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REPORT

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List of abbreviations

3-CO – Concise Consumer Communication through Robust Labels for Biobased Systems - Project

B/C ratio – Benefit cost ratio

BCI – Better Cotton Initiative

CB – certification body

CBA – cost benefit analysis

CH – certification holder

CM – certification manager

CRCF – Carbon Removal and Carbon Farming Framework

CS – certification consultant

CSDDD – Corporate Sustainability Due Diligence Directive

CSRD – Corporate sustainability reporting directive

CSL – certification schemes and labels

ECD – Empowering Consumers Directive

ESG – Environmental, Social and Governance

ESPR – Ecodesign for Sustainable Products Regulation

EU – European Commission

EUDR – EU Deforestation Regulation

EUTR – EU Timber Regulation

FPIC – free, prior, and informed Consent

FSC – Forest Stewardship Council

GCD – Green Claims Directive

GHG – greenhouse gas

GOTS – Global Organic Textile Standard

GRI – Global Reporting Initiative

ha – hectare

HVC – high conservation value

ICS – Internal Control System

IFOAM – Organics International (previously called International Federation of Organic Agriculture Movements)

IRR – internal rate of return

ISCC – International Sustainability & Carbon Certification

ISPO – Indonesian Sustainable Palm Oil

LUC – land use change

LULUCF – Land Use, Land-use Change and Forestry

n/a – not applicable

NGO – Non-governmental organisation

NPOP – National Programme for Organic Production

NPV – net present value

Mha – million hectare

MU – management unit

OCA – Organic Cotton Accelerator

RA – Rainforest Alliance

RED – Renewable Energy Directive

PEFC – Programme for the Endorsement of Forest Certification

RSB – Roundtable on Sustainable Biomaterials

RSPO – Roundtable on Sustainable Palm Oil

RTRS – Roundtable for Responsible Soy

SBP – Sustainable Biomass Program

SRA – Sustainability Risk Assessment

USD – United Statues dollar

WP – work package

1 Executive Summary

The project “Harmonization and monitoring platform for certification schemes and labels to advance the sustainability of bio-based systems” (HARMONITOR) targets different certification schemes and labels (CSLs) in various sectors of the bioeconomy within the European Union (EU), aiming at improving the effectiveness of these CSLs, and additionally the use of CSLs as co-regulation instrument. The present report (Deliverable D6.3) presents findings from Task 6.4 (overall feasibility of certification), building on findings from Task 6.1 (direct costs), Task 6.2 (indirect costs of certification) and Task 4.3 (benchmarking sustainability, assurance and governance criteria by CSLs). The goal of this report is to evaluate overall (economic) feasibility of sustainability certification in the bioeconomy and assess how policy design affects certification governance and assurance. This report examines these two interrelated aspects in separate parts as follows:

Part A (Feasibility) addresses economic feasibility as well as non-economic barriers to feasibility. This is done by investigating three case studies related to three feedstock types (wood, cotton and palm oil) and examining the costs and benefits of getting these feedstock types certified. In addition, Part A identifies financial, market, operational and governance barriers, and strategies to overcome them.

Part B (Verification and certification in EU bioeconomy policy) systematically investigates how different verification mechanisms and specifically certification is currently used in EU policy relevant for the bioeconomy. Next, it analyses whether the use and design of certification in these policies affects the certification design with specific focus on assurance characteristics of CSLs and provides insights on how stakeholders perceive a potential future role of certification in EU policy. In addition, the report presents an overview of stakeholder familiarity with CSL use in EU policymaking.

Overview of main findings and conclusions

Part A: The analyses show that in most cases certification is economically feasible for companies. The findings highlight that the direct costs of certification are strongly influenced by economies of scale. For large landowners and producers, these costs constitute a marginal addition to total costs per unit, whereas for smallholders, especially in the initial stages of certification, they can pose a significant financial barrier. The indirect costs are influenced by geographical and structural factors. For example, feedstocks certified in tropical regions normally face higher certification costs compared to wood certification in Europe. The latter benefits from more structured policies that make it easier to meet certification requirements.

Despite the high costs, sustainability certification can provide long-term economic and social benefits. In certain markets, such as wood certification in the EU, it has become the market standard, reducing additional indirect costs. However, certification in low-income countries presents greater challenges, particularly for smallholders. The high upfront costs and lack of institutional support can deter participation, highlighting the need for more accessible certification models.

Part B: The analysis shows that assurance requirements in CSLs are generally aligned with those found in policy, suggesting that sustainability certification is shaped by the broader regulatory context. This highlights that sustainability certification cannot be viewed as a standalone tool to guarantee sustainability outcomes. While it can be effective in promoting more sustainable practices and demonstrating compliance with regulatory or market requirements—particularly when widely adopted across sectors—it has limited capacity to address broader structural and systemic challenges.

In biomass markets, certification schemes compete for market relevance. When policies set low sustainability requirements and market demand for more ambitious standards is weak, companies may lack incentives to adopt more complex or stringent certification schemes. As a result, less demanding schemes often gain higher adoption, potentially leading to a race to the bottom. This poses a significant risk, as it can undermine the credibility of certification as a tool and weaken trust in the overall sustainability performance of the sector.

Recommendations

Based on the research conducted for this report, the following recommendations are made, organized by topic.

Challenges for smallholders and companies in low-income countries:

- Policymakers: promote policies to ensure technical and financial support to economically disadvantaged companies to avoid their exclusion.
- Downstream companies (e.g., multinational brands): use market power and resources to support smallholders in achieving certification, incl. funding training programs, co-investing in necessary infrastructure, or offering long-term purchasing agreements.
- CSLs: simplify certification requirements and invest in user-friendly, digital systems to reduce the administrative burden. Develop clear guidance, case studies, and multilingual training materials tailored to different financial and regional contexts.
- Certification Bodies (CB's): adopt cost-effective IT tools and smart record-keeping systems to streamline monitoring and reporting processes. Support companies in implementing these tools and interpreting certification criteria to reduce confusion and operational workload.

Use of certification as verification instrument in EU policies:

- Policymakers: strengthen and harmonise policy requirements to ensure that only credible and robust certification schemes are recognised in public frameworks. This includes setting ambitious and consistent minimum standards for both sustainability criteria and assurance processes.
- CSLs: engage in continuous dialogue with policymakers and stakeholders to ensure alignment with public policy objectives. Participate in structured platforms, such as the roundtable promoted by HARMONITOR and the BiobasedCert cluster, to co-develop strategies that strengthen the effectiveness of certification in sustainability governance.
- Industry: prioritise credible and ambitious certification schemes, even when not mandated by regulation, to uphold the integrity of sustainability claims and promote higher standards across the sector.

Need for better understanding impacts of certification:

- Policymakers: promote policies that require collecting harmonised and reliable information on overall sustainability performance of CSLs, including socio-economic aspects.
- Researchers: investigate the impacts of certification.
- CSLs: put in place systems to effectively monitor their impact.

2 Introduction

The European Union (EU) has identified the bioeconomy as a key element in the EU's sustainability transition, helping to accelerate progress towards a circular and low-carbon economy. Although it entails many promises to fulfil this contribution, the bioeconomy also raises concerns about environmental, social and economic impacts both inside and outside the EU. Sustainability certification can play a key role in addressing these impacts, serving as a mechanism to demonstrate that biological resources and bio-based products and materials meet environmental, social, and economic sustainability standards. Also other, sometimes related verification mechanisms exist, such as due diligence, third-party audits or disclosure of information, and these can also help in demonstrating commitment to a more sustainable bioeconomy.

Verification mechanisms, incl. certification[1], are already being used as support instruments in EU policies for guiding a sustainable bioeconomy. For example, the Renewable Energy Directive[2] requires minimum greenhouse gas savings and has a number of environmental sustainability criteria for bioenergy and biofuels that can be verified by means of EC approved voluntary certification schemes. In addition, voluntary certification has also developed as a means for businesses to differentiate themselves in sustainability-conscious markets or to facilitate trade with environmentally regulated economies. Examples of this approach are the Forest Stewardship Council (FSC) and the Roundtable on Sustainable Palm Oil (RSPO). Used in different forms, certification serves as a tool for meeting sustainability objectives. This occurs mainly through its verification of compliance with sustainability criteria. Certification thereby can enhance market transparency and provide assurance to consumers, regulators, and investors.

However, the feasibility of sustainability certification for market actors in the bioeconomy varies widely, depending on the mandatory vs voluntary nature, how certification is designed and implemented in policy or legislation, as well as other economic, institutional and technical factors. For example, economic feasibility is affected by whether certification is mandatory or voluntary, whether there are financial or market incentives that link certification to subsidies or public procurement criteria, and whether there is harmonization and standardization of certification requirements across policies. Non-economic aspects relevant for the feasibility of certification by market actors relate to the regulatory clarity and administrative simplicity, technical support regarding traceability and monitoring tools or certification training programs, and credibility and trust by different stakeholders (e.g. businesses downstream interested in buying certified input material, consumers buying certified products or investors interested in investing in companies producing certified materials and products). Depending on how these elements are configured through EU bioeconomy policies and support programs determines whether certification can act as a barrier or enabler for market actors. Previous research has mainly focused on the economic feasibility of certification, although quantification of costs and benefits remains limited, while also non-economic aspects of feasibility need to be studied in detail to fully understand feasibility of certification.

As a result, the feasibility of certification as experienced by market actors also directly influences the effectiveness of certification as a policy support tool. If certification becomes a barrier rather than an enabler of a sustainable bioeconomy, it will lead to low adoption rates

[1] While verification is the process of checking if a product, service, or system meets specified requirements, certification is the formal recognition by an authoritative body that a product, service, or system actually complies with established standards or regulations.

[2] Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (recast).

or reliance on less rigorous schemes. This weakens certification's role as a policy support tool: fewer companies participate, and the credibility of sustainability claims diminishes. Conversely, when certification is economically viable, technically feasible and aligned with business incentives, it enhances compliance with policy. Widespread adoption then strengthens certification's legitimacy and effectiveness as a tool to monitor and enforce policy objectives.

In addition, policy configurations in terms of certification used as a support tool also affect how certification schemes and labels are designed and implemented, particularly CSL governance structures, transparency, and verification rigor as well as what role different stakeholder play in setting sustainability standards. However, so far the literature has not examined how certification design in bioeconomy policies has affected the set up of CSLs - although this is important for future refinements to achieve increased feasibility of certification.

For ensuring certification serves as an effective voluntary or mandatory tool for guiding the sustainability of the bioeconomy, it is essential to better understand the overall feasibility for market actors, how certification is currently used and whether this affects how certification is designed.

2.1 Goal

The overall goal of Task 6.4 is to evaluate overall (economic) feasibility of sustainability certification in the bioeconomy and assess how policy design affects certification governance and assurance. This report (Deliverable D6.3) examines these two interrelated aspects in separate parts as follows:

Part A: Feasibility (Section 3) addresses economic feasibility as well as non-economic barriers to feasibility. This is done by investigating three case studies related to three feedstock types (wood, cotton and palm oil), examining the costs and benefits of getting these feedstock types certified, and identifying financial, market, operational and governance barriers, and strategies to overcome them.

Part B: Certification in EU policy (Section 4) systematically investigates how different verification mechanisms and specifically certification are currently used in EU policies relevant for the bioeconomy. Next, it analyses whether the use and design of certification in these policies affects the certification design with specific focus on assurance characteristics of CSLs and provides insights on how stakeholders perceive a potential future of role certification in EU policy. In addition, the report presents an overview of stakeholder familiarity with CSL use in EU policymaking.

Each part includes an introduction, method, main findings, discussion, recommendations and conclusions. The report concludes with recommendations relevant for both parts (Section 5).

2.2 Link with other tasks and projects

Part A: The research conducted on costs and benefits of the three case studies was conducted in close collaboration with the 3-CO project. While the underlying work was largely created by both projects together, the HARMONITOR contribution focused on further analysing the collected data to compare the costs and benefits across different types of companies (e.g., different plantation sizes for palm oil). Also, the research on barriers and strategies to overcome these barriers was conducted primarily for and expanded in

HARMONITOR. As a result, this deliverable also presents largely new results and findings. However, it is important to re-iterate the shared underlying research, which means that underlying methods, assumptions and some findings overlap.

As designed in the project proposal, this task also builds on previous tasks, including incorporating findings from Task 6.1, 6.2 and 6.3. As a result, findings from those reports are drawn upon when fitting.

Part B: The research on governance aspects of certification is original work conducted in the HARMONITOR project, there are no overlaps with other projects. The research conducted for this part of the report applies findings from the benchmarking exercise of WP4 (deliverable D4.3 -benchmarking sustainability, assurance and governance criteria by CSLs) to enhance the understanding of how the manner in which certification is used by bioeconomy policies affects the assurance requirements of certification schemes. In addition, Task 6.4 stipulated the analysis of stakeholder familiarity with certification as a co-regulation tool in EU bioeconomy policies at two points in time. The first time this was investigated was part of the public consultation reported in HARMONITOR deliverable D2.2 (public consultation). Here results of the second public consultation are presented and compared to the first.

3 Part A: Economic feasibility

3.1 Introduction

For companies operating in the bioeconomy, certification offers both an opportunity and a challenge. On the one hand, certification can enhance market access, improve brand value, and provide a competitive advantage by demonstrating compliance with sustainability standards. For certain sectors - such as biofuels, where the Renewable Energy Directive (RED II) is an EU mandate - certification is a legal prerequisite for market participation. Next to the EU mandate, voluntary certification schemes such as the Forest Stewardship Council (FSC) or the Roundtable on Sustainable Palm Oil (RSPO) can differentiate businesses in sustainability-conscious markets and facilitate trade with environmentally regulated economies.

On the other hand, the costs and administrative burdens associated with certification present significant challenges. Companies must invest in auditing, compliance monitoring, and supply chain transparency, which can be particularly burdensome for smallholder farmers and small and medium-sized enterprises with limited resources. Moreover, certification often requires technical expertise, access to traceable supply chains, and compliance with evolving regulatory standards, all of which add complexity. The fragmentation of certification schemes also creates uncertainty, as companies must navigate multiple overlapping or conflicting standards. For example, FSC certified forest owners need additional EC approved voluntary certification in case they wish to sell wood chips for energy and biofuels production. It is noted though that PEFC recently obtained RED III approval (Commission Implementing Decision (EU) 2024/3181 of 19 December 2024).

Existing literature investigating the economic feasibility of certification often presents mixed findings, and most studies highlight the need for further research (Rossi et al., 2023). Quantitative data on costs and benefits of certification are difficult to find. Studies that reported data often use different methodologies to collect and calculate them. For instance, for this report, a review on the economic viability of forest certification was carried out, using the large review study of Wolff and Schweinle (2022) and the underlying publications as starting point. The review revealed a lack of publicly available quantitative data on costs and benefits of forest certification. Most studies assessed the perceived (rather than obtained) financial impacts, i.e. opinions on financial benefits, rather than calculated values. In addition, some studies indicated that cost data was treated confidentially and as proprietary or was not fully reported. Moreover, forest managers may not be fully aware of the financial costs and benefits of certification, because indirect benefits such as improved market access make forest certification necessary anyway. Based on this, we identified a clear need for a quantification of the costs and benefits, based on transparent assumptions on costs, time and money to be spend on audit preparation, audits, record keeping, and opportunity costs of forest area set aside, and the benefits in the form of a price premium.

In addition, there are also non-economic aspects relevant for the feasibility of certification by market actors. These relate to regulatory clarity and administrative simplicity, as well as technical support such as traceability and monitoring tools or certification training programs. They also concern credibility and trust among different stakeholders, particularly businesses downstream interested in buying certified input materials, consumers purchasing certified products, and investors. However, these non-economic aspects have not been systematically assessed and are not well understood, whereas they are highly relevant for the feasibility of certification.

Better understanding the economic and non-economic feasibility of CSLs as experienced by market actors is important for ensuring that they can take up certification and for identifying how barriers can be reduced to do so. Here we aim to provide a comprehensive overview of the current state of knowledge of the feasibility of certification for market actors. This is done by bringing together dispersed knowledge on the topic of costs and benefits of certification for market actors, other barriers and how to overcome them. The research builds on the literature, conducting case studies to investigate these topics in more detail, conducting interviews and using results of a short survey among stakeholders.

The report is structured as follows: In Section 3.2, we present the methods applied to reach the aim of this study, including explaining the scope and concepts of the analysis, the literature review, public consultation, interviews and costs-benefit analysis. Section 3.3 then provides an overview of the factors that determine the costs and benefits of certification. Section 3.4 presents the cost-benefit analysis of three case studies (palm oil, wood and cotton). This is followed by the results on barriers (Section 3.5) and strategies for overcoming the barriers (Section 3.6). Part A concludes with a discussion of findings and limitations, conclusions and recommendations.

3.2 Methods

3.2.1 Scope & concepts

Focus on feedback production: Feedstock production for the bioeconomy is associated with large impacts, while also a lot of requirements address agricultural and forestry management and therefore costs of production. As a result, our analysis of the feasibility of certification for market actors focusses on feedstock producers. The analyses of feasibility conducted for this report address three main topics: i) costs and benefits of certification as well as what factors drives them, ii) barriers and challenges of certification, and iii) options to address these challenges.

Categories of costs and benefits: To determine the feasibility and economic performance of CSLs, it is important to distinguish and understand the different associated costs and benefits as well as define the factors that influence them. For costs, there are: (a) the direct costs of getting certified by a CSL; and (b) indirect costs of certification, i.e. the cost of achieving the sustainability criteria set by the CSL. At the same time, certification promises numerous benefits such as (increased) access to certain end user markets, higher prices for certified products as well as benefits for the environmental and society. In section 3.3, we define the relevant cost categories and benefits in more detail and define the factors that influence them.

Case studies: The analysis of feasibility focuses around three key feedstocks that are relevant for the bioeconomy and where certification play an important role in governing sustainability challenges: wood, cotton and palm oil. For the understanding of barriers and challenges as well as strategies for overcoming them, we also consulted with literature on other feedstocks.

Overall approach: The approach is based on bringing knowledge together from different sources: existing literature findings and updating this information based on interviews and expert knowledge of certification bodies, certified companies, CSLs, consultants, and researchers. In the following we describe the elements of the methodology in more detail, addressing the literature review (Section 3.2.2), public consultation (Section 3.2.3), and expert

interviews (Section 3.2.4). Then we describe the method and data used for the cost-benefit analysis of the three case studies (Section 3.2.5).

3.2.2 Literature review

To assess the costs and benefits of sustainability certification for biobased products, we conducted a comprehensive literature review. Both scientific and non-scientific literature was scanned to gain insights into the socio-economic costs and benefits of certification. By analysing existing research, reports, and policy documents, we identified common themes, challenges, and potential benefits associated with certification schemes.

We collected information on three specific case studies: palm oil, wood, and cotton. The goal was to gain a deeper understanding of certification in different sectors of the EU Bioeconomy. For this, we collected both quantitative and qualitative data on the economic costs and benefits of certification, including aspects such as compliance costs, market access, price premiums, and broader socio-economic impacts. These case studies allowed us to compare sector-specific challenges and benefits, providing a more detailed assessment of how certification influences different supply chains.

3.2.3 Public consultation

For part B of this report, we conducted a public consultation to map stakeholders' perspectives on the use of certification in EU policies related to the bioeconomy and map their familiarity with the current regulatory framework. We also included questions on the barriers and challenges of certification, as well as possible mitigation measures.

The full list of questions and possible answer options for multiple choice questions are provided in the annex, section

A.2 Public consultation. For relevant questions for the feasibility analysis related to barriers and strategies for overcoming barriers, see questions Q1, Q4, Q5 and Q6. The public consultation was also used to identify experts for interviews (Q8). To ensure anonymity of the public consultation answers, experts interested in participating in an interview were linked to a separate form for leaving their contact information.

3.2.4 Interviews

To complement the information collected from literature and public consultation, we conducted 15 in-depth, semi-structured interviews with different stakeholders, aiming to represent the diversity of perspectives taken in society. The interviews were conducted between November 2024 and February 2025. The goals of the interviews were to i) gain additional data on the costs and benefits of certification for the three case studies and ii) complement the literature knowledge on the overall feasibility of certification. Table 1 shows an overview of the interviewees and their stakeholder category. A list with the interview questions is available in the annex A.1. The interviews lasted 30-45 minutes each.

To join efforts and avoid stakeholder fatigue, these interviews were a joint effort of the HARMONITOR and the 3-CO project. For HARMONITOR, five additional interviews were added.

Table 1 Overview of interviews

Stakeholder category	Geographical location	Case study	Code
Certification body	Austria	Overall feasibility	CB1
Certification body	Denmark	Overall feasibility	CB2
Certification consultant	Netherlands	Palm oil/ overall feasibility	CS1
CSL representative	Germany	Overall feasibility	CSL1
Non-governmental organisation	Netherlands	Overall feasibility	NGO1
Researcher	Netherlands	Palm oil/ overall feasibility	RE1
Certification manager[a]	Netherlands	Wood (FSC)	CM1
Certification body	Spain	Wood (FSC and PEFC)	CB3
Certification manager	Sweden	Wood (FSC and PEFC)	CM2
Certification manager	Netherlands	Wood (FSC and PEFC)	CM3
Certification body	Lithuania	Wood (FSC)	CB4
Researcher	Netherlands	Wood	RE2
CSL representative	United Kingdom	Cotton (Better Cotton)	CSL2
Business using certified products	Germany	Cotton (GOTS)	B1
Certification Body	India	Cotton (Better Cotton & GOTS)	CB5

[a] Certification manager: a person that manages the sustainability certification process on behalf of the forest owner, or - in case of group certification - a group of forest owners.

Abbreviations: B – business using certified products, CB – certification body, CM – certification manager, CS – certification consultant, RE – researcher, NGO - Non-governmental organisation

3.2.5 Cost and benefit analysis

To quantify the costs and benefits of certification, we conducted three case studies related to palm oil, wood and cotton production. Given very different production processes and relevant factors for costs of certification, the approach for assessing costs and benefits is unique for each case study and described in more detail below. Common characteristics are that the analyses are based on cost-benefit analysis of certification from the perspective of market actors, i.e. feedback producers getting certified. As on the ground data collection requires extensive amounts of resources that were not available in this project, the analyses rely on existing data on costs and benefits. This information is scattered across different sources and the analysis here focussed on bringing the dispersed information together and processing it to determine an overall perspective of costs and benefits. Data collected from the literature is complemented with data and assumptions discussed in the interviews.

Palm oil

Producer categories and data collection

For palm oil, the farm size is an important factor that influences the economic benefits of certification (DeFries et al., 2017; Durst et al., 2006; So and Lafortezza, 2022). We distinguished three producer categories based on the sizes: scheme smallholders, independent smallholders and large producers. While large variations exist within these categories, we selected characteristics that are typically associated with each group. Data on the costs and benefits of RSPO certification for these producer categories were collected from literature as on the ground data collection requires extensive amounts of resources that were not available in this project. Instead, existing studies that already collected such data were brought together, data was processed and the NPV and benefit/cost ratio were calculated. The three producer categories, their main characteristics as well as the source of data are as follows:

- Scheme smallholders: plantations below 50 ha structurally bound by contract, by a credit agreement or by planning to a particular mill or plantation company. They have limited decision-making authority over land use and production practices. The affiliated company or mill supports these smallholders with technical and financial assistance and usually receive part of the premiums derived from selling certified products (Hidayat et al., 2016). Regarding the report, the average plantation area reported in the literature was 3.9 hectares. The data were collected from Hidayat et al. (2016).

- Independent smallholders: plantations below 50 ha that operate autonomously, bear the full costs of certification, and retain all associated premiums. For the case study, the average area of plantations of the data collected in literature was 3.9 ha. The data were collected from Hidayat et al. (2016).

- Large producers (50,000 ha): large scale producers managing approximately 50,000 ha of plantation land. The data were collected from Levin et al. (2012), and WWF (2022).

Each category varies in terms of resource access, compliance costs, and potential benefits from certification, shaping their capacity and incentives to adopt RSPO (Solidaridad, 2023). An overview of input data is provided in section A.3.

Data analysis

Although previous studies have collected data on costs and benefits of certification, they did not determine indicators that allow assessing the net effect of certification. Therefore, we processed data from the existing studies and calculated the net present value (NPV) and benefit/cost (B/C) ratio. As described above, the analysis of the three categories are based on different studies, which presented different cost and benefit categories. Therefore, we aggregated the cost items to the following categories: Membership, Audit costs, Staffing and training, Environmental, social assessments, Standard compliance/corrective actions, Organisation and Internal Control System (ICS), Document recording collection (also see section A.3).

To compare the costs and benefits for the different producer categories, all items were converted to Euros/ha based on data provided by the study. Hidayat et al. (2016), Levin et al. (2012), and WWF (2022) provided data in USD/tonnes. These were converted to Euros according to the average exchange rate of the year of each study according to data retrieved from the European Central Bank (2025). To convert from tonnes of certified palm oil to hectares, the average yield of palm oil plantations was estimated to be 2.8 tonnes/ha, based on Ritchie et al. (2025) and Statista (2025). The benefits considered in our calculations are based exclusively on price premiums for certified products, as reported in the original studies, and not on total revenues. All data and calculations refer only to the incremental costs and benefits attributable to certification, not to the total operating costs or revenues of the plantations.

The NPV was calculated over a period of 5 years, using a discount rate of 13%, as done by Hidayat et al. (2016). The period of 5 years was chosen because it represents the duration of a RSPO certificate. The costs are assumed to begin at year 0 with the investment costs, and then continue as ongoing costs for the remaining years. The initial investment costs were calculated by combining the costs items provided by the selected literature. The only study providing information on the ongoing costs was Levin et al. (2012), which mentioned that they are 33-57% lower than the initial certification costs. The average value of 45% was used to estimate the ongoing costs of the case studies.

The B/C ratio was calculated by dividing the discounted benefits by the discounted costs. Given the large variations in the price premiums reported in literature, a sensitivity analysis was conducted using the average certified palm oil price premiums reported in the Global Market Report: Palm Oil Prices and Sustainability (Voora et al., 2023).

Wood

The costs and benefits of forest certification were investigated with focus on FSC and PEFC as applied in Europe. We focussed on Sweden as a country with large forests and a well-developed forest industry, and the Netherlands, which has smaller forests with more emphasis on multifunctional forests that combine production, nature conservation and recreation. The certification costs depend strongly on the size of the certified forest and the number of management units. In this case study, we made calculations of the costs and benefits of a 50,000 hectare forest that has one owner with a single management unit, or with 50 management units, to show the impact of the number of management units. Moreover, group certification is widely applied in forest certification, meaning that one organisation, which can be a forest owner foundation, a consultancy or a wood processing industry, manages a group certificate that has many forest owners as members. During the yearly audit, a sample of the member forests is visited. To compare group certification with single owner certification, we

assumed a forest management certificate covering 50,000 hectare forest and 100 group members.

Direct costs of forest certification

Direct costs of certification, e.g. related to the external audit and audit preparation time, were estimated by assessment of FSC audit reports that include audit times, and interviews with auditors and certification managers, i.e. the staff organising the certification process on behalf of the forest owners. In total six persons were interviewed and listed in Table 1.

Indirect costs of forest certification – management system costs

The indirect costs of certification consist of the costs to comply with (1) the management system criteria and (2) performance criteria of the scheme. The management system costs were estimated by the time required by the certification manager to take care of the record keeping, keeping the forest management plans and overviews of HVC areas etc. up to date.

Indirect costs of forest certification – performance criteria / set aside areas

Indirect costs of compliance with the *performance criteria* of forest management certification vary and are site specific. Examples include the use of mechanical instead of chemical removal of invasive species, investments in harvest equipment using biodegradable hydraulic oil, and the opportunity costs of keeping the 5% (PEFC) or 10% (FSC) of area set aside for nature conservation. The latter costs mainly play a role in case of private forest owners aiming to maximise the harvested volumes, and not so much in case of public forests or forests owned by nature preservation organisations. Similarly, private forest owners are - in general - keener on, and able to, obtaining a price premium for certified wood. In this case study, we have focused on the opportunity costs of setting aside part of the areas, with focus on PEFC and FSC in Sweden.

The opportunity costs are formed by the volume that will be harvested in absence of forest certification but is not harvested in case of forest certification. The opportunity costs vary between zero (in case the forest owner can allocate 5% or 10% of set aside area to plots that cannot be harvested in an economic viable way, e.g. in areas that are difficult to access with harvesting equipment (e.g. steep areas) (situation 1)), and the full loss of opportunity costs (if the whole area has forests that would be harvested in case of absence of certification (situation 2)).

Price premium

Interviews and literature research will be applied to establish an estimation of price premiums for PEFC and FSC certified wood.

Cost-benefit analysis

The cost-benefit analysis will be based on the average yields and the average mix of wood assortments as found in Sweden. It is observed that there are important differences between wood yields in the northern and southern parts of Sweden, and in practice each forest has his own different mix of wood assortments.

The cost benefit analysis focusses on the costs and benefits of *certification* - not on the cost and benefits of harvesting as such - and compares the situation of sustainability certification with a situation without certification. The following variations are considered:

- Single MU, multiple MU and group certification, impacting the direct costs of certification and the indirect management system costs.

- The indirect costs of compliance with performance criteria are represented by the opportunity costs of not harvesting the set aside area. The size of set aside area of 5% in case of PEFC and 10%, which impact both opportunity costs and benefits from sales, compared to a situation without certification.
- To illustrate the impact of the potential yield of the set aside areas on the net benefit of forest certification, two situations were elaborated:
  - Situation 1, with 0% productive set aside areas, in which there are no opportunity costs because the set aside area cannot be harvested anyway also in absence of certification, and
  - situation 2, with 100% productive set aside areas, in which the opportunity costs are maximal because – in absence of certification - the whole set aside area would be harvested with the same yield as the rest of the forest area.
- Given that the productivity of the set aside area is highly important for the opportunity costs and thus the net benefits of forest certification, the assumed yield of the set aside area in absence of certification has been varied from 0% to 100% of the yield of the rest of the forest in steps of 5%. The higher the yield of the area set aside, the higher the opportunity costs. The variation in yield counts for 10% of the forest. In case of FSC this part of the forest of set aside. In case of PEFC certification, 5% of the forest has a lower yield, and 5% is counted as opportunity costs. In the reference case in absence of certification the yield of 10% of the forest is also varied accordingly with the assumed percentage.

More background information and calculations are presented in Appendix A.4 and main results are found in section 3.4.2.

Cotton

Data collection

India has been selected for the case study due to its status as the country with the largest area devoted to certified cotton cultivation in the world. The main certification scheme is Better Cotton with over 1.35 Mha of certified cotton area followed by organic certification with 0.23 Mha (Kemper et al. 2024), giving the opportunity to assess both CSLs in one country.

The organic standard GOTS (Global Organic Textile Standard) strives to define worldwide recognised strict and binding requirements that ensure the status of organic cotton fabrics. Their focus lies throughout the entire value chain on ecological and social requirements verified by a third-party certification in every facility (GOTS, 2024a; GOTS, 2024b). GOTS does not verify farms, instead it verifies facilities that handle organic cotton. In India, the organic cotton must be sourced from farms that are certified as organic by the National Programme for Organic Production (NPOP). Therefore, given the focus of this case study on producers, NPOP has been selected for further assessment. NPOP is approved by IFOAM – Organics International (previously called International Federation of Organic Agriculture Movements), an organization that promotes organic production.

The literature incorporated into this study may be subject to biases, as some of them are studies financed or executed by certification schemes themselves. For example, the India Impact Report 2014-2023 (Better Cotton, 2023a) states that the average cotton yield in India is 449 kg/ha in the 2021-2022 season while Better Cotton produced an average cotton yield of 650 kg/ha in the same season. Highlighting a significant increase in yield, whereas the Organic Cotton Accelerator (OCA) Farm Programme Impact Report 20/21 (Organic Cotton Accelerator, 2022) indicates that organic cotton offers a substantial reduction in production cost from 376 Euro/ha vs 462 Euro/ha due to lower fertilizer and pesticides usage. These

results differ from more robust findings of De Hoop et al. (2019) that shows Better Cotton has a lower yield (-10%) compared to conventional cotton, and organic cotton has higher material costs of 712 Euro/ha compared to 593 Euro/ha for conventional cotton.

Given that a portion of the underlying research is funded by the fashion industry, our subsequent calculation predominantly relies on scientifically more robust findings of De Hoop et al. (2019). This research was a social, economic & environmental Impact assessment of cotton farming in Madhya Pradesh region in India and collected data through a large-scale survey in 2017 among 1.662 organic, 2.109 Better Cotton and 1.200 conventional farmers from over 133 villages, with a total of 3,628 farmer responses. This was supported by 46 in-depth interviews. Given the large number of survey responses and interviews, as well as the independence of the researchers, this reference is deemed the most reliable for the present analysis.

Data analysis

Case description

Group certification has been identified as a common certification practice for both organic and Better Cotton through literature (Meinshausen et al., 2019) and insights obtained through expert interviews. India stands out as the country with largest number of producers utilizing organic group certification systems, with over 1.100.000 farmers and approximately a total of 1.600.000 ha. The analysis of costs and benefits of certification in cotton production focussed on an illustrative example (herein called scenario) of group certifications. The scenario of this case study was therefore based on (organic) group certification regulations. Specifically, a cohort of 500 farmers, each managing an average area of 2 hectares.

Direct costs and indirect management system costs of cotton certification

The direct costs of cotton certification i.e. audit costs, scope certificate, certification fee and domestic transaction certificate are estimated based on an average of the 23 accredited certification bodies by the NPOP. Data collection time of the ICS and audit times are based on expert interviews. From these interviews it is assumed that 4-5 individuals will require one month to complete the data collection for the ICS, with an average salary of 279 euros per month in India. For the audit time, it is assumed that one auditor can conduct audits for eight farms per day, and around 22 audits are required per group of 500 farmers.

Indirect costs of compliance with performance criteria cotton certification

The indirect costs of compliance with the performance criteria are based on the literature of De Hoop et al. (2019). These values showcase the indirect costs of certified cotton production indicating the indirect costs of compliance with the performance criteria of the certification scheme. The values provided in de Hoop et al. are converted to Euro using a currency of 0.01396 INR to Euro, based on data from oanda.com/currency-converter on 01/01/2017.

The total direct costs and indirect management system costs are calculated by dividing the total costs calculated for an entire ICS by 500 farmers that have 2 ha of land to get the costs in (Euro/ha/year).

Benefits of cotton certification

The total revenue of the different CSLs is calculated by multiplying the average price data from Texpro Sourcing Intelligence (2025a) by the average yield data from De Hoop et al. (2019) in Euro/ha and for the entire ICS with 500 farmers with an average land of 2 ha.

Cost-benefit analysis

The net benefit is calculated by subtracting the total costs from the total revenue. The cash flow over time is calculated in a similar way as described in the previous paragraph (Benefits of cotton certification), however, during the transition period for organic farmers, the average conventional cotton market price is used. From the fourth till the last year, the average organic cotton market price is used for the calculation. The NPV and IRR are calculated over a period of 10 years, with a discount rate of 13%.

3.3 Factors driving costs and benefits

Various factors influence the costs and benefits of certification. While these are partially context and CSL-specific, we provide here an overview of the factors that are most relevant in general to explain what drives the costs and benefits of market actors getting certified. This section first presents the relevant categories of costs and benefits (Section 3.3.1), and describes the relevant factors for each category (direct costs in Section 3.3.2, indirect costs in Section 3.3.3, and benefits of certification in Section 3.3.5).

3.3.1 Categories of costs and benefits

Direct costs are those costs directly associated with certification, i.e. external auditing costs (certification fees, administration fees and cost of audits), as well as internal costs (preparation and participation in process) (Simula et al. 2004). *Indirect costs* are those associated with meeting the sustainability criteria established by CSLs which can be broken down into costs associated with compliance with performance criteria and with management system criteria (see *Figure 1*).

Benefits of certification are diverse, ranging from financial benefits such as in form of price premiums for certified products and non-financial benefits such as reduced environmental impacts. As for costs, benefits can be direct or indirect (*Figure 2*). Often financial benefits are considered first. This can be direct financial benefits such as getting a price premium for certified product or indirect such as increasing access to funding, which may be easier to attract when certified. Other benefits are market access and/or a competitive advantage over other companies. This is because certified products often appeal to environmentally conscious consumers, and certification could distinguish products from competitors or open up new market segments. Other times, certification is required or aids in compliance with regulations so to access a specific market. Reputation and trust is another non-financial benefit of certification as it demonstrates a commitment to sustainability and thereby allows building trust with consumers, stakeholders, and partners by. Certification can also contribute to increased operational efficiency as required data collection and monitoring can encourage efficient use of resources, reducing waste and lowering operational costs. Finally, another important non-financial benefit, and key driver, of certification is the environmental impact it aims to reduce.

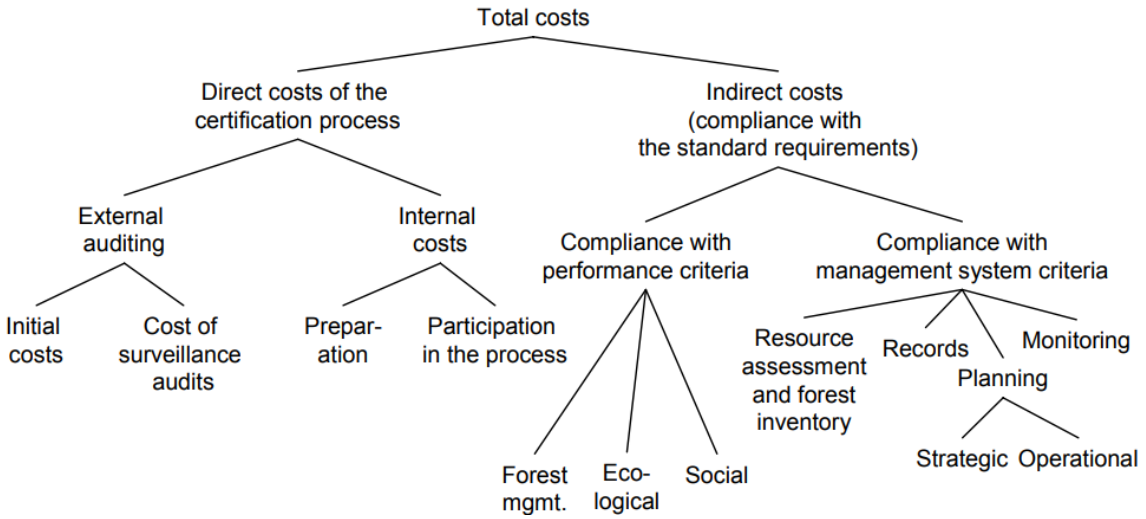

Figure 1: Classification of costs associated with forest certification. Source: Simula et al (2004)

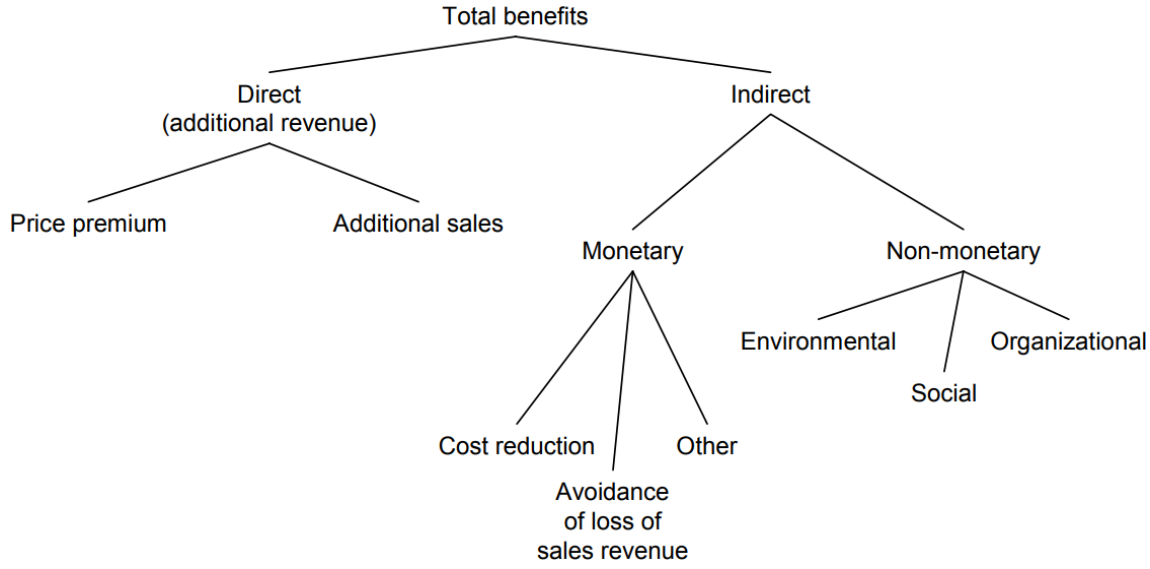

Figure 2 Classification of Benefits Associated with Forest Certification. Source: Simula et al. (2004)

3.3.2 Direct costs

Direct costs are those costs directly associated with certification, i.e. external auditing costs (certification fees, administration fees and cost of audits), as well as internal costs (preparation and participation in process). Key factors driving direct costs of certification are:

- Location of audits (onsite vs online)
- Coverage of audits (random sampling vs comprehensive coverage; farm audits, document checks and/or interviews)
- Location of the certification body (CB) relative to the Certificate Holder (CH) (local vs wages abroad, travel costs for CB)
- Risk level application (auditor vs CSL)

Cost mitigation factors include recognition of EU standards and cross-compliance between CSLs, reducing audit durations and costs. While rare, CSLs accepting equivalency with other schemes can reduce the need for additional audits.

HARMONITOR deliverable D6.1 (direct and indirect costs) looked at these and other influencing factors in more detail, as well as estimated the direct costs of certification.

3.3.3 Indirect costs

The indirect costs of certification are the costs needed to upgrade the production and management system to meet the requirements set by the CSL. Their extent therefore depends on how well the company already aligns with certification requirements before starting the certification process. A scientific literature review allowed to identify the key driving factors for the indirect costs.

- Size and location of the company: literature often reports that smallholders and companies in low-income countries face higher costs and obtain lower benefits from certification compared to larger companies in high-income countries ((DeFries et al., 2017; Durst et al., 2006; So and Lafortezza, 2022). The high direct costs can be explained by the fact that many certification bodies are located in high-income countries, and therefore charge high prices compared to local currencies (Durst et al., 2006). The indirect costs are also often higher for low-income countries because of the complexity of local ecosystems, such as tropical forests, which require high management costs (Durst et al., 2016). Moreover, smallholders and companies in low-income countries often lack the financial and technical capacity needed for the certification process. As discussed in section 3.5, certification requires a lot of bureaucratic steps, documents collection, record keeping, etc., which need adequate capacity. Smallholders and companies in low-income countries often lack this and therefore need external support, which increases the costs.
- State of company pre-certification: the state of the company before certification is an important factor in determining the indirect costs associated with certification. As a result of the first auditing processes, the company is requested to implement corrective actions to meet the sustainability requirements of the CSL. The extent of these corrective action is therefore dependent on the state of the company prior to certification. Additionally, the company's existing capacity plays a significant role in determining the need for staffing and training, as well as the scale of these requirements.
- Supply chain element: upstream producers often face higher costs of certification when compared to downstream firms (Rossi et al., 2022). The lack of data on the indirect costs of certification for downstream firms is likely since these companies typically do not need to make substantial changes to their management or production processes in order to comply with certification standards. Consequently, downstream firms generally incur lower indirect costs than feedstock producers, whose operations may require more significant modifications to meet certification requirements.
- Type of supply chain model: Certified supply chains can operate under several models, including Mass Balance, where certified and non-certified materials are mixed but tracked to ensure certification is maintained; Segregation, which keeps certified and non-certified materials completely separate for strict traceability; and Book and Claim, where certification credits are traded rather than physical goods, offering flexibility but less direct traceability.

The supply model adopted influences the indirect costs of certification. In the case of palm oil, for example, the segregation model generally requires higher costs. This is due to the need for strict physical separation of certified and uncertified products throughout the entire supply chain. This includes additional investments in infrastructure, logistics, and monitoring systems at each stage, from production to final processing (Levin et al., 2012).

HARMONITOR deliverable D6.1 (direct and indirect costs) looked at these influencing factors as part of a literature review of costs and benefits of certification.

3.3.4 Deep dive: Factors influencing the costs of sustainability risk and land use change (LUC) assessment

A cost category that is not well understood, is the costs associated with risk assessment. Risk assessment is often an essential component of CSLs in the bioeconomy and generally focusses on the production of bio-based resources. These assessments help identify potential environmental, social and economic risks associated with the bio-based resource production. In this section, we provide a deep dive of the factors that influence the costs of risk assessment, separating sustainability risk assessment and land use change assessment.

Sustainability Risk Assessment (SRA) is a systematic process used to identify and evaluate the potential sustainability risks, by analysing different risk indicators. SRA helps to identify areas with high risk in the supply base.

Land Use Change (LUC) assessment is focused on verifying land use changes and determining the precise moment when a land use change took place in an area of interest. LUC assessment helps to exclude non-compliance within the supply base and to facilitate certification processes.

The costs associated with sustainability risk assessments are influenced by several factors (Table 2). First, it is important to identify and understand the scope, objectives, and the number of sustainability aspects that are required to be analysed in a sustainability risk assessment. Data availability plays also a significant role in estimating costs. Furthermore, it is crucial to consider the specifics of the assessed area. Not only the number of locations that must be analysed is relevant, but also their spatial extent. Additionally, procedural requirements such as audit, stakeholders' consultation, and information on the transparency and traceability of the supply chain are also relevant factor to be considered.

Table 2. Factors influencing the cost of sustainability risk assessment. Own elaborations.

Factor	Observation
Scope and objectives, complexity of the analysis	Number of components (key topics, issues and indicators to be considered in the risk assessment) to be considered in the risk assessment. The number of components influences the costs of the sustainability risk assessment, the higher the number of analysis components, the higher the costs. Examples of components that an analysis can include: - Land use change - Carbon Stock / GHG emissions - Biodiversity / High Conservation Values - Social / Due Diligence - Economical

	- Governance.
Data availability	Is the sustainability risk assessment performed based on open-source databases or are there any proprietary datasets required?
Number of locations to be analysed	The higher the number of locations, the higher the effort required for the assessment. Locations could be represented by plantation outlines, point(s) with defined radius or administrative unit of a country or of several countries.
Audit	Should the findings of the risk assessment be audited by a certified auditor or not?
Frequency of observation	Is the monitoring of the results required? If yes, what is the monitoring period? Regular monitoring over a certain period (e.g., monthly, seasonal) will require improved techniques, more datasets and it is more time-consuming, resulting in higher costs.
Stakeholders' consultation	Is the consultation with involved stakeholders required in the sustainability risk assessment?
Supply chain transparency and traceability	Is information on the transparency and traceability of the entire supply chain required in the sustainability risk assessment?

Regarding the number of components required in a sustainability risk assessment, for example, there can be sustainability risk assessments that focus solely on identifying the risk of land use change. In contrast, more complex sustainability risk assessments that go beyond land use change analysis might require additional relevant information, on topics like carbon stock or GHG emissions, biodiversity and areas with high conservation values, social and due diligence, economic aspects or governance characteristics. Collecting this information entails additional costs.

For carbon stocks and GHG emissions, for example, information on proximity or overlap with lands with high carbon stock is needed, and GHG emissions calculation might be of relevance and required. Information on proximity or overlap with lands with high biodiversity value or high conservation value might also be demanded as important aspects of sustainability risk assessments. Regarding the social and due diligence requirements, aspects like human and labour rights, labour practices, occupational safety and health, community engagement and relations are of high relevance. The sustainability risk assessment might be complemented with an analysis of the economic aspects of sustainability. Not least, elements like governance structure, compliance with laws, regulations and treaties might be relevant characteristics to assess the governance aspects.

Several factors influence the costs of land use change assessments, as presented in Table 3. Several specifics are very important to be considered, including the number of land use change types to be analysed, the cut-off date of the analysis, and the level of specificity (commodity-specific or not). A significant factor in desk-based land use change assessments (performed based on available remote sensing data and geospatial datasets) is the spatial coverage and distribution of the assessment area. Relevant to be considered here are the size and spatial distribution of the assessment area, but also any specific requirements related to the spatial resolution of the input datasets. The potential necessity of an audit, results monitoring, or complementary field work also influences the effort and, consequently, the cost of LUC assessments.

Crucial in determining the price scheme of the LUC assessment are the specifics of the assessment area: size, number, and spatial distribution. It is important to note that the larger, more heterogeneous, and less aggregated the location of the assessment area (e.g. plantation outlines), the higher the effort and thus also the higher the potential costs. Furthermore, in a LUC assessment, it is important to have knowledge of the focus area and to determine

whether it is sufficient to conduct the analysis solely on the production area or if it is necessary to encompass the entire plot area in the analysis. These two distinct requirements directly influence the complexity of the LUC assessment as well.

Scheme vs. company-developed risk assessments

The development of risk assessments can either be carried out by the CSL themselves or the company under certification. CSLs, such as FSC and SBP, mainly develop their risk assessments centrally at country level and ask for companies to make use of them for managing the risks of their sourcing base. In this case, indirect costs are likely to be associated with the implementation of risk mitigation measures. Only in case no risk assessment has been developed for a relevant country and supplier base, the companies will have to develop risk assessments themself, following the risk assessment framework developed by the CSL.

While centrally developed risk assessments offer efficiency and a reduced costs for the users, the time and costs associated with the developing of risk assessment at CSL level is still substantial and has lead to several CSL and other organisations to go together under the Risk Information Alliance (RIA) to try to align risk assessment frameworks and share costs. While still in the early stages of framework alignment, the Risk Assessment Alliance does reflect the interest and need for reducing costs across CSLs.

Table 3. Factors influencing the cost of land use change assessments. Own elaborations.

Factor	Observation
Complexity of the analysis	Number of LUC types to be analysed. Is there only deforestation analysis required or more land use change types should be analysed? (e.g. grassland conversion, tree plantations conversion, etc.). The higher the number of LUC types to be analysed, the higher the costs.
Cut-off date of the analysis	The longer the period of analysis, the higher the costs. Also, the earlier the cut-off date, the higher the costs because satellite images are scarcer.
Spatial coverage and distribution	
• Size of the assessment area	The bigger the area, the higher the potential costs.
• Number of locations to be analysed	The higher the number of locations, the higher the effort, thus the costs.
• Spatial distribution of the assessment area	Number of farms to be analysed and their spatial distribution. For example, it is important to know if the farms are aggregated, located close to each other or spread over large areas. The spatial distribution of the assessment area influences the remote sensing data required for processing. For example, it influences the number of Landsat or Sentinel tiles that are required to cover the entire assessment area (the bigger the assessment area, the higher the number of required Landsat / Sentinel tiles).
• Spatial resolution	Is there a minimum threshold regarding the spatial resolution required in the land use change assessment? In case the threshold if less than 10 meters, satellite products are more likely to be proprietary, which would imply the need to be purchased.
• Production area x property area	Is it sufficient to conduct the analysis solely over the production area, or does the assessment requires encompassing the entire plot area?
Level of specificity	Is the LUC analysis commodity specific?
Audit	Should the findings of the land use change assessment be audited by a certified auditor or not?
Frequency of observation	Is the monitoring of the results required? If yes, what is the monitoring period? Regular monitoring over a period (e.g., monthly, seasonal) will require improved techniques, more datasets and it is more time-consuming, resulting in higher costs.

Field work	Is field work required to complement the desk-based land use change assessment? For very specific land uses and conversions (e.g., types of forest or crops), fieldwork may be necessary to verify and complement the results at specific locations.
Data processing requirements	
• Software requirement	Does the selected methodology require the use of paid software, tools or systems? For example, using Google Earth Engine for data processing necessitate acquiring a commercial license.
• Hardware requirement	Will the project create a significant amount of new data? Is there more HD space necessary? The need for more powerful workstations (e.g., with GPU) can also be included here.
• Cloud storage and/or processing	Is there the need for cloud storage and/or processing (e.g., Google Cloud Bucket, AWS, etc.)? Using a cloud storage and/or processing might necessitate acquiring a commercial license.
• Maintenance	Maintenance steps like updating the algorithm, or creating the dataset for new years, or others, might increase the processing effort, leading to higher costs.

3.3.5 Benefits

Whether, what and how much benefits are obtained from getting certified depends on various influencing factors, such as market conditions, regulatory environment, support government policies, long-term considerations and whether and how environmental impacts are valued or even monetarized. Benefits are strongly affected by market conditions. High demand for sustainable and/or certified products can amplify price premiums, market access and competitive advantage. Also, the regulatory environment of the country where biomass resources or biobased products are produced also affects benefits. In countries with already stringent environmental laws or requirements, the preparations for and changes in production processes because of certification are likely smaller than in countries where that is not the case. Similarly, supportive government policies, including incentives for sustainable practices, can also boost the benefits of certification. In the long term, investment in more sustainable practices as well as better monitoring of production processes, incl. input and output data, can improve operational efficiency and reduce costs. However, as these benefits may only be obtained in the long run, they may not be directly linked to certification.

The main purpose of sustainability certification is to reduce environmental and socio-economic impacts of the bioeconomy. Certification scope and requirements affect what sustainability benefits are achieved. For example, more rigorous standards can lead to greater environmental benefits. However, more rigorous standards may also require more substantial changes and investments, which means that the net financial benefit may not necessarily be higher.

At the moment, the environmental and socio-economic impacts of the bioeconomy are not reflected in the market price of biomass resources or biobased products, which is why these impacts are also called externalities. Also a reduction in impacts as a result of certification are not normally valued in monetary terms. However, doing so may further clarify the value and/or financial benefit of impact reduction as a result of certification. In HARMONITOR Task 6.3 (see deliverable D6.2, environmental externalities of the EU bioeconomy), we analysed the environmental externalities of the EU bioeconomy (GHG emissions, water use and land use) and made first estimates of the affect of internalizing these externalities on industry sector profits, i.e. incorporating the monetary value of environmental impacts as a cost subtracted from the profits. This illustrated that the environmental impacts are especially large for some sectors (dairy and meat) and that the effect can be up to 40% of the sectors profits. Due to

data limitations in terms of trade of certified products (see also HARMONITOR deliverable D3.3, Trade flows of biological resources, bio-based materials and products) as well as still limited quantifications and large variability in the environment impact reduction as a result of certification, it was not possible to consider the effect that certification may have on externalities of the EU bioeconomy. As a result, this could also not be further incorporated in the present analysis of the economic feasibility of certification.

3.4 Cost benefit analysis

In the following, for each case study (palm oil, wood and cotton) the results of the cost-benefit analysis are presented.

3.4.1 Palm oil

This section examines the costs and benefits of RSPO certification across three categories of palm oil producers: scheme smallholders, independent smallholders and large producers.

Costs and benefits of certification

Table 4 presents the main costs associated with obtaining RSPO certification, expressed in Euros per hectare. The indirect costs constitute the largest share of certification expenses for all producer groups, with their magnitude depending largely on the pre-certification conditions of the farm. In contrast, direct costs appear to be proportionally higher for smallholders compared to larger growers, suggesting that larger plantations benefit from economies of scale.

Table 4. Initial costs of certification for different categories of palm oil growers. Data source indicated in the table. Own calculations.

Cost item	Cost type	Scheme smallholder [Euro/ha]	Independent smallholder [Euro/ha]	**Large producers ~50,000 ha [Euro/ha]**
Membership	Direct	0.00[a]	0.25	0.04
Audit costs	Direct	10.44	11.36	1.43
Staffing and training	Direct	0.00[a]	3.17	3.56
Environmental, social assessments	Indirect	-	-	2.95
Standard compliance/corrective actions	Indirect	2.80	5.27	12.22
Organisation and ICS	Indirect	1.89	32.83	-
Document recording collection	Indirect	8.40	1.38	-
Total direct costs	Direct	10.44	14.78	5.03
Total indirect costs	Direct	13.09	39.48	15.16
Total costs	Total	23.53	54.26	20.19
Share direct costs	Direct	44%	27%	25%
Share indirect costs	Indirect	56%	73%	75%
Data source	-	Hidayat et al., 2016	Hidayat et al., 2016	Levin et al., 2012; WWF, 2022
Plantation area in original data source	-	3.9 ha	3.87 ha	50000 ha

a – in the case of scheme smallholders, the membership costs and the costs for trainings are covered by the associated plantation company.

After obtaining certification, companies incur some maintenance costs, such as surveillance audit costs, that are typically 33-57% lower than the initial certification costs (Levin et al., 2012). Table 5 shows the maintenance annual costs for the four categories of producers, as well as the price premium collected from literature.

The price premiums received by the producers' categories vary. This is probably because data was collected from different studies conducted in different years and countries. Premiums normally vary depending on the supply chain model adopted by farmers, with book-and-claim credits offering the lowest returns and segregated and identity-preserved models the highest. Moreover, palm oil prices are influenced by supply-demand dynamics, competing vegetable oils, and global market trends. Despite certification, many smallholders continue to sell their palm oil as conventional due to low demand for certified products (Voora et al., 2023). All this influences the price premium that farmers receive and explains the variations observed across studies.

Table 5. initial costs of certification, ongoing costs, and price premiums shown as Euro/ha

Item	Scheme smallholder [Euro/ha]	Independent smallholder [Euro/ha]	**Large producers ~50,000 ha [Euro/ha]**
Initial costs	23.5	54.3	20.2
Maintenance annual costs	12.9	29.8	11.1
Price premium	10.2	34.8	30.3

Although price premiums are not the only benefit of certification, they play an important role in determining its economic feasibility, especially for smallholders (Hidayat et al., 2016). Table 6 show the results of the benefit/cost ratio calculated for the four categories and confirm the importance of price premiums.

Table 6. Costs and benefits of certification for grower categories. Own calculations (NPV with a discount rate of 13%).

Item	Scheme smallholder [Euro]	Independent smallholder [Euro]	Large producers ~50,000 ha [Euro]
Investment cost	92	210	1,009,475
Maintenance annual costs	50	115	555,000
Annual price premium	40	135	1,514,062
Present value cost	238	545	2,620,830
Present value benefit	159	539	6,052,540
NPV	-79	-7	3,431,710
B/C ratio	**0.67**	**0.99**	**2.31**
B/C Sensitivity analysis price premium[a]	**1.66**	**0.72**	**1.94**

a – The same price premium is applied to all three producer categories, using average price premiums reported in (Voora et al., 2023)

Price premiums are the only monetary benefits of RSPO certification consistently reported in the analysed literature and are therefore the only benefits accounted for in the benefit/cost ratio. The results indicate that, in most cases, the premiums outweigh the costs of certification, particularly when equal premiums are assumed for all producer groups, as shown in the sensitivity analysis (Table 6). Under this assumption, certification appears to be profitable for scheme smallholders and large producers, with larger producers benefiting more than smaller ones.

Scheme smallholders seem to benefit from the planation company covering some of the costs associated with certification - the B/C ratio is higher for scheme smallholders than for independent smallholders when assuming uniform premiums. However, their actual profitability is likely lower, as scheme smallholders typically receive only a portion of the premium, with the remainder allocated to the affiliated company. This highlights the importance of premium distribution in determining the true economic benefits of certification.

3.4.2 Wood

The costs and benefits of forest certification were investigated with focus on FSC and PEFC as applied in Europe. We focussed on Sweden as a country with large forests and a well-developed forest industry[3]. The certification costs depend strongly on the size of the certified forest and the number of management units (MUs). In this case study, we made calculations of the costs and benefits of a 50,000-hectare Swedish forest that has one owner with a single management unit, or with 50 management units, to show the impact of the number of management units. To compare group certification with single owner certification, we assumed a forest management certificate covering 50,000-hectare forest and 100 group members. The approach is further described in section 3.2.5 and the estimation of the direct and indirect costs of certification are elaborated in Appendix A.4. The cost-benefit analysis was conducted for two situations regarding how opportunity costs of set aside areas are considered:

- Situation 1, with 0% productive set aside areas, in which there are no opportunity costs because the set aside area cannot be harvested anyway also in absence of certification, and
- situation 2, with 100% productive set aside areas, in which the opportunity costs are maximal because – in absence of certification - the whole set aside area would be harvested with the same yield as the rest of the forest area.

Situation 1 – set aside area with no opportunity costs

Table 7 shows the costs and benefits of forest certification in case the set aside area is not productive, meaning that there are no opportunity costs. In this situation, FSC certification gives the highest benefits because of the higher price premium compared to PEFC. Group certification has the lowest net benefit, because of the higher direct and indirect management system costs.

Table 7: Cost-benefit analysis of FSC and PEFC certification of a 50,000-hectare forest area, assuming unproductive set aside areas, and therefore no opportunity costs (€/year). Source: own elaboration.

Costs and benefits	FSC			PEFC		
	Single MU[a)]	Multiple MU[a)]	Group	Single MU[a)]	Multiple MU[a)]	Group
Direct cost- audit preparation and audit	5,850	13,725	28,350	5,850	13,725	28,350
Indirect costs - management system costs	10,000	20,000	30,000	10,000	20,000	30,000
Indirect costs - opportunity costs	-	-	-	-	-	-

[3] General background on the level of certification, ownership (public, private), area per FSC certificate, number of management units per owner, area per management unit or group member in Sweden and the Netherlands can be found in the case study on wood certification in 3-CO deliverable D1.5 Cost and relevance of LCS for the bioeconomy, https://3co-project.eu/public-deliverables/

Total costs of certification	15,850	33,725	58,350	15,850	33,725	58,350
Total benefits (due to price premium)	111,756	111,756	111,756	81,954	81,954	81,954
Net benefit of certification	**95,906**	**78,031**	**53,406**	**66,104**	**48,229**	**23,604**

[a)] management unit, a spatial area or areas submitted for certification with clearly defined boundaries managed to a set of explicit long term management objectives which are expressed in a management plan. (Source: FSC Glossary of terms)

Situation 2 – set aside area with full opportunity costs

Table 8 shows the costs and benefits of FSC and PEFC certification in case the whole forest area consists of 100% productive forest, leading to high opportunity costs, as the 5% (PEFC) and 10% (FSC) area result in a full loss of yield compared to a forest that is not certified. In this situation, the price premium and associated benefits are not high enough to outweigh the opportunity costs, resulting in a net loss in case certification is applied. In this case, forest certification may still be applied, for example to guarantee market access, or for a green image.

Table 8: Cost-benefit analysis of FSC and PEFC certification of a 50,000-hectare forest area, assuming 100% productive set aside areas, and therefore maximal opportunity costs (€/year). Source: own elaboration, assumptions described in main text.

Costs and benefits	FSC			PEFC		
	Single MU	Multiple MU	Group	Single MU	Multiple MU	Group
Direct cost- audit preparation and audit	5,850	13,725	28,350	5,850	13,725	28,350
Indirect costs - management system costs	10,000	20,000	30,000	10,000	20,000	30,000
Indirect costs - opportunity costs	331,128	331,128	331,128	165,564	165,564	165,564
Total costs of certification	346,978	364,853	389,478	181,414	199,289	223,914
Total benefits (due to price premium)	111,756	111,756	111,756	78,643	78,643	78,643
Net benefit of certification	- 235,222	- 253,097	- 277,722	- 102,771	- 120,646	- 145,271

Impact of variation in opportunity costs on net benefit of certification

Given that situations 1 and 2 are both extremes, it has been investigated at what level of productivity of the set aside area, the net benefit of forest certification is above or below zero. Figure 3 shows the net benefit of forest certification, related to relative yield of the set aside area (in % of total yield per hectare compared to the rest of the forest). In situation 1 the set aside area has a relative yield 0%, represented by the left of the x-axis; situation 2, with a set aside area as productive as the main forest (100% yield per hectare compared with the rest of the forest) is represented by the right part of the x-axis. Depending on the type of certification scheme (FSC or PEFC) and single MU/multiple MU/group case, a positive net benefit is found if the yield of the set aside area is below 20 – 45% compared to the yield per hectare of the main forest. It can be observed that the slopes of the PEFC cases are less steep than of the FSC cases. This is because of the lower opportunity costs and lower price premium of PEFC.

In Figure 4 it is estimated what price premium (in % of the wood price) is needed to cover all opportunity costs in the different levels of productivity of the set aside area. The figure clearly

shows that FSC-certification requires a higher price premium than PEFC-certification. This is because there is a higher opportunity cost related to the larger set aside area (10%) required by FSC compared to the case of PEFC (5% set aside area). In Figure 10 the price premiums have been translated to a price in €/m^3 wood, assuming an average sales price of 66 €/m^3 wood excl. bark.

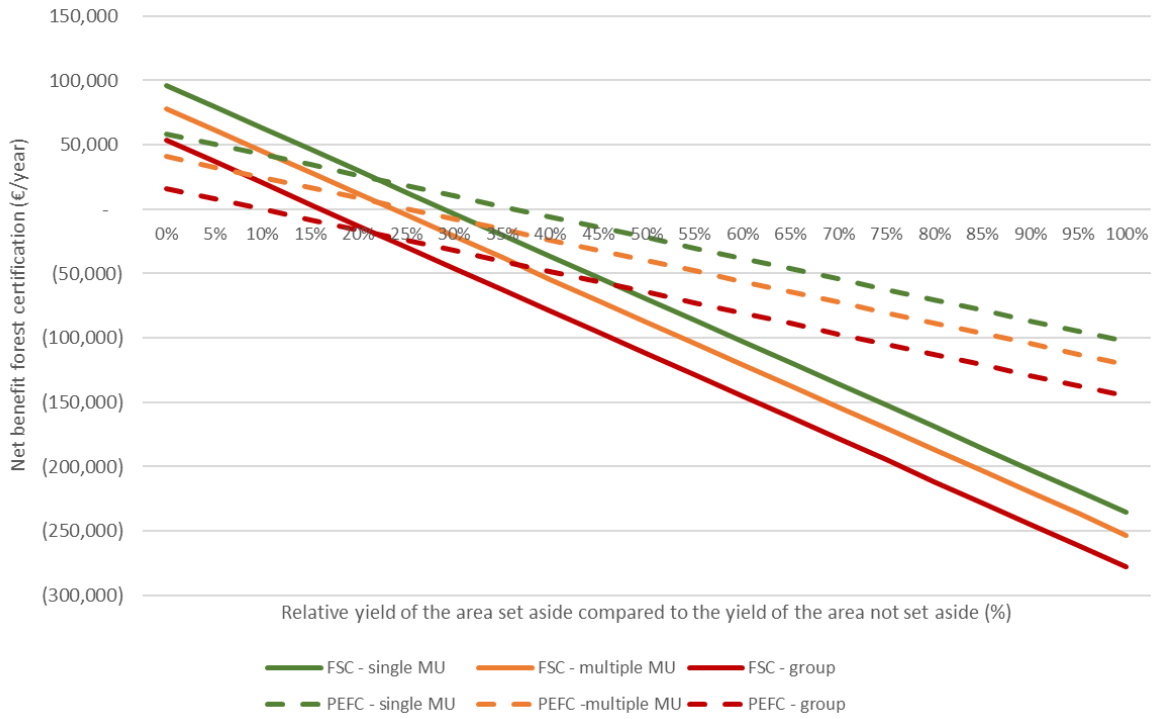

Figure 3: Net benefit depending on opportunity costs related to relative productivity of the set aside area (in % of total productivity of the rest of the forest) at price premium of 3.75% for FSC wood and 2.50% for PEFC wood of a 50,000-hectare forest certificate

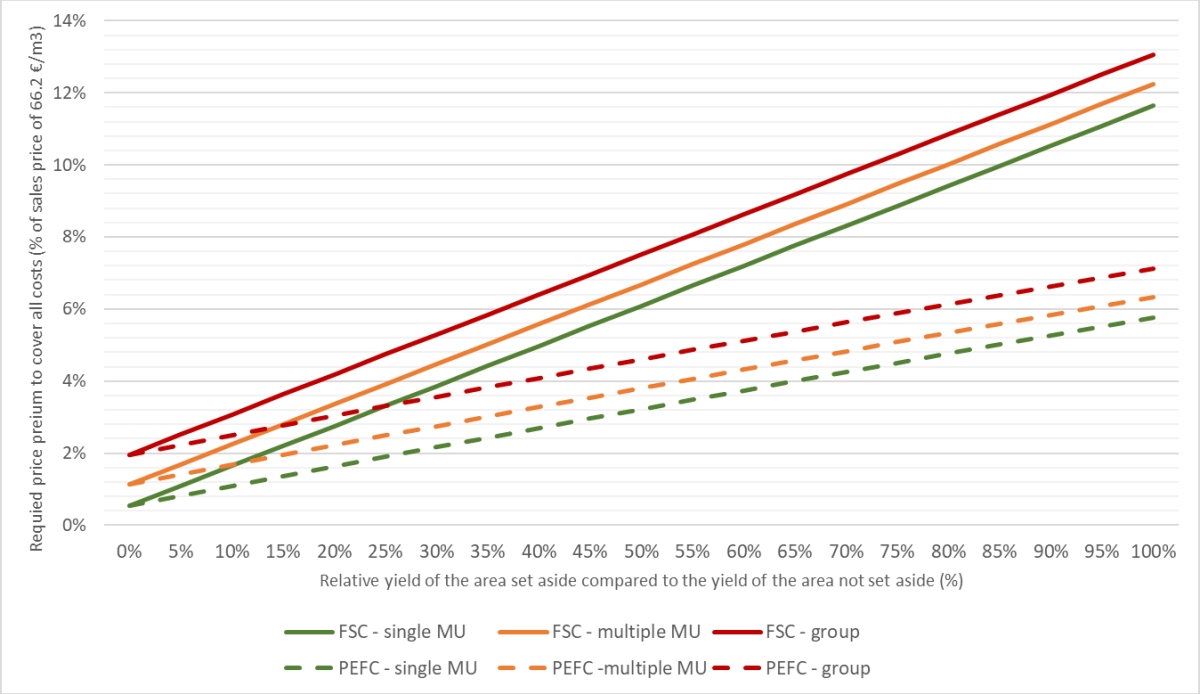

Figure 4: Required price premium to cover all costs of certification, depending on the relative productivity of the set aside area in % of total productivity of the rest of the forest, assuming an average sales price of 66 €/m³ wood excl. bark. Source: own elaboration

The relative yield per hectare of the set aside area in absence of certification compared to the rest of the forest, and the associated opportunity cost is one of the main drivers for the outcome of this cost-benefit analysis. A net positive benefit of certification is only reached in case the yield per hectare of the set aside area is below 20-40% of the yield per hectare of the rest of the forest.

In case of low productive set aside areas (in this case study yields below 20% of the yield of the non-set aside area) FSC gives higher benefits because of the higher price premium. In case of high productive set aside areas (in this case study yield of more than >40% of the yield of the non-set aside area) compared to PEFC gives a higher benefit or - better formulated - a lower loss because of lower opportunity costs related to a lower set aside area (5%) compared to FSC (10%).

The cost benefit calculation clearly shows that in case of a 50,000-hectare forest, if managed by a single owner, is less expensive than group certification of a similar forest area. However, from the perspective of the group member, i.e. an owner of a smaller forest of say 500 hectares, group certification is expected to be the only option to get certified at reasonable costs. From forest owner perspective, group certification has the advantage that not all group members have an audit visit each year. The cost for the group member depends on the fees demanded by the group member.

The case study shows the mechanism of opportunity costs versus price premium, and their dependence on the relative yield of the area set aside. The exact outcomes of the calculations will differ from case to case and should not be generalised. Also, it is stressed that the many - especially public - forest owners may not calculate opportunity costs in the way as presented in this case study as they have no intention to harvest 90% or more of their certified forest anyway. Also, for many forest owners the price premium may not be the first driver to certification. Certification may be a prerequisite for having access to markets, to secure

internally proper sustainable practises, or to show sustainable forest management to a broader audience.

3.4.3 Cotton

This section focuses on the costs and benefits of cotton certification. The economic feasibility of two certification schemes, Better Cotton and organic cotton, are compared to conventional cotton. The certification schemes are inherently different in terms of design and implementation, and it is therefore important to first explain these differences.

Better Cotton aims to engage a large number of farmers by making the scheme very accessible (Better Cotton, 2023b). Its nature is rather informative than restrictive, focussing on farmer learnings instead of a binary pass/fail system. Regarding costs, it is important to mention that their certification costs do not lie with the farmer (free for farmers with an area of up to 200 ha of cotton) but with the retailers and brands that sell Better Cotton via the Growth and Innovation Fund (Better Cotton, 2024). Farmers can therefore simply become members by following the training sessions about sustainable farm practices and decent work, which they are urged to implement. Due to the flexibility of Better Cotton towards their criteria and indicators, obtaining a license is comparatively straightforward. This raises concerns about the actual credibility, and benefits of the label for the primary producers.

Organic cotton certification has a high participation barrier due to its strict regulation on farming practices (Indian Organic, n.d.), such as the prohibited use of genetically modified organisms (e.g. seeds), toxic or persistent pesticides, and synthetic fertilizer. Moreover, there is an additional three-year conversion period before the land can officially be certified as organic. This entails costs for farmers, while potential price premiums for organic cotton can only be received after the transition period of thee years.

Direct costs and indirect management system costs of cotton certification

The structure of the Better Cotton CSL (Better Cotton, n.d.) ensures that primary producers are exempt from bearing the direct costs of certification. Instead, these costs are covered by the end of the supply chain, where brands that use Better Cotton pay a fee that facilitates this free training-based system for primary producers. Therefore, the direct costs and indirect management system costs of Bette Cotton are not mentioned in Table 9. Contrarily, organic cotton producers are obliged to pay direct certification costs themselves. Alongside the direct costs of certification, there are indirect costs associated with compliance to management system criteria. These costs are only paid by the farmers in man hours for Better Cotton while they are monetized for obtaining the organic farming certification and are therefore presented in Table 9.

The scenario of this case study is based on (organic) group certification regulations. Specifically, an Internal Control System (ICS) of 500 farmers, each managing an average area of 2 hectares, as described in Section 3.2.5. The direct costs for organic certification are summarised in Table 9.

Table 9 Direct costs and indirect management system costs for organic certification of an ICS of 500 farmers [Euro/year for ISC]. Data source: own elaboration and calculations.

Cost item (Euro/year)	Audit costs	Staffing and training	Scope certificate	Certification fee	Data collection ICS	Domestic transaction certificate	Total
Direct costs	354	-	23	202	-	12	591
Indirect management system costs	-	7,000	-	-	1,256	-	8,256
Total	354	7,000	23	202	1,256	12	8,847

Indirect costs of compliance with performance criteria cotton certification

Better Cotton and organic cotton have different certification requirements, each involving varying compliance costs. These indirect compliance costs arise from meeting the ecological and social performance criteria for each CSL.

Table 10 represents these indirect compliance costs with an emphasis on material and labour costs as well as the cost of conventional cotton production (as determined from de Hoop et al. (2019), see also Section 3.2.5). The last row of Table 10 shows the total indirect cost of certified cotton production compared to conventional cotton production. The negative value could be interpreted as a monetary benefit of Better Cotton and possibly be attributed to a reduction in fertilizer and pesticide use that is stimulated during Better Cottons sustainable farmer training.

Table 10 Indirect cost of cotton production per CSL expressed in Euro/ha, source De Hoop et al. (2019). The indirect cost of compliance with the performance criteria of the CSL (last row) is determined by the difference between Better Cotton or organic cotton certification compared to conventional cotton.

Indirect cost per category (Euro/ha)	Better Cotton	Organic Cotton	Conventional Cotton
Total Material costs	**516**	**712**	**593**
Value of purchased seed	8	8	10
Value of organic manure [a]	43	350	49
Value of chemical fertilizer	139	65	166
Value of chemical pesticide	148	44	168
Value of organic pesticide	1	32	0
Expenditure on irrigation	27	54	43
Expenditure on transportation	17	13	17
Other material expenditure	12	8	11
Expenditure on hire/use of bullocks	4	9	6
Expenditure on Tractor rental	41	44	46
Non specified material costs	78	85	77
Total Labour costs	**1,266**	**1,436**	**1.232**
Wage labour costs	829	806	777
Family labour value[b]	437	629	455
Total indirect cost of cotton production	1,345	1,518	1,371

Indirect cost of compliance with performance criteria CSL (comparison certified vs. conventional cotton production)	-26	148	n.a.

a. During expert interview (CB5),it was stated that on average one cow can produce organic manure for the cultivation of one hectare of cotton. Therefore, it is common practice for farmers to keep two cows as an alternative to monetary expenses for purchasing organic manure. Excluding this expense, the total indirect costs of cotton production would be lower than those associated with conventional cotton, indicating a monetary benefit.

b. De Hoop et al. (2019) and insights from expert interviews (CB5,CSL2), indicate that family labour is typically unpaid in this sector. Given this is common practice, it is considered more accurate to exclude the value of family labour from further indirect cost calculations.

The most distinct categories have been selected and presented in Figure 5. The figure shows that Better Cotton has lower material costs and higher wage labour[4] costs both in line with the sustainable farm practices of the CSL. Organic cotton shows higher material costs that can mainly be attributed to the high value of organic manure (see also note a. in Table 10), and higher wage labour costs.

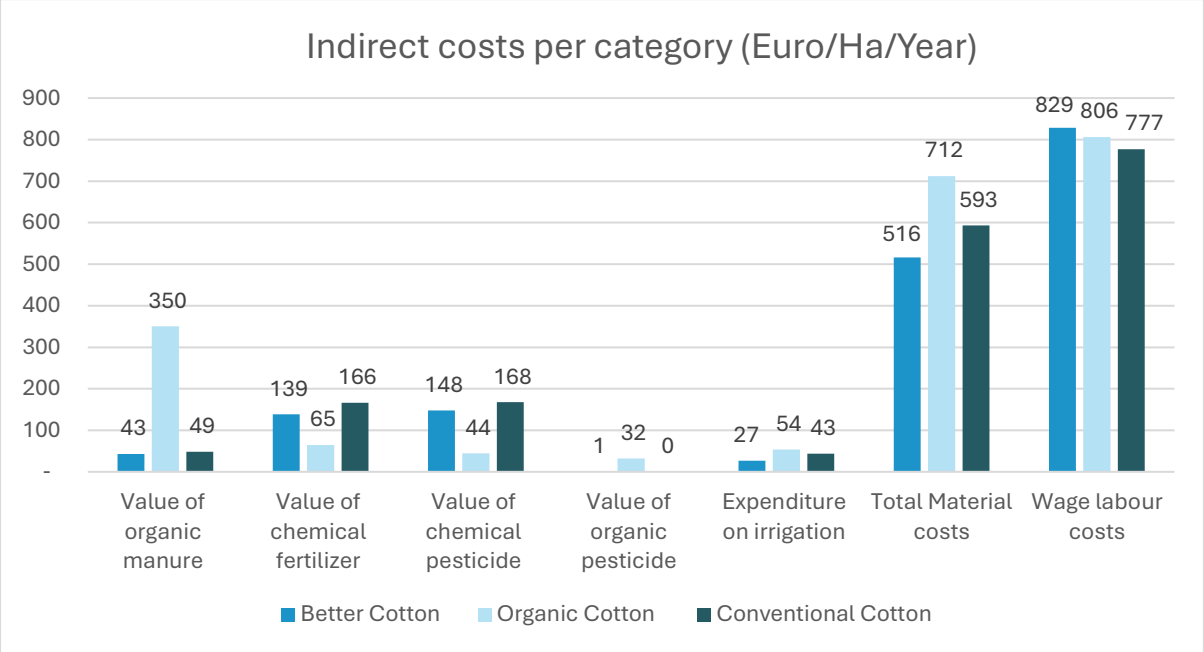

Figure 5 Indirect costs of compliance of cotton production per category, source De Hoop et al (2019).

For organic cotton it is possible to calculate the share of the total costs of organic certification that is directly associated with certification (direct costs for organic group certification). This is found to be 0.4% (Table 11). The direct costs are fairly low due to the organic group certification where the costs are calculated for 500 farmers with an average area of two hectares. The main certification costs are the indirect costs of certified cotton production compared to conventional cotton production as elaborated in Table 10 and Figure 5.

[4] Wage labour refers to labour paid to a person working on the farm and distinguished from family labour that is not typical paid a wage (de Hoop et al. 2019).

Table 11 Share direct - indirect costs of organic cotton certification, source own calculation

Certification cost	Organic Cotton
Total direct costs (Euro/ha/year)	0.6
Indirect management system costs (Euro/ha/year)	8.3
Total indirect cost of certified cotton production compared to conventional cotton production (Euro/ha/year)	148
Share direct costs/ total costs (%)	0.4%

Benefits of cotton certification

The quantitative benefits associated with the CSLs are compared based on the market price data provided by Texpro (2025a, 2025b, 2025c) and yield data from De Hoop et al. (2019), resulting in a total revenue of the ICS (see Table 12). The yield data, however, presents certain discrepancies. Due to these discrepancies and the subjective nature in the majority of the literature reviewed as detailed in section 3.2.2, two extra scenarios are introduced.

In the case of Better Cotton, data from De Hoop et al. (2019) indicates an average yield reduction of -10.4% compared to conventional cotton. This differs from claims by Better Cotton that their field training improves yields through better farming practices. Since it is unlikely that the negative yield gap noted by De Hoop et al. (2019) only stems from Better Cottons training, an extra scenario is introduced where Better Cotton is assumed to have the same yield as conventional cotton, see Table 12 column 3.

Findings from De Hoop et al. (2019) indicate that the average yield of organic cotton is statistically comparable to that of conventional cotton. Variations in climatic conditions may be a factor of influence explaining the low difference found between organic and conventional cotton. Typical organic farming observations, however, generally report lower yields of organic cotton compared to conventional cotton. The Organic Cotton Accelerator (OCA) states that a yield reduction of 7% is common in organic farming compared to conventional cotton. Therefore, an additional scenario is introduced that assumes a 7% lower yield for organic cotton relative to conventional cotton, see Table 12, column 5.

Table 12 shows that the revenue difference between certified and conventional cotton is influenced by the average yield and price premium. In the low-yield scenario, Better Cotton generates lower revenue compared to conventional cotton. Due to the small price premium compared to organic cotton, a marginal decrease in yield of Better Cotton would result in a lower revenue than that of conventional cotton. The organic price premium provides a higher revenue in both scenarios with high and lower yield.

Table 12 Quantitative benefit per scenario, Source: Market data from Texpro, yield data from De Hoop et al. (2019) and own calculations.

	Scenarios				
	Better Cotton	Better Cotton with conventional cotton yield	Organic Cotton	Organic cotton with OCA yield	Conventional Cotton
Average price (Euro/kg)	1.85	1.85	2.29	2.29	1.81
Average yield (Kg/ha)	1,705	1,903	1,893	1,770	1,903
Total revenue (Euro/ha)	3,153	3,518	4,331	4,048	3,447

Total Revenue ICS (Euro/year)	3,152,598	3,518,116	4,330,611	4,048,499	3,447,043
Revenue difference between certified and conventional cotton (Euro/ha)	-294	71	884	601	n.a.

Cost-benefit analysis

The cost-benefit analysis is based on a case study using an ICS comprising a cohort of 500 farmers, each managing an average area of 2 hectares. The total costs and benefits were calculated over the entire system.

Table 13 shows that there is a difference between the economic feasibility of certified and conventional cotton cultivation. Specifically, the analysis indicates that under low-yield conditions with Better Cotton certification (see “Benefits of cotton certification” paragraph above), the price premium and associated benefits are not high enough to offset the applied better farming practices. However, when yields are assumed to approximate conventional cotton, Better Cotton obtains a marginal net benefit of certification.

Contrarily, organic cotton shows a considerably larger net benefit compared to conventional cotton, even when accounting for the typical yield reductions associated with organic production. These findings suggest that more restrictive CSLs correspond to higher financial benefits compared to less restrictive schemes such as Better Cotton.

Table 13 Cost-benefit analysis of certified vs conventional cotton. Source: own calculations

	Better Cotton	**Better Cotton with conventional yield**	**Organic Cotton**	**Organic cotton with OCA yield**	**Conventional Cotton**
Total revenue (Euro/ISC/Year)	3,152,598	3,518,116	4,330,611	4,048,499	3,447,043
Total costs (Euro/ISC/Year)	1,344,649	1,344,649	1,527,321	1,527,321	1,370,487
Net benefit (Euro/ISC/Year)	1,807,948	2,173,467	2,803,289	2,521,178	2,076,557
Net benefit difference between conventional cotton (Euro/ISC/Year)	-268,608	96,910	726,733	444,621	-
Net benefit (Euro/ha/Year)	1,808	2,173	2,803	2,5 21	2,077
Net benefit difference between conventional cotton (Euro/ha/Year)	-269	97	727	445	-
Net benefit difference between conventional cotton (%)	-13%	5%	35%	21%	-

When evaluating the financial feasibility of certification, in case of organic cotton, it is valuable to asses the net benefit over time since it requires an upfront investment, i.e. direct certification costs and indirect cost for organic farm practices coupled with a mandatory three-year conversion period. Consequently, the price premium linked to organic cotton is only realized from the fourth year onwards. Table 14 shows that during the initial three-year conversion

period, the primary producers incur a net loss, i.e. a lower net benefit compared to conventional cotton production.

Table 14 Cash flow over time, source own calculations (Euro/ISC/year)

	Cash flow over time	Transition period	Certified organic period
	years	1-3	4-10
Conventional	Costs	1,370,487	1,370,487
	Revenues	3,447,043	3,447,043
	Net benefit	2,076,557	2,076,557
Organic	Costs	1,527,321	1,527,321
	Revenues	3,429,137	4,330,611
	Net benefit	1,901,815	2,803,289
	Net benefit difference with conventional	-174,741	726,732
Organic with OCA yield	Costs	1,527,321	1,527,321
	Revenues	3,205,750	4,048,499
	Net benefit	1,678,429	2,521,178
	Net benefit difference with conventional	-398,128	444,621

In order to assess the profitability of the organic cotton investment, an NPV and IRR are calculated over a period of 10 years. Table 15 shows that both organic with a yield comparable to conventional cotton and organic cotton where the yield is assumed to be reduced with 7% compared to the conventional yield have a positive value. This positive NPV suggests that the investment is expected to generate a net profit. The IRR is higher when a high yield is assumed, which is in line with expectations since a higher net benefit implies that the investment can generate returns more quickly. Although the survey from De Hoop et al. (2019) showed that the yield of organic cotton is as high as the yield of conventional cotton, given that the OCA itself indicates that the yield of organic cotton growing is 7% less than conventional cotton, we believe the associated IRR of 23% is the most plausible.

Table 15 Profitability of organic certification of ICS of 500 farmers over 10 years, Source: own calculations

	NPV (€/ICS)	IRR (%)
Organic	1,814,911	72%
Organic with OCA yield	422,764	23%

The financial feasibility of the CLSs Better Cotton and organic cotton is mostly determined by the price premium paid for the certified cotton and the yield of cotton. Due to the structure of the Better Cotton scheme, there are no direct costs for the farmer. Still, the indirect costs i.e. the cost for implementing the sustainable farming practices, are only offset when a similar yield to conventional cotton is reached. Table 13 shows that a Better Cotton farmer in a low yield scenario has 269 Euro/ha/year less benefit than conventional cotton, corresponding to a decrease of 13% of benefits. When the yield is comparable to conventional cotton, this scenario results in an increase in benefits of 97 Euro/ha/year compared to conventional cotton, a +5% increase in benefits.

Organic cotton has stricter sustainability criteria and certification requirements, resulting in higher direct and indirect costs (Table 13). However, the price premium offered to organic cotton results in a considerably larger net benefit compared to conventional cotton, even when accounting for the typical yield reduction associated with organic production. Table 13 shows that an organic farmer in a low yield scenario has 445 Euro/ha/year more benefit than conventional cotton, corresponding to a +21% increase in benefits. In a scenario where organic cotton has a similar yield to conventional cotton, the scenario results in an increase in benefits of 727 euro/ha/year compared to conventional cotton, equivalent to +35% increase in benefits.

Organic cotton requires an upfront investment where the mandatory three-year conversion period is the main driver for a net loss (Table 14). The NPV and IRR (Table 15) show the profitability of the organic cotton investment over time. Both have a positive value, indicating that the investment is expected to generate a net profit.

The numerical estimates presented in this cost-benefit analysis are derived from a synthesis of literature, expert interviews, market data and necessary assumptions. Given the price volatility of the cotton market and the susceptibility of the yield to climatic variations, in practice the presented costs and benefits are expected to differ considerably from year to year.

3.5 Barriers

Companies along biobased supply chains face barriers and challenges that limit the feasibility of certification. Based on information collected from literature and in-depth interviews, we divided the challenges into four main categories, shown in Table 16 and discussed in more details below.

Table 16 Overview of barriers for companies

Barrier category	Examples	Mitigation measures
Financial barriers	• High costs of certification • Low economic benefits	• Financial support from government and other companies along the supply chain
Market barriers	• Price premiums not always received • Low demand for certified feedstock/products	• Policies to increase market uptake of certified products • Inform consumers
Operational barriers	• Bureaucratic process • Low education level • Lack of technical knowledge	• Trainings • Technical support by governments and/or companies along supply chain
Governance barriers	• hard to apply certification requirements to local context	• Stakeholders involvement in CSLs standard setting procedures

Operational barriers

Most interviewees indicated operational challenges as the main barrier to certification. Operational challenges include extensive bureaucratic requirements, which can be time-consuming and complex for producers to navigate (Brako Dompreh et al., 2021). Additionally, limited education and technical knowledge among farmers, particularly independent smallholders, present a significant challenge. Many smallholders lack the expertise to implement good agricultural practices, which are essential for meeting certification standards (Brandi et al., 2015; Brako Dompreh et al., 2021). This knowledge gap further limits their ability to comply with certification requirements and benefit from sustainable production practices. CS1 explained it based on their experience as a consultant:

"*I worked with various companies in Indonesia and I always heard about how much work it is filling out forms, writing reports, conducting audits. It's a lot of work also to comply to all the principles and criteria, for example with RSPO but also ISCC. Companies often have different types of certifications. ISCC, RSPO, ISPO and although some of the principles and criteria are overlapping, so they can combine the workloads for different certification schemes, it still uses a lot of people, it needs a lot of people to be involved and that costs a lot of money.*"

Financial barriers

As discussed in previous paragraphs, certification can be associated with high costs, particularly for smallholders, even despite the option of group certification with other producers or companies (Brandi et al., 2015). An example is the cotton sector, where smallholders account for 60% of global production. Many of these farmers live below the poverty line and face challenges such as volatile market prices, rising input costs (e.g., pesticides and fertilizers), declining yields, and increasing household expenses. These financial constraints limit their ability to invest in training, adopt improved farming practices, and implement sustainable measures such as soil health management, irrigation systems, and high-quality

seeds (Voora et al., 2023). Financial aspects of certification were also indicated by many interviewees as one of the most important barriers, and all agreed that smallholders are particularly affected by it. As reported during the interview with CS1 "*smallholders face the biggest problems because […] it takes a lot of resources, a lot of knowledge and a lot of farmers are not trained to do this"*. The challenges faced by smallholders also affect other companies in the supply chain because "*to be certified themselves, they also have to certify their smallholders*".

Although the high financial costs of certification can represent a challenge for certified companies, the results of the CBAs conducted for the three case studies show overall positive results in terms of its financial feasibility. However, the economic feasibility largely depends on factors such as the availability of price premiums, the initial conditions before certification, and the specific requirements of the certification scheme. Higher price premiums can offset certification costs, while pre-certification conditions influence the extent of required investments. Additionally, more stringent certification requirements may increase the costs of compliance. Section 3.3 and 3.4 provide additional information on the factors driving the costs and benefits of certification and how they influence the results of the three CBA case studies.

Market barriers

Market challenges are mainly related to low demand for certified products and lack of price premiums. Low demand for certified products poses a significant challenge for producers, as a portion of certified feedstocks must often be sold as conventional. For example, in 2016, only half of the Fairtrade-certified cotton produced was sold as such, while in 2018, just over 20% of Better Cotton Initiative (BCI) certified cotton was purchased as certified (Voora et al., 2023). When certified products are sold as conventional products, producers do not receive a price premium, making it difficult to cover the costs of compliance with certification standards. Although price premiums are a key incentive for certification, they can be reduced due to insufficient market demand, further limiting the financial viability of certification for producers (Brako Dompreh et al., 2021). It is important to notice that market demand can vary for different feedstocks and CSLs. For instance, as mentioned in the cotton case study and as opposed to other feedstocks, the demand for organic cotton, and especially high-quality organic cotton, is quite high.

Market barriers also play a significant role in the effectiveness of certification in general. As explained by CB2, one typical critique of certification is that, if there is no (or not enough) market demand, improvements caused by certification can only be marginal. For instance, in the case of Better Cotton, the changes made to comply with the CSL are smaller compared to organic cotton and this is reflected by the lower price premium typically paid for Better Cotton as can be seen in section 3.4.3.

Governance barriers

Governance barriers in certification arise from multiple factors. One issue relates to the application of certification requirements to different local contexts. Some certification principles and guidelines are rooted in international agendas and debates rather than national realities. For instance, even though RSPO standards stipulate that oil palm growers and millers should demonstrate legal ownership/lease, history of land tenure, and the actual legal land use, most Ghanaian farmers lack official land titles (Brako Dompreh et al., 2021). Another example was provided during our interview with CB1 and relates to the use of protective gear (e.g., masks, boots, long sleeves, etc.), which can be difficult to apply in very warm tropical climates.

Another governance barrier to certification is the proliferation of schemes and their lack of harmonization. This creates confusion for producers, other companies as well as consumers, and risks increasing the perception of certification as 'greenwashing', due to the different stringency and transparency levels of different schemes. Finally, policies influence the feasibility of certification. For example, in the cotton sector, several African and Asian governments have implemented and increased price floors, reducing the relevance of Fairtrade International's minimum price and premium (Voora et al., 2023).

Stakeholder opinions on barriers

One of the questions of the public consultation asked respondents to rank the barriers to certification based on how much they limit the feasibility of using certification to promote sustainability. 31 of 62 total respondents completed this question and the results are shown in **Error! Reference source not found.** The responses are in line with those from the interviews, with operational and financial barriers ranked high by most respondents.

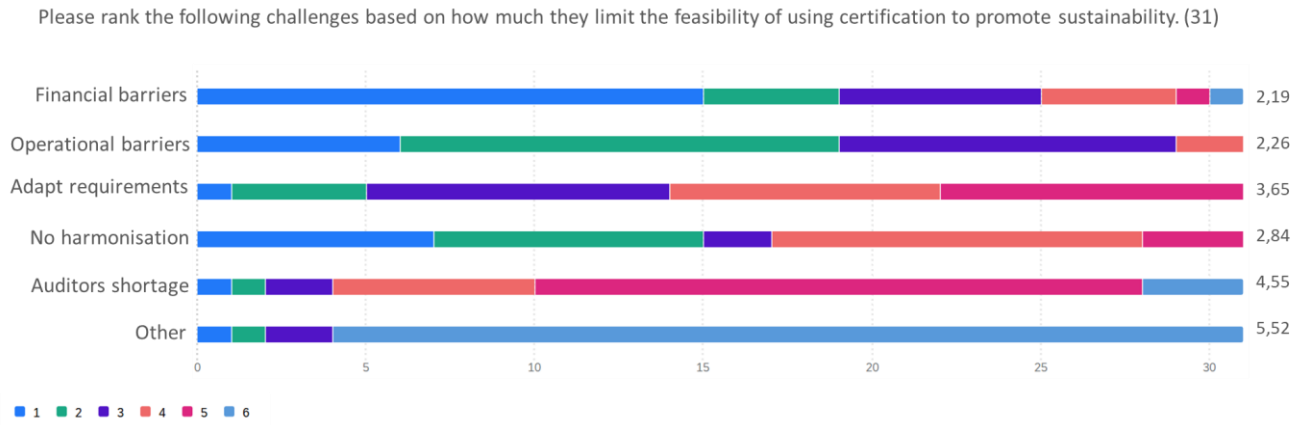

Figure 6. Overview of how respondents ranked each barrier to certification. The bars show how high respondents ranked each barrier. For instance, the blue part of the top bar indicates that 15 respondents ranked financial barriers as the top barrier, 4 as the second most important barrier, and so on. The number at the right of the bars shows the average rank each challenge received.

3.6 Strategies for overcoming barriers

Strategies to overcome the barriers of certification was a topic discussed during all interviews. Operational and financial challenges are closely linked to each other and often related to lack of resources in companies. In particular, the lack of technical capacity often requires companies to invest in staffing, training, or external support, which increases the financial burden. According to CS1, a way to reduce the *operational challenges* of certification is to improve the efficiency in reporting requirement and review processes. CB2 adds that "*we have a lot of IT tools that can support us, and many of them are really convenient. Even if we talk about spreadsheet solutions, IT already has many tools and instruments to resolve calculations, monitoring, and so on. […] And it doesn't require investing too much money to do so. What's essential is having a record-keeping system. If we make it smart, I think it can be done effectively*."

Although this requires a time investment for CSLs, it would reduce the administrative burden for companies. CB1 explained that many schemes are moving towards digitalisation of their systems, but also noted that it takes time before these changes make a positive impact, as there is first a transition period where they could even add additional administrative burden.

CB2 argued that CSLs "*should try to simplify the requirements for those who don't fully understand them*", as well as "*allocate time to create case studies and training materials*", with the goal of making "*this support available across different regions and at different financial levels".* Another strategy that could support adaptation and clarity is the development of national interpretations of international certification standards. These interpretations help tailor criteria and indicators to local conditions while still meeting overarching requirements. As one certification manager (CM3) explained, in the case of FSC, both the international and national standards must be met. This dual approach can make certification more relevant and achievable for local producers, particularly smallholders.

As discussed in previous paragraphs, support is particularly needed for smallholders. In the case of forest and organic cotton certification, group certification is used to make forest and organic cotton certification in reach of smallholders. Better Cotton takes this one step further by not imposing any audit cost on individual smallholders, and costs of farmer training are paid by fees of actors higher in the value chain. In the case of palm oil, CS1 explained that the support is currently mainly coming from NGOs, with palm oil companies and RSPO also contributing but to a lesser extent. However, as discussed with RE1, it is relatively easy to mitigate challenges on an individual basis, but the main challenge is to apply it at a larger scale. As they mentioned, "*now only 1% of palm oil production is certified. There are 6.4 million hectares of palm oil plantations but only 30,000 are certified. A systematic change is needed for this, especially a regulatory one. There should be a dialogue with the ministries at national level to achieve this change."*

CS1 agrees that "*alignment between policies and CSLs works very well. […] Alignment between different certification schemes also works very well, so I think alignment is very important at the policy level as certification*". Harmonization across different policies is also important to avoid that standards change too frequently, which increases compliance challenges for companies: "*sometimes, due to changes in legislation and market demand, new amendments are published every six months, and companies need to adapt to that. It's not just the certificate holders who are affected, but also CBs and other stakeholders. The certification scheme cannot monitor this effectively, especially when requirements are controversial or open to different interpretations.*" CLS1 shares the same vision, adding that schemes can also help by making sure that their system is user friendly and providing trainings and information to companies.

Another point raised by NGO1 regarding regulations is that they can improve the robustness of certification. "*It's sort of logical that when things like conflict of interest, auditor competence, training, and methodology are regulated, they would improve*." This could help mitigating one of the main critiques to certification, which "*is the method of verification—ensuring that farms comply with certification standards. Currently, the process relies heavily on auditing, which we don't see as a very reliable method. Audits typically take place only once a year, capturing just a snapshot of conditions at that particular moment. Additionally, audits are often announced in advance, allowing farms to prepare and even coach workers. There's also a conflict of interest between auditors and farms: auditors may be inclined to provide favorable reports because farms want positive assessments. This weakens the credibility of certification as a whole—if the verification process is flawed, the certification itself loses reliability*."

Apart from regulations, another actor that could play a role in reducing the challenges of certification, especially for small feedstock producers, are larger companies along the supply chain. As pointed out by NGO1*: "in supply chains in general, we assume that it is the end buyer who has more power because they are usually the multinational big brands. And so, they have more power, they can do more to support improvements in the supply chains. If that*

includes getting certified, then the end buyer with that power should also support and help the suppliers through the process." According to CB2, supporting smallholders would even be beneficial for such companies, as "*it's true that supporting them can be challenging sometimes, but in the long run, it's a huge benefit because everyone in the supply chain will be certified. I know companies that understand this and invest money and time, and in the end, they see very good outcomes*."

Stakeholder opinions on strategies for addressing barriers

31 respondents answered the public consultation question on how the barriers to certification could be mitigated. The results are presented in Figure 7 and show that reducing the complexity and the costs of certification could be achieved through streamlined certification processes and enhanced collaboration across industry, governments, and CBs. The importance of support policies was also highlighted, as well as the role that could be played by companies more downstream in the supply chain in supporting their suppliers.

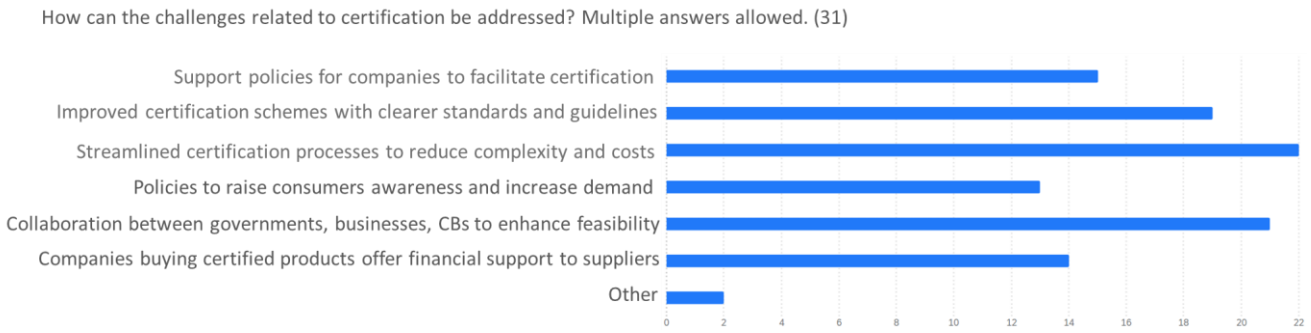

Figure 7. Overview of which strategies to mitigate the barriers to certification should be adopted according to public consultation respondents.

3.7 Discussion, conclusion & recommendations

The results from literature and case studies show that, in most cases, certification is economically feasible for companies. The findings highlight that the direct costs of certification are strongly influenced by economies of scale. For large landowners and producers, these costs constitute a marginal addition to total costs per unit, whereas for smallholders, especially in the initial stages of certification, they can pose a significant financial barrier. The indirect costs are influenced by geographical and structural factors. For example, feedstock certified in tropical regions normally face higher certification costs compared to wood certification in Europe, which benefits from more structured policies.

Despite the high costs, sustainability certification can provide long-term economic and social benefits. In certain markets, such as wood certification in the EU, it has become the market standard, reducing additional indirect costs. However, certification in low-income countries presents greater challenges, particularly for smallholders. The high upfront costs and lack of institutional support can deter participation, highlighting the need for more accessible certification models. It is worth noting that the distribution of certification benefits is uneven across the supply chain. Downstream actors often experience greater benefits compared to upstream producers, who face disproportionate financial and operational burdens.

3.7.1 Study limitation

It is important to mention that the main limitation of our analyses was data availability. Due to resource limitations, on-site data collection was not possible, and the report mainly builds on data collected from literature and in-depth interviews. However, even within the literature, data availability remained limited, and methodological inconsistencies in how cost and benefit data were collected and processed complicated cross-study comparisons.

Future research should focus on standardizing methodologies to ensure more consistent and reliable data. Additionally, investigating how regional and local conditions influence certification outcomes would provide insights into the varying impacts of certification. Moreover, more empirical research is needed on key economic indicators such as market access and price premiums, which have been underexplored in quantitative studies. The same applies to many social impact categories, where improved measurement approaches are needed. Finally, better harmonization in assessing certification outcomes would facilitate cross-study comparisons and provide a clearer picture of certification's overall effectiveness.

3.7.2 Recommendations

Our analysis shows that certification is often profitable for certified companies. Nonetheless, certification can pose significant challenges to companies, especially smallholders and companies in low-income countries. This disadvantage should be taken into account by policies enabling or encouraging the use of certification. Moreover, policies from the EU and from biomass sourcing countries supporting more economically disadvantaged companies (both financially and in terms of operational capacity) could help reduce this discrepancy. Along with this, policies aimed at increasing consumer awareness could help certified companies by indirectly increasing the market demand for certified products, which could translate to higher premiums for the companies.

As discussed during the interviews, other actors also play important roles in increasing the feasibility of certification. Larger companies and companies downstream the supply chain could support upstream producers with their certification process. Similarly, scheme owners could make the certification process more efficient, especially in terms of requirements for record keeping. For example, investing in good digital tools could simplify some of the processes companies undergo to obtain certification, reducing the indirect costs associated with certification.

Lastly, as the main limitation of our study was connected to data availability, one important recommendation from part A of this report is to increase and better harmonise data collection on the economic impacts of certification. Many organisations, including private companies and CSL owners, do not gather any information related to costs and benefits of certification, often considered as sensitive information. Policies could encourage companies or scheme owners to collect such information, so that additional research could be done on this topic. Additional research could also focus on the social impacts of certification, that for now are understudied compared to other sustainability dimensions.

4 Part B: Verification as a governance tool for a sustainable EU bioeconomy

4.1 Introduction

The bioeconomy is considered important for, and supportive of, a transition to a climate neutral and more sustainable Europe (Liobikienė and Miceikienė, 2023). Based on biological resources, the bioeconomy aims to reduce dependency on fossil fuels, mitigate climate change, and promote sustainable development. However, the expansion of the bioeconomy has raised significant concerns regarding its environmental, social, and economic impacts both within Europe and globally. These concerns stem from the production of both domestic and imported biological resources (also called biomass feedstocks), biobased products and materials, which can have far-reaching consequences on ecosystems, communities, and economies (Gawel et al. 2019; Searchinger et al. 2008; Hunsberger et al. 2017). In response to these challenges, the European Union has implemented various policy initiatives to define and enforce sustainability requirements for the bioeconomy (Moosmann et al. 2020; Vogelpohl et al. 2021).

To support the practical implementation of these requirements, different verification mechanisms, including certification schemes and labels (CSLs), have emerged as crucial tools in these policy initiatives (Partit 2018; Dietz et al. 2018). They serve to demonstrate that biological resources and bio-based products meet established environmental, social, and economic sustainability standards. CSLs are particularly relevant in supporting EU bioeconomy policies. They provide a structured approach to verifying compliance with sustainability criteria, thereby enhancing transparency and accountability. Additionally, other verification mechanisms, such as due diligence processes and information disclosure, play complementary roles in promoting a sustainable bioeconomy. These tools collectively help stakeholders to demonstrate their commitment to sustainability, and the EU to shape these commitments.

The impact and effectiveness of certification schemes and labels are strongly influenced by their inherent characteristics regarding governance and assurance. While they offer robust frameworks for verifying policy requirements, their practical implementation can encounter several barriers and challenges. A key challenge relates to the economic feasibility of certification as experienced by market actors, as the costs associated with certification can be prohibitive for some market actors. Other important concerns include ensuring consistent application of standards, maintaining stakeholder engagement, and adapting to evolving sustainability criteria (see also Part A of this report).

The design and implementation of CSLs are influenced by policy configurations as policies can shape governance structures, transparency, and verification rigor of CSLs. Despite the recognized importance of verification mechanisms in EU bioeconomy policy making, several knowledge gaps persist. First, there is limited understanding of how verification and specifically CSLs are integrated into various policy frameworks and the extent to which policy design affects the governance structures and verification mechanisms of CSLs. A related point is that the need to investigate how policy configurations can enhance the governance of CSLs, ensuring they are robust and capable of driving sustainable practices. A systematic comparison of policy requirements and the characteristics and rigor of CSL requirements is missing, although understanding how well they align can help refine policy requirements as well as certification processes to enhance the feasibility and effectiveness of CSLs. Another

critical knowledge gap relates to stakeholder perspectives on the role of verification and certification in EU policy making. Stakeholder engagement and collaboration are essential for ensuring that CSLs are perceived as legitimate and credible tools for sustainability verification. Therefore, understanding stakeholder positions is crucial for designing verification and certification requirements by bioeconomy policies.

The aim of the second part of this study is to understand the current use of verification (and specifically certification) as support instruments for EU bioeconomy policy and find out how stakeholders perceive this use. To address this aim, this part of the report first provides a systematic overview of the current role of verification and specifically CSLs in different EU policies related to the bioeconomy, focusing on potentially different roles and motivations for their implementation. Second, an analysis is provided of potential implications of different roles of CSLs in the above-mentioned EU bioeconomy policies on the governance structure and verification mechanisms used by CSLs. Third, it presents an analysis of stakeholder familiarity and positions on CSLs as a verification mechanism for EU policy making for a sustainable bioeconomy. Finally, the report aims at identifying governance options to increase effectiveness of CSLs.

Part B is structured as follows: In Section 4.2 we describe the methods and data used for the analysis, including the policy document analysis, analysis of alignment between policy requirements and scheme design, as well as the public consultation. Section 4.3 presents the results in four parts: verification instruments used in policy, EU bioeconomy policy and the role of certification, scheme design, stakeholder positions on CSLs as support instrument for EU bioeconomy policy, and stakeholder familiarity with CSLs instrument supporting EU bioeconomy policies. Section 4.4 then discusses the results, and provides recommendations and conclusions.

4.2 Methods

4.2.1 Policy document analysis

A policy document analysis was conducted to obtain an overview of the use of verification in EU policy making, including distinguishing different types of verification and identifying different uses of verification in EU policies, where the term “policies” is used in this report as an overarching term for policies, directives, regulations, delegated and implementing acts.

Selection of policies

Nine policies that directly or indirectly relate to biobased products and certification were selected as a starting point for the analysis. The choice of policies were also validated during an internal project workshop, building on project partners’ expertise. The goal of the selection was to identify and include in this report the diverse ways verification and certification are used in EU policies related to the bioeconomy.

The selected policies and their key focus areas are follows:

- **Renewable Energy Directive (RED III):** The Renewable Energy Directive (RED III) came into force on July 1, 2021. It sets sustainability criteria for biofuels, bioliquids, and biomass fuels, aiming to increase renewable energy use in the EU’s energy sector.
- **EU Taxonomy Regulation (EU Taxonomy):** The EU Taxonomy Regulation entered into force on July 1, 2021. It provides a classification system to guide investments towards environmentally sustainable economic activities.

- **Corporate Sustainability Due Diligence Directive (CSDDD):** The Corporate Sustainability Due Diligence Directive (CSDDD) was proposed in February 2022 and entered into force on 18 July 2024. It requires large companies to conduct due diligence in their supply chains to prevent and address adverse human rights and environmental impacts.
- **Corporate Sustainability Reporting Directive (CSRD):** The EU's Corporate Sustainability Reporting Directive (CSRD) requires large companies to report on their social and environmental impacts and risks, using European Sustainability Reporting Standards (ESRS), to improve transparency and support stakeholders in assessing sustainability performance. As of 2024, the rules apply to large firms, but a 2025 proposal aims to limit reporting obligations to companies with over 1000 employees, reducing burdens on smaller businesses in their value chains.
- **Green Claims Directive (GCD):** The Green Claims Directive (GCD) was proposed in March 2022 and is expected to be adopted by 2025. It aims to regulate how companies substantiate and communicate environmental claims to prevent greenwashing and ensure transparency.
- **Ecodesign for Sustainable Products Regulation (ESPR):** The Ecodesign for Sustainable Products Regulation (ESPR) was proposed in March 2022, and entered into force on 18 July 2024. It sets requirements for product sustainability and circularity, focusing on improving resource efficiency and reducing environmental impact.
- **EU Deforestation Regulation (EUDR):** The EU Deforestation Regulation (EUDR) entered into force on the 29th of June 2023. However, in December 2024 the European Union granted a 12-month additional phasing-in period, making the law applicable on 30 December 2025 for large and medium companies and 30 June 2026 for micro and small enterprises. The regulation establishes due diligence requirements for commodities like soy, palm oil, and coffee, ensuring that they are not linked to deforestation or forest degradation.
- **Empowering Consumers Directive (ECD):** The Empowering Consumers Directive (ECD) was adopted in 2019 and came into force in 2020. It enhances consumer protection by ensuring transparency and preventing misleading environmental claims in the marketplace.
- **Carbon Removal and Carbon Farming Framework (CRCF):** The Carbon Removal and Carbon Farming framework (CRCF) was adopted in November 2024. It aims to establish methodologies and standards for measuring and certifying carbon sequestration through sustainable land management practices.

Text analysis

A text analysis was conducted to map how verification and certification are used in the selected EU bioeconomy policies. This method was chosen because text analysis is a common and effective approach in qualitative research, enabling the systematic extraction of relevant information from textual sources (Kuckartz, 2019). Text analysis allows for a detailed examination of documents, identifying key themes, patterns, and relationships within the text. For this study, text analysis is crucial for understanding how certification schemes are integrated into policy frameworks. The analysis focused on identifying specific references to certification mechanisms, their role in achieving policy goals, and the associated assurance structures and verification processes outlined in the selected policy documents. These topics were identified based on previous project activities and authors' expertise, and further refined during the analysis of the first policy documents.

The data was drawn from the nine EU policies selected for the analysis. The main text of the policy, the delegated and implementing acts were included in the analysis. These texts were reviewed to extract information on how verification and certification are mentioned, what their intended impacts are, and how they are implemented within each policy context. Table 17 shows a simplified version of the main information extracted from policy documents as well as potential variations.

In addition, the text analysis examined in more detail whether and how assurance is considered in the policies. Five assurance topics are selected for the analysis, based on and adapted from HARMOBITOR deliverable D4.3 (benchmarking sustainability, assurance and governance criteria by CSLs):

- *Competence and qualifications:* the policy requires that auditors and verifiers are qualified and competent to evaluate compliance with CSLs requirements.
- *Impartiality at audit level:* the policy includes requirements to ensure that auditors and other personnel of the Certification Bodies are impartial to the entities under evaluation and the regulator.
- *Auditing process:* the initiative requires that the auditors apply a documented methodology for the evaluation of compliance with the requirements.
- *Stakeholder consultation:* the initiatives requires that certification bodies have mechanisms in place to conduct consultations with stakeholders in relation to the audits.
- *Corruption:* the initiative requires CSLs to include mechanisms that identify or prevent corruption within companies.

Table 17. Main information extracted from the policy documents, including answer options.

Type of verification instrument	Certification allowed	Category of certification (proof of compliance, support tool)	Certification schemes approved by Commission	Coverage of assurance topics in initiative				
				Competence & qualifications	Impartiality at audit level	Auditing process	Stakeholder consultation	Corruption
Third-party, Due diligence, Disclosure of information	Yes, No	Proof of compliance, Supporting tool	Yes, No	Yes, No	Yes, No	Yes, No	Yes, No	Yes, No

4.2.2 Analysing alignment between policy requirements and scheme design

In addition to studying the assurance requirements set by EU bioeconomy policies, this study examines the differences in assurance requirements of ten selected certification schemes based on the nine policies we selected. The CSLs were selected based on the benchmarking conducted in WP4 and presented in HARMONITOR deliverable D4.3 (benchmarking sustainability, assurance and governance criteria by CSLs). The assurance elements included in our analysis are those covered in D4.3 (requirements B.1-B.5, for full description see D4.3 - Appendix) and introduced in section 4.2.1.

It is worth noting that CSLs often include specific modules tailored to different policies, such as the REDIII or the EUDR (see D4.3). These policy-specific adaptations may cause variations in assurance requirements, governance structures, and sustainability criteria across different CSLs. These modules were not specifically included in our analysis, but could be included in future research.

4.2.3 Public consultation

Through public consultation, we aimed at identifying stakeholder perspectives on the use of CSL as a general verification instrument and specifically as a co-regulation tool, as well as understand stakeholder familiarity with this instrument. In combination with the earlier public consultation of HARMONITOR (Spring 2023, Deliverable D2.2, public consultation), this information allowed measuring and monitoring if familiarity with using CSLs as co-regulation instrument has improved over time. The policies selected for the second public consultation only partially overlap with those analysed in the rest of this report. This selection was made to ensure some level of comparability with the policies included in the first consultation. The full list of questions for the second consultation is provided in the appendix (A.2). The full list of questions for the first consultation can be found in HARMONITOR deliverable D2.2.

The public consultation was conducted together with research on the feasibility of certification (see Part A of this report) where we focused on identifying challenges and barriers of certification as experienced by market actors and identify strategies to overcome them. Relevant questions for the analysis of stakeholder perspectives on CSLs as verification or co-regulation tool in EU bioeconomy policies are Q1, Q2, Q3, Q7, Q8 (see appendix A.2).

The second public consultation was conducted from 3 March to 11 April 2025. The link to the consultation was distributed on LinkedIn and posted in several LinkedIn groups. Additionally, HARMONITOR project partners and other BiobasedCert cluster partners helped resharing the post and further distributing it within their networks. To encourage participation, the consultation was kept short and could be completed in 5 to 10 minutes.

4.3 Results

4.3.1 Verification instruments used in policy

The EU Bioeconomy policy framework includes different requirements to establish safeguards in relation to environmental and social impacts as well as instruments to facilitate improvements regarding specific parameters. To implement these requirements in practice, market actors use different verification mechanisms to show compliance as well as to quantify and report relevant information.

The main frameworks including related requirements for market actors use different verification mechanisms. The three main types of verification approaches are: certification, due diligence and disclosure of information. The following table presents the differences between these verification instruments.

Table 18 Types of verification mechanisms in different policy frameworks of the EU bioeconomy

	Type of verification instrument		
	Certification	Due Diligence	Disclosure of information
Examples of relevant policy frameworks	- RED II/III - EUDR - EU Organic Regulation	- EUDR - EU Taxonomy for Sustainable Finance	- CSRD - LULUCF Regulation - GRI & Voluntary ESG Reporting
General approach	- Third-party audit & certification by approved certification bodies - On-site inspections, supply chain tracking and compliance testing	- Companies must assess and prove sustainability via trace-ability tools - Risk assessments & reporting obligations for deforestation-free supply chains	- Companies publicly report sustainability metrics (e.g., CO_2 emissions, land use, etc.) - Data is published in reports and subject to third-party audits for reliability
Verification mechanism	- Audited by independent certification bodies - Tracing of sustainability information through a supply chain	- Self-assessment + regulatory checks - Digital verification (e.g., satellite monitoring for deforestation)	- Regulatory oversight & public scrutiny - Data must align with sustainability reporting standards (e.g., EU Taxonomy)
Examples of instruments and methods used	- Product and sector specific standards - On-site inspections, mass balance approaches - third-party verification by independent CBs	- Geolocation & remote sensing - Risk-based supply chain audits through third-party verification	- Software based ESG reporting platforms - Blockchain & digital traceability tools - Reports can be third-party verified

The three mentioned verification approaches differ significantly. For the instrument of certification, as it is applied for example under the Renewable Energy Directive, different certification schemes have implemented the policy requirements into verifiable standards. These certification schemes are approved by the European Commission, and only production certified by these schemes are considered as eligible. Third party verification by certification bodies is used to show compliance of market actors with these requirements.

The instrument of due diligence is mainly based on company responsibility. Companies can use instruments like satellite monitoring, remote sensing to prove compliance with frameworks like the EUDR or the EU Taxonomy framework. Finally, disclosure is focused on self-reporting, public scrutiny and third party audits, with frameworks like the CSRD, requiring public transparency. It is important to note that the different methods partly overlap, for example in case third-party verification is used as an instrument under all three verification mechanisms.

4.3.2 EU bioeconomy policy and the role of certification

Different EU policies use different verification instruments to ensure compliance with their criteria. For instance, RED III and CRCF both rely on third-party verification to prove compliance with sustainability requirements, such as greenhouse gas emissions and carbon sequestration. This approach ensures that biofuels and carbon farming practices meet the necessary environmental standards. Similarly, the Green Claims Directive and the Empowering Consumers Directive use third-party verification to substantiate and prevent misleading environmental claims, ensuring transparency and consumer protection. In

contrast, EUDR and CSDDD focus on due diligence as their verification instrument, assisting companies in assessing and demonstrating compliance with human rights, environmental impacts, and deforestation-free supply chains. The EU Taxonomy also utilizes a disclosure of information mechanism, supporting the assessment of environmental footprints. All the policies included allow the use of certification. Table 19 shows an overview of the main finding from the text analysis on how certification is used in the selected policies.

From the text analysis, we identify two main roles of certification in EU bioeconomy policy making: as proof of compliance or as a support tool to facilitate specific regulatory aspects.

Certification as a proof of compliance is more prevalent in policies that establish clear sustainability criteria, such as RED III and CRCF. In these cases, certification schemes are used to verify that biofuels, carbon farming practices, and other bio-based products meet established environmental standards. In this case, certification is used to ensure that the products entering the market align with the sustainability goals of the EU.

In other cases, *certification as a support tool* is used in initiatives that are more focused on due diligence and risk management. For example, in the EUDR, certification schemes are not required as proof of compliance but rather as tools to support companies in conducting risk assessments and ensuring that their supply chains do not contribute to deforestation. Similarly, under the CSDDD, certification schemes help companies evaluate and demonstrate their compliance with human rights and environmental due diligence requirements, even though they do not serve as the official means of certifying compliance.

The text analysis also highlighted that some policies require CSLs to be formally approved by the EU in order to be used under that policy, while others allow the use of CSLs without requiring formal approval. Certification schemes that are approved have undergone a rigorous evaluation process to ensure they align with specific EU regulatory standards, providing legally binding verification of compliance with sustainability criteria such as those for biofuels, carbon sequestration, or deforestation-free production. For instance, under RED III and CRCF, approved schemes are authorized to confirm that practices meet the EU's environmental requirements. In contrast, non-approved certification schemes do not carry the same formal regulatory backing. This distinction underscores the varying levels of oversight and regulatory validation within EU policies, with some policies requiring more stringent, Commission-approved schemes, while others provide greater flexibility with non-approved alternatives.

Table 19: Overview of selected EU policies relevant for bioeconomy and the role of verification and certification (n/a – not applicable, x – assurance topic is covered by initiative, - assurance topic is not covered by initiative)

Initiative	Description	Type of verification instrument	Category of certification	Role of Certification Schemes	Certification schemes approved by Commission	Coverage of assurance topics in initiative				
						Competence & qualifications	Impartiality at audit level	Auditing process	Stakeholder consultation	Corruption
Renewable Energy Directive (RED III)	Sets sustainability criteria for biofuels, bioliquids, and biomass fuels used in the EU energy sector.	Third-party	Proof of compliance	Approved certification schemes verify that fuels meet sustainability and greenhouse gas (GHG) emissions requirements.	Yes	x	x	x	x	-
Regulation on Deforestation Free Products (EUDR)	Sets deforestation-free requirements for commodities placed on the EU market, including soy, palm oil, and wood.	Due diligence	Support tool	Certification schemes can be used to support the risk-assessments required by the policy.	No	x	x	x	-	x
Corporate Sustainability Reporting Directive (CSRD)	Requires large companies and listed companies to publish regular reports on the social and environmental risks they face, and on how their activities impact people and the environment.	Due diligence	Support tool	Certification schemes can help companies reporting according to the European Sustainability Reporting Standards (ESRS).	No	x	x	x	-	x
Corporate Sustainability Due Diligence Directive (CSDDD)	Requires companies to identify, prevent, and address human rights and environmental impacts in their supply chains.	Due diligence	Support tool	Certification schemes help companies assess and demonstrate compliance with human rights and environmental due diligence requirements in their supply chains.	No	x	x	-	-	-
EU Taxonomy	Classifies sustainable economic activities, providing standards for sustainability in sectors like forestry and agriculture.	Disclosure of information	Support tool	Certification schemes can be used as support in assessing the environmental footprint of economic activities.	No	-	-	-	-	-
Carbon Removal Carbon Farming (CRCF)	Supports practices that sequester carbon in soils and biomass, promoting	Third-party	Proof of compliance	Certification schemes verify that carbon removal and carbon farming practices meet sustainability and	Yes	x	x	x	-	-

	sustainable land management and climate mitigation.			additionality criteria for climate mitigation.						
Green Claims Directive (GCD)	Regulates how companies substantiate and communicate environmental claims to prevent greenwashing.	Third-party	Proof of compliance	Certification schemes substantiate the accuracy and transparency of environmental claims made by companies to ensure they are not misleading.	Yes	-	-	-	-	-
Empowering Consumers Directive (ECD)	Strengthens consumer rights by ensuring transparency and preventing misleading environmental claims.	Third-party	Proof of compliance	Certification schemes help verify and validate environmental claims, ensuring they are credible and aligned with consumer protection standards.	No	-	-	-	-	-
Ecodesign for Sustainable Products Regulation (ESPR)	Sets sustainability and circularity requirements for products to improve energy and resource efficiency.	n/a	n/a	Will be specified in delegated acts after the 19th of June 2025	n/a	n/a	n/a	n/a	n/a	n/a

4.3.3 Scheme design

Using HARMONITOR deliverable D4.3 (benchmarking sustainability, assurance and governance criteria by CSLs) as a foundation, we identified which CSLs are relevant for the selected policies, as shown in Table 20. The mapping in Table 20 shows that most CSLs are used across multiple policies. This overlap suggests a level of flexibility in the selected policies, enabling the use of different CSLs. It also highlights the broad applicability of CSLs, as many schemes have developed assurance mechanisms that align with multiple regulatory requirements.

Table 20: Mapping of policies and relevant CSLs. The ESPR was not included as the implementing act that would define certification requirements has not been adopted yet.

	EUDR	CSDDD	CSRD	GCD	ECD	CRCF	EU Taxonomy	RED III
FSC	X	X	X	X	X		X	
EU Ecolabel		X	X	X	X		X	
Bonsucro		X	X	X	X		X	X
BCI		X	X	X	X	X	X	
ISCC	X	X	X	X	X	X	X	X
RA	X	X	X	X			X	
RTRS	X	X	X	X	X	X	X	X
RSB		X	X	X	X	X	X	X
RSPO	X	X	X	X	X		X	X
SBP	X	X	X	X	X		X	

The results of the benchmark conducted in HARMONITOR deliverable D4.3 (benchmarking sustainability, assurance and governance criteria by CSLs) were used to compare how CSLs meet assurance requirements of three policies: RED III (Table 21), EUDR (22), and CSDDD (23). These were chosen as examples that reflect different ways in which CSLs are used in policy. In particular, RED III uses CSLs as formal proof of compliance, requiring them to be approved by the European Commission. In contrast, EUDR and CSDDD use CSLs as supporting tools, and without requiring Commission approval.

In all three tables, CSLs consistently meet the assurance requirements for auditor competence and qualification, audit-level impartiality, and the auditing process. These requirements are explicitly stated in both RED III and EUDR, so it is unsurprising that CSLs align with them. CSDDD is the only policy among the three where the auditing process is not a formal requirement. Nevertheless, all CSLs fully comply with these assurance elements, except for BCI, which partially complies. This is likely because CSLs are designed to be applicable across multiple policies, including those where the auditing process is explicitly required.

Stakeholder consultation and corruption are the assurance areas where CSLs show the most variation in performance. This aligns with the fact that these are also the areas where most policies do not explicitly define assurance requirements (Table 19). Without clear regulatory mandates, CSLs may adopt different approaches based on their own governance structures, stakeholder expectations, or industry best practices. Although our analysis is by no means comprehensive, it suggests that regulations might stimulate CSLs to have more stringent requirements or cover more areas than they normally would.

Table 21: Comparing assurance requirements in RED III and relevant CSLs. For the policy, the requirements can either be covered (Yes) or not (No). For CSLs, (✓) indicates that the requirements are fully covered, (~) that are partly covered, and (X) that they are missing.

	Competence & qualification auditors	Impartiality audit level	Auditing process	Stakeholder consultation	Corruption
RED III requirement	Yes	Yes	Yes	Yes	No
Bonsucro	✓	✓	✓	✓	X
ISCC	✓	✓	✓	X	✓
RTRS	✓	✓	✓	✓	~
RSB	✓	✓	✓	✓	✓
RSPO	✓	✓	✓	✓	X

Table 22: Comparing assurance requirements in EUDR and relevant CSLs. For the policy, the requirements can either be covered (Yes) or not (No). For CSLs, (✓) indicates that the requirements are fully covered, (~) that are partly covered, and (X) that they are missing.

	Competence & qualification auditors	Impartiality audit level	Auditing process	Stakeholder consultation	Corruption
EUDR requirement	Yes	Yes	Yes	No	Yes
FSC	✓	✓	✓	✓	✓
ISCC	✓	✓	✓	X	✓
RA	✓	✓	✓	✓	✓
RTRS	✓	✓	✓	✓	~
RSPO	✓	✓	✓	✓	X
SBP	✓	✓	✓	~	✓

Table 23: Comparing assurance requirements in CSDDD and relevant CSLs . For the policy, the requirements can either be covered (Yes) or not (No). For CSLs, (✓) indicates that the requirements are fully covered, (~) that are partly covered, and (X) that they are missing.

	Competence & qualification auditors	Impartiality audit level	Auditing process	Stakeholder consultation	Corruption
CSDDD requirement	Yes	Yes	No	No	No
FSC	✓	✓	✓	✓	✓
EU Ecolabel	✓	✓	✓	X	~
Bonsucro	✓	✓	✓	✓	X
BCI	~	~	✓	~	X
ISCC	✓	✓	✓	X	✓
RA	✓	✓	✓	✓	✓
RTRS	✓	✓	✓	✓	~
RSB	✓	✓	✓	✓	✓
RSPO	✓	✓	✓	✓	X
SBP	✓	✓	✓	~	✓

CSLs entirely operating in voluntary sectors, where no regulations reference their use, may exhibit greater variation in assurance requirements. Without regulatory alignment, these schemes could differ more widely in their approaches to auditor competence, impartiality, auditing processes, stakeholder consultation, and anti-corruption measures. This raises the question of whether the absence of policy-driven requirements leads to weaker assurance mechanisms or simply allows for greater flexibility in design. An additional consideration that would be interesting for future research is how such variations are reflected in the auditing costs, and the costs of certification in general. Future studies could also assess whether CSLs operating in voluntary sectors maintain comparable levels of stringency, or whether regulatory oversight is a key factor in ensuring consistency. Another relevant aspect is the strategic positioning of CSLs, which may influence assurance choices—some schemes may deliberately target specific market niches with particular combinations of ambition and market volume.

An important aspect to consider is that our analysis focuses on EU policies, which tend to have relatively stringent sustainability requirements compared to regulatory frameworks in other regions. As a result, CSLs operating within the EU are generally designed to align with these higher standards. However, in regions with less strict sustainability regulations, CSLs may sometimes exceed the requirements set by local policies. This means that the relationship between CSLs and regulations can vary depending on the regulatory context, and in some cases, CSLs may act as a stronger driver for sustainability than the policies themselves.

As mentioned in the methods section, CSLs can develop separate modules tailored to specific policies, such as the EUDR (see D4.3). These policy-specific adaptations can lead to variations in assurance requirements, governance structures, and sustainability criteria across schemes. Although these variations were not included in our analysis, findings from deliverable D4.3 (benchmarking sustainability, assurance and governance criteria by CSLs) indicate that CSLs are able to adapt their requirements and structures to align with different regulatory frameworks. For example, in response to the EUDR, several CSLs have revised their standards to incorporate geolocation data, risk assessments, and chain-of-custody models aimed at segregating compliant commodities. Many schemes also address legal land tenure and indigenous rights, requiring documentation and adherence to free, prior, and informed consent (FPIC), to better align with EUDR requirements. Nonetheless, incomplete forest definitions, inconsistent approaches to plantation forests, and limited anti-corruption measures may hinder overall effectiveness. Deliverable D4.3 (benchmarking sustainability, assurance and governance criteria by CSLs) also discusses how smaller producers face particular barriers, including high certification costs and limited awareness of regulatory requirements, although mechanisms like group certification and cost-sharing initiatives are emerging to provide support. The authors of D4.3 also stress that, in the EUDR, certification does not replace companies' due diligence obligations. Operators remain responsible for mapping supply chains, assessing corruption risks, verifying legal compliance, and continuously monitoring suppliers. When combined with robust internal systems, certification can serve as a useful risk mitigation tool and support improved traceability across supply chains.

4.3.4 Stakeholder positions on CSLs as support instrument for EU bioeconomy policy

For the second public consultation, 67 responses were collected. Out of these, 51 indicated their stakeholder category (Figure 8). Figure 9 shows the stakeholders category of the

respondents of the first public consultation, as presented in D2.2 (Summary open public consultation inputs).

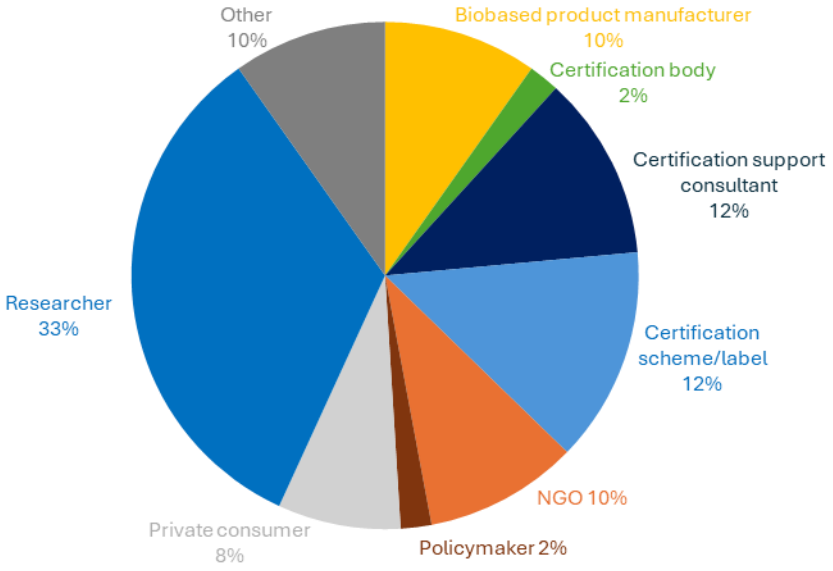

Figure 8. Respondent categories of second public consultation

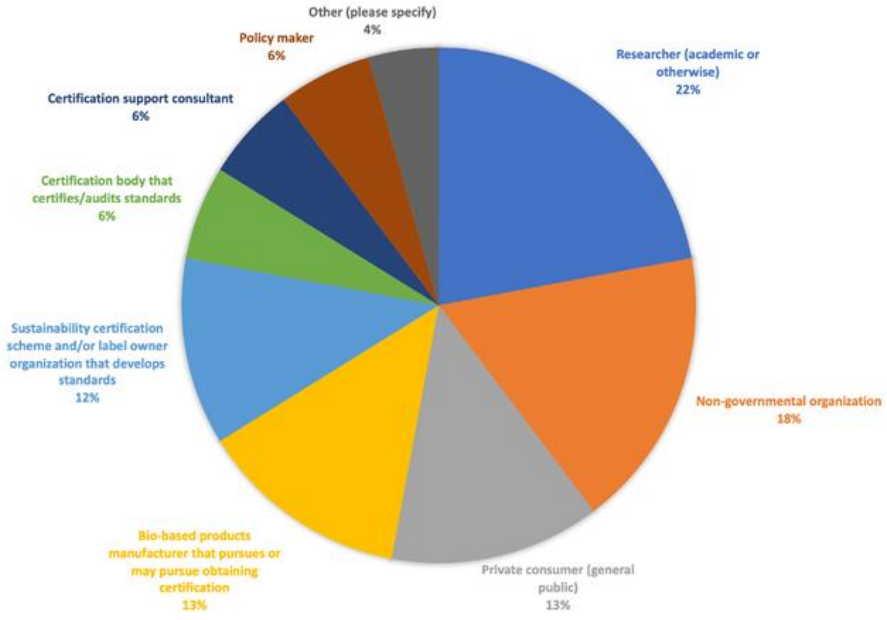

Figure 9. Respondent categories of first public consultation

The public consultation asked respondents about their view on the best way to use certification in EU policies related to the bioeconomy (question 2). Out of 40 respondents, more than half (22) indicated that it should be allowed to use certification as a tool to prove compliance with EU policies (Figure 8). The result is similar to that of the public consultation conducted as part of deliverable D2.2 (Summary open public consultation inputs), where about 50% of the respondents welcomed co-regulation by the EU.

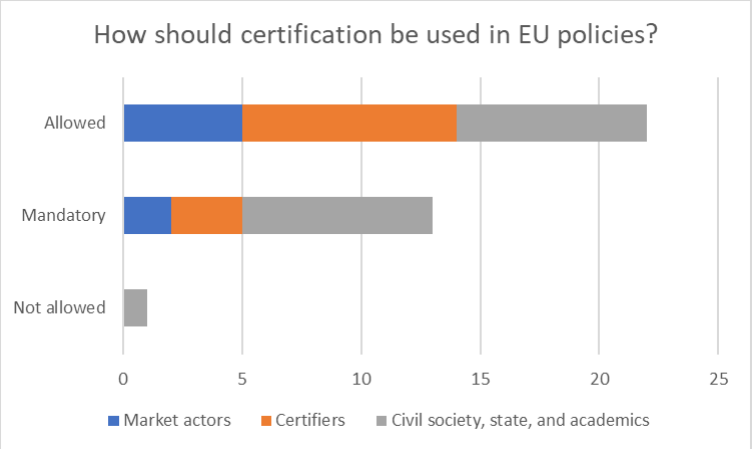

Figure 8 Opinions of respondents participating in the second public consultation on how certification should be used in EU policies related to the bioeconomy. The Y axis shows how many respondents indicated that certification should be allowed as a tool to prove compliance with policies (allowed), how many indicated that it should be a mandatory tool to prove compliance with policies (mandatory), and how many indicated it should not be allowed at all (not allowed).

One of the respondents of the second public consultation indicated that certification should be allowed, but specified that this should be possible only when the "*certification and third-party verification methods are science based and recognized by EU, and deal with the aspects for which the regulation was meant*". 52% of the respondents participating in the first public consultation also supported the opinion that the EU should regulate CSLs and impose mandatory rules for the industry to obtain sustainability certification and labelling.

About 33% of respondents to our public consultation thought that certification should be mandatory to prove compliance with regulations. One of the reasons for making certification mandatory was that "*this way there will be more uniformity in reporting and hopefully bureaucracy can be minimized."* One respondent indicated that certification should not be allowed to prove compliance with policy requirements and explained that "*sustainability certifications do not evidence fulfilment of obligations under EU regulations. Certification standards are not always in line with what's required under the respective EU regulations. Their methods of verification (e.g. audits) can be unreliable with problems such as conflict of interest between the auditor and the audited entity, corruption and the auditor's lack of competence."*

Overall, the results of the public consultation reflect a general openness toward the use of certification as a tool to demonstrate compliance with EU bioeconomy-related policies. Most respondents supported its use, with several emphasizing the need for certification schemes and verification methods to be science-based, reliable, and aligned with EU regulatory objectives. While a significant portion also advocated for making certification mandatory to ensure uniformity and reduce administrative burden, others expressed caution, highlighting persistent concerns around the credibility, rigour, and independence of certification processes. These divergent views underscore the importance of setting clear, robust, and transparent criteria for the recognition and use of CSLs in EU policy.

4.3.5 Stakeholder familiarity with CSLs instrument supporting EU bioeconomy policies

A question regarding the familiarity of stakeholders with specific policies was present in both public consultations. Figure 9 shows the results from the 2 consultations on how familiar the stakeholders that took part in the survey are with some policies that use CSLs.

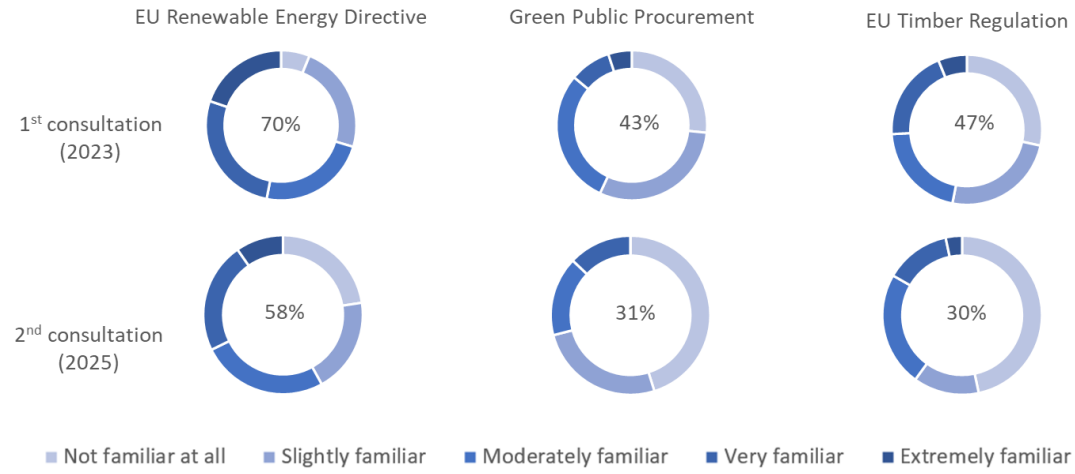

Figure 9 Comparison of respondents' familiarity with three selected EU directives and regulations that use CSLs as co-regulation instruments in first and second open public consultation. The percentage in the middle of each pie chart indicates the share of stakeholders that is moderately, very or extremely familiar with the directive/regulation.

Most stakeholders reported being moderately familiar with the EU directives and general CSL regulations included in the consultation. Among the three policies assessed, the Renewable Energy Directive (RED) was the most widely recognized, with 70% of respondents in the first consultation and 58% in the second indicating moderate to high familiarity. In contrast, stakeholder awareness of Green Public Procurement (GPP) and the EU Timber Regulation (EUTR) was lower in both consultations, with a noticeable decline in the second round. This decrease in familiarity could be due to the ongoing development of new policies that are set to replace existing ones—for instance, the EUTR is being replaced by the EU Deforestation Regulation (EUDR). Another possible explanation is the composition of respondents: the second consultation saw a higher proportion of researchers (33% vs 22%), who may be less familiar with specific regulatory instruments than industry stakeholders or CSL representatives directly impacted by them.

While the sample sizes are too small to draw statistically significant conclusions, we chose to include these results as they still offer useful qualitative insights into stakeholder awareness and engagement with relevant EU policies.

4.4 Discussion, recommendations and conclusions

4.4.1 Strengths and limitations of using CSLs in EU policies

The use of CSLs as an eligible verification instrument for requirements in bioeconomy policies has been growing significantly in recent years, leading to their institutionalization and integration into various policy instruments such as free trade agreements, sustainable public procurement, and export promotion policies. This shift reflects the increasing recognition of

CSLs as effective governance tools for promoting sustainability across supply chains (Marx et al., 2024). While CSLs have gained legitimacy in many sectors, particularly in high- and middle-income countries (Marx et al., 2024), their use in policy also raises a range of concerns, particularly regarding their effectiveness and inclusivity.

The integration of CSLs into public policies can have beneficial effects by encouraging companies to adopt sustainable practices. Our analysis shows that CSLs often align with EU policy requirements and can even develop add-ons to comply with specific regulations. Literature shows that the same happens outside of the EU, for instance in Brazil, where CSLs such as FSC have demonstrated their potential to support the enforcement of national environmental and labour laws, contributing to better compliance with regulations in forest management (Marx et al., 2017). The certification process helps identifying areas of non-compliance and prompts corrective actions, strengthening the role of CSLs in promoting good governance and supporting the enforcement of public regulations.

Additionally, the rise of CSLs has led to greater institutional support and recognition, providing a framework for producers to access new markets and respond to the growing consumer demand for sustainable products (Marx et al., 2024). These standards also facilitate the establishment of international norms and, in the case of the EU, the enforcement of sustainability regulations in extraterritorial regions (Schleifer, 2013). Finally, relying on existing initiatives (e.g., private certification) to enforce policies can be a cost-efficient solution as it does not require to create an entirely new public control system (Schleifer, 2013).

However, there are notable criticisms and negative effects associated with the growing reliance on CSLs in public policy. One major concern is the significant barriers CSLs pose for producers in low- and middle-income countries, who often struggle with the high costs of certification and lack the resources to meet the requirements of multiple CSLs. This creates a risk of excluding smaller or less economically capable producers from the benefits of sustainable trade, thus exacerbating global inequalities, as discussed in Part A of this deliverable. Furthermore, the increasing number of CSLs has led to a lack of harmonisation, with different standards showing varying levels of rigor and implementation. This diversity creates confusion for producers, buyers, and consumers, and raises questions about the credibility and effectiveness of CSLs.

Research also highlights the inherent flaws in industry schemes, multi-stakeholder initiatives, and third-party auditing processes. These initiatives are often subject to conflicts of interest, lack of transparency, and fail to detect risks or prevent harm effectively. In cases like the Ali Enterprises factory fire and the Rana Plaza collapse, companies certified by these standards were still involved in catastrophic events, revealing the inability of certification to ensure safety and accountability (Quijano and Wilde-Ramsing, 2023). Such failures show the limitations of relying on voluntary, industry-driven mechanisms for ensuring compliance with human rights and environmental standards. Moreover, as Schleifer (2013) explains, low baseline requirements in policies lead to significant variations in stakeholder engagement, standard rigour and auditing practises. The risk is that weaker schemes with less stringent verification processes gain more market share compared to more comprehensive and inclusive ones, harder and more expensive to obtain.

If CSLs are integrated in policies, it is fundamental to account for all these weaknesses. Clearer and stricter policy requirements in terms of robustness, transparency, and assurance aspects of certification and auditing may increase the reliability of such instruments. Our analysis indicated two aspects that received less or mixed attention in policies and CSLs, i.e. stakeholder engagement and corruption. These aspects are particularly important to strengthen in future refinements of policy requirements. This includes setting higher baseline

criteria for CSLs, promoting greater transparency in governance and auditing processes, and ensuring better support mechanisms for producers in low-income countries. Without such safeguards, the increasing reliance on CSLs risks reinforcing existing inequalities, enabling greenwashing, and undermining the credibility of sustainability initiatives. Future research and policy development should focus on improving CSL governance, strengthening enforcement mechanisms, and ensuring that these tools contribute to meaningful and equitable sustainability outcomes.

4.4.2 Study limitations

This study provides valuable insights into the integration of CSLs into EU bioeconomy policies, demonstrating how CSLs are currently used as well as how best practices in assurance are implemented in policies and CSLs relevant for these policies. However, this study has important limitations. First, the analysis is based on a selection of nine policies and ten CSLs, which, while informative, does not fully capture the complexity of the EU bioeconomy policy framework and certification system. Expanding the scope to include additional policies and a broader range of CSLs could provide a more comprehensive understanding. Second, the study focuses on CSLs that operate within regulated frameworks, meaning that certification is used as a form of co-regulation. Future research could explore CSLs in sectors where certification is not embedded in policy frameworks to assess differences in governance, assurance and effectiveness. Lastly, our analysis concentrated on assurance requirements, providing a focused but partial view of CSL robustness. Further research could examine additional aspects such as transparency, stakeholder engagement in standard setting procedures, and overall standard stringency to gain a more holistic picture of CSL effectiveness in public policy.

In addition, the public consultations provide first impressions on stakeholder positions regarding the use of certification in EU bioeconomy policy making and their familiarity with policies where verification and certification are used as showing compliance or as a support tool. Despite spreading the survey widely and among different stakeholders, the number of responses was limited. Therefore, statistical significance is not guaranteed. While these results still offer useful qualitative insights into stakeholder awareness and engagement with relevant EU policies, future research can address this by expanding the number and diversity of respondents.

4.4.3 Conclusions and recommendations

Certification as a verification instrument for public policy requirements has several well-documented strengths and weaknesses (Majer et al., 2023). It is essential that policymakers and stakeholders recognise these aspects when further developing the EU bioeconomy policy framework or other initiatives that rely on certification for verification purposes. Our analysis has shown that sustainability certification cannot be viewed as a stand-alone tool to guarantee sustainability outcomes. While certification can be an effective mechanism for encouraging companies to adopt more sustainable practices and for demonstrating compliance with regulatory or market requirements—particularly when scaled across sectors—, it remains limited in its ability to address broader structural and systemic challenges.

To enhance its effectiveness, certification should be embedded within more comprehensive governance strategies, including jurisdictional, landscape, and national frameworks that ensure compliance with legal and international standards. In this context, stronger integration

with due diligence regulations could create synergies that improve traceability, accountability, and overall governance performance. Ideally, such integration would lead to the development of complementary mechanisms that mutually reinforce the credibility and robustness of sustainability governance (Majer et al., 2023).

This process requires an intensified exchange between policy makers and certification schemes. HARMONITOR has developed a roundtable format to organise the exchange between certification schemes and various stakeholder groups. One of the successful events of the roundtable has shown the need for a continuous exchange to discuss and further develop the opportunities for the integration of certification in EU policies.

In most biomass markets, sustainability certification schemes compete for market relevance. However, when policies set low sustainability requirements and there is little market demand for more ambitious standards, companies may see little incentive to adopt complex or stringent certification schemes. As a result, less demanding schemes risk gaining broader acceptance, potentially leading to a race to the bottom. This poses a significant risk, as it can undermine the credibility of certification as a tool and weaken trust in the overall sustainability of the sector. To address this, it is crucial to establish clear minimum standards in the respective policies —not only for sustainability criteria but also for the assurance processes that ensure these requirements are effectively implemented. This includes setting baseline expectations for aspects such as auditor training and support, which play a key role in maintaining the integrity and reliability of certification systems.

5 General recommendations on improving feasibility and effectiveness of CSLs

This section draws on parts A and B of the report to provide a synthesis of the main recommendations for improving the feasibility and effectiveness of CSLs. The recommendations are divided by topic.

Challenges for smallholders and companies in low-income countries:

- Policymakers: promote policies to ensure technical and financial support to economically disadvantaged companies to avoid their exclusion from certification programmes.
- Downstream companies (e.g., multinational brands): use market power and resources to actively support smallholders in achieving certification. This can include funding training programs, co-investing in necessary infrastructure, or offering long-term purchasing agreements that incentivize certification.
- CSLs: simplify certification requirements and invest in user-friendly, digital systems to reduce the administrative burden. Develop clear guidance, case studies, and multilingual training materials tailored to different financial and regional contexts.
- CBs: adopt cost-effective IT tools and smart record-keeping systems to streamline monitoring and reporting processes. Support companies in implementing these tools and interpreting certification criteria to reduce confusion and operational workload.

Use of certification as verification instrument in EU policies:

- Policymakers: strengthen and harmonise policy requirements to ensure that only credible and robust certification schemes are recognised in public frameworks. This includes setting ambitious and consistent minimum standards for both sustainability criteria and assurance processes, so that certification contributes meaningfully to policy goals rather than enabling weak or inconsistent implementation.
- CSLs: engage in continuous dialogue with policymakers and stakeholders to ensure alignment with public policy objectives. Participate in structured platforms, such as BiobasedCert roundtable, to co-develop strategies that strengthen the effectiveness of certification in sustainability governance.
- Industry: prioritise credible and ambitious certification schemes, even when not mandated by regulation, to uphold the integrity of sustainability claims and promote higher standards across the sector.

Need to better understand impacts of certification:

- Policymakers: promote policies that require collecting harmonised and reliable information on overall sustainability performance of CSLs, including socio-economic aspects.
- Researchers: more research is needed to investigate the impacts of certification.
- CSLs: need to put systems in place to effectively monitor their impact. This recommendation is also linked to WP5 of HARMONITOR, that is conducting research on how CSLs monitor their impacts and progress.

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7 Appendices

A.1 Interview questions

As already mentioned in the introduction to this report, the research conducted on costs and benefits of the three case studies was conducted in close collaboration with the 3-CO project. For this, most interview questions overlap with the ones available in 3CO's deliverable D1.5 (Cost and relevance of LCS for the bioeconomy): Public Deliverables - 3CO project.

A.1.1 Questions interviews on barriers and challenges of certification

Barriers to certification

- What are the barriers/challenges that companies face during certification process?
- Of these barriers and challenges, which ones are the most important?
- Which actors/stakeholders along biobased value chains experienced most barriers?
- Differences in barriers/challenges:
    - Do barriers/challenges differ for different feedstocks, actors in supply chain/stakeholders or global regions/countries, certification schemes?
    - (How) do challenges/barriers change if regulated vs voluntary certification?
    - How did the challenges/barriers change over the last 10/15 years? Is it getting easier or harder for companies to access certification? What are the reasons for making it easier/harder?
- Literature shows that smallholders and companies in low-income countries experience higher certification barriers. Do you agree?
- What are the main reasons for higher barriers for these groups?

Mitigating barriers/challenges

- How can barriers be mitigated?
- Which actors should be responsible for these measures? Any specific mitigation measure for smallholders?
- One of the barriers that was mentioned often is that certification is very bureaucratically intense and e.g., record keeping can be very resource intensive. It's also something that is needed to ensure that the principles of certification are actually met. So how can such challenges be mitigated still ensuring that certification is 'serious'? (How) will this get better for example with digitalization or AI?
- Literature focuses on the barriers for companies that would like to get certified. What are the main challenges for [interviewee stakeholder category].

A.1.2 Questions interviews on wood and cotton certification

General

1. What are the main characteristics of companies that influence the costs and benefits of certification? How do these change along the supply chain?

Drivers

2. What do you think are the main drivers for companies to get certified? How does this change across different regions of the world?

Costs & barriers

While the direct costs (e.g. auditing costs) are more “standardised”, the indirect costs (e.g. costs to meet the standard’s requirements including monitoring and management system requirements) vary depending on the state of the company before certification.

3.1 What are the costs for external audits (total or fee per day)?
3.2 How many person days do companies spend to prepare for external audits?
3.3 What are the effort (and expenses) required to comply with the management system criteria of the sustainability scheme (e.g. inventories, records keeping, monitoring etc.)?
3.4 What are the efforts (and expenses) required to comply with the performance criteria of the sustainability scheme (e.g. opportunity costs set aside areas, minimum wages, less use of pesticides, etc.)?
3.5 In your experience, which requirements usually result in the highest costs?
3.6 Can the costs of certification be reduced? If yes, how?
3.7. What are the most important barriers/challenges for certification process in general?
Benefits

4.1 What are the main drivers for forest owners to get certified? [first ask for answer respondent, keep list below in mind to obtain more complete response]. What drivers are dominant?

For example:

- Signalling: Consumers ask for it, Image, transparency?
- Market: Financial, price premium, needed to access the market?
- Legal: Participate in public procurement, compliance with mandatory regulation?
- Moral: environmental benefits, employee satisfaction?
- Learning: improve quality of the product, improve internal processes?

4.2 Do you observe price premiums for certified wood? If so, can you talk more about it (keeping data confidential).

Other questions

5.1 Are there any differences between (costs of) FCS and PEFC certification? If yes, what are the main differences?

5.2 Is FSC, PEFC certification helpful with regards to compliance with EUDR?

A.1.3 Additional questions for interviews on cotton

Drivers

2. How do the drivers to get certified differ across the supply chain?

Benefits

4.1 What is the price premium paid B2B for a certified product? Where does this premium lie in the supply chain?

Other questions

5.1 What is your opinion on the Directive Empowering Consumers for Green Transition?

5.2 What is the reason for selecting a specific CSL e.g. Better Cotton over GOTS?

A.2 Public consultation

Q1 Stakeholder Type – Which stakeholder category best describes you?

- Sustainability certification scheme and/or label owner organization that develops standards
- Certification body that certifies/audits standards
- Bio-based product manufacturer
- Business or public sector purchaser of certified and/or non-certified products
- Trader of goods
- Certification support consultant
- Researcher (academic or otherwise)
- Non-governmental organisation (NGO)
- Policy maker
- Private consumer
- Other, please specify

Q2 How can sustainability certification be best used in EU policies related to the bioeconomy? Please choose one

- It should be mandatory for companies to adopt sustainability certification to prove compliance with EU regulations.
- Companies should be allowed to use sustainability certification or other third-party verification options to prove compliance with EU regulations.
- Sustainability certification should not be allowed to prove compliance with EU regulations
- Other, namely ….

Q3.1 If option 2 selected in Q2: You indicated that certification and other forms of verification should be allowed to prove compliance with regulations. How effective are the following certification and verification options to ensure a more sustainable bioeconomy? Please rate 1 (not effective) to 5 (very effective).

- Sustainability certification
- Third-party verification (e.g., consultants, etc.)
- Verification internal to the company
- Due diligence
- Disclosure of information
- Other, namely …

Q3.1 If option 3 selected in Q2: You indicated that certification should not be allowed to prove compliance with regulations. How effective are the following alternative verification options to ensure a more sustainable bioeconomy? Please rate 1 (not effective) to 5 (very effective).

- Third-party verification (e.g., consultants, etc.)
- Verification internal to the company
- due diligence
- disclosure of information
- Other, namely ….

Q4 Please rank the following challenges based on how much they limit the feasibility of using certification to promote sustainability.

- Not enough financial benefits from certification
- High complexity of certification requirements and process
- Certification requirements are hard to adapt to local contexts
- Too many different schemes and labels
- Shortage of auditors and verifiers
- Other? Pls indicate

Q5 How can the challenges related to certification be addressed? Multiple answers allowed.

- Support policies for companies to facilitate certification
- Improved certification schemes with clearer standards and guidelines
- Streamlined certification processes to reduce complexity and costs
- Policies to raise consumers awareness about certification and increase demand
- Collaboration between governments, businesses, and certification bodies to enhance certification feasibility
- Companies buying certified materials and products should offer financial support to suppliers
- Other, namely….

Q6 How could the measures to reduce certification challenges be implemented in practice and what considerations are important for their successful implementation?

Q7 For the following directives in the European Union (EU), how familiar are you with the use of sustainability certification within each directive (hovering over the name of each directive/regulation will display a brief summary). For each, "Not familiar at all" to "Extremely familiar".

- EU Renewable Energy Directive - The Renewable Energy Directive (RED, RED II, RED III has set sustainability requirements (GHG reduction, use of land, protection of biodiversity) for biofuels, bioliquids and biomass for energy. It has also set a mechanism for the use of product certification schemes for demonstrating compliance with those sustainability requirements.
- EU Timber Regulation - The EU Timber Regulation (EUTR) establishes obligations to counter illegal logging on companies that place or buy timber and timber products on the EU market. Sustainability certification is the most common method used by industry to inform risk mitigation actions.
- Green Public Procurement – The purchase of supplies and services by the government for internal use that prioritizes reducing the impact of those products and services on human health and the environment
- Green claims directive - Aims to address misleading environmental claims and ensure that businesses provide clear, verifiable information about the environmental impact of their products or services. Sustainability certification can help companies substantiate their green claims.
- Eco-design directive - Focuses on improving the environmental performance of products throughout their lifecycle, from design to disposal. This directive encourages the use of sustainability certifications to demonstrate a product's eco-design credentials.
- Carbon removal and carbon farming certification regulation (CRCF) - Defines standards and criteria for carbon removal practices, including carbon farming, and sets out

requirements for certification schemes to validate the effectiveness of carbon offset projects in reducing emissions.

- EU deforestation regulation (EUDR) - Addresses deforestation and forest degradation associated with supply chains in the EU. It sets rules to ensure that products linked to deforestation (like palm oil, soy, and cocoa) are sustainably sourced and certified to demonstrate compliance with the regulation.
- Other (please specify)

Q8 To further explain the results of this survey and understand stakeholder perception concerning certification schemes and labels as effective support instruments for EU bioeconomy policy, we are planning on conducting interviews with stakeholders. Are you available for a follow-up interview? If so, please follow this link to leave your contact information.

A.3 Background information case study palm oil

Table 24. Final selection of cost items included in current analysis (first column on the left) and cost categories included in original data collected from literature.

Final cost categories	Scheme smallholders	Independent smallholders	Producer 50,000 ha
Membership	Membership	Membership	Membership
Annual audit cost	Audit implementation External audit Follow-up audit Internal audit	Audit implementation External audit Follow-up audit Internal audit	Annual audit cost
Staffing and training	Capacity building and training	Capacity building and training	Group member trainings
Standard compliance	Data verification Environmental and biodiversity standard compliance Legal aspect compliance Social standard compliance	Data verification Environmental and biodiversity standard compliance Legal aspect compliance Social standard compliance	Corrective actions Conservation area establishment
Environmental and social assessment, HCV, etc.	-	-	HCV, SIA, LUCA, CSA/GHG, soil and topography assessments
Organization and ICS	Organization establishment	Organization establishment	-
Document recording collection	Document recording	Document recording	-

Data on palm oil collected from literature:

D6.2 palm oil original data

A.4 Background information case study forest certification

This appendix gives background information to the calculation of direct and indirect cost of forest certification, as presented in section 3.4.2. The general approach can be found in section 3.2.5. Please note that this estimation of direct and indirect management costs is also used in 3-CO deliverable D1.5[5]. This deliverable can be consulted for further general background on the level of certification, ownership (public, private), area per FSC certificate, number of management units per owner, area per management unit or group member in Sweden and the Netherlands. The estimation of opportunity costs and benefits, as well as the cost-benefit analysis and its sensitivity analysis based on variations in opportunity costs is further elaborated below in the frame of the HARMONITOR project.

Direct costs of forest certification

Direct costs of certification, e.g. related to the external audit and audit preparation time, were estimated by assessment of FSC audit reports that include audit times, and interviews with auditors and certification managers, i.e. the staff organising the certification process on behalf of the forest owners. In total six persons were interviewed and listed in Table 1.

Based on audit times available in audit reports, and FCS advice on auditing time (FSC 2024), we estimated that the yearly external audit times of the 50,000-hectare forest are 3, 4.5 and 7 days in case of a single management unit, multiple management units and group certification, respectively. Based on the interviews, the time required by the certification manager and forest owner/manager active at management unit level, to prepare and be available at the audit has been estimated. An overview of audit time requirements is presented in Table 7.

Indirect costs of forest certification – management system costs

The indirect costs of certification consist of the costs to comply with (1) the management system criteria and (2) performance criteria of the scheme. The management system costs were estimated by the time required by the certification manager to take care of the record keeping, keeping the forest management plans and overviews of HVC areas etc. up to date. Based on the interviews, it was estimated that this requires 20, 40 and 60 days, in case of a single management unit, multiple management units and group certification, respectively. See Table 7.

Table 25: Estimation of time required for 50,000-hectare forest certification (days/year). Source: own elaboration

Certification-related activity	Actor	Single management unit	Multiple management unit	Group
Audit	External auditor	3	4.5	7
Audit preparation and audit	Certification manager	3.5	10.8	24.5
Audit preparation and audit	Forest owner/manager field level	2	3.5	6
Compliance with management system criteria	Certification manager	20	40	60

[5] 3-CO deliverable D1.5 Cost and relevance of LCS for the bioeconomy, https://3co-project.eu/public-deliverables/

We assumed an audit fee of 1100 €/day for external auditors, labour costs of the certification manager of 500 €/day, and labour costs of the forest owner/manager at field level of 400 €/day to estimate the direct costs and indirect costs of compliance with the management system criteria. Associated costs are shown in Table 26. Please note that the table does not include the costs of establishment of a forest management plan from scratch, as in many cases forest owners already have a forest management plan.

Table 26: Estimation of direct costs and indirect costs of compliance with the management system criteria of annual certification of a 50,000-hectare forest (€/year), excluding costs of establishing a first forest management plan (see text for explanation). Source: own elaboration

Certification-related activity	Actor	Single management unit	Multiple management unit	Group
Audit	External auditor	3,300	4,950	7,700
Audit preparation and audit	Certification manager	1,750	5,375	12,250
Audit preparation and audit	Forest owner/ manager field level	800	3,400	8,400
Total direct costs		**5,850**	**13,725**	**28,350**
Compliance with management system criteria	Certification manager	10,000	20,000	30,000
Total forest certification costs (excl. set aside costs)		**15,850**	**33,725**	**58,350**
		0.32 €/ha	0.67 €/ha	1.17 €/ha

Indirect costs of forest certification – performance criteria / set aside areas

Indirect costs of compliance with the *performance criteria* of forest management certification vary and are site specific. In this case study, we have focused on the opportunity costs of setting aside part of the areas, with focus on PEFC and FSC in Sweden.

The Swedish national FSC standard (FSC 2019) article 6.5.1, requires that "*A selection of the productive forest land area is set aside and exempt from measures other than management to maintain and promote natural biodiversity or biodiversity conditioned by traditional land use practices. The selection of areas covers a minimum of 5 % of the productive forest land area".* Moreover, "at least 5 % of the productive forest land area is managed with long-term protection and enhancement of conservation values and/or social values as the primary objective" (Art 6.5.1). It means that in total 10% of productive forest land needs to be set aside. Productive forest land is forest land that produces an annual volume increment of at least one cubic meter per hectare. However, it is not required that land set aside is harvested in absence of certification, i.e. productive land set aside can for instance be located at a location difficult to reach with harvesting equipment. The PEFC Sweden Forest Standard (PEFC 2017) requires that "*At least 5 % of the productive forest land shall be set aside for conservation purposes"* (Art. 5.1). A map with set aside areas of important certificate holders in Sweden can be found here.

The opportunity costs are formed by the volume that will be harvested in absence of forest certification but is not harvested in case of forest certification. The opportunity costs vary between zero (in case the forest owner can allocate 5% or 10% of set aside area to plots that cannot be harvested in an economic viable way, e.g. in areas that are difficult to access with harvesting equipment (e.g. steep areas) (situation 1)), and the full loss of opportunity costs (if the whole area has forests that would be harvested in case of absence of certification (situation 2)). One of the respondents indicated that about 50% of the private owners can allocate set

aside areas to low productive parts of their forest, while the other 50% have only productive forests and thus a real loss. Breukink (2015) assumes that set aside areas have 60% of the productivity of the non-set aside part of the forest and point out that also in set aside areas harvest is allowed under specific conditions, e.g. if it serves nature conservation. According to an international assessment of the application of the FSC set aside criterion (FSC 2023), in Sweden the 10% set aside criterion has led to increased protection in the certified management units. This indicates that in Sweden the set aside criterion is not simply a continuation of common practice as in absence of forest certification, and thus it is likely that there are real opportunity costs.

Price premium

During the interviews, indications of a 2 - 3% price premium for PEFC and 3 - 4% price premium for FSC certified wood were obtained. This is in line with Villalobos et al (2018) that found premium of 1.64% - 2.08% and 0.90% - 1.98% for single PEFC (or FSC) certified wood, and 3.17% - 4.17% and 3.00% - 3.97% for double certified PEFC & FSC wood. For the cost benefit analysis, we will assume a price premium for 2.50% for PEFC certified wood and 3.75% for FSC certified wood.

Cost-benefit analysis

The cost-benefit analysis is based on the average yields and the average mix of wood assortments as found in Sweden. It is observed that there are important differences between productivity in the northern and southern parts of Sweden, and in practice each forest has his own different mix of wood assortments.

The productive forest area of Sweden is 22.5 Mha[6], of which each year 1.10% is subject to final felling with a yield of 264 m^3sk/ha[7], i.e. 65.3 Mm^3sk/year, which is 2.90 m^3sk/ha/year related to the total productive forest area. Moreover, each year 1.30% of the productive forest of Sweden is subject to thinning with a yield of 72 m^3sk/ha[7], i.e. 21.06 Mn^3sk/year, or 0.936 m^3/ha/year related to the total productive forest area. Thus, in total, the average yield of productive forest is 2.90 m^3sk/ha/year from final harvest plus 0.936 m^3sk/ha/year from thinning is 3.84 m^3sk/ha/year[8]. Given that 86.4 Mm^3sk (growing stock, solid over bark), resulted in a net felling of 72.1 Mm^3f pb (solid volume excluding bark), a factor 0.834 has to applied to derive to a net felling of 3.20 m^3/ha/year f pb.

In Table 27 an average wood price of 66.2 €/m^3f pb, has been derived from the average net felling of the different wood assortments. In monetary terms the average harvest of 3.20 m^3/ha/year f pb results in an average income of **212 €/ha/year**.

Table 27: Estimation of average price of wood in Sweden

Wood assortment	Net felling (Mm^3f pb)[a)]	Price (€/m^3f pb)
Sawlogs	34.4	81.8
Pulpwood	31.4	53.7
Other roundwood	0.3	59.4
Fuelwood	6.0	42.8

6 https://www.swedishwood.com/wood-facts/about-wood/wood-and-sustainability/the-forest-and-sustainable-forestry/

7 https://www.skogsstyrelsen.se/en/statistics/subject-areas/felling/#:~:text=The%20average%20annual%20felling%20volume,metres%20per%20hectare%20in%20thinning

8 m^3sk = growing stock, solid over bark, meaning the volume of the whole tree above the stump cut, including bark.

Total / average	**72.1**	**66.2**

a) Solid volume excl. bark. Source: https://www.skogsstyrelsen.se/en/statistics/subject-areas/felling/#:~:text=The%20average%20annual%20felling%20volume,metres%20per%20hectare%20in%20thinning (Figure 5, downloaded as excel file) b) Source: https://app.vonwood.com/nl/articles/mellanskog-log-price-increase-central-sweden-2023 1 € = 11.4479 SEK (Oanda.com, 6 Jan 2025)

Figure 10 shows the required price premium in €/m^3 wood excl. bark to cover all costs of certification, depending on the relative productivity of the set aside area in % of total productivity of the non-set aside part of the forest, assuming an average sales price of 66 €/m^3 wood excl. bark. See chapter 3.4.2 for more results and a further discussion on the findings.

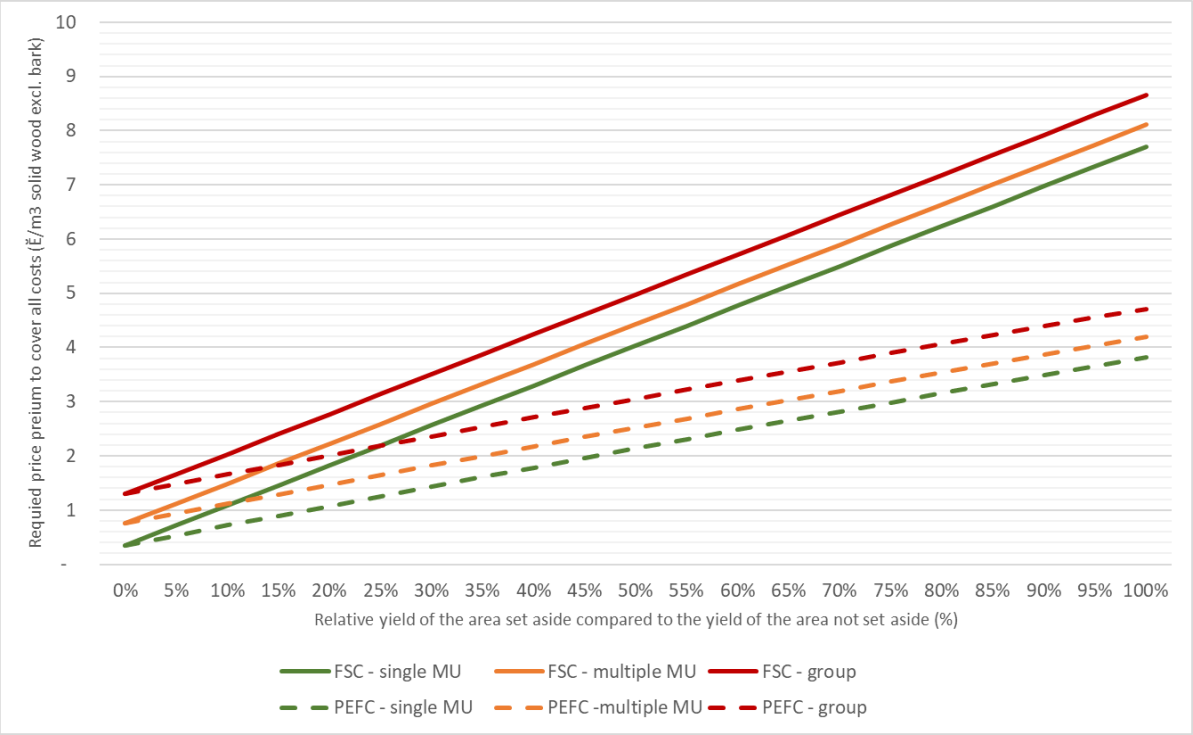

Figure 10: Required price premium in €/m^3 wood excl. bark to cover all costs of certification, depending on the relative productivity of the set aside area in % of total productivity of the non-set aside part of the forest, assuming an average sales price of 66 €/m^3 wood excl. bark. Source: own elaboration.