The company notes that these activities can help improve biodiversity, carbon sequestration, and soil health (Luker Chocolate, 2025), combining environmental restoration with social and economic development in Colombian cacao-growing regions. The first agro-ecology work was done at a farm in Necocli, where 557 ha was planted on land that was once barren and used for cattle

grazing. Luker reports that the area became rich in biodiversity, with 480,000 cocoa trees from eight varieties and 329 species of animals and birds as of 2023 (Luker Chocolate, 2023).

Natura's SAF Dendê program in Pará, Brazil, is another example that demonstrates how multi-species agroforestry can be scaled in palm oil supply chains. Developed with Embrapa (the Brazilian Agricultural Research Corporation) and Tomé-Açu Mixed Agricultural Cooperative (CAMTA, a cooperative of agroforestry farmers in Pará), the program integrates palm oil production with diverse species, such as a mix of native fruit and timber. This method supports rebuilding canopy and habitat, stabilizing soils and slopes, improving water regulation, and accelerating natural regeneration (e.g., shade/nurse effects). Diversified harvests among farmers finance maintenance, so recovery persists. After more than 13 years of research and field trials to assess the feasibility of the proposed system, Natura began scaling the system, and reports that 400 ha has been converted to agroforestry by 2024 and it has established a long-term target of 45,000 ha by 2035. The initiative aims to ensure that palm oil sourcing aligns with RSPO and Union for Ethical BioTrade guidelines, allowing for audits of restoration plans, verified ecological outcomes, and opening access to responsible markets (Natura & Co, 2024).

These examples illustrate that agroforestry initiatives can be beneficial as they encourage forests and biodiversity restoration by creating habitat heterogeneity, enhancing soil fertility, supporting carbon sequestration, and improving microclimates supporting crop resilience (International Fund for Agricultural Development, 2025; Intergovernmental Panel on Climate Change, 2022; Santos et al., 2019; Sprenkle-Hyppolite et al., 2024). Agroforestry can thus contribute to the recovery of degraded land, enhance forest cover, and support more sustainable production models while helping farmers better understand the challenges posed by deforestation and unsustainable farming. It can also provide a diversity of income sources for farmers (International Fund for Agricultural Development, 2025). For instance, selling fruit reduces farmers' dependency on a single commodity and lowers the incentive to expand production into forest areas.

However, agroforestry has limitations due to the upfront costs needed for seedlings, training farmers, and labour (Endeki et al., 2025; Nkurikiye et al., 2024). In addition, economic returns can take years to materialize (FAO, 2022b). This, combined with insecure land tenure, can discourage long-term investment and planning among farmers. Scaling this method also depends on improving farmers' and smallholders' knowledge of tree-crop interactions and access to extension services. To make agroforestry initiatives successful in restoring degraded lands, companies must work with partners on the ground, promoting agroforestry systems that enable farmers to adopt improved agricultural practices that benefit both people and the environment. They must also provide long-term financial incentives, support securing land tenure for farmers, and invest in capacity building.

4.4 Adapt: Systemic change and long-term resilience

To address deforestation in a more integrated, long-term way, private sector actors are increasingly engaging in systemic approaches that go beyond isolated supply chain measures. Private sector strategies to support adaptation emphasize collective action, coordinated governance across multiple actors, and shared responsibility for preventing forest loss and promoting long-term recovery by building the strengths of local actors.

Landscape Interventions

Landscape interventions go beyond plot-level measures and are typically defined as collaborative efforts among multiple stakeholders, such as companies, governments, civil society, and local communities, to achieve sustainable land use that balances production, conservation, and livelihoods within a defined geographic area (Reed et al., 2015; Turley, 2016; Waeber et al., 2023; WWF, n.d.). This approach recognizes that the drivers of deforestation extend beyond individual sites and require coordinated, multistakeholder engagement to design and implement effective solutions (FAO, 2025b). Many landscape interventions have manifested as public–private partnerships, achieving systemic change in tackling deforestation, as they leverage the complementary strengths of different actors to create enabling environments for sustainable supply chains (Mishenina & Dvorak, 2022).

An example of this approach is one adopted in Brazil's Cerrado biome by Carrefour Foundation, METRO, Nestlé, and Conservation International, members of the FPC.[11] They supported a landscape initiative in Tocantins, promoting deforestation-free soy and beef production by helping farmers adopt low-carbon and deforestation- and conversion-free agriculture practices with training on no-tillage systems, integrated crop-livestock models, and pasture restoration. The program also promoted agricultural production on degraded pasturelands to improve land-use efficiency and conserve natural capital, while also strengthening access to climate finance through awareness building, training, and collaboration with local financial institutions. The CGF reports that 53 rural producers and 40 extension professionals were trained in 2022 on implementing low-carbon regenerative farming practices in soy and beef, covering close to 60,000 hectares (CGF, 2023b).

Similarly, in Indonesia, the Riau Landscape Initiative, led by the Earthworm Foundation in collaboration with Reckitt, Nestlé, Givaudan, Walmart, Target, and Colgate-Palmolive, says it has embedded NDPE commitments into district-level spatial planning (which usually allocated HCV or other protected areas where conversion is not allowed) and regulations (such as no burning and community monitoring). The partners report that 307,077.62 ha of forest have been protected, with 304,077.62 ha protected by village regulations and 3,000 ha protected inside concessions. The project says it has supported more than 900 farmers in adopting good agricultural practices and best management practices (Bergeret, 2025)—a governance and practice shift that strengthens climate resilience and supports adaptation.

[11] The FPC is an initiative of the CGF that aims to drive collaborative, transformative change to remove deforestation, forest conversion, and degradation from key commodity supply chains and support forest-positive businesses. More information is available at https://www.theconsumergoodsforum.com/planet/forest-positive/about/

Both of these examples show how the private sector can pair change at the farm level (soil cover, integrated systems, restoration of degraded lands) with rules and monitoring at the landscape level (plans, village regulations, periodic reviews), creating conditions that lower conversion risk, stabilize soils and water, and maintain forest connectivity in the long term. The benefits of landscape interventions, evident in the examples above and extant research, are that they enable collaborative, jurisdictional-level solutions to deforestation, where stakeholders work together and combine resources to achieve deforestation-free goals (CGF, 2025; IDH, 2018b). They create synergies between protecting forests, livelihoods, and climate resilience by delivering approaches that can successfully support adapting to the risk of deforestation, providing social benefits, and reducing deforestation pressures through better agricultural practices and socio-economic benefits.

However, implementation of these interventions can be challenging due to the complexity and the requirement of significant coordination across diverse actors, often leading to governance challenges and slow decision making (Reed et al., 2015; Ros-Tonen et al., 2018; Schütz, 2019; Stickler et al., 2020). There may also be a risk of power imbalance where larger corporate actors dominate decision making (Ros-Tonen et al., 2018), potentially not considering smallholder interests. Monitoring and attribution of impacts at the landscape scale can be difficult, given that some results may take longer, making it harder to link private investments to measurable deforestation reduction. Lastly, the interventions may be challenging to sustain beyond the funding period if incentives are not ensured for local actors such as farmers.

To make landscape interventions successful public–private partnerships, companies can ensure their proposed activities align with local contexts and national forest and land-use plans. They can invest in capacity building for government agencies and farmer organizations to sustain programs beyond corporate timelines. In addition, incentives for local actors can boost willingness to collaborate, and companies can ensure equitable benefit sharing, prioritize smallholder participation, and access to resources.

4.5 Summary

Table 8. Private sector practices and initiatives

SRVC category	Measures undertaken by private sector actors
Plan/Prepare	Leveraging technology to prevent deforestation: Mapping supplier farm polygons and detecting deforestation risks via satellite imagery; using blockchain or mass-balance tokens to carry origin attributes through mixing and keeping claims tied to source plots. Financial support and incentives for farmers: Provide low-interest loans or performance-based payments that fund replanting, buffer restoration, and verified remediation, and avoid future deforestation.
Respond	Strengthening supply chain policies: Apply clear NDPE rules, suspend non-compliant suppliers, and require time-bound recovery plans. Conducting audits: Launch risk-triggered audits and field checks on flagged suppliers, verify, and have defined follow-up action plans.

SRVC category	Measures undertaken by private sector actors
Recover	Agroforestry-based remediation: Reintroduce tree cover on degraded/converted plots (e.g., multi-species systems) to rebuild canopy, soil, and water functions.
Adapt	Landscape interventions: Work together with other actors to scale integrated crop–livestock, pasture restoration, and agroforestry so tree cover and soil health persist over time and reduce re-clearing pressure; embed no-deforestation and conservation set-asides in local plans and village bylaws, with shared monitoring and review cycles.

Source: Authors.

5.0 Smart Mix of Solutions to Advance Sustainable and Resilient Value Chains

Value chain actors, producers, and other actors are increasingly adopting a "smart mix" of solutions that combines certification schemes with complementary approaches, such as landscape interventions and multistakeholder partnerships to address the various drivers of deforestation in complex global supply chains. While certification continues to serve as an important entry point for firms seeking to demonstrate compliance with their deforestation-related commitments, its limitations and challenges have prompted companies to move beyond certification alone. The smart-mix approach allows businesses to integrate compliance mechanisms with broader, context-specific strategies that enhance resilience in supply chains, transparency, and long-term sustainability (Schleifer & Fransen, 2024).

Several companies illustrate how this approach is being operationalized in practice. Ferrero, for example, says it has sourced 100% RSPO-certified segregated sustainable palm oil since 2015, achieving this milestone a year ahead of its target. However, recognizing the limitations of certification alone, Ferrero launched a Palm Oil Charter to address some of the root causes of deforestation, covering three topics: human rights and social practices, environmental protection and sustainability, and supplier transparency (Ferrero, n.d.). The charter requires suppliers to adopt practices that can help address deforestation, such as respect for land rights and FPIC in any land acquisition to reduce land-use conflict; and strengthens supplier transparency via full traceability to plantations and satellite verification of no-deforestation in HCV/HCS areas (Ferrero, 2023). While certification added a baseline, the charter adds issue-specific commitment and enforcement across suppliers.

Another example from the palm oil sector is Unilever, which supplements RSPO certification with jurisdictional engagement through the Mosaik Initiative, in partnership with Inobu (Kaleka) and local district governments. The program complements traditional certification by embedding it within a broader landscape approach, working with local governments and communities on governance reforms, smallholder mapping/training, and restoration/conservation at the landscape scale. Unilever reports that as of 2023, nearly 1,900 farmers had been mapped, more than 1,000 certified under RSPO/ISPO, 254 smallholders trained, and 23,000 trees planted to restore degraded land (RSPO, 2015a; CGF, 2023a). Unilever says these interventions improved smallholder livelihoods and reduced the risk of forest fires and flooding, demonstrating how certification impacts can be strengthened when implemented alongside holistic, landscape-level strategies carried out in collaboration with local actors (RSPO, 2015a; CGF, 2023a).

The activities of McDonald's are an example in the soy sector. To address deforestation risks in soy supply chains, the company applies a mix of RTRS credits, ProTerra certification, and its own TraQtion traceability platform for sourcing soy for its chicken feed from high-risk regions (McDonald's, n.d., 2023). Through this approach, McDonald's aims to integrate VSSs' certification with internal monitoring and remediation systems that are tailored to high-risk sourcing areas to prevent deforestation.

These examples illustrate that smart-mix approaches can support companies in addressing deforestation and make supply chains more resilient by combining the value of certification with systemic interventions that address root causes and build on local needs and capacities—often in coordination with communities and local governments. Companies can use these approaches not only to achieve their deforestation-related goals but also to make their supply chains more resilient by supporting their value chain actors with socio-economic goals, such as tenure security and farmer livelihoods, and build credibility with stakeholders and consumers by demonstrating that sustainability efforts go beyond minimum compliance requirements. By combining VSS applications with flexible, context-based interventions, value chain actors are better equipped to manage deforestation risks and to strengthen the resilience and sustainability of their value chains. This blended approach reflects an important shift: from compliance-driven action to proactive investment in the long-term health of forests, communities, and nature. However, for smart-mix approaches to successfully address the drivers of deforestation, there needs to be a focus on collaboration among actors, incentivizing change or practices, and direct measures to address root causes and support smallholders.

Box 3. Regulatory frameworks and complementary tools: The case of EUDR

While many companies are doing more than adopting voluntary certifications and a smart-mix of measures to address deforestation risk, their efforts are being increasingly shaped by mandatory regulations such as the EUDR, which prohibits the import and export of forest-risk commodities in the EU market unless they are proven to be deforestation-free and legally produced (European Union, n.d.). This has created strong incentives for companies to enhance traceability, strengthen supplier engagement, and align their sustainability commitments with legal requirements.

To this end, public and private actors have developed many tools that companies can use in addition to certifications to strengthen forest monitoring and compliance capacities. For example, FAO has developed Whisp (an acronym for What is in that plot?), an open-source application programming interface that applies a convergence-of-evidence approach to geospatial analysis, helping firms determine land-use status against the EUDR cut-off date of December 31, 2020 (FAO, 2024a). Similarly, the International Trade Centre's Deforestation-Free Trade Gateway provides an integrated digital platform for data collection, mapping, and sharing across value chains, particularly to help smallholders and producers demonstrate compliance (International Trade Centre, 2025).

The Sustainable Agriculture for Forest Ecosystems project, co-funded by the European Union, the German Federal Ministry for Economic Cooperation and Development, and the Dutch Ministry of Foreign Affairs, is another example of work being done by public actors. The project promotes sustainable agrifood systems by supporting smallholders, strengthening local land-use governance, and facilitating access to green finance and digital infrastructure (Zero Deforestation Hub, n.d.). Complementing these initiatives, IISD's recent work provides an overview of emerging due diligence regulations, including EUDR, and interoperability among regulations, and identifies tools that can facilitate

compliance, particularly for producers and companies operating in high-risk supply chains (Verma, 2024; Verma & Sarmiento, 2025).

Together, these initiatives show how voluntary private sector action and mandatory frameworks are converging, providing a variety of tools to protect forests and boost the resilience of forest-based supply chains. For companies, this means that investments in traceability, landscape approaches, and community partnerships strengthen sustainability outcomes and prepare them to meet evolving regulatory requirements. To successfully use these tools at the farm level, it is important to lower the cost of compliance and increase interoperability. Companies can co-invest (with standards and public agencies) in open digital infrastructure and training so smallholders can meet plot-level proofing and documentation needs under regulations such as the EUDR and also ensure deforestation-free production.

6.0 Conclusions and Recommendations

Agricultural expansion is one of the main drivers of deforestation, especially for forest-risk commodities such as soy, timber, and palm oil. Addressing deforestation can be complex, and effective solutions may require coordinated action among stakeholders. While VSSs have been one of the tools that value chain actors use to address deforestation, their results are mixed, and they continue to evolve and innovate. At the same time, firms are increasingly piloting innovative methods that may complement or go beyond certification and address drivers of deforestation.

On the VSSs' side, our analysis indicates that most schemes now embed ex-ante measures, including risk assessments before expansion of agricultural land, cut-off dates beyond which no deforestation is allowed, and (in some cases) geospatial data requirements—all measures that align well with the SRVC framework's Plan/Prepare stage. In general, prevention is the strongest pillar among VSSs' requirements, but opportunities remain for VSSs to integrate digital monitoring tools into their requirements and expand support for smallholders to use these technologies, while also improving FPIC requirements. Deforestation-specific response pathways are less common in VSSs because conversion after the specified cut-off date is often ineligible for certification, which limits remedial responses when deforestation has already occurred. However, some standards have provisions to implement deforestation-specific CAPs that can lead to the recovery of degraded lands.

Recovery (regeneration/rehabilitation and grievance channels) is present among standards but varies in scope: some VSSs set explicit, post-impact measures to be undertaken (e.g., natural/assisted regeneration with or formal remediation/compensation procedures), others express broader restore/protect natural areas intentions. All have broad grievance mechanisms but with limited, deforestation-specific remedies—an area in which VSSs can improve. VSSs have an opportunity to add in their requirements (where applicable) indicators to measure how restoration targets are met and verified over time. Where recovery actions do exist beyond VSSs' requirements, they can seed longer-term "adapt" outcomes, especially when linked to measures such as agroforestry.

Our analysis indicates that VSSs operating in different commodities offer different types of opportunities/initiatives to advance SRVC and address deforestation. A deeper analysis is needed to better understand the on-ground and actual impacts of their requirements and the measures they adopt beyond those.

There is movement by the private sector beyond commitment level and voluntary action. On Plan/Prepare, companies are scaling geospatial technology (farm polygons, satellite imagery) for detecting deforestation and innovating the use of technologies such as blockchain to have a tamper-proof record of data and trace products back to their origin. These technologies support detecting deforestation risks, though the challenge remains in making these technologies available to smallholders, reducing the costs of application, and ensuring correct data entry to get good-quality data. Companies are also using financial incentives, such as low-cost loans that are tied to compliance with zero-deforestation commitments, aiming to ease pressure on forests by reducing financial barriers for farmers and incentivizing conservation.

Inclusive access to these instruments remains a key hurdle, especially for smallholders lacking important documents such as proof of land ownership.

On Respond, buyers are strengthening their supply chain policies to block non-compliant suppliers. However, the challenge remains to make sure that these audits capture indirect suppliers. For Recover and Adapt, companies are linking corrective actions and longer-term shifts: agroforestry-based remediation on degraded plots and landscape/jurisdictional collaborations that align company no-deforestation policies with local plans, restoration goals, and farmer mapping/training. Evidence from our report suggests that these landscape approaches can protect forest areas and prepare producers for climate and market shocks, but they require long-term funding, incentives for local actors, and government buy-in to scale and move beyond pilot-level interventions.

Our analysis indicates an opportunity to address deforestation by adopting a smart mix of tools, combining VSS requirements, geospatial monitoring, sourcing policies, producer finance/incentives, and landscape collaboration, which makes it possible to address the different root causes of deforestation. Overall, the report analysis suggests that Plan/Prepare and Adapt measures may tackle deforestation more effectively than Respond or Recover, as there is value in being proactive to address deforestation rather than reactive. Further, solutions that are measurable, verifiable, designed with the local context in mind, address the needs of local actors, support smallholder inclusion, facilitate producers' incentives to avoid deforestation, and reduce factors that motivate producers to clear forest land could be more successful in embedding sustainable and resilient practices in GVCs.

6.1 Key Takeaways

Plan/Prepare (Prevent Before It Happens)

VSS Criteria and Practices

- **Require production farm geolocation, focus on deforestation hotspots:** All certified plots must have GPS points (≤4 ha) or polygons (>4 ha), and records should be maintained of the percentage of plots mapped or the percentage of supply volume with polygons. These data can then be used to assess any deforestation that has occurred and predict the possibility of future deforestation. This requirement should be accompanied by training/capacity building for farmers, especially smallholders, and ensure they have access to and an understanding of the necessary technology. Standards can also produce practical guidance (e.g., on using satellite alerts and assessing risks) and FAQs for auditors and producers.
- **Set clear no-conversion/no-deforestation rules with credible cut-off dates:** VSSs, especially national ones such as ARSO, can reinforce the requirements that set ambitious cut-off dates that align with (or exceed) regulatory requirements and serve as a strong deterrent to deforestation.

Private Sector

- **Require production farm geolocation to improve monitoring of deforestation, especially in areas prone to deforestation risk:** Map supplier polygon or geolocation data and run satellite alerts that can be followed by specific actions such as correction timelines and support in addressing deforestation hotspots. Ensure that indirect suppliers are also included in the implementation of this measure. This should be paired with support for suppliers/SMEs/producers so they can comply without facing the risk of being excluded from value chains.

Respond (Act When Clearing Is Suspected/Found)

VSS Criteria and Practices

- **Specify CAPs against deforestation:** If deforestation is detected in audits, define time-bound correction actions, verification steps, measures for re-entry or reassociation with certification, and consequences such as suspension or pause in certification.

Private Sector

- **Strengthen audits and action against no-deforestation/conversion sourcing policies:** Ensure strict no-conversion policies in value chains with independent third-party audits. This should be accompanied by defined and implemented consequences of violation (such as halting/holding non-compliant suppliers) that apply to indirect suppliers and include indirect suppliers as well. To support suppliers and tackle deforestation in value chains, defined time-bound CAPs should be made instead of immediately cutting off non-compliant suppliers.

Recover (Repair Harm and Verify Results)

VSS Criteria and Practices

- **Improve tracking of measures implemented:** VSSs should tighten assurance around what already exists—require periodic, field-based verification that remediation has been delivered (for instance, based on the forest management plan indicators set up as a part of Plan/Prepare) and disclose remediation status and completion.
- **Strengthen grievance mechanisms and include provisions for deforestation:** VSSs can ensure that grievance outcomes consistently facilitate and track ecological/social remedy with proportionate sanctions where remediation fails, focusing on deforestation, especially when operating in regions that are seen as prone to the risk of forest clearing.

Private Sector

- **Solutions for recovery should support socio-economic benefits:** Companies should make sure that solutions such as agroforestry are supported with benefits including improved agricultural practices, financial incentives for producers, support

in getting land tenure, and capacity building of farmers to ensure recovery of degraded lands and prevention of future land conversion.

Adapt (Build Long-Term, Forest-Positive Systems)

VSS Criteria and Practices

- **Integrate better production practices into VSS requirements:** Where possible, VSSs should set minimum natural-vegetation cover and agroforestry expectations for shade crops; provide crop/region-specific practice guides (agroforestry designs, buffer restoration, soil/water management) tailored to key crops/regions.
- **Encourage landscape-level initiatives:** Landscape and multistakeholder governance structures are critical for system-wide impact, especially where regional or cross-sector dynamics drive forest degradation. Community-led landscape management is also emerging as a powerful tool for adaptation and forest resilience. VSSs should promote such landscape collaboration and provide clear guidance, long-term funding, and coordination mechanisms in collaboration with other stakeholders to sustain outcomes.

Private Sector

- **Join or co-finance landscape/jurisdictional initiatives:** Embed no-deforestation and conversion plans in local plans and community rules, with shared monitoring, and co-fund restoration for sustaining long-term results. Make sure there are incentives for local actors, as they can increase willingness to collaborate and companies can ensure equitable benefit sharing, prioritize smallholder participation, and access to resources.

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