



How do companies implement their zero-deforestation commitments

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ABSTRACT

More than 500 companies engaged in supply chains of forest-risk commodity have adopted zero-deforestation commitments (ZDCs). We use corporate social responsibility strategy and policy implementation theories to analyse the processes and conditions for ZDC implementation. We base our study on 35 semi-structured interviews with company representatives and sector actors, publicly available ZDC data, and company reports. The objective is to understand the opportunities and challenges of ZDC implementation at the level of companies. While past research addressed ZDC coverage and effectiveness, knowledge is still lacking on companies' perspectives on the implementation of their commitments. This study provides a unique perspective by integrating the direct experience and knowledge of private actors on an environmental governance regime. We find that companies see implementation of ZDCs as a journey and often rely on voluntary sustainability standards, aligning their strategies and key performance indicators (KPIs) to these. They engage directly in the supply chain, conducting projects "on-the-ground." Implementing ZDCs requires the involvement of procurement departments and upper management, and collaborations within and between companies. Companies rely on service providers for in-depth knowledge and field implementation. They use monitoring tools, e.g. remote sensing, and see supply chain traceability as a prerequisite for implementation. Companies face numerous implementation challenges. Internally, companies often lack leadership on their ZDC, struggle to align commitments with the organization's operations and to manage suppliers, especially smallholders, and allocate insufficient resources. Externally, they lack common standards and stakeholder support, and face challenging regulatory conditions and missing market incentives. An uneven playing field creates leakage markets. Companies identify better leadership, technology and pre-competitive collaboration as potential solutions. Zero-deforestation commitments are unlikely to greatly contribute to reducing deforestation until better implementation processes, mechanisms, and conditions are in place.

1. Introduction

Production of agro-food commodities – mainly beef, soy, palm oil, rubber, cocoa, and coffee, and other forest-risk commodities (FRC) such as pulp and paper (IDH, 2020) – is the main driver of tropical deforestation (Curtis et al., 2018; Hong et al., 2021). Agriculture accounts for 60–80% of total forest loss (Hosonuma et al., 2012; Pendrill et al., 2019), which directly contributes to climate change and biodiversity loss (IPBES, 2019; IPCC, 2019). The impact of agricultural expansion on forests could further increase with economic growth and growing demand for agro-food commodities (Godfray et al., 2010; Springmann et al., 2018). Global supply chains involving millions of companies and

farmers produce, distribute, and manufacture agro-food commodities. Multi-national corporations (MNCs) control these supply chains and the global trade arising from them, while smallholders supply large fractions of many FRCs, notably coffee, cocoa, and palm oil. MNCs and other dominant actors shape agricultural production and supply chain governance through investments in, collaborations with, and leverage over global supply chains (Folke et al., 2019; Ponte, 2019; Thorlakson et al., 2018).

Actors within the agro-food sector face significant pressure from consumers, civil society organizations, and governments to address deforestation risks associated with agro-food commodities (Dasgupta, 2021; Garrett et al., 2019). As a result, both public and private actors

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have embraced deforestation policies and targets (Bager et al., 2021; Brown and Zarin, 2013). Notable examples include the New York Declaration on Forests (NYDF, 2014), the Amsterdam Declaration Partnership, 2015 on Deforestation, the Glasgow Leaders' Declaration on Forests and Land Use (UN, 2021), and the EU regulation on deforestation-free products (European Commission, 2021). Civil society actors, and NGOs in particular, put pressure on companies to end tropical deforestation (Dauvergne, 2017; Lyons-White et al., 2020). In 2010, the Consumer Goods Forum (2010), an organization of more than 400 consumer goods manufacturers and retailers, pledged that its members would mobilize their collective resources to help achieve zero net deforestation by 2020. Since then, hundreds of companies have made similar commitments, collectively known as “zero-deforestation commitments” (ZDCs), which aim at eliminating deforestation from FRC supply chains by a target date (Lambin et al., 2018). However, many companies still fail to adopt ZDCs to address deforestation risks. In 2019, Forest Trends (2019) tracked 865 companies with deforestation risk. Of these, 484 (56%) had set various sustainable commodity commitments, though only 72 had set explicit ZDCs for at least one FRC. Forest500 (2021a) data show that, of the 350 agro-food companies tracked by Forest500, 60% do not have any ZDCs, while 20% have set one or more commodity-specific ZDC, and 20% have ZDCs for all relevant commodities.

There are great variations in the nature, scope, stringency, level of transparency, and effectiveness of ZDCs (Barrett et al., 2020; Forest500, 2021b; Jopke and Schoneveld, 2018; Lambin et al., 2018). The impact of ZDCs on reducing deforestation still lacks thorough evaluation. Most studies focus on the coverage, criteria and potential effectiveness of ZDCs. Garrett et al. (2019) suggest that ZDCs can be “moderately effective in reducing deforestation within targeted supply chains and regions.” Given different definitions adopted by companies, only 34–74% of global forests are potentially protected by ZDCs (Leijten et al., 2020). A study from Indonesia suggests that the effect of ZDCs is contingent on local land use conditions (Austin et al., 2017), while data from Brazilian soy supply chains suggest that traders with “sticky” sourcing patterns have less effective ZDCs (Leijten et al., 2022). Another study from the Brazilian soy sector finds “no evidence of additional reductions in the deforestation risk of committed actors” after ZDC adoption (zu Ermgassen et al., 2020, p. 6). Further, several NGOs report that companies fail to adequately adhere to or report on their ZDCs (Bregman et al., 2016; Haupt et al., 2018). Just four companies follow best practices in disclosing their ZDC efforts (CDP, 2021). Despite ZDCs, global tropical deforestation remains at unsustainable levels (IDH, 2020) and companies have largely missed the 2020-deadline set for some ZDCs (Lyons-White et al., 2020; NYDF Assessment Partners, 2020, 2019). This raises the question of why companies have so far been unable to remove deforestation from their FRC supply chains.

Here, we argue that the strategies companies use to implement ZDCs can help explain this gap between commitments and outcomes. Implementation is a necessary – but not sufficient – condition for meeting ZDC objectives. Thus, a focus on implementation allows for a better understanding of how companies succeed or fail in translating aspirational goals into operational actions and on-the-ground changes, as implementation and effectiveness are intertwined (Nicholson-Crotty and Carley, 2015; Pressman and Wildavsky, 1973). Some research has already delved into issues related to ZDC implementation, but we lack a cross-commodity overview from the perspective of companies, some of whom act across multiple commodities and supply chains. Lyons-White and Knight (2018) analysed implementation among companies across a palm oil supply chain, showing that supply chain complexity impedes implementation, and urged for increased collaboration and advances on definitions, standards, and regulations. Similarly, in a study on ZDC coverage and effectiveness, Jopke and Schoneveld (2018) found ZDCs' implementation mechanisms “particularly ill-developed.” Lyons-White et al. (2020) argued that ZDCs lack supporting frameworks and accountability measures, while Grabs et al. (2021) identify and assess

effectiveness-access equity tensions for ZDC implementation mechanisms across leading companies within palm oil, soybeans, beef cattle, and cocoa supply chains.

The objective of this study is to understand how internal and external opportunities and challenges affect ZDC implementation at the level of companies. We ask what processes and mechanisms companies adopt to implement ZDCs, and which conditions affect companies' ZDC implementation. This study is unique as it provides a perspective from the vantage point of companies across all forest-risk commodities, which uncovers a key piece of the zero deforestation puzzle. Engaging companies in scientific research is notoriously difficult, but much can be gained by integrating the direct experience and knowledge of private actors in the understanding of regimes of global environmental governance. In the next section, we introduce the theoretical frameworks applied in the study. The third section presents the methods and the fourth section summarizes the results. We end with a discussion of our findings before drawing conclusions.

2. Background

ZDCs include specific sustainability objectives that companies pledge to voluntarily meet. ZDCs are thus both public expressions of corporate social responsibility (CSR) strategies and voluntarily adopted deforestation policies. From a CSR and a strategic management perspective, a ZDC is a business strategy. Like other corporate strategies, it includes two phases (Mintzberg and Waters, 1985): formulation – i.e., specifying scope and target – and implementation – i.e., defining the specific activities required for translating the strategy into action (Engert and Baumgartner, 2016; Epstein and Roy, 2001). From a policy perspective, implementation is one of the stages in the policy making cycle (Howlett et al., 1995; Jann and Wegrich, 2007). After a problem is identified and incorporated in the policy agenda, a policy is formulated and actors then decide to adopt and implement it (Howlett, 2018; Sabatier and Mazmanian, 1979; van Meter and van Horn, 1975). In the last stage of the policy cycle, actors evaluate the success of the policy, which may lead to a new problem identification and an updated policy agenda (Fig. 1).

Neither CSR nor policy theory include an overarching theory on implementation (Engert and Baumgartner, 2016; Howlett, 2018). However, both provide empirically or theoretically derived propositions on important characteristics for implementation. Policy theory analyses the relationship between policy implementation and performance, i.e., do outcomes correspond to the objectives set forth (van Meter and van Horn, 1975), and identifies implementation stages and conditions required for policies to succeed (Hill and Hupe, 2002; Pressman and Wildavsky, 1973; Sabatier, 2005; Sabatier and Mazmanian, 1979).

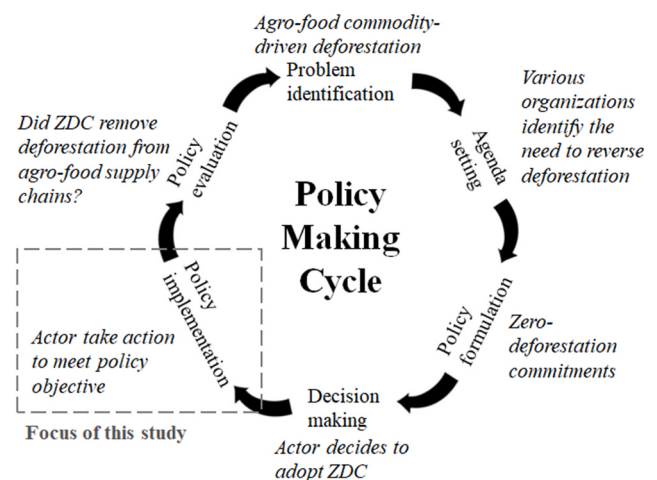


Fig. 1. The policy making cycle adapted to zero-deforestation commitments. Figure based on the policy cycle framework by Howlett et al. (1995).

Policy theorists emphasize the importance of basing implementation upon a valid theory of change, which spells out how actions lead to changes in outcome (Hogwood and Gunn, 1984; Sabatier, 2005). CSR theory focuses more on the organizational aspects affecting implementation. This includes the importance of organizational culture, leadership, stakeholder engagement, incentive structures, corporate commitment, and the development of plans and processes (Crosby, 1996; Engert and Baumgartner, 2016; Epstein and Roy, 2001; Klettner et al., 2014).

This literature describes implementation as the result of both the processes that companies put in place and the broader conditions under which companies implement ZDCs. Processes define and structure policy implementation. This includes specifying how, who, based on which resources, and through which activities companies carry out implementation. Processes also define how companies measure, monitor, and communicate implementation and impact (Crosby, 1996; Epstein and Roy, 2001). This requires setting targets and priorities (e.g., key performance indicators, KPIs), collecting data, and reporting. Mechanisms supporting processes include guidelines, standards, and technological applications. Companies may define some of these through internal codes of conduct or through voluntary sustainability standards defined by third party actors. Conditions are external and internal factors that affect implementation outcomes. Externally, it includes wider industry and stakeholder influence, regulatory and market forces, and the ability to influence the underlying causes of the problem (Hogwood and Gunn, 1984; Sabatier, 2005; van Meter and van Horn, 1975). Internally, it concerns company structure, culture, and organization, including available resources and the skills and qualifications of employees (Engert and Baumgartner, 2016; van Meter and van Horn, 1975). Implementation also requires management and leadership (Crosby, 1996; Engert and Baumgartner, 2016), particularly a “policy champion” (Crosby, 1996) to bring the issue forward, develop a vision, and garner support. Building on these two strands of literature, Fig. 2 illustrates our analytical framework for analysing ZDC implementation.

3. Methods

We conducted 25 interviews with company representatives, including executives and experts within CSR, sustainability, procurement, and corporate affairs departments. Table 1 lists all interviewees and their main characteristics. They represent a range of supply chain actors, regions, commodities, executive positions, and company sizes, as illustrated in Fig. 3. We selected the interviewees among Forest500-listed companies, excluding financial institutions. We contacted more than 150 companies; several did not respond and more than 50 declined to participate, even when granted full anonymity. Our sample of

interviewees is thus non-random and affected by a self-selection bias. To understand the role and perspective of external stakeholders, we also conducted 10 semi-structured interviews with experts from NGOs and consultancies working on ZDCs, which we selected based on their publication records and companies’ reference to their work. To contrast and complement the interviews, we collected reports and policies published by companies and NGOs on ZDCs – involving companies beyond the sample interviewed. We analysed ZDC data on commitment scope, implementation, and reporting collected by Forest500 (2021a), which we obtained explicit permission to use. The analysis concerns only corporate commitments related to deforestation.

The interviewees were all involved in work on supply chain sustainability, commodity sourcing, and/or deforestation. The 25 company representatives mainly occupied sustainability ($n = 13$) and procurement ($n = 8$) positions, thus being closely involved in defining sustainability strategies and sourcing forest-risk commodities. Two experts held corporate affairs positions, bringing a perspective on how to communicate sustainability efforts, while another two held executive positions, thus being closely involved in defining a company’s overall sustainability strategy (Fig. 3). All interviewees were permanent full-time employees in their respective companies and with enough seniority and expertise to represent their company’s perspective on ZDC implementation. Each interviewee spoke as company representative and not as individual topic expert.

For the semi-structured interviews (Flick, 2009), we developed an interview guide with questions addressed to all interviewees. We also asked interviewee’s additional questions as these emerged from the conversation (Kvale and Brinkmann, 2009). The interview guide and the introductory comments stressed that the questions were about the implementation of zero-deforestation commitments and the company’s supply chain sustainability efforts. We also emphasized that interviewees should bring the perspective of their department and individual role. We continually refined and updated questions as new insights emerged to ensure that the interview guide reflected our improved knowledge of ZDC implementation (Kvale and Brinkmann, 2009). The first author conducted all interviews either in person or by videoconference, and recorded and transcribed all interviews. We briefed interviewees about the content of the interview and the purpose of the research in an advance email or when initiating the conversation, asking for prior informed consent to participate, record, transcribe and subsequently analyse interviews. All participants were granted anonymity (most interviewees demanded this as a pre-condition for their involvement). Interviews lasted 45–90 min, though one interview lasted only 20 min. Given the anonymity granted to interviewees, we cannot publish the full transcripts of the interviews. We include full-sentence quotes (with names and places removed) in the analysis.

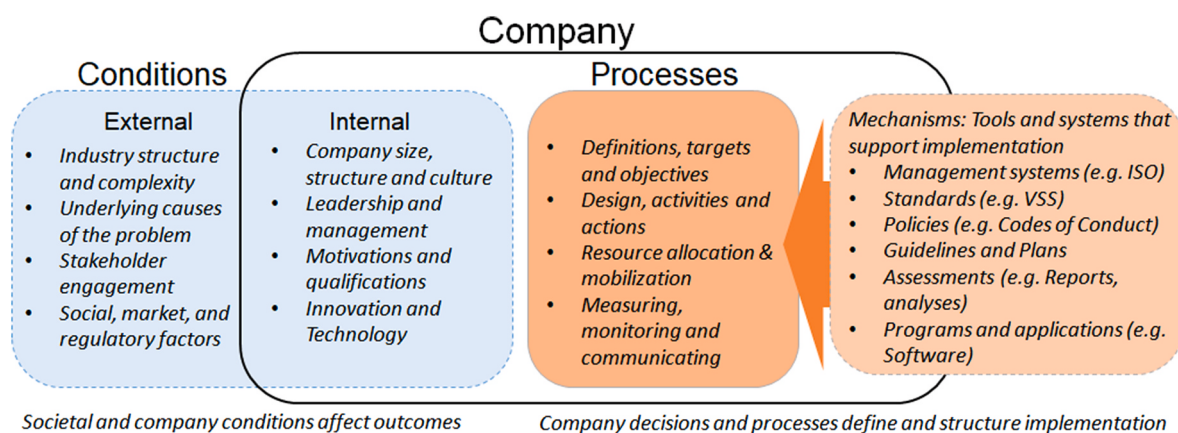
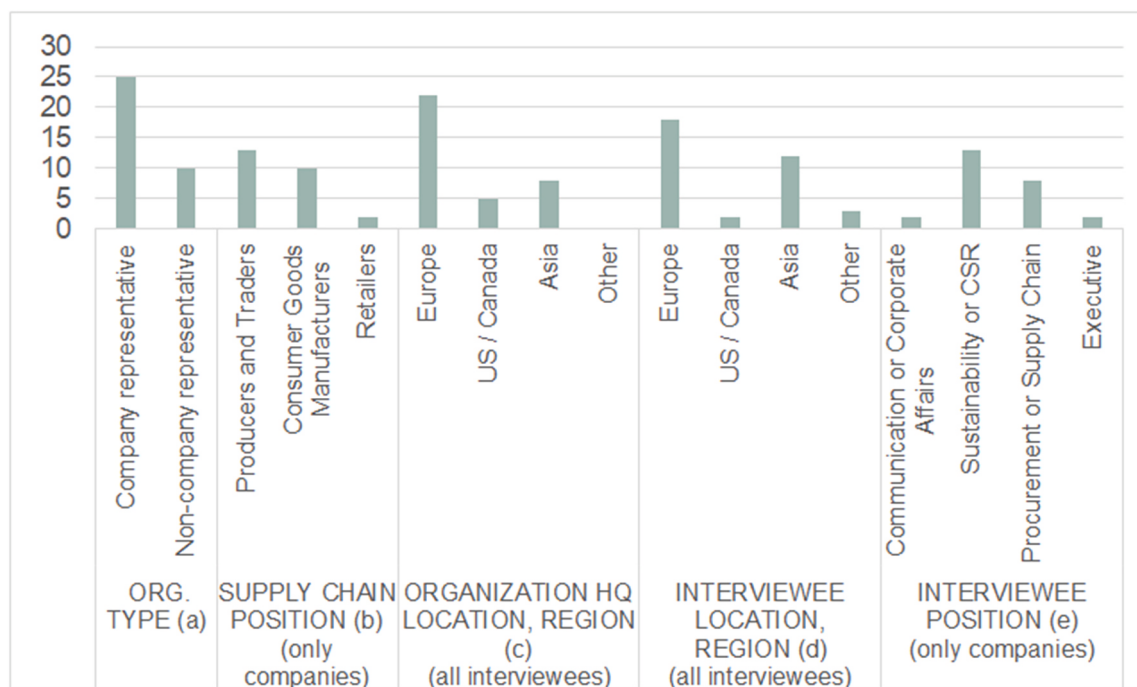


Fig. 2. Analytical framework for analysing ZDC implementation. Based on implementation theories from CSR and policy theory (see Supplementary Table 1). Conditions are circumstances or factors that must exist to successfully implement ZDCs. Processes are the series of actions taken to define, structure, and implement ZDCs.

Table 1

List of interviewees and their main characteristics.

Code	Type	Employee position	Company type	Employee location	Company HQ location	Main FRC
A1	Corporate	Procurement	Trader	Europe	Europe	Soy
A2	Corporate	Sustainability	FMCG	Europe	Europe	Multiple FRCs
A3	Corporate	Sustainability	Manufacturer	Europe	Europe	Palm oil
A4	Corporate	Sustainability	Manufacturer	Europe	Europe	Soy
A5	Corporate	Sustainability	Retailer	Europe	Europe	Multiple FRCs
A6	Corporate	Procurement	Retailer	Europe	Europe	Multiple FRCs
A7	Corporate	Sustainability	FMCG	Asia	Europe	Multiple FRCs
A8	Corporate	Sustainability	Trader	North America	North America	Multiple FRCs
A9	Corporate	Sustainability	Trader	North America	North America	Multiple FRCs
A10	Corporate	Procurement	FMCG	Europe	Europe	Multiple FRCs
A11	Corporate	Director/C-level	Producer	Asia	Asia	Palm oil
A12	Corporate	Procurement	Manufacturer	Asia	Europe	Multiple FRCs
A13	Corporate	Director/C-level	Producer	Asia	Asia	Palm oil
A14	Corporate	Sustainability	FMCG	Europe	North America	Cocoa
A15	Corporate	Sustainability	Producer	Asia	Asia	Multiple FRCs
A16	Corporate	Corporate Affairs	Producer	Asia	Asia	Palm oil
A17	Corporate	Corporate Affairs	Producer	Asia	Asia	Palm oil
A18	Corporate	Procurement	Producer	Europe	Asia	Palm oil
A19	Corporate	Procurement	Trader	Europe	North America	Soy
A20	Corporate	Sustainability	FMCG	Europe	Europe	Multiple FRCs
A21	Corporate	Sustainability	FMCG	Asia	Europe	Multiple FRCs
A22	Corporate	Sustainability	FMCG	Asia	North America	Multiple FRCs
A23	Corporate	Procurement	FMCG	Europe	Europe	Cocoa
A24	Corporate	Sustainability	Producer	Asia	Asia	Palm oil
A25	Corporate	Sustainability	Producer	Asia	Asia	Palm oil
B1	Non-corporate	Director/C-level	Consultancy	Europe	Europe	Multiple FRCs
B2	Non-corporate	Specialist	Consultancy	Europe	Europe	Soy
B3	Non-corporate	Specialist	Consultancy	Europe	Europe	Multiple FRCs
B4	Non-corporate	Director/C-level	Consultancy	Europe	Europe	Multiple FRCs
B5	Non-corporate	Specialist	Consultancy	Europe	Europe	Soy
B6	Non-corporate	Specialist	Consultancy	Africa	Europe	Cocoa
B7	Non-corporate	Local expert	Consultancy	Africa	Europe	Cocoa
B8	Non-corporate	Local expert	Consultancy	Africa	Europe	Cocoa
B9	Non-corporate	Local expert	Consultancy	Europe	Europe	Multiple FRCs
B10	Non-corporate	Specialist	Consultancy	Europe	Europe	Palm oil

**Fig. 3.** Organization type (a), supply chain position (b) and location (c), and interviewee location (d) and position (e) for the interviewees in this study. See Table 1 for details.

To analyse the interviews, we used a systematic combined approach grounded in qualitative policy research. The first author coded the interviews using the software MaxQDA and classified the responses (Locke

et al., 2020; Skjott Linneberg and Korsgaard, 2019). We analysed interview transcripts using thematic analysis (Willig et al., 2013) and the constant comparison method (Charmaz, 2014), an analytical

approach to interview analysis based on iterative hypothesis development. Firstly, using identified themes from the literature, we began with an initial round of deductive coding, i.e., a top-down approach based on theoretical insights (Skjott Linneberg and Korsgaard, 2019). We developed a codebook with an initial set of codes based on our research questions and theoretical framework. The codes covered supply chain actors, scope and definitions, company aspects, regulations and standards, tools and technologies, and key FRC commodities. We then assigned each statement made by interviewees to different overall code segments, allowing for a specific statement to cover more than one code. Secondly, we used an inductive approach (i.e., bottom up) to derive codes from the data (Skjott Linneberg and Korsgaard, 2019). In this approach, we allowed the narrative to emerge from the raw interview data, i.e., identifying specific topics that interviewees brought up rather than following preconceived notions of what ought to be relevant. As such, we applied both deductive and inductive approaches to coding interview data. In addition to the initial set of codes, we inductively came up with new codes and iterated on the existing codes as we analysed interview data. As a result, we had to code most interviews two or three times to reassign statements to new codes created as part of the inductive approach. This increased familiarization with the data.

In the analytical phase, we extracted the main topics, organized them by dominant themes and interpreted the data using the overarching distinction between ‘processes’ and ‘conditions’ suggested by the theoretical framework. As coding and interpretation are interrelated processes (Skjott Linneberg and Korsgaard, 2019), the analysis evolved with the coding process. We used analytical memos to capture ongoing reflections and bridge the gap between data, interpretation and final results (Skjott Linneberg and Korsgaard, 2019). We present our results using detailed descriptions, quotes and specific examples, inclusion and discussion of both patterns and outliers, and descriptive statistics.

4. Results

4.1. Variable forest definitions and missed targets

All 25 interviewees represent companies having adopted ZDCs, though these vary in scope and stringency. Two companies have only recently pledged to remove deforestation from their supply chains, while the remaining companies are in various stages of implementation. Having adopted a ZDC, the companies interviewed are among the most committed. Most have commodity-specific ZDCs and none have zero-conversion commitments for all commodities, the strictest version of

ZDCs. Early on, companies struggled to define forest areas included in their commitment. Up to 80% of the companies interviewed applied High Carbon Stock (HCS) or High Conservation Value (HCV) standards to delineate forest boundaries (Fig. 5), while the others used unspecified definitions. Forest500 (2021a) data show similar patterns.

Most companies missed the 2020-deadline, as some admitted would be the case during their interview: “It has been challenging. Personally, I do not think we are going to meet our timeline targets” (A18). At the time of the interview, 60% of the companies had not set a new target date and still stuck to 2020. Two had set short-term targets, while the rest had target dates between 2025 and 2030. Forest500 (2021a) data are generally consistent with these findings, though specifics vary across commodities and indicate that most companies have not (yet) revised ZDC timelines (Fig. 4).

4.2. Reliance on certification and engaging in the supply chain

Companies are aware of the complexity of halting deforestation; many interviewees acknowledge that deforestation is a “complex” or “wicked” issue where no simple solution exists. Companies see implementation as a journey requiring iterations and re-assessments of scope, approach and activities. Companies apply different mechanisms to implement ZDCs. Eco-certification is widely used for implementation, as 80% of companies interviewed build implementation on certifications (Fig. 5). Companies also align strategies and key performance indicators (KPIs) to existing standards. This especially concerns commodities with strong and well-established standards, mainly palm oil, timber and soy. Forest500 data corroborate this, as 68% of all soy-specific commitments refer to RTRS, 85% of all palm oil-specific commitments refer to RSPO, and all timber-specific commitments refer to FSC or PEFC. Only 20% of beef-specific ZDCs refer to certifications. 50% of the interviewed companies acknowledge that eco-certification alone is insufficient for implementing commitments, but in many cases, they see certification as a stepping-stone for further action.

Due to standards’ limitations, weak or non-existing standards for some commodities (e.g., rubber), and commodity-specific challenges, e.g., smallholder-driven deforestation (palm oil, cocoa), companies increasingly go “beyond” certification. Initially, companies believed they could push standards through supply chains, but today they see suppliers and producers as key enablers of ZDCs. As a result, all but three companies engage directly in the supply chain, for example working with suppliers and farmers to conduct trainings or workshops (Fig. 5). Companies thus claim to take an active role in implementing activities

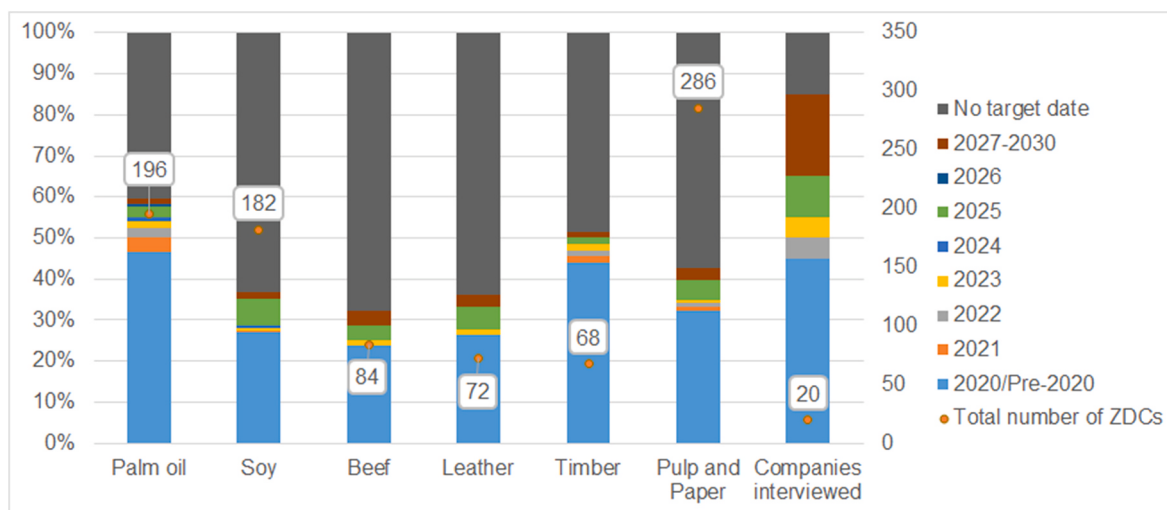


Fig. 4. Percentage of zero-deforestation commitment with given target dates (left axis) out of the total number of ZDCs pledged for the given commodity (call outs). Based on data from Forest500 (2021a) (bar 1–6 from left) and interviews (rightmost bar).

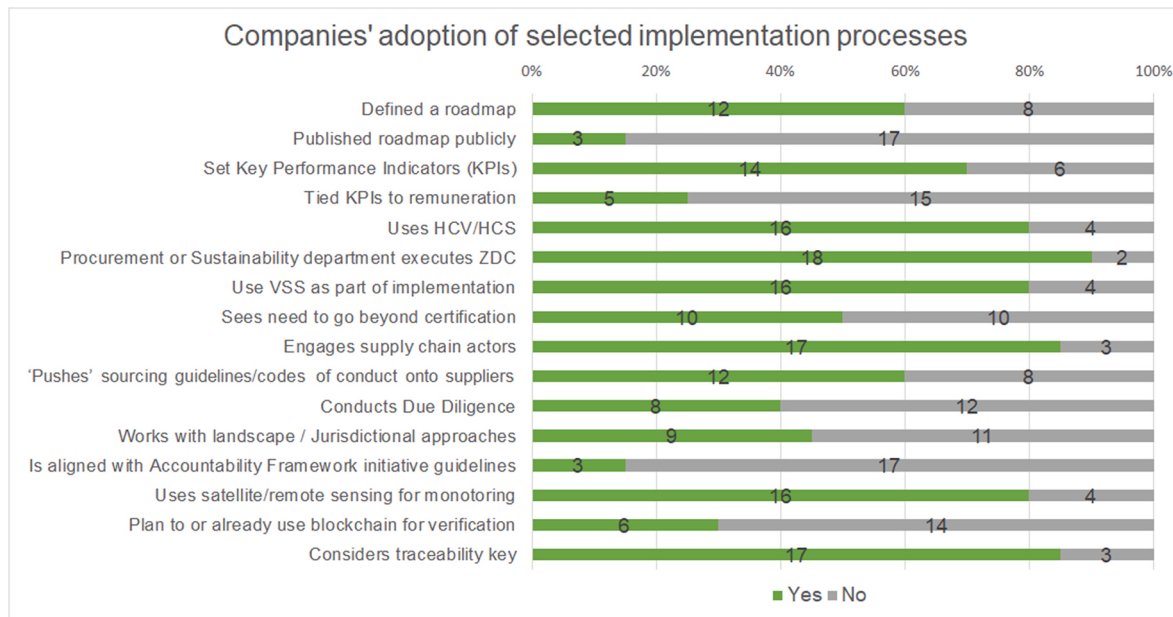


Fig. 5. Interviewed companies' adoption of different implementation processes and mechanisms.

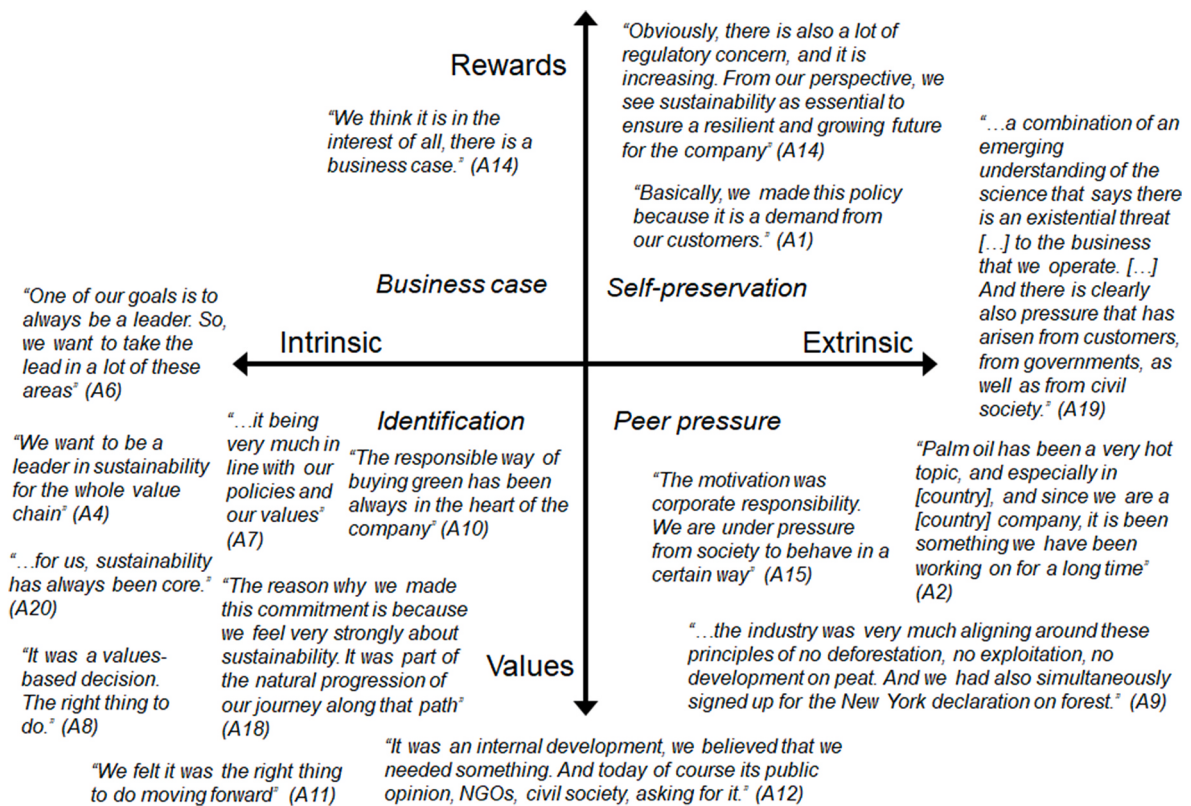


Fig. 6. A combination of, on one hand, company values and rewards and, on the other hand, internal and external pressure shape companies' motivations for adopting ZDCs. This creates four types of motivations: identification (intrinsic pressure and company values), business case (internal pressure and company rewards), peer pressure (external pressure and company values), and self-preservation (external pressure and company rewards). We categorize quotes from interviewees by their alignment to the four values.

across the entire supply chain and engaging with producers on the ground. This is challenging for companies that traditionally have had little engagement with on-the-ground practices (e.g., retailers and consumer goods manufacturers). However, companies' engagement levels differ, as some engage only tier-1 suppliers and expect them to handle

further upstream engagement, while others are 'on-the-ground' themselves (Table 2).

Table 2

Examples of interviewee statements underscoring and explaining outcomes of key implementation processes and conditions for zero-deforestation commitments.

Key finding	Supporting statements
Companies rely on certification for implementation, but they acknowledge the need to go beyond certification	"The foundation sits on RSPO principles and criteria." (A22) "We have grounded our sustainability commitment and the way that we implement things into the RSPO process." (A18) "Certifications are good to have because it is a third party and objective assessment. That is why it is very easy for us to use certifications as KPIs." (A4) "We see certification as a starting point and somewhere to build from. Of course, it depends on which certification you look at and how strong they are within the deforestation area. But it is a good starting point." (A2) "Certification mechanisms do only to a certain extent ensure a no deforestation, but cannot drive that for us as the way forward. We need to be much more specific on how we go in to set up a supply chain." (A21)
Companies take different approaches to engaging supply chain actors	"When we see that we have higher risk categories and more complex supply chains, we try to work deeper into our supply chains and more actively engage with our first-tier suppliers." (A2) "We need to touch the ground. It is really tough for us as a retailer; we do not go to ground traditionally." (A6) "We are active on the ground, we are going there, we are talking to them [producers] directly. [...] We realized that to be able to make changes you need [...] to be more active, to engage; you need to have people on the ground [being] part of the discussion." (A20) "We expect suppliers to engage their upstream suppliers as well. If an upstream supplier is found to be involved in deforestation, then we would expect our tier-one supplier to be managing that." (A14) "We have people embedded on the ground in the various different regions to be able to actually carry out the day-to-day practices." (A18)
Companies find implementation costly and difficult to allocate resources to	"When you are a listed company, you have shareholders. There is an expectation that your entire KPI is geared around profitability." (B4) "It is quite huge, this investment. Deforestation-free is not for free." (A23) "For a strong commitment, you really need to spend money." (A12) "Internally there is often a conflict between profitability and doing this [implementing the ZDC]." (A15) "We have to do this on our own internal budgets. Nobody helps companies do this. And that is a crying shame, because everybody wants it, but the burden falls once more on the producer." (A11) "The procurement team has this in their KPIs, that is connected to their bonuses, and that has been a quite critical component too." (A7)
Companies rely on service providers to extend their reach across supply chains and acquire ZDC-specific expertise and local, context-specific knowledge	"They [service providers] provide expertise and knowledge and inspiration to companies that want to ensure that their production is responsible [...], but

Table 2 (continued)

Key finding	Supporting statements
	do not have the knowledge to be able to do it themselves." (A14) "They [service providers] also bring to us a perspective on what is possible and what is not because they have ears to the ground and they are also seeing a little bit more what other retailers or other supply chain actors are capable of or have already started doing." (A5) "They [service provider] have good field presence in the producer countries and they have of course knowledge on sustainability policies and no deforestation commitments and how to do assessment of these issue areas." (A7) "I think it is important to have one partner. They have been developing our implementation manual. If you work with different people, you have different priorities, different points of view. I believe it is important to have one partner, and this is also the message we give to our suppliers." (A12) "You really need that interaction through the lens of NGO partnerships, as well as service providers. Because they bring something additional that you yourself, on your own, cannot do." (A21) "[Companies] provide us with sufficient amount of information about the company, their resources, how they work, their mechanisms for achieving things. They are then the ones who are supposed to channel any outcomes of our work into their organization, and to ensure that it is being implemented by the relevant person, department, operation in the company." (B1)
Companies see traceability as a prerequisite for implementation	"One of the most challenging things is of course the traceability and the monitoring aspects of implementing the deforestation commitments." (A6) "The biggest challenge is traceability. If you don't know where your commodity is coming from, you can talk about deforestation, but you're not aware." (A23) "It is a challenge because it is hard to follow each bean back to the farm, but we are working on some very fancy traceability tools there. [...] It is been asked for in the marketplace, people want to know where things come from." (A4) "As I mentioned before, only if we can trace, can we really take action." (A12) "What do you need to implement that commitment? You need a perfect traceability system. And then you need a due diligence or a purchase control system and when you combine that in theory you can make sure that you implement that commitment." (B2)
Companies must collaborate internally, but face barriers from internal silos and miscommunication	"Operationally it sits within the responsible sourcing team, which is part of the procurement division." (A7) "It sits with sustainability, but it is embedded within the commercial teams. [...] In general, it is a partnership. [...] It has to be a joint exercise." (A8) "[It] is really about good communication between the different businesses, [...] that flow of information and alignment across the supply chain." (A9) "There is a difficulty in getting [our] colleagues to understand what this [ZDC]

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Table 2 (continued)

Key finding	Supporting statements
Company leadership is crucial for driving ZDC implementation	really means and how it can be done." (A15)
	"It can be tricky, to motivate people to work with this, especially when there is not always clear KPIs and targets." (A2)
	"The leadership needs to be 100% behind this vision. If it is just a sustainability person who has a small sustainability budget, it will never achieve anything." (A14)
External pressure and company values motivate ZDC adoption	"The key is top-level commitment. If you do not have that, it will never be a success. The whole company, starting with the top CEO, the management group, everyone needs to be on board. Then you can actually do something and achieve something." (A4)
	"When there is a strongly committed leader in the company who has true leverage in the company, a lot can happen." (B4)
	"It is a long-term investment; you have to put people and money, so you need a very strong engagement from the board of the company." (A23)
Technology provides new opportunities, but is not a silver bullet	See Fig. 6.
Companies find it difficult to engage stakeholders across supply chains involving numerous smallholders, but they want to avoid boycotts	"Technology is important for monitoring, [...] because it is impossible to keep track of everything that is happening on the ground for all your suppliers." (A24)
	"Technology is really what is needed to drive this agenda faster and to deliver upon that commitment that everybody sets out. [...] The leap that technology has made from when we started and trying to get satellite imagery, data, cloud coverage and you needed to go to specific providers to do your analysis of your satellite imagery data. The resolutions were quite poor. I mean, that was one of the limitations I think we had at the time." (A21)
	"there is a tremendous development which has happened in the last five years. 11–12 years ago there was nothing, absolutely nothing, no satellite images, no, nothing. No digital systems and platforms which could enable a new system. So, I think that the technological progress enables the companies to build up such a system. So, it is not a question of any technological limitations." (A3)
	"For driving impact, technology might not really help that much. And that is for many companies, not always an easy message, because we all hope to have an easy solution that you can apply from behind the desk." (B2)
	"My onset is that these tools are telling you the past. They are not preventing the future." (A23)
	"One of the challenging areas [...] that we are spending the most time on is how to balance smallholders, to ensure that we are achieving inclusion and [...] economic development for the farmers." (A7)
	"We have used certification to try and support smallholders and encourage them, incentivize them, to also come on the journey with us. And to be honest, we have had a mixed bag of results" (A18).
	"We have never believed in straightforward boycotts. Boycotts make you absent from the debate. And all that

Table 2 (continued)

Key finding	Supporting statements
Companies find collaboration crucial to ensure implementation across complex supply chains	will happen is that these groups will join the leakage market. [...] They wished us to suspend and then engage. We decided that we would engage, then suspend. [...] You cannot draw the line if you do not give them a way back" (A11).
	"Suspension is not the end goal. The end goal is to get them compliant and coming back in [...], to get them to be committed" (A24).
	"Most of our suppliers would have a comparable no-deforestation policy to ours and then many of their suppliers would as well. So over time the policy cascades further upstream." (A7)
	"The supply chains and value chains are getting more and more complex." (A3)
	"We have around 23,000 first tier suppliers. So, you can only imagine the second tier, how many that is." (A2)
	"We simply do not have the power, if I may say so, to say to [a large supplier], you need to do so and so." (A1)
	"If you are alone, if you are one company, you are not going to be able to achieve the impact you want because supply chains are very complex. They are global" (A14).
	"[We need] to engage in more collaborative efforts [...]. Because I do not think this is a commitment that we can reach on our own." (A2)
	"We have heavy emphasis in our strategy implementation on cross-collaboration. Both within the industry and across industries." (A9)
	"A lot of companies are now looking at something they call collective action. The basic realization being that if you are alone [...], you are not going to be able to achieve the impact you want because supply chains are very complex. They are global. And in order to work on these issues you need the private sector, the public sector, civil society sector to all work together." (B5)
	"We need to engage the legislators, to push them on increasing, improving, and enforcing the local legislation." (A20)
	"A lot of it comes down to better enforcement of the law. So, there is an even playing field. [...] Governments need to be creating an enabling atmosphere through their regulations. Which I do not think that they necessarily do at the moment." (A9)
Implementation requires enabling regulatory conditions and a level playing field	"You need good governance of land use in the origin regions for the raw material. Without that, you will never succeed." (A14)
	"The real challenge is the leakage market. [...] So far as there is no real recognition that it is really a two-tier market – the sustainable, and the non-sustainable, – we are not really going to address this problem." (A24)

4.3. Covering the costs of sustainability

For the responsible departments to actually implement change requires "staffing and resources; they need to actually have people to do this work." (A7). Companies generally underestimate the scale and cost of ZDC implementation and almost half find that "the financial cost is a challenge" (A11) as especially shareholders worry about "the cost of

sustainability" (A13) (Table 2). Companies focus on short-term profits and increases in revenue rarely match up-front implementation costs. Companies do commit financial, human and technical resources to implementation, but the ability of smaller companies to invest sufficient resources hamper this. Meanwhile, companies have little opportunity to recapture costs through added value on products. As several interviewees expressed, consumers demand this but do not want to pay extra – “they want these additional guarantees, but at the same price” (A1).

The companies interviewed generally argue that revising remuneration and KPIs to align with ZDC objectives is key to implementation. 70% of the companies interviewed have KPIs for ZDC implementation. However, defining these can be challenging. “We are working on the KPIs. [...] It is pretty difficult” (A15). Linking KPIs directly to remuneration of employees increases internal uptake and incentivizes employees to reach targets. However, only five companies interviewed link KPIs to remuneration (Fig. 5). Across the sector, less than 5% of Forest500 companies link executive compensation to deforestation-related issues.

4.4. Relying on service providers

To aid implementation, companies engage external service providers “to both access external expertise and create scale” (A9). The “service providers all specialize in something” (A21), but their roles and responsibilities vary, “depending on the skill set for which we [companies] are employing them” (A19) (Table 2). From the interviewees’ description, we identified three types of service providers. *Operators* provide additional resources, allowing companies to extend their reach without in-house expertise. As the strategic partner, *orchestrators* have ZDC-specific expertise and local, context-specific knowledge on specific regions or commodities, allowing them to collaborate with companies to scope and design ZDC implementation. *Organizers* ensure buy-in and legitimacy across their network, reaching across the supply chain to connect businesses to stakeholders, such as consumers and local governments (Table 3).

Operators help companies “collect and compile data and analyse it” (B2). They implement specific programs and projects, e.g., smallholder engagement, production standards, or farming practices. Operators also shape ZDC communication, “making sure that what they are communicating is interpreting the reality correctly” (B1), as they know “the requirements from external stakeholders along the supply chain [...] and [are] plugged into the wider network of actors and sustainability initiatives” (B1).

Orchestrators are strategic “partners working with the companies” (B4), who “act as the facilitator” (B10) by using their “on-the-ground capacity to inform corporate-level strategy development” (A19). They scope commitments and set overall goals, define roadmaps and guidelines, and steer execution and implementation. They often work directly with the

companies’ suppliers and producers. As experts on specific commodities or regions, they “are on the ground doing either assessment, capacity building, training, a range of interventions, supporting around remediation, that kind of thing” (A19). This helps companies “move forward [...], but also supports us in how to get there” (A5) and provide “third party confirmation of what you are doing is correct” (A24).

Organizers are not technical experts but mostly collaborative NGOs, who provide networks and partnerships and “endorse” (A6) what companies do, which is crucial for public engagement and stakeholder management. They cooperate with stakeholders, including local governments, producers, and multi-stakeholder bodies, to facilitate or establish projects, especially jurisdictional and other landscape approaches, which around half the companies interviewed engage in.

4.5. Traceability is a prerequisite for implementation

Traceability is essential. Companies want to know who and where they source from, especially those working through direct engagement (Table 2). Mapping and tracing supply chains through tier 1-2-n take up a significant portion of companies’ efforts, and 85% of the interviewed companies consider this among the first and most important tasks (Fig. 5). The complexity and opaque nature of many supply chains and commodification of most FRCs make mapping and tracing an extremely complex task, but companies see this as a prerequisite for implementation.

The “first mile” – from farm or plantation to aggregation point or mill – presents a particular challenge and traceability is often only possible to a certain level. Companies use multiple tools to provide traceability, spending large sums on technological development to aid implementation. 80% of the interviewed companies rely on various geospatial tools, especially Global Forest Watch Pro, while some large actors also employ in-house geographical information systems (GIS) experts to map concessions and supply regions (Fig. 5). Companies use satellite monitoring “for land use purposes, specifically risk protection” (A14) and to identify “potential clearings quicker and more frequently” (A18).

Second- or third-party auditors assess companies’ general sustainability efforts, especially the larger companies. However, less than half of the interviewed companies have independent, well-established verification systems in place for zero-deforestation commitments, while only 15% rely on external frameworks or align implementation with the Accountability Framework initiative (Fig. 5).

4.6. Need for collaboration within companies

For implementation to succeed, companies need to align goals and collaborate across the firm (Table 2). In all but two companies,

Table 3
Service providers provide companies with different types of knowledge and services to foster ZDC implementation.

Type	Operators	Orchestrators	Organizers
Role	Technical	Strategic	Cooperative
Description	“technical knowledge provider” (A19), “operational support” (B9)	“thought partner” (A19) “knowledge partner” (B4)	“endorse what we are doing” (A6).
Who	Technical and sustainability consultancies	Specialised consultancies and organizations	International and local environmental and humanitarian NGOs
Expertise	Technical aspects Operations and projects	Strategic insights Local knowledge On-the-ground, field presence	Stakeholder management Partnerships
Tasks	Solutions, reviews and assessments (e.g., satellite monitoring, life-cycle assessment)	Strategy and execution Implementation plans, roadmaps, and guidelines Diagnostics and analytics	Establish partnerships and networks Build legitimacy
	Capacity building, training and workshops	Capacity building, training and workshops	Stakeholder and public relations (e.g., governments, producers, consumers)

execution falls on sustainability or procurement departments. Most commonly, the sustainability department sets the strategy and the procurement department supports implementation. To organize intra-firm collaborations, 60% of the companies interviewed use roadmaps outlining targets, deadlines, ownership, and instructions for rolling out implementation (Fig. 5): “We have a specific roadmap with KPIs, deadlines and clear ownerships” (A20). Companies generally use roadmaps for internal purposes, though three companies make these available for public communication and accountability: “Our roadmap is on the website, and that is how people could measure our progress. So far, nobody has contacted us and asked us, ‘how far have you got, where are you going?’” (A11).

The procurement and sustainability divisions in particular face opposing incentives and often sit in separate locations within the company. At least half of the interviewed companies struggle to design organizational processes across business silos, allocate tasks and responsibility, especially between sustainability and procurement, and link implementation to relevant KPIs. Aligning with non-expert colleagues can be especially challenging.

4.7. Need for a committed leadership

Given the complexity of the problem, company leadership plays an important role in driving ZDC implementation (Table 2). More than half the company interviewees explicitly express leadership engagement as imperative for implementing changes across the organization (Fig. 7). To move the agenda forward and ensure that implementation has teeth requires ‘internal champions’, i.e., ZDC advocates with sufficient ‘sway’, ideally at C-level. Leaders can help form a vision and set the direction, ensuring that implementation is “seen as a business imperative across all stakeholders, both internally and externally” (A8), while providing tools and resources for sustainability and procurement to execute on this, as non-company interviews corroborate. While management sets the vision, “steering committees” – often guided by advisory panels or high-level experts – set the direction. Among Forest500 companies, 29% have established steering committees or high-level management positions focused on ZDC, often reporting directly to the board or the executive director.

4.8. External pressure and company values motivate adoption

Companies have different motivations for adopting ZDCs (Fig. 6). These are driven by internal (company-specific) or external (various stakeholders) forces and motivated by values (reducing deforestation as an end in itself) or rewards (reducing deforestation to increase profits or reduce risks), respectively. Extrinsic factors shape companies’ motivations, which drive adoption by companies with greater brand exposure through NGO campaigns and stakeholder pressure (values-oriented) or consumer boycotts and cost decisions (rewards-oriented). This creates four types of motivations: identification (intrinsic pressure and company values), business case (internal pressure and company rewards), peer pressure (external pressure and company values), and self-preservation (external pressure and company rewards) (Fig. 6).

The promises and limits of new technologies.

There are ample examples of how companies employ technology (novel or existing) to drive implementation – i.e., technology is part of the implementation process. New technologies are most frequently focused on monitoring (e.g., satellites, drones, sensors) (80% of companies interviewed do this) or tracing supply chains (e.g., databases, blockchain) (55% of companies interviewed do this) (Fig. 5). There are

also innovations on production and harvest practices (e.g., robots) and in streamlining and improving traceability, audit, grievance, and compliance processes (e.g., AI, devices and apps).

While technology was a barrier at the onset of ZDCs, more than half of interviewed companies mentioned that technology has progressed so rapidly that the cost and availability of technological assistance is not a barrier anymore – i.e., the technological conditions for implementation now exist (Fig. 7). Some interviewees believe that technological innovations can aid implementation, with around half expressing ‘techno-optimism,’ believing that real-time satellite data will spell the end of deforestation. However, there is disagreement as to the transformational role that technology plays in meeting commitments, with the other half being more cautious. Interviewees generally acknowledge that technology alone will not address the problem (Table 2).

4.9. Challenges in engaging stakeholders

More than a third of companies find it challenging to engage stakeholders (Fig. 7). In particular, working with smallholders and reducing smallholder-driven deforestation is an issue that about half the companies grapple with, particularly those sourcing from smallholder-dominated sectors, such as cocoa and palm oil (Table 2). To reach smallholders, companies conduct extensive supply chain mapping and adopt certification. On the one hand, due to the lack of uptake, using standards is difficult, as it *de facto* leads to exclusion of smallholders from these supply chains. On the other hand, companies source from thousands of smallholders, which makes active engagement and enforcement of sourcing guidelines difficult.

Companies take different approaches when deciding whether to exclude or sanction suppliers. On the one hand, companies can achieve “clean” supply chains by excluding suppliers engaging in deforestation. On the other hand, when excluding suppliers, companies lose control and indirectly support leakage markets: 80% prefer to work with suppliers as long as possible and only exclude suppliers if they are unwilling to change or if they repeatedly violate agreements (Fig. 7). However, all but one company have suspended some suppliers (Table 2).

4.10. Collaborating across supply chains and industries

ZDCs can ‘trickle up’ supply chains, as downstream actors ‘push’ sourcing guidelines or codes of conduct with specific requirements onto suppliers (60% do this, Fig. 5). A sustainability expert from a large North American trader explained that they help and monitor suppliers to ensure that they meet the commitment and “empower them to take accountability for cascading this through their supply chain” (A9). However, supply chain complexity complicates implementation. Smaller companies often lack enforcement capacity and leverage across supply chains, while large actors face enormous complexity.

As companies emphasize, “stopping deforestation is not something you can do on your own” (A21). Companies are aware of the complexity and all but three companies view collaboration within companies and with supply chain actors, service providers, and even competitors, as key to implement ZDCs (Fig. 7). “No one actor controls everything, so you have to have complex alignment between a big network of actors, both private and public” (A14). These collaborations facilitate cross-sector, cross-supply chain action. Collaborations across supply chains also address sourcing issues overlooked by standards or support policy-specific targets. 60% of interviewees mention the need for “pre-competitive targets” (A10) and collaboration or “collective action agendas” (A19) with companies

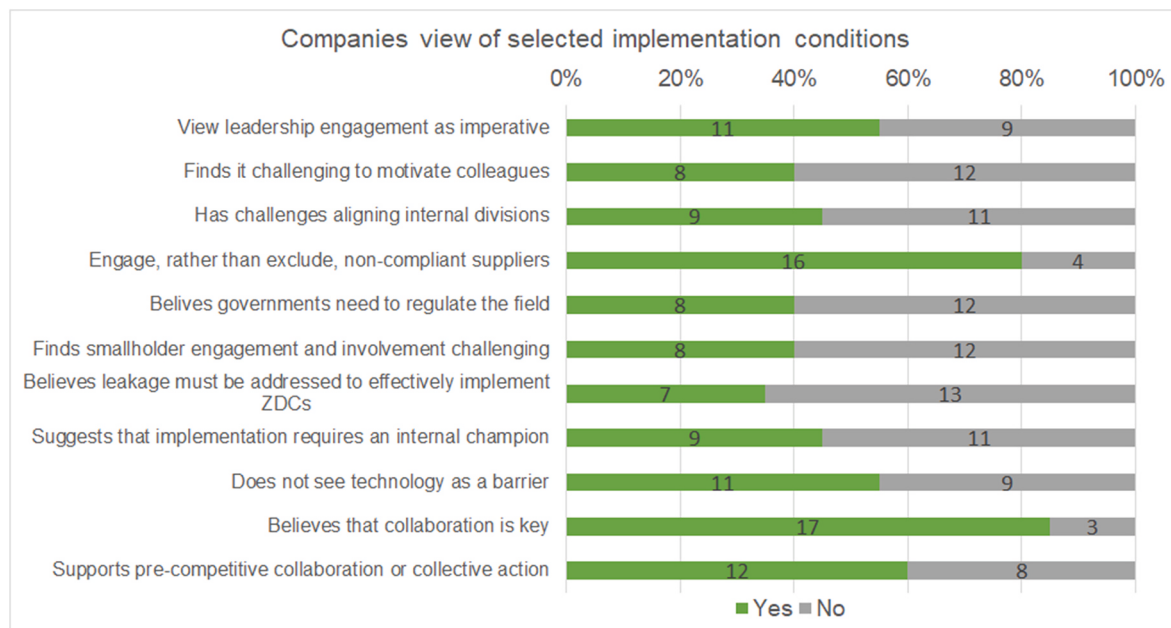


Fig. 7. Interviewed companies' view of selected implementation conditions.

engaged in similar businesses (Fig. 7). The aim is that such collaborations – with actual or indirect competitors – could streamline the ZDC approach and its definitions and ensure a level playing field, which would reduce leakage and scale impact (Table 2). However, companies fear accusations of forming cartels or of colluding. There is a need to find “ways that we can overcome commercial confidentiality and anti-competition restrictions” (A17), allowing “everyone to act in concert without breaching anti-trust” (A8).

4.11. Creating enabling conditions and a level-playing field

Current regulatory conditions do not foster implementation (Table 2). More than a third of the companies, who are likely the more progressive actors, suggest that governments need to regulate this field “to create an enabling atmosphere” (A9) (Fig. 7). Especially the lack of regulation by governments in producer countries undercuts ZDC implementation. Some suggest building regulatory measures based on existing voluntary sustainability standards, like RSPO, while others suggest due diligence schemes, support for local governments, and international frameworks. Higher costs currently disadvantage companies implementing ZDCs. Companies participate in roundtables and multi-stakeholder fora to align their work, lobby, and extend action beyond individual companies. Progressive companies point to the need for multi-stakeholder platforms to bring together “the government, NGOs, the industry, and smallholders [to define] new global standards” (A13) for zero-deforestation across the industry, acknowledging that moving the agenda forward requires common approaches and definitions.

Even companies not arguing for additional regulation are worried about (unfair) competition from actors unwilling to implement ZDCs and thus contributing to (or benefitting from) leakage markets. An Asia-based producer noted that, without addressing leakage, their efforts will only reduce, but not halt deforestation. Some suggest that establishing

markets for deforestation-free products and creating broader incentives to drive impact at scale, including “revamping the commodity trading system to trade commodities on sustainability criteria” (A14) could ease these barriers.

5. Discussion

Despite the concept of ZDCs being ‘clear, concise and intuitive’ (Lyons-White et al., 2020), companies struggle to implement their commitment and thus to reduce deforestation across supply chains. The objective of this study was to better understand the opportunities and challenges faced by the companies implementing ZDCs. We identified firstly the processes and mechanisms adopted by companies to implement their ZDCs, and secondly the broader conditions that enable or hinder these companies’ efforts. Processes and conditions do interact and influence each other. Companies can take actions to modify conditions – especially internal ones, but not only – while changes in conditions affect companies’ implementation processes. For example, adopting a technology as part of the implementation (e.g., using remote sensing for monitoring) is a process, but the availability and affordability of a technology as an enabler of implementation is a condition. Below, we discuss the key findings of the study.

5.1. Reliance on existing sustainability standards

Some companies take an active and direct approach to implementation, engaging suppliers and producers across supply chains and working on the ground with local actors. Others intervene less with suppliers or upstream actors and implement their commitment by integrating existing sustainability standards in their company sourcing policies. For example, they rely on externally defined standards, such as HCS and HCV to define the forests covered by the ZDC, or RSPO and

RTRS for sustainable production of, respectively, palm oil and soy. Implementation through standard-compliant production and sourcing provides advantages such as established processes for stakeholder engagement, auditing, and grievance (Mallet et al., 2016), which company-defined processes might lack. Strengthening the standard-based approach requires improving standards' ability to deliver reduced deforestation and increasing price premiums for deforestation-free production to incentivize upstream actors to comply (Garrett et al., 2021). Several interviewees recognized that sourcing eco-certified products might not be sufficient to implement ZDCs.

Companies generally engage suppliers rather than exclude them, in line with due diligence approaches and guidelines (Brack and Ozinga, 2020; OECD, 2018). This suggests a tolerance for non-compliance and a desire to avoid non-compliant suppliers entering leakage markets, while reducing the risk that ZDC implementation excludes smallholders (Pasiecznik et al., 2017). This explains why commitments are not always strictly enforced.

5.2. Covering the high cost of sustainability

Throughout the interviews, company interviewees emphasized that implementing ZDCs is costly. Large companies are able to spend more on sustainability governance (Drempetic et al., 2020) and have greater leverage across supply chains (Dallas et al., 2019; Ponte, 2019; van der Ven, 2018). However, large companies are more likely to face complex supply chains, which increases the cost of ZDC implementation (Kim and Davis, 2016). Small companies are more likely to be captive or embedded in large companies' supply chains, limiting the scope of their implementation choices (Bager and Lambin, 2020; Sako and Zylberberg, 2019; van der Ven, 2018). Profit-generation objectives by private companies may challenge the legitimacy of ZDCs, as companies balance implementation costs with reputational costs (Bloomfield, 2014; Dauvergne, 2017; Tetrault Sirsly and Lvina, 2019).

Implementation requires resource allocation, but our interviewees often characterised these as being insufficient. This suggests that some companies fail to back commitments with tangible investments. A recent NGO report states that costs of ZDC implementation are "*significant but not excessive for large companies, although possibly beyond the capacity of smaller companies*" (FERN, 2017). Consultants suggest that costs for most major consumer goods manufacturers and retailers are less than 1% of annual operating profits (Rijk et al., 2020), making the required investment manageable. The failure to invest sufficient resources mirrors findings from other CSR programs. For example, a recent survey on supply chain sustainability initiatives identifies a similar gap between companies' commitments and the investments required to fulfil these (Bateman et al., 2021).

5.3. Relying on external service providers

To help companies move along the learning curve on how to implement ZDCs, they often rely on external support (Weber, 2020). Service providers deliver crucial on-the-ground presence and context-specific knowledge, facilitate stakeholder representation, and provide additional resources (Cadman et al., 2017), often taking part in implementation (Grabs et al., 2021; Hayward et al., 2017). However, aligning actors and actions across supply chains pose a challenge to implementation (Bateman et al., 2021). Outsourcing partnerships for the provision of services related to information systems have been well studied in other industrial sectors (Lee and Kim, 2005). This study revealed similar outsourcing arrangements that are mutually beneficial for the parties involved. Agri-business companies benefit from the expertise, network, independence and reputation of the service providers. The latter gain an opportunity to implement via large transnational companies a priority of the global sustainability agenda, which is often at the core of their mission. Successful outsourcing partnerships require common interests and mutual trust, both of which exist among

ZDCs adopters and service providers.

5.4. Ensuring traceability and transparency

Verifying, monitoring, auditing and reporting on the impact of ZDC implementation are key to progress on reducing deforestation. This requires that companies ensure traceability – i.e., knowing where products are sourced from – and transparency – i.e., making information on this readily available to certain actors – across supply chains (Gardner et al., 2019). Achieving traceability largely depends on supply chain complexity and the position of the company. Companies increasingly benefit from satellite monitoring and supply chain data, e.g., provided by Trase. Novel tracking opportunities provided by Internet of Things (IoT) devices or blockchain could further expand companies' ability to track commodities, even in real-time, but they are not "silver bullets" (Bager et al., 2022). Transparency fosters accountability and enable civil society actors to assess companies' progress. Some companies, especially in the palm oil sector, publish supplier lists and grievance reports, while other sectors, especially beef, lag far behind (Alix-Garcia and Gibbs, 2017). Common standards and reporting frameworks, such as those developed by the Accountability Framework initiative, are key to hold companies accountable to their commitments.

5.5. Improving alignment of objectives within companies

It is often assumed that the greatest divergence in objectives lies between private companies and environmental NGOs. The last couple of decades have displaced this dividing line to within companies. ZDCs often create a tension between the procurement and sustainability divisions, which have different incentives and are sometimes weakly connected in a company's organization. In most cases, sustainability departments have orders of magnitude less staff and resources than procurement departments. Better aligning the missions of these two components of private companies is key to a successful implementation of ZDCs.

Successful implementation also requires committed and skilful employees (Galpin and Lee Whittington, 2012; Lacy et al., 2009). Large companies are probably more likely to attract skilful employees, but an individual employee's ability to affect change also diminishes with company size and complexity. A highly committed employee is more likely to be able to drive change in a small company than in a gigantic multinational corporation. Several interviewees identified a poor alignment within companies between incentive structures and KPIs related to sustainability and ZDCs. Without clear incentives to change practices, ZDC implementation becomes an appendix located within a small sustainability department, rather than a deep transformation of core business practices that affects the entire organization. The latter approach requires fully embedding ZDCs into corporate strategy (Baumgartner, 2009; Esty and Winston, 2006).

Executive-level "policy champions" (Crosby, 1996) affect corporate sustainability outcomes by driving implementation forward and help secure resources (Chatterji and Toffel, 2019; Chithambo et al., 2020). For example, Unilever's green profile was for long synonymous with its CEO, Paul Polman (The Economist, 2017). Without these champions, a company is less likely to take action. Bateman et al. (2021) show that executive-level engagement strongly correlates with sustainability commitments, "*suggesting that when executives champion the cause, companies commit to improving supply chain sustainability performance.*" Our results corroborate this finding.

5.6. External pressure as a source of motivation

Many companies taking action on deforestation are responding to external pressure to address the problem. Information disclosure by civil society actors, mainly environmental NGOs, help to identify laggards and put influential actors into the spotlight. Consumer decision also

drive companies into action, especially if companies serve markets with pro-environmental engagement. Action by one actor group can catalyse action through other channels. For example, NGO action may lead to increased consumer or investor engagement, or vice versa (Bullock and van der Ven, 2020). The impact of external actors' engagement points to the important role that these actors play in keeping companies engaged. However, there is a risk when NGO pressure is mostly aimed at the most well-known companies and brands, who might already be pioneers in sustainability engagement. This strategy of targeting the most progressive and well-known brands might discourage them to sustain their engagement, while letting lesser-known companies and local brands off the hook and fuel leakage markets.

New technologies are key for implementation.

Companies rely to very different degrees on technology, but development in satellite and supply chain technology generally aids implementation as this increasingly allows companies to monitor concessions or track specific supply chains (Moran et al., 2020; Sarzynski et al., 2020). The monitoring technology is especially well developed with near-real-time monitoring systems and various cross-sectoral technology-enabled services (e.g., Global Forest Watch, Starling). However, there is limited evidence of technology-enabled forest protection. For example, satellite-enabled deforestation alerts do “not significantly change deforestation outcomes” (Moffette et al., 2021). Further, the risk that technology-enabled progress drives additional sales, e.g., delivering on consumer demands for traceability, rather than reducing deforestation levels, requires further investigation (Dauvergne, 2020).

5.7. Pre-competitive collaborations across supply chains and industries

Beyond the company, collaborative engagement across entire sectors is crucial to address the underlying deforestation drivers and tackle leakage (Lyons-White et al., 2020; Pasiecznik et al., 2017). International initiatives for pre-competitive collaboration to address the limitations of companies' implementation attempt to address the implementation challenges posed by the structure and complexity of agro-food commodity supply chains. Deforestation is a complex problem with no simple solution, requiring companies to collaborate to identify and implement solutions. Companies represented in our sample do engage in various collaborative governance interventions, most notably jurisdictional approaches. So far, the evidence that this solution effectively addresses deforestation is limited, pointing to a need for a portfolio of

solutions (Chervier et al., 2020; Reed et al., 2020; von Essen and Lambin, 2021).

Initiatives such as the Accountability Framework, which produce guidelines, specify key definitions and identify effective implementation approaches help companies “speak the same language”, making it easier to deliver on commitments. While variations in scope, definitions, targets and timelines of ZDCs provide flexibility to companies, it entails extra work and opens companies to criticisms of cherry-picking convenient definitions (Pasiecznik et al., 2017). Multi-stakeholder approaches that involve producer-country stakeholders help determine standards and set requirements on transparency, monitoring, and reporting (Garrett et al., 2019; Leijten et al., 2020; Pasiecznik et al., 2017).

5.8. Leveraging all stakeholders to create enabling conditions

Interviewees identified a lack of support for ZDC implementation from key external stakeholders, notably public actors in producer countries, but also from consumers and shareholders. Public actors have several options for supporting implementation (Bager et al., 2021; McCoy and Servent, 2017), e.g., working through private-sector embraced jurisdictional-, trade-, or standards-based approaches. Governments in producing and consuming countries can play a ‘catalytic’ or ‘enabling’ role by supporting private-sector implementation efforts (Bager, 2021; Lambin and Thorlakson, 2018; Reinecke and Ansari, 2016). One way to achieve this is to establish sufficient market demand and regulatory conditions. Currently, weak market incentives and insufficient government regulation lead to an uneven playing field. As a result, companies implementing ZDCs are placed at a competitive disadvantage relative to those ignoring the problem or free riding on other companies. Moreover, the lack of market-wide uptake of ZDCs creates leakage (Bastos Lima et al., 2019). The financial sector could also commit to zero deforestation, as it currently lags behind other supply chain actors (Forest500, 2021b).

Fig. 8 qualitatively summarizes the state of the different ZDC implementation processes and conditions. On the one hand, some processes and conditions are well developed and in place and provide important input to implementation. For example, service providers provide strategic insights, technology for monitoring, and aid local, on-the-ground presence for actors far removed from places of production. On the other hand, other processes are not adequately addressed and many conditions are not in place. For example, most companies do not

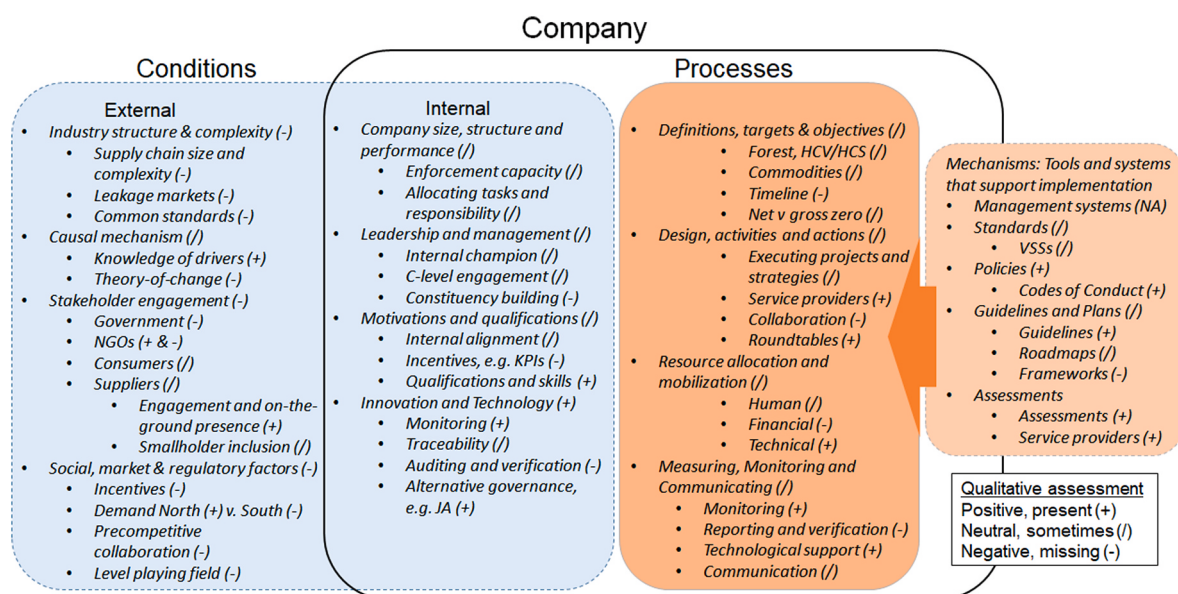


Fig. 8. Qualitative assessment of implementation processes, supporting mechanisms, and internal and external conditions for ZDCs. Based on interview responses and company documents.

commit sufficient funds to implement ZDCs, and external conditions, such as the complexity of the industry and the engagement of stakeholders, generally need improvement.

6. Conclusion

Clearly defined processes are essential to structure policy implementation, but conditions internal and external to companies affect implementation outcomes. When first adopting ZDCs, few companies grasped the complexity of deforestation and the scale of transformation required across companies and supply chains to address the problem. This realization has been slowly dawning as companies' ramp up implementation efforts, but it has taken time, causing missed targets and shifted timelines. At the time of the interviews, processes to implement ZDCs were generally still insufficient, but organizations were adapting to progressively put into place the required activities and mechanisms. Company structure, as well as commodity and supply chain characteristics affect companies' approach to implementation. Factors beyond the direct control of companies, such as the regulatory environment in producing and consuming countries, the availability and deployment of monitoring technologies, and commitments (or lack thereof) by competitors also influence implementation of ZDCs. A novel insight of this study is the role played by service providers in facilitating and executing companies' ZDC policies, as they provide operational support and strategic insights. The importance of these outsourcing partnerships had not been previously analysed. Further research should explore in greater detail their role in successfully implementing ZDCs.

The main contribution of this study is to offer "a look under the hood" on how companies implement ZDCs and on their perception of the main challenges in doing so. The interviewees' comments on, for example, the uncompensated cost of implementing ZDCs, the need to go beyond existing eco-certification schemes, their perceived lack of support from stakeholders, the importance of pre-competitive collaborations across supply chain actors, and internal tensions between their procurement and sustainability departments are rarely discussed in the literature. It is essential to understand the perspective of the actors at the centre of ZDCs to accelerate their implementation at scale. This study therefore fills a gap in the academic literature on supply chain interventions to eliminate deforestation.

Given that policy implementation and effectiveness are inescapably interwoven, ZDCs will not deliver a meaningful contribution to reducing deforestation until implementation processes and conditions are fully in place. This requires addressing several challenges. Internally, companies struggle to align their organizational structures with their sustainability commitments, and secure leadership and stakeholder buy-in. Interviewees view leadership, collaboration, resources, and technology as crucial. Externally, companies' main challenge lies in managing suppliers, especially smallholders. Leakage markets, the lack of common standards, and an uneven playing field also hinder successful implementation. Interviewees identified pre-competitive collaborations and market incentives as facilitative conditions.

The main limitation of this study is that our sample of interviewees is non-random and affected by a self-selection bias. In particular, companies with no ZDC are underrepresented and therefore our interviews largely represent the perspective of progressive companies. One could argue that the view of "laggards" is even more important to understand to identify the factors that explain their lack of commitment to eliminate deforestation. Now that many of the challenges and solutions to implement ZDCs have been identified, more research needs to focus on how to transform the sector at scale to eliminate deforestation from all supply chains. Success will depend on enhanced collaborations between private, public and civil society actors to solve this wicked problem.

CRedit authorship contribution statement

Simon L. Bager: Conceptualization, Methodology, Formal analysis,

Investigation, Writing – original draft, Writing – review & editing, Visualization. **Eric F. Lambin:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

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

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jclepro.2022.134056>.

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