SUST CERT 4 BIOBASED
SUSTAINABILITY CERTIFICATION FOR BIOBASED SYSTEMS

D5.1

Summary of project findings and recommendations

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ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
BMT	BIOBASEDCERT Monitoring Tool
BP	Benchmarking Platform
CBA	Cost-benefit analysis
CGF	Consumer Goods Forum
CSL	Certification scheme and label
ECOWAS	Economic Community of West African States
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FSC	Forest Stewardship Council
GDP	Gross domestic product
GHG	Greenhouse gas
GRS	Global Recycled Standard

ILUC	Indirect land-use change
ISCC	International Sustainability & Carbon Certification
ISO	International Organization for Standardization
ITC	International Trade Centre
LCA	Lifecycle analysis
LDPE	Low-density polyethylene
MERCOSUR	The Southern Common Market
NACE	Statistical Classification of Economic Activities in the European Community
PEFC	Programme for the Endorsement of Forest Certification
PHA	Polyhydroxyalkanoate
R&D	Research & development
RED II	Renewable Energy Directive (EU) 2018/2001
RIA	Recommendation for industrial actors
RP	Recommendation for policymakers
RRA	Recommendation for regional actors
RSB	Roundtable on Sustainable Biomaterials
RSS	Recommendation for scheme owners and standard writers
RVO	Rijksdienst Voor Ondernemend
SAFA	Sustainability Assessment of Food and Agriculture systems
SDG	UN Sustainable Development Goals
SSCI	Sustainable Supply Chain Initiative
UN	United Nations
UNEP	United Nations Environment Programme
WP	Work package

Executive Summary

This report synthesises the principal findings and recommendations emerging from the Horizon Europe project SUSTCERT4BIOBASED. The project aims to support the transition towards a sustainable bio-based industry by defining and promoting the adoption of effective and robust sustainability certification schemes and labels for bio-based systems. This document collates the key insights from the project, providing an overview of research findings and presenting targeted recommendations for key stakeholders involved in the European bioeconomy.

Project findings

The SUSTCERT4BIOBASED project undertook research across several interconnected areas. A comprehensive classification system for biological resources and bio-based products was developed, categorising feedstocks and linking them to bio-based product groups across six key industrial sectors. The project established and applied a methodology for reviewing sustainability certification schemes and labels (CSLs), assessing their alignment with sustainability principles (environmental, circularity, social, economic) and identifying gaps.

An analysis of bio-based value chains identified synergies and trade-offs concerning Sustainable Development Goals (SDGs), highlighting the benefits of utilising waste feedstocks. Eighteen representative value chains were ranked based on their potential contribution to sustainable development, with those utilising residues (e.g., mulch film from organic waste) scoring highly. Conversely, sectors like textiles, reliant on primary dedicated raw materials, showed less potential without significant innovation.

Investigations into global trade flows revealed significant challenges in obtaining reliable data on certified bio-based products, hindered by inconsistent reporting, accounting issues (e.g., mixing product types, mass balance methods), and a lack of monitoring by certification providers.

A key output was the BIOBASEDCERT Monitoring Tool (BMT), developed collaboratively with sister projects, designed to evaluate the robustness and effectiveness of CSLs across system, content, and outcome levels.

Furthermore, the project reviewed and adapted Cost-Benefit Analysis (CBA) methodologies to include the internalisation of externalities for bio-based value chains, although data collection for external costs and benefits proved highly challenging.

Project recommendations

The project offers numerous recommendations targeted at policymakers, scheme owners/standard writers, industrial actors, regional actors, as well as, secondarily, for civil society and researchers. A cross-cutting theme is the need for a holistic approach to sustainability assessment, incorporating circularity and socio-economic aspects alongside environmental concerns. Enhanced data collection, transparency, standardisation of metrics, and monitoring of certified production and trade are crucial.

The derived recommendations stress the importance of adapting bioeconomy strategies to local contexts, fostering cross-sector collaboration, and increasing the use of locally sourced feedstocks. Stakeholders are encouraged to use tools developed by the project, such as the BMT for scheme evaluation, as well as the enhanced CBA methodology.

Specific actions are proposed to fill research gaps, improve impact assessment methodologies, address scope differences in CSLs, promote innovation in underperforming sectors, and strengthen regulatory enforcement and integration with public procurement. Addressing deforestation links and considering the global impacts of EU policies are also highlighted.

Overall, the recommendations aim to guide stakeholders towards a more credible, transparent, and effective system for certifying sustainability in the rapidly evolving bio-based economy.

1. Introduction

This report is a presentation of the collation and synthesis of the findings and recommendations derived from the SUSTCERT4BIOBASED project. This entails the recommendations and findings of the deliverables within work packages 1-4 based on the research conducted and work done in the respective tasks. This work also aligns with identified EU policy objectives linked to harnessing the bioeconomy for a green transition. These policies include the EU Bioeconomy Strategy, the EU Circular Economy Action Plan, the EU Green Deal, the Zero Pollution Action Plan, and the Environment Action Programme to 2030.

The objective of this report is to provide stakeholders with targeted recommendations derived from the project and give an overview of the project findings. The project has explored critical aspects of sustainability certification within the European bio-based economy, including the classification of resources and products, the development and evaluation of methodologies for reviewing certification schemes and labels (CSLs), analysis of bio-based value chains concerning trade flows and sustainability impacts, the creation of a monitoring tool (BMT), and methodologies for cost-benefit analysis (CBAs) incorporating externalities.

Section 2 provides an overview of the findings from the deliverables within work packages 1-4. Section 3 presents actionable recommendations tailored for the selected four stakeholder groups: policymakers, scheme owners and standard writers, industrial actors, and regional actors.

The findings and recommendations were derived by reviewing the finalised deliverables and extracting key messages, findings, and recommendations. Additionally, for deliverables that were under preparation, findings and recommendations were provided as input by the partners leading their preparation (i.e., D3.2, D3.3 and D4.4).

For each recommendation, relevant stakeholder groups were identified. Based on this identification, the recommendations were categorised in this report by stakeholder group for ease of reading.

The findings and recommendations, as well as this report, were reviewed by project partners to ensure that all findings and recommendations were accurate, reflected the messages of the deliverables, and were consensus-based among project partners. Potential open questions were discussed in periodically occurring project partner roundtable meetings, whose goal was to develop findings and recommendations that all partners could stand behind. Finally, a recommendations matrix (Annex 1) was prepared, providing a collated list of all recommendations with the source project deliverable as well as the stakeholder groups to which the recommendation applies to.

2. Summary of project findings

D1.1: Classification of biological resources and bio-based products

(T1.1. Classification of biological resources and biobased products)

The objective of D1.1 was to review and classify biological resources and bio-based products. This work was a precursor to the general goal of WP1: identifying the certification schemes and labels (CSLs) that would be relevant to these resources and products. The study identified and categorised the bio-based materials and products and the range of biological resources intended for industrial bio-based systems.

D1.1 provides valuable insights into the different types of biological feedstocks that can be used for each of the identified 345 bio-based product groups. These insights can be useful in identifying bio-based value chains and the relevant feedstocks for each industrial bio-based sector. From this analysis, it can be concluded that several biological resource categories can be part of different bio-based products and can be useful in various sectors.

Classification of biological resources

This deliverable entailed classifying biological resources used in EU industrial bio-based value chains. Four main feedstock categories were identified:

i) Primary dedicated: Biomass purposely grown as such or which constitutes the primary result of production.

ii) Primary residues: Biomass generated as an element of production and/or management but not the main product, e.g. parts of biomass left on the field or in the forest after harvesting.

iii) Secondary residues: All forms of biomass that arise from the processing of biomass in industry.

iv) Tertiary residues and waste: Sources that have already had a use (post-consumer) and that consist partly or fully of biological material (e.g. organic fraction of municipal solid waste, demolition wood).

These four categories were further grouped by origin (plant, animal or microbial). Finally, the source of the feedstock was identified as either marine, agricultural, forest, industrial, or urban. From the interplay of these categories, subcategories and types, the project identified 22 distinct classifications of biological resources: 10 primary dedicated feedstocks, five primary residue feedstocks, four secondary residue feedstocks and three feedstocks from tertiary residues and waste (see Table 1).

Table 1 Excerpt highlighting classification of biological resources (primary dedicated and primary residues)

CATEGORY	TYPE	FEEDSTOCK SUB-CATEGORY	SOURCE	SUB-TYPE FEEDSTOCK	EXAMPLES
Primary dedicated	Plant	Aquatic biomass	Marine	Aquatic plants and macroalgae	Seaweed, duckweed
				Microalgae and cyanobacteria	Spirulina, chlorella
		Lignocellulosic from croplands and grassland	Agriculture	Short rotation coppice (SRC)	Willow, poplar
				Agricultural fibres	Cotton, Flax, Hemp, Jute, Sisal, Coir
				Herbaceous perennials and grasses	Miscanthus, Giant reed, Reed canary grass, Switchgrass
		Lignocellulosic wood/forestry	Forest	Softwood	Pine, Spruce, Fir
				Hardwood	Oak, Birch, Beech
				Cork	Cork (cork oak)
		Oil crops and plants	Agriculture	Oil crops	Soybean, Rapeseed, Sunflower, Canola, Castor beans, Linseed
				Oil plants (fruit, nut)	Coconut, Olive, Jatropha curcas
		Starch crops	Agriculture	Edible grains	Wheat, corn, barley, rye, oat, rice
				Tubers	Potato, Cassava
		Sugar crops	Agriculture	Sugar crops	Sugar cane, sugar beet
		Other primary biomass	Agriculture/ Forest/ Marine	Natural resins	Natural latex (rubber tree), natural dyes, amber
	Animal	Livestock-based biomass	Agriculture	Fibres of animal origin	Wool, silk
		Marine animals	Marine	Fish	Cod, tuna, shark
				Marine arthropods	Crab, shrimp, lobster
	Microbial	Microbial biomass	Industry	Enzymes	Xylanases, amylases, proteases, cellulases
				Bacteria	Nocardioides nitrophenolicus, Rhodococcus opacus
				Protist	Heterotrophic protist
				Fungi	Fungal biomass
Primary residues	Plant	Residues from agriculture	Agriculture	Agricultural field residues	Straw (wheat, rice), Leaves (sugar beet), Stover (corn), Sugarcane trash, Oil palm fronds
		Residues from forestry	Forest	Forest field residues	Logging residues, branches, stumps, foliage, roots
		Residues from nature and landscape management	Urban	Biomass from nature and landscape management	Green biomass (grass clippings), Tree pruning, felling
		Residues from aquatic biomass cultivation	Marine	Residues from aquatic biomass cultivation	Residues from aquatic biomass cultivation
	Animal	Animal-based residues	Agriculture	Animal manure	Dry manure (poultry, sheep & goat, cattle), Wet manure (pig, cattle)

Classification of bio-based products

The project has further identified and classified bio-based products according to selected industrial sectors considered to be of interest to the European bio-based economy. These six sectors – construction, woodworking, textiles, pulp and paper, chemicals, and plastic – are prominent sectors identified in the European Commission's Bioeconomy Strategy.

The classification includes products that are wholly or partially biobased. To maximise the possibilities of linking with available statistical data, NACE codes were used to identify product classes and PRODCOM for the corresponding subcategories. Furthermore, the range of biological raw materials that can be utilised within each product category was analysed. The result was 345 product categories, classified according to industrial sector and possible biological feedstock.

D1.2: Catalogue of sustainability certification schemes and labels

(T1.2 Setting up a methodology for reviewing schemes and labels, T1.3 Identifying and reviewing existing sustainability certification schemes and labels relevant to biobased value chains)

This deliverable aimed to investigate the extent to which current CSLs align with legislation, scientific recommendations, and industry best practices.

Collation of sustainability principles and indicators

A key output of this work was the development of a template for evaluating sustainability principles and criteria concerning environmental, circularity, social and economic themes contained in the standards of CSLs for bio-based resources and products. The collection of principles and criteria was informed by a review of relevant legislation, standards, and previous studies focused on the

sustainability of bio-based products and the bioeconomy in general. Further relevant information, such as geographical scope, feedstock, product/sector coverage, and governance of schemes and labels, was also included in the template.

This review resulted in the identification of the key dimensions and associated principles (Table 2) that cover the topics considered relevant for the sustainability management of bio-based resources and products:

Table 2 Identified principles within each sustainability dimension

Sustainability dimension	Principles identified
Environmental	• Reduce GHG emissions • Protect land with high carbon stock and peatland • Promote sustainable forest management • Promote the positive and reduce the negative impacts on ecosystems and biodiversity • Conserve and protect water resources • Protect soil quality and productivity • Implement best practices for the use of (agro)chemicals • Restrict air pollution, promote good air quality • Limit the risk of Indirect Land Use Change (ILUC)
Circularity	• Promote waste reduction and responsible waste management • Promote efficient use of energy and material resources • Promote material circularity
Social	• Compliance with labour rights • Working conditions • Property and usage rights • Wellbeing of the local population • Food security
Economic	• Financial and economic viability • Fair business practices, Integrity • Inclusive economic growth • Use of knowledge and technology • Fair trade and market practices • Risk assessment and management

Identification & selection of relevant schemes and labels for bio-based systems

The project identified schemes and labels relevant to bio-based resources and products, producing an extensive list. These were narrowed down to 11 by utilising a variety of criteria, as well as proposing a methodology for further evaluation. The schemes and labels assessed were found in the ITC standards map, the ISEAL membership list, the Global Ecolabelling network and other online indexes of certificates and labels. These included four schemes that certify bio-based products and materials, four schemes focusing on biological feedstocks, and three ecolabels.

Criteria for selecting relevant schemes and labels included:

- Applicable to biological resources intended for industrial bio-based value chains or to bio-based materials and products.
- Ecolabels: Ecolabels adhering to ISO14024 standards.
- Exclusion of schemes/labels specifically developed for food, feed, biofuel or bioenergy.

- Geographical coverage of at least EU. Exclusion of those specific to a single country or only outside of the EU.
- Full supply chain coverage. Exclusion of those focused on only one stage of the lifecycle.
- Principles and criteria concerning all sustainability dimensions. Exclusion of schemes that were focused on one sustainability topic (e.g. climate impact).

Subsequently, a factsheet was created for each selected scheme and label. Each factsheet covers various aspects of the schemes, including general information, governance, scope, and coverage of sustainability principles and criteria. This analysis deduced that the focal points of schemes vary significantly, especially considering governance, stringency in requirements, and rules of implementation and audit. Consequently, this can lead to different levels of sustainability impacts through their implementation.

D1.3: Analysis of synergies and trade-offs

(T1.4. Analysis of synergies and trade-offs)

The objective of this deliverable was to identify through a qualitative analysis the trade-offs and synergies of selected bio-based value chains considering sustainability perspectives, including economic, social, and environmental aspects. This work was anchored on the 17 sustainable development goals (SDGs) defined by the United Nations and a selection of the 85 most relevant targets for industrial bio-based products.

The SDG targets were categorised into four main areas: environmental, circularity, social, and economic, and linked to the sustainability principles and criteria collated for industrial bio-based systems identified in a previous task. Six major sectors were considered in this analysis (i.e. chemicals, construction, plastics, textiles, woodworking, and pulp & paper). Three to five value chains were selected per sector, totalling 25 value chains. These value chains constituted the most representative bio-based value chains for trade flows in Europe, narrowing down the number of selected SGD targets further to 43.

Each selected value chain was evaluated with respect to each SDG target to identify

- positive correlations;
- negative correlations that refer to synergies or trade-offs;
- lack of any identified interactions that result in neither a synergy nor trade-off and;
- non-applicable targets.

The qualitative scores were defined based on reliable online information and data, such as technical reports from the European Commission, peer-reviewed academic literature, published life cycle analyses of relevant stakeholders, news articles, and expert opinions.

The results of the analysis showed that significant synergies can be found between some SDG targets and the assessed value chains, particularly the ones using waste as feedstock (instead of primary resources such as starch crops, sugar crops, and virgin wood). There was also a significant positive synergy between the SDG targets and the proposed principles and criteria to evaluate schemes and labels. While all SDG targets are related to sustainability to some extent, the analysis found that the strongest alignment was in SDGs 2 and 7, all of whose targets matched the proposed criteria. SDGs 4 and 17 had the lowest coverage with 14% and 16% of targets corresponding to proposed criteria, respectively.

Figure 1 Percentage of SDG targets matched with sustainability criteria of bio-based systems

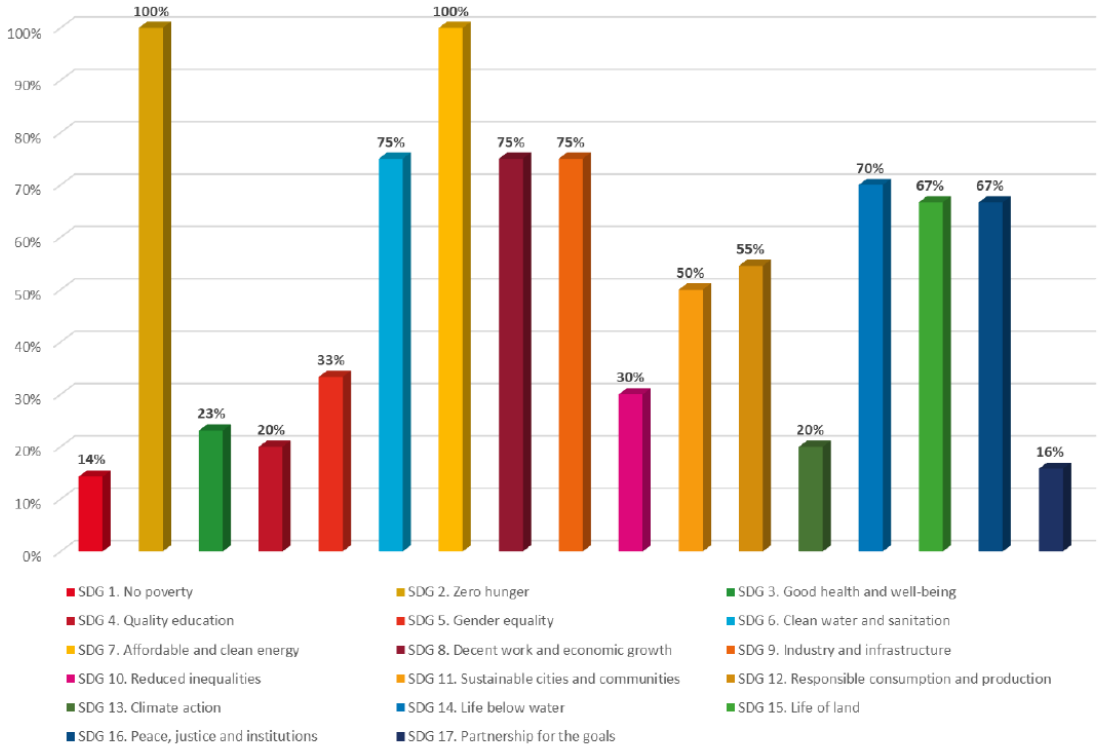
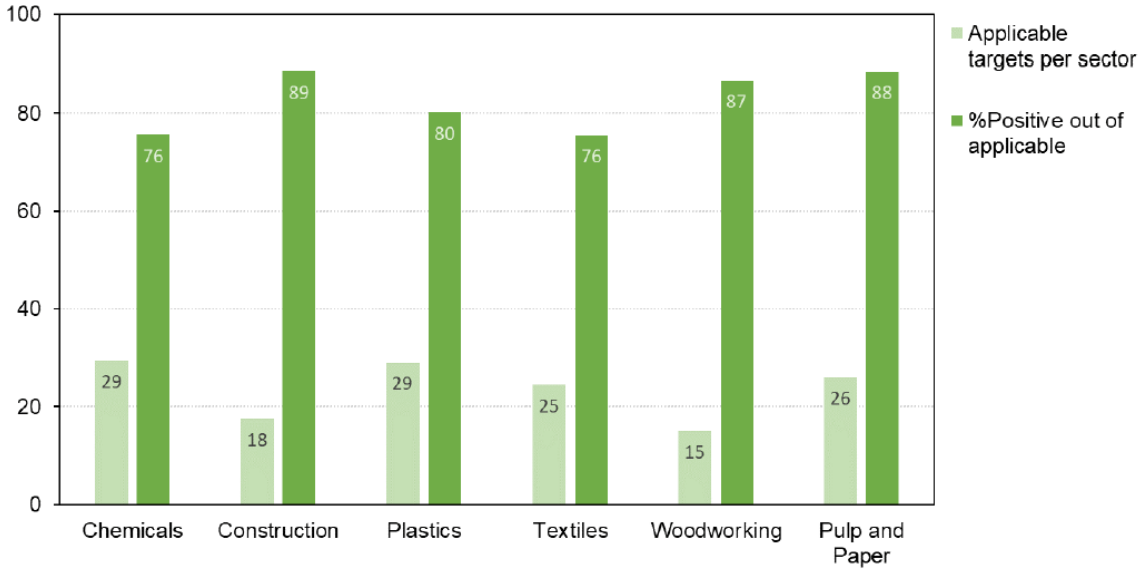


Figure 2 Number of targets assessed per sector and percentage of synergies



D2.1: Identification of the most representative bio-based value chains

(T2.1 Identifying the most representative biobased value chains)

This deliverable aimed to identify and rank bio-based value chains in the EU in terms of their potential to contribute to sustainable development. Six industrial sectors were considered in the analysis: textile, woodworking, plastic, pulp and paper, construction, and chemicals. The sectors chosen were those considered of interest for the European bio-based economy and prominent sectors identified

in the European Commission's Bioeconomy Strategy. For each sector, three bio-based value chains were selected based on, among others, the existence of relevant sustainability CSLs and the amount of production in Europe.

The value chains were ranked based on environmental, socioeconomic and technical criteria (see Table *3*). The environmental criteria utilised included the potential bio-based share of the final product, the estimated percentage share of bio-based products in the market, environmental concerns, and relevance to EU policy priorities. The socioeconomic criteria included market size, market growth, and social concerns. The technical criteria were determined as the innovative character of the value chain, feedstock availability in the EU, bio-based final product produced in the EU, and the valorisation of residues and waste. The importance assigned to each criterion was based on desk research and input from various experts. The criteria that had the most significant impact on the final ranking were social concerns, valorisation of residues and wastes, and market growth. It is important to note that the final ranking depends on the weight of each criterion and sub-criterion, which may vary depending on the goals and priorities of different stakeholders.

The value chain that scored the highest and was thus considered to have the most potential to contribute to sustainable development in the EU was mulch film from organic waste (plastics sector, agricultural subsector). Conventional agricultural (mulch) film is made from fossil-based plastic (LDPE). LDPE can be substituted with bio-based alternatives, such as biodegradable bioplastic polyhydroxyalkanoate (PHA), an organic acid produced by bacteria. For example, food waste can be used to cultivate this bacterium due to its high carbon content.

The second-highest scoring value chain concerned refabricated buildings from wood and wheat straw (construction sector, the building envelope subsector). This can be explained by the fact that building envelopes, prefabricated buildings, and insulations are Europe’s most produced and sold construction products. Conventional insulations can be substituted with bio-based alternatives, such as straw insulations.

The third-highest scoring value chain was adhesives from tall oil (chemical sector, adhesives subsector). Traditionally, adhesive formulations have been largely fossil-based. However, they can be substituted by natural resins, increasing the bio-based content of the final product. This new type of adhesive uses tall oil, a by-product of wood pulping.

The textile sector stands out with its three value chains ranking among the bottom six. Compared to other assessed sectors, it can be considered to show the least contribution to sustainable development in the EU. This is because the three value chains studied in this sector are based on primary dedicated raw materials, and there is a lack of innovation in the value chains. This demonstrates the need for the textile sector to transition to alternative biological resources. These novel value chains could also reduce the EU’s dependency on imports, increasing the need for efficient recycling technologies and advancing the shift from fast to slow fashion.

This ranking can help stakeholders, policymakers, and investors identify promising bio-based value chains and make informed decisions regarding investments, policies, and research and development initiatives.

Table 3 Final ranking of the bio-based value chains.

Bio-based value chain	Subsector	Sector	Final score (from 0 to 100)
Mulch film from organic waste	Agriculture	Plastics	89.09
Prefabricated buildings from wood and wheat straw	Building envelope	Construction	76.75
Adhesives from tall oil	Adhesives	Chemical	76.55
Paper for graphical purpose from recycled paper	Graphical Paper	Pulp and paper	72.85
Wooden bedroom furniture from Residues from sawn wood	Furniture	Woodworking	72.29
Cases, boxes, crates, drums and similar packings from coniferous wood	Carpentry pieces	Woodworking	68.61
Sacks and bags of polymers of ethylene from raw cane and beet sugar	Packaging	Plastics	65.37
Tableware and kitchenware of plastic from maize	Consumer goods	Plastics	64.05
Wooden frames for paintings, photographs, mirrors or similar object from ligneous materials (wheat straw + wood)	Manufacture articles	Woodworking	62.98
Doors, frames and thresholds subflooring from hemp	Wooden structures	Construction	60.77
Solvent for cleaning from maize	Solvents	Chemical	60.65
Builder´s joinery and carpentry for window from coniferous wood	Interior Construction	Construction	59.26
Table linen of flax	Furniture	Textile	58.75
Napkins from bagasse sugar cane fibre	Sanitary Paper	Pulp and paper	56.79
Cartons, boxes and cases of corrugated paper from coniferous wood	Packaging	Pulp and paper	55.85
Lubricants from vegetable oil	Lubricants	Chemical	54.56
T-shirts, singlets and vests, knitted or crocheted from cotton, carded or combed	Clothing	Textile	52.54
Textile wicks, conveyor belts or belting from greasy wool not carded or combed	Industry	Textile	51.78

D2.2: Database of trade volumes for biological resources and biobased products

(T2.2 Data collection and filling gaps on global trade flows for (un)(certified biobased value chains)

The objective of D2.2. was to find data evidence for the indicator *'certification rate of traded intermediate and final bio-based products at the global regional level in year x*' for a selection of the eighteen value chains identified in D2.1. This indicator should monitor the development of sustainably produced and traded bio-based products at a global level compared to total production and trade.

The analysis was conducted for ten value chains. The complete output of D2.2 is provided in an Excel file with the trade flow data of certified products in the selected value chains. Finding high-quality data for measuring this indicator was challenging, and the number could only be estimated.

In general, certification providers only publish lists of companies that have valid, withdrawn or fake certificates. There is no annual monitoring of certified production and trade for intermediate and final bio-based production (in terms of volume) at a regional market level and/or sector level, which hinders the monitoring of the indicator. The extent of certified trade of the raw biological feedstock used in the bio-based value chains analysed has been approximated from data in the ITC standards map on certified land use of a specific feedstock in a specific region.

Especially downstream in the value chain, there are data gaps concerning certification rates of intermediate and final bio-based products produced in the EU or traded between the EU and non-EU regions. More detailed and frequent reporting about the breakdown of certifications per sector, product, and region by schemes would help understand the inventory of certified products.

There are several critical limitations to mapping the amount of certified bio-based products in the bioeconomy. First, many certification standards do not create or publish annual reports with data useful to monitor the contribution of certified bio-based production to achieving sustainability goals. Second, there are a variety of accounting issues; for example, intermediate and final products are often mixed in certification accounting. Some schemes, such as ISCC Plus and RSB, mix mass balance methods with segregated methods. In addition, many certification schemes report on awarded certificates instead of currently valid ones. Standardised data reporting by certification scheme holders can improve the monitoring of valid certificates assigned to companies and products and how they contribute to sustainable goals.

There are also sector-specific challenges. For example, in the construction sector, there is an abundance of self-reported claims of products being bio-based but that lack third-party certification. There are also no standard criteria for what is certified, i.e. the building company, the producer or the specific products. Furthermore, the range of products made from wood, which is naturally bio-based, or of products with bio-based substitutes replacing fossil-based materials, should be disentangled and further investigated to understand the bio-based economy in this sector.

Further efforts are needed to map what products are certified by which standards and how significant a share of the bio-based market they constitute. A monitoring system with a harmonised set of indicators would require close collaboration of different actors, such as certification scheme owners, industry, the EU, and statistical offices.

D2.3: Analysis of effects of certification on EU trade of bio-based value chains

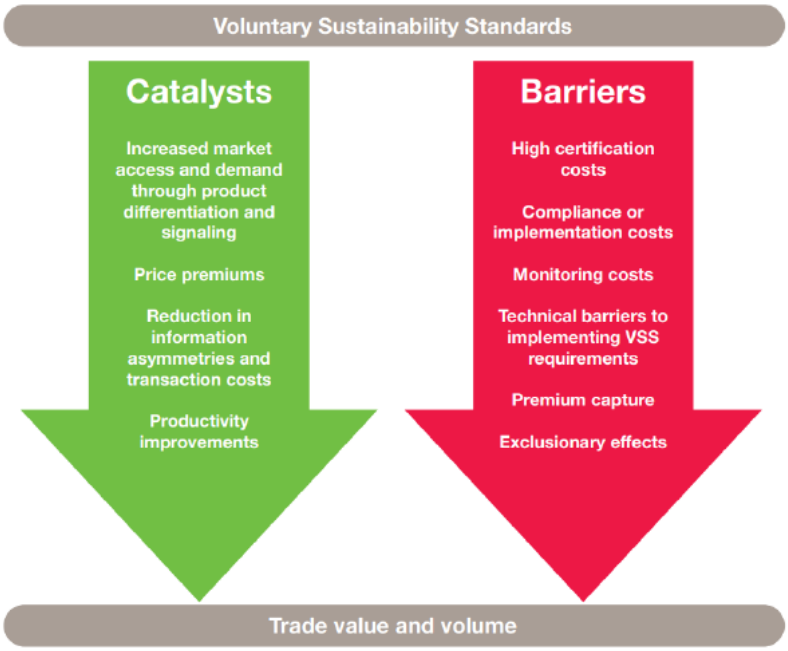
(T2.3. Analyzing effects of certification on trade of biobased value chains)

The objective of D2.3. was to investigate whether certification schemes and labels could impact the trade volume of certified bio-based products, and which factors influence the volume of trade flows of biobased products. The challenges with these investigations included the lack of applicable literature and statistical data, partly due to the novelty of the bio-based economy. Therefore, the review was extended to the sustainable sourcing of agro-food and forestry products to identify best practices for biobased products.

Sustainability and the role of certification

The introduction of CSLs has had an impact on trade flows across the globe as well as the achievement of the UN SDGs.

Figure 3 Potential channels through which CSLs can affect the volume and the value of traded commodities



The number of certified agricultural commodities has been increasing in the last decade, driven, at least partly, by the increasing interest of market participants, consumers, traders, and producers.

The increasing globalisation of agri-food commodity markets has led to the emergence of book-and-claim traceability systems. As such, traceability is becoming a market of its own. Traceability requirements are driving the creation of other systems, such as identity preservation, segregation, and mass balance. New technologies such as blockchain have the potential to improve the sustainability and traceability of agri-food products, notably coffee and sugarcane.

There are benefits linked to the utilisation of CSLs: 85% of the EU retailers consulted have experienced increased sales of sustainable products, and 92% have positive expectations regarding the sales of sustainable products in the near future. Nevertheless, some sectors, such as mining, fossil fuels and plastics, are lagging in their implementation. The benefits of CSLs can vary depending on factors such as the a) level of economic development of the destination market: the higher the income of the destination country, the stronger the effects of certification (positive relation), and b) transaction costs of the trading regions (negative relation)

The scope of analysis was broadened to include food due to limited information on trade flows regarding biobased products. When assessing the economic, social, and environmental performance of certified food compared to conventional reference products, certified food fared higher on most economic and social indicators. Certified products include a price premium and thus produce more added value and a higher operating margin. Certified food can also create more employment with higher productivity. On the other hand, the environmental performance of certified food is similar to its conventional counterpart on the most common indicators. Nevertheless, certified products report lower greenhouse gas and water pollutant emissions per hectare.

Factors influencing agri-food trade flows

According to a literature review of gravity models, the extent of agri-food trade flows is highly dependent on a variety of factors. These exogenous variables need to be considered in the context of available data and the choice of bio-based products whose supply chains are being analysed.

Factors that can hinder agri-food trade between two countries include strict environmental policies, significant geopolitical distance, and historical trade relationships or past colonial links.

Factors that can promote agri-food trade between two countries include the existence of certain regional trade agreements (e.g. MERCOSUR, APEC), cultural similarities, common language, common religion, and the importing country's EU or ECOWAS (Economic Community of West African States) membership. Market liberalisation and mandatory biofuel blending have also positively impacted agri-food trade in certain regions.

Other factors that can impact trade either positively or negatively include the GDP and population of the respective countries, as well as exchange rates.

CSL evaluation and policy tools

The negative impacts of large-scale biomass production, such as deforestation or the competition between food and biomass production for non-food applications, have motivated the development of sustainability CSLs.

There is also a need for criteria and indicators for evaluating CSLs. Schemes should address both producers and consumers of biomass and bio-based products and consider local socio-economic and environmental conditions. Improved methodologies are needed to capture environmental impacts such as water depletion, indirect land use change, and effects on ecosystem quality and biodiversity. Overall, having a better understanding of the environmental impacts of bio-based products on the local economy and beyond is key to developing proper certification systems that ensure the sustainability of biomass and biobased products at the production level. This would eventually lead to more sustainable trade of raw biomass feedstocks and bio-based products.

A large part of tropical deforestation is caused by an increasing demand for agricultural land, driven by third countries' demand for commodities such as beef, palm oil, soybeans and wood. The following instruments could serve policymaking in consumer countries to curb this phenomenon: informational instruments, import tariffs, carbon pricing, regulation, capacity building, monitoring and research. Public policy can play a significant role when pursuing low-carbon economic growth, environmental preservation, and sustainable biomass usage. However, other issues, such as resource efficiency or conflict between policy instruments, could emerge if policies are not well-designed. Drivers such as GDP, population developments, trade and land use can play a crucial role by significantly favouring or inhibiting the transition. Productivity increases in agriculture and the reduction of post-harvest losses are important to alleviate potential competition between uses. Changes in consumer behaviour and food preferences are also vital to encourage this transition.

D3.1: Review of existing monitoring approaches for schemes and labels

(T3.1. Review of available monitoring approaches and indicators)

The objective of D3.1 was to conduct an in-depth review of existing tools meant for assessing sustainability certification schemes and labels. These tools included guidelines, assessment tools, benchmarks, evaluations, and legislation. Existing criteria, rating and scoring methodologies, and visualisation approaches were assessed, and a wide selection of criteria for measuring effectiveness and robustness were identified. The findings of the review supported T3.2, the development of the monitoring system (later referred to as BIOBASEDCERT Monitoring Tool, BMT).

The review was conducted through scanning, screening and synthesising various tools. The screening process resulted in a selection of 15 tools that were reviewed in depth. Examples of these tools included: various ISEAL codes (e.g., the Assurance Code of Good Practice); the Revised Renewable Energy Directive (RED II); Sustainability Assessment in Food and Agriculture (SAFA) by the Food and Agriculture Organisation (FAO); Benchmarking Platform (BP) by the EU Horizon project STAR-ProBio; and Sustainable Supply Chain Initiative (SSCI) by the Consumer Goods Forum (CGF).

The criteria present in these tools were analysed to create an overview of the criteria present, resulting in 137 criteria that reflected the various criteria included in the tools. These criteria were organised under two overarching themes: (1) criteria that assessed the overall governance of schemes and (2) criteria that assessed the management of schemes. Subthemes under the governance theme included, for example, sustainability outcomes, performance monitoring, and transparency. Subthemes under the management theme included, for example, multi-stakeholder engagement, assurance, competence, and chain of custody.

The majority of the reviewed criteria focused on the processes of developing, maintaining, managing and revising a certification scheme or label. This type of criteria can be used to assess the robustness of the scheme, in other words, the extent to which the assurance system in place is implemented well. The review also highlighted criteria that can be leveraged to assess the achievement of results. These criteria can be used to assess the effectiveness of the scheme, in other words, the extent to which the scheme or label achieves, or is expected to achieve, its objectives and brings results.

Most tools classify criteria into basic and advanced criteria. In terms of rating and scoring, schemes generally have two approaches: a binary approach to determine if criteria were met (yes/no) or a more nuanced approach (met/partially met, etc.). Some tools assigned different weights to different criteria and/or themes, whereas some schemes weighted everything equally.

These findings were used to support the development of the BMT in T3.2.

D3.2: Evaluation of existing schemes and labels

(T3.3 Testing the developed monitoring system and indicators on reviewed scheme and labels)

The objective of D3.2 was to evaluate a set of selected prominent sustainability CSLs for industrial biobased systems against the requirements of the BIOBASEDCERT monitoring tool (BMT0), with the goals of i) providing feedback for the development of the content level of the BMT from testing it on a range of CSLs, and ii) analysing the coverage of the defined (mandatory) requirements of the content level , and accordingly provide an overview of the current coverage of BMT requirements of the CSLs being tested and communicate recommendations for improvement. For this purpose, an

iterative approach to testing was used; two testing phases were conducted, each followed by a revision of the BMT based on the generated feedback.

In deliverable D3.2 the results from the assessment of the content level BMT on the selected nine CSLs[1] are presented. Individual recommendations were devised for each CSL based on identified gaps. The aim is to encourage label/scheme owners to improve the coverage and ambition level of their systems to stay competitive and be considered credible. This can drive a voluntary process of improvement and can lead to the harmonisation of the standards of existing schemes. Regulatory support and recognition of the BMT by the EC would be instrumental for achieving this harmonisation.

The testing process

The content-level testing method comprised of the five steps in Figure 4. In the second testing phase, step 0 was added for scope-definition.

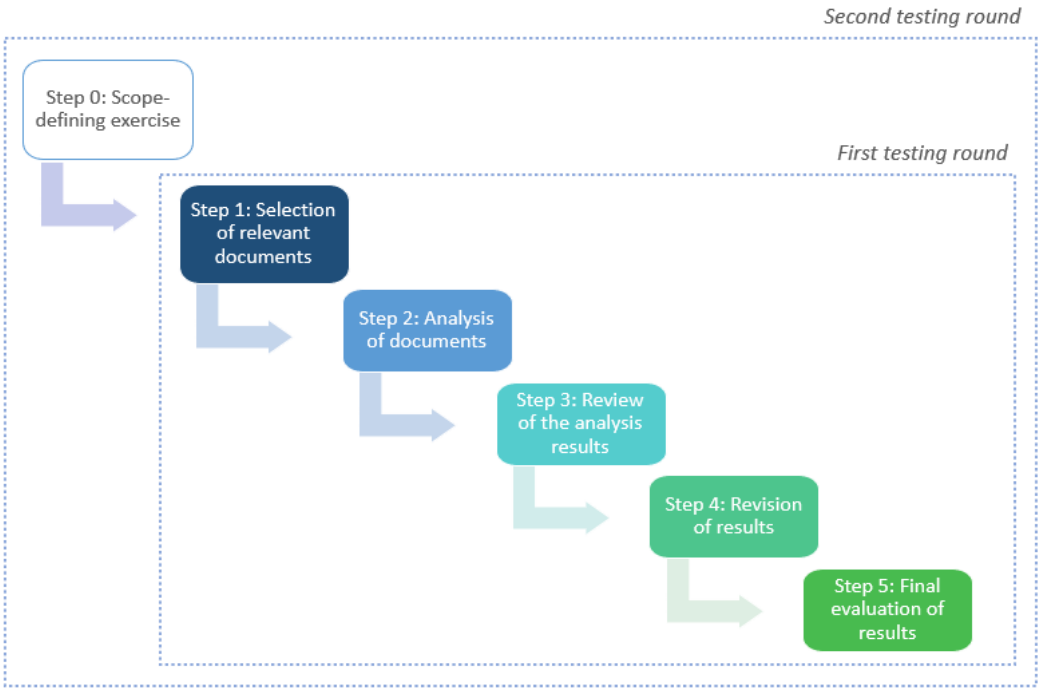


Figure 4. Stepwise method to testing the content level BMT, with the addition of step 0 in the second testing round

The selected sustainability CSLs have a wide variety of scopes in terms of applicable feedstocks (e.g., forests, crop), value chain actors (e.g., biomass producer, industrial processor, final product manufacturer) and sustainability principles (e.g., climate change management, circular resource use, labour and human rights, economic and financial viability). Prior to the assessment, a self-assessment questionnaire was filled in by scheme owners, determining, among other things, the scope of the schemes. This pre-assessment proved useful, although further discussion with the scheme/label owners was needed for clarification on determining the applicable feedstock categories, value chain actors and sustainability principles for that specific CSL. This exercise was

[1] Better Biomass, Better Cotton, Bonsucro, EU Ecolabel, FSC, ISCC, Nordic Swan, RSB, SBP

only deployed in the second testing phase due to the experiences of the first testing phase, which led to identifying the exercise as a solution to various challenges with the practical testing.

Although initially perceived as a barrier by some CSLs, the deliberate choice of using a binary system for the assessment (with Yes/No as response options and no “Partially met” option) was seen to provide consistency AND objectivity to the evaluations and to ensure same results if the testing was done by different testers.

The testing results

It was decided not to calculate a single overall score for the sustainability performance of a CSL, but instead provide results per principle, distinguishing also in terms of requirement level (mandatory, basic and advanced). This was considered to provide more transparency in providing feedback and avoid making comparisons, which would not be fair since the CSLs have varying scopes with different set of requirements being applicable. Accordingly, the results are presented as tables, showing under each principle and each requirement level the following information: the first number (numerator) represents the number of applicable requirements met, and the second number (denominator) the total number of applicable requirements (see Table 4).

Table 4. Example results table

Principle	**Fraction of applicable requirements covered**		
	Mandatory	**Basic**	**Advanced**
Environmental Management	1/1	1/2	N/A
Climate change management	1/1	2/3	0/3

In general, CSLs demonstrate relatively high coverage of the defined mandatory requirements of the BMT. Basic requirements, which provide more prescriptive details, were less covered. The coverage of these basic requirements varied quite strongly among the different CSLs; some intentionally left these aspects to be decided by the organisation itself and do not prescribe them in their standards. Advanced requirements, whose purpose is to drive continuous improvement, were found to be scarcely covered by the tested CSLs. However, these are requirements that are expected not to be met now but to be integrated by the CSLs in the future.

The assessed ISO-standard compliant ecolabels have quite different coverage compared to sustainability certification schemes. These differences can be explained by the fact that ecolabels are focused on the product and not on the sustainability of the resource (biomass) used. They mostly rely on or refer to sustainability certification schemes (e..g FSC, Bonsucro) to ensure the sustainable sourcing of biomass. Therefore, it was decided to leave out biomass producers from the scope of the ecolabel assessments. Additionally, ecolabels base their criteria on the sustainability topics that are identified as hotspots of impact in the product lifecycle. These hotspots differ per product category. In this study, for each assessed ecolabel, one product group was selected: building and construction materials for the Nordic Swan Ecolabel, and detergents and cleaning products for the EU Ecolabel. For these product groups, the social (except for the wellbeing of consumers) and economic aspects are considered out of the scope or not applicable. Within the two dimensions of the BMT covered by ecolabels, Environment and Circularity, ecolabels addressed most extensively climate change, air quality, chemical use, and responsible waste management. Opportunities for improvement included increased coverage of water consumption and quality monitoring, requiring GHG emissions reporting, and discouraging landfilling and open-air burning as waste management practices.

For sustainability certification schemes, there was a relatively high coverage of the requirements in the social and environmental dimensions. Notably, most of the principles in the environmental dimension were often well covered by the CSLs, especially the mandatory requirements. In the social dimension, especially labour and human rights were well addressed, as well as the mandatory requirements in the Healthy and safe working conditions and Wellbeing of the local community principles. The identified opportunities for improvement were very much scheme-specific, depending also on the scope of that scheme. Regarding the social dimension, some of the opportunities for improvement identified include requirements concerning fair contract practice, occupational skills training, provision of social security benefits, maternity leave, and medical treatment in emergencies.

The majority of the tested certification schemes were seen to have less focus on the economic and circularity dimensions. The most addressed principles within these dimensions were Responsible waste management and Economic and financial viability, whereas most CSLs had gaps concerning the Circular resource use, Circular design & material cycling, and Financial risk management principles. Concerning the circularity dimension, the integration of criteria beyond waste management alone, such as the application of the 9R framework or the cascading use principle for resource use was identified as an opportunity for improvement. For schemes certifying biobased products it is also recommended to expand the scope to include requirements related to design for high-quality recyclability and product-life extension strategies. Finally, when it comes to the economic dimension, the schemes could have more explicit requirements on business plans, fighting against fraudulent, deceptive and dishonest practices, and for financial risk management.

Feedback for the BMT following the first and second testing phase (as input for T3.5):

The testing phases generated relevant feedback that was used as input for T3.5 *Implementing feedback and optimising the monitoring system and indicators*. The variety of scopes of the tested CSLs was useful for improving the BMT to ensure the applicability of the tool to the different scopes that CSLs could have. The table below (Table 5) highlights some of the findings and the according revisions made to the BMT.

Table 5. Findings from the testing of BMT on CSLs and action taken during subsequent BMT revision

Finding	Action
Due to the number of requirements and the high level of detail, testing is resource-intensive.	Simplification of the criteria and requirements to increase their conciseness and thus the user-friendliness of the tool. Where possible, requirements were merged or grouped.
It is challenging to test CSLs with different scopes with a single tool.	Scope-defining questionnaire was created and illed by CSL owners before the second testing phase. A follow-up Q&A session was arranged for clarification.
The requirements are often not met if following strictly the exact phrasing of the prescriptive requirements.	Adaptation of requirements and accommodating different ways to meet these if the intent is fulfilled.
Some schemes deliberately do not include detailed prescriptive requirements, but rather provide a generic requirement and leave it to the operator to decide how to meet this requirement.	Reformulation of requirement levels in terms of mandatory – basic – advanced. Mandatory refers to must (i.e., minimum) requirements, basic to more detailed requirements, and advanced to aspirational requirements.
Inconsistencies between requirements and unclear definitions hinder effective assessment of CSLs.	Harmonisation of similar requirements to improve consistency (e.g., using the same structure for each requirement demanding a management plan) and clarification of definitions.

D3.3: Description of the monitoring system

(T3.2 Developing a new monitoring system, T3.3 Testing the developed monitoring system and indicators on reviewed scheme and labels, T3.4. Carrying out pilot audit for testing the monitoring system requirements, T3.5. Implementing feedback and optimizing the monitoring system and indicators)

The objective of WP3 was to develop a monitoring framework and indicators to evaluate the effectiveness and robustness of sustainability schemes and labels. This monitoring framework, named the BIOBASEDCERT Monitoring Tool (BMT), was developed building on all the tasks in WP3, including a review of current available monitoring approaches (T3.1.), the development of the framework itself (T3.2), and the testing and piloting of the tool (T3.4, T3.3.) as well as the review and optimisation of the tool based on feedback from testers and schemes that were being tested (T3.5.).

The detailed monitoring framework can be found in the Excel spreadsheet that acts as the D3.3. deliverable.

The BMT consists of three levels, each of which was developed by one of the BIOBASEDCERT sister projects:

- System level (STAR4BBS): governance and management of the scheme;
- Content level (SUSTCERT4BIOBASED): content and requirements of the scheme's standards;
- Outcome level (HARMONITOR): impact and effectiveness of schemes.

The system level has four categories under which more specific principles and criteria are compiled: (i) governance and scheme management, (ii) standard setting, (iii) assurance, and (iv) traceability and claims.

Likewise, the content level has four categories (i.e. dimensions) for principles and criteria: environment, circularity, social, and economic. For each requirement, it has been determined which value chain actors and feedstock it applies to.

Before conducting the assessment, a pre-assessment is done where the applicable value chain actors, feedstock, and principles are selected. If a principle is deemed as not applicable, it must be justified. The pre-assessment determines which requirements are applicable to the scheme. For each requirement, a level is also determined (mandatory, basic, advanced). Mandatory requirements are expected to be met by every credible scheme, whereas basic and advanced requirements can be considered as a roadmap for further improvement. The results of the assessment are displayed as tables and graphs, showing the percentage of requirements met for each level and each principle.

The outcome level consists of an assessment of the scheme's requirements and evidence of effectiveness monitoring, as well as an assessment of the monitoring indicators and the actual outcomes based on data provided by the CSL and evidence from literature.

The BMT can be used by several stakeholders, including EU policymakers, schemes themselves, civil society, and researchers. EU policymakers can use it to improve their knowledge about the credibility and robustness of the sustainability schemes currently active in various markets. Sustainability certifications can use it as a self-assessment tool, a gap analysis, and a tool to identify future development opportunities and ambition roadmaps. Civil society can use it as a tool when looking into the requirements and robustness of certification schemes' standards and hold schemes accountable if baseline requirements are not met. Researchers can use the BMT as a research and assessment tool and utilise its results to understand the certification schemes landscape better.

D4.1: Review of methodologies for cost-benefit analysis and internalising externalities for sustainability certification

(T4.1. Making inventory of relevant methodologies to assess cost and benefits, internalise externalities)

The aim of T4.1., which produced deliverable D4.1., was to provide an inventory of relevant methodologies for cost and benefit analysis (CBA), including internalising externalities. A literature review on CBAs associated with sustainability certifications was conducted, and recent methodological developments on internalising externalities were explored.

Approaches to assess costs and benefits of sustainability certification

A cost and benefit analysis (CBA) is a process for comparing the benefits and costs of a specific decision. It involves assigning a monetary value to activities. The aim of a CBA is to determine whether the expected benefits are higher than the expected costs.

Two methodologies that address the costs and benefits of certifications at the value chain level were found in the literature: the Netherlands Enterprise Agency (RVO) methodology and the UNEP methodology. The RVO methodology has a producer/company perspective and focuses on biofuel certification, while the UNEP methodology has a public sector perspective and focuses on the agricultural, forestry, and fishery sectors.

Costs of certification can vary widely depending on the certification scheme and the company seeking certification. The same is true for benefits, which can depend on the local context, standard stringency, certification update, and patterns of adoption. However, the benefits of certification, such as increased market access and improved sustainability outcomes, can often outweigh costs in the long term. It is to be noted that studies considering the effects, costs, and benefits of certification schemes are limited, focusing on limited geographical regions and sectors.

When quantifying the costs and benefits of certification schemes, it is important to consider both internal and external success factors as well as challenges faced, especially by small-scale companies when adopting certification schemes.

Literature on internalising externalities

Externalities are defined as positive or negative consequences of an economic activity that affect other parties without this being reflected in the price of goods or services in question.

The internalisation of externalities refers to measures that ensure external costs and benefits are considered in the prices of goods and services. Internalising externalities is key to establishing sustainable models. External costs can become internal by incorporating them into the market decision-making process through pricing (e.g., taxation) or regulatory interventions. To internalise externalities, they need to be identified, quantified and monetised. Environmental and sometimes social externalities are often quantified using a life cycle assessment (LCA).

The monetisation of externalities involves the valuation of externalities in monetary terms so that they can be better considered in decision-making. In terms of valuation, some externalities have been studied more extensively (e.g., climate change), whereas others less so (e.g., land use). Monetary valuations are often not comparable, as different valuation methods can produce very different results.

There are significant methodological challenges in conducting a cost-benefit analysis of certification schemes that considers externalities. Several studies identify impacts of certification, but few value these effects. Data on external costs and benefits is hard to come by. While there are challenges in

conducting CBAs for certification schemes, literature and empirical findings can provide valuable insights.

Adaptation of CBA for the assessment of sustainability certification in bio-based value chains

The UNEP and RVO methodologies for certification CBA do not consider externalities. These methods have been expanded in this deliverable by incorporating external costs and benefits into the CBA of certification schemes. Table 6 presents this extended version as well as possible data and evidence sources. This method that considers externalities can also be used for other sectors apart from the bio-based sector as long as the cost-benefit items and indicators are adjusted for the relevant sector.

Table 6 Extended cost typology with internalised externalities and indication for data collection (adapted)

Item	Internal/ External	Direct/ Indirect	Item	Description	Possible sources of information for data collection
Costs	Internal	Direct	Auditing costs	Costs that a company must pay for an external audit to become or remain certified	Auditing costs will be collected from auditors and literature such as Van Dam et al. (2012).
			Certification fees	Membership fee and/or quantity-dependent fee	Certification fees will be collected from the documentation of certification schemes.
		Indirect	Administrative indirect costs	Adapting the company or farm administration to adequate traceability tools and systems and man-days to ensure the correct (and documented) implementation of the chain of custody	Administrative indirect costs will be collected from auditors and case study/pilot participants, literature such as Van Dam et al. (2012)
			Indirect costs related to sustainability compliance, including training	Investments for adapting production and trade processes to the requirements of sustainability standards, training of workers in sustainable agriculture technologies and processes etc..	Indirect costs related to sustainability compliance will be collected from case studies using interviews. The Evidensia database is to be consulted.
	External	n.a.	Environmental	Environmental costs (e.g. from pollution) arising from the production or consumption of a good or service	These will be collected from literature and biobased value chain members if they are quantified. The Evidensia database is to be consulted.
		n.a.	Social	Costs arising from the production or consumption of a good or service (e.g. child labour)	Costs related to negative social impacts are difficult to quantify, and interviews and case studies need to be searched for.
Benefits	Internal	Direct	Efficiency and/or management improvements within company	Benefits related to reduction in the use of inputs, such as water, fertilizers and energy	Benefits from efficiency and or management improvements will be collected from specific cases.
			Price premium	Additional revenues obtained by selling the certified product	Market data on prices for certified and non-certified products
		Indirect	Improved market position	Image and branding, meeting demands of the market	Image and branding, legal compliance. Information will be based on expert estimation and/or interviews

	External	n.a.	Environmental	Environmental external benefits arising from producing and/or consuming the certified product	Will be collected from literature and/or biobased value chain members if they are quantified. The Evidensia database is to be consulted.
		n.a.	Social	Social external benefits arising from producing and/or consuming the certified good or product	Will be collected from literature and/or biobased value chain members if they are quantified. The Evidensia database is to be consulted.

D4.2: Selection of biobased value chains for cost-benefit analysis

(T4.2 Selection of biobased value chains)

Deliverable D4.2. is the output of T4.2, which aims to select three industrial biobased value chains for in-depth evaluation of the costs and benefits of adopting sustainability CSLs in these three value chains. This evaluation will be conducted using the cost and benefit analysis (CBA) method, including the internalisation of externalities. The purpose of the CBA is to illustrate the different aspects that need to be considered when calculating the costs and benefits of different sustainability schemes in biobased value chains.

The three biobased value chains were selected based on three information points: (1) deliverable D2.1. *Identifying most representative biobased value chains*; (2) information on applicable CSLs for the type of value chains from *D1.2 Identifying and reviewing existing sustainability certification schemes and labels relevant to biobased value chains*, and (3) additional value chain -specific criteria, such as data availability, value chain boundaries, and alignment with sister projects (i.e., HARMONITOR, STAR4BBS).

The three biobased value chains selected were in the textile, chemical, and wood sectors. For each sector, a value chain will be selected for further analysis.

For each sector, a variety of certification schemes were selected for further CBA analysis based on their market representation, number of certifications, data availability and completeness:

- Textiles: Textile Exchange (notably Global Recycled Standard (GRS) and Better Cotton
- Chemicals: ISCC Plus, and RSB Advanced Products or Better Biomass
- Wood: FSC or PEFC[1]

[1] Please note that since the writing of the deliverable, the focus in this work package shifted slightly when it comes to the chemical sector. Due to practical and data collection reasons, the focus in the chemical sector was in the end placed on a sugarcane certification. Sugarcane is a key raw material for bio-based plastics (e.g., in the production of biopolyethylene).

For textiles, GRS was originally considered, and multiple companies were approached. However, due to companies' reluctance to provide sensitive data in their responses and the resulting data gaps, the focus of the CBA was later placed on Better Cotton only.

For wood sectors, the focus was placed on FSC, as originally planned. In addition, PEFC was also assessed as another leading scheme for forest biomass.

Each selected value chain is coupled with a suitable certification scheme to perform a CBA. The final selection of the value chains depends largely on data availability. Value chain identification and the development of the data collection template takes place in T4.3, data collection in T4.4, and the performance of the CBA itself in T4.5.

D4.3: Data collection template for cost-benefit analysis

(T4.3. Developing data collection template)

Deliverable 4.3 aimed to develop a data gathering template to facilitate the collection of data on biobased value chains. The data gathering template supports carrying out a cost-benefit analysis (CBA) of the adoption of sustainability certification schemes and labels. As part of this effort, an Excel CBA file and an accompanying Word document were created, describing the steps necessary for conducting a CBA analysis.

Conducting a cost-benefit analysis, including the internalisation of externalities, is a complex and ambitious task. The issue of data sensitivity and difficulties with obtaining data were already predicted in the proposal phase of the SUSTCERT4BIOBASED project. Indeed, obtaining robust data from companies proved a complex, challenging and time-consuming task. This can be attributed to the sensitive nature of the data, including companies' reluctance to share information related to economic costs and benefits. Other issues include resource limitations and that companies simply do not collect this type of data in the first place.

Nevertheless, further research into conducting cost-benefit analyses, including internalisation of externalities, is needed in the future to assess the feasibility of adopting certification. It is hence recommended to take into consideration the aforementioned limitations when planning to conduct research on this topic in the future.

Some solutions to tackling the issue of data availability include ensuring anonymity, creating trust, and exploring other data collection methods, such as desk research and engaging key actors (e.g., certification schemes owners) early in the data collection phase. In this deliverable, the lack of data was partially addressed by using alternative sources of data, e.g., using certification costs available on scheme websites or estimating auditing costs based on real-life data from a certification body. However, the calculation of indirect costs remains difficult without direct data from companies. As such, the findings of deliverables D4.3 and D4.4 should be viewed as a first effort in tackling this complex issue and should be built upon by further research efforts in the future.

D4.4: Assessment of feasibility of certification adoption in selected value chains

(T4.4 Collection of data for the selected biobased value chains, T4.5. CBA for selected biobased value chains and feasibility assessment)

Deliverable D4.4. aims to conduct a cost-benefit analysis (CBA) of certification schemes for companies seeking certification and society. Existing literature typically explores the economic aspects of certification, such as price premiums and financial returns, but often overlooks environmental and social costs and benefits. This omission can lead to underestimating the true costs and benefits of certification. D4.3. aims to conduct a feasibility assessment of certification schemes in biobased value chains by adopting a new CBA approach, which includes the internalisation of externalities. This includes the integration of environmental and social costs and benefits into CBAs to provide insights into the costs and benefits of schemes in three selected

biobased value chains. The deliverable builds on a literature review and the CBA framework developed in D4.1, D4.2, and D4.3.

The feasibility of certification adoption in selected value chains is influenced by a complex interplay of economic, environmental, social, and policy-driven factors. The case study findings indicate that while certification can improve efficiency, market access, and sustainability outcomes, its impact is highly context-dependent.

One of the main drivers for certification adoption is direct financial incentives, such as price premiums and cost savings from improved efficiency. The case studies demonstrate mixed economic outcomes—while some certifications led to higher producer prices and cost reductions, others showed negligible or regionally dependent benefits. The presence of supporting infrastructure, such as training programs and market linkages, can enhance the economic viability of certification.

Beyond economic factors, environmental and social impacts also play a role. Certification schemes often contribute to improved biodiversity, carbon sequestration, and ecosystem services. However, the extent of these benefits varies depending on prior land use and regional conditions. Socially, certification can reduce harmful labour practices, such as child and forced labour, and improve workplace safety, but its impact on wages and working conditions remains uncertain. This highlights the need for complementary policies and institutional support to maximise social benefits.

These findings suggest that the feasibility of certification adoption depends on a combination of market conditions, environmental considerations, social governance structures, and policy support. Certification schemes are more likely to be successful when they are backed by strong market demand, cost-effective implementation strategies, and regulatory incentives. However, the difficulty in collecting reliable data highlights the need for better systems and processes to track certification performance over time.

The assessment of effectiveness is challenged by a lack of data. Despite the clear drivers of certification adoption, the collection of data to assess its effectiveness is challenging. Various barriers impeded data availability, including companies' concerns about the sensitivity of the data, the lack of internal systems to track or quantify the required environmental and social performance indicators, and general hesitation to invest time and resources in providing detailed responses. In some cases, companies expressed concerns about confidentiality or feared competitive disadvantages if their data were disclosed, even in anonymised formats. These challenges were discussed extensively in collaboration with sister projects, Harmonitor and STAR4BBS. Despite continuous efforts to mitigate these issues, data availability remains a significant hurdle.

Because of limited data availability, some environmental and social externalities were excluded from the analysis. This implies that the CBA does not provide a complete insight into the external costs and benefits associated with certification. As a result, if something is not measured, its impact remains unknown, making it difficult to assess the true costs and benefits of certification. Addressing these data limitations is critical to better align certification practices with sustainability goals and to enhance the accuracy of cost-benefit analyses for biobased value chains.

Costs of certification can be affected not only by the requirements of a certification scheme but also by other factors such as climate change impacts, soil conditions, technological advancements and different management practices. These effects were not separated from the certification effect because data was lacking for these variables. Additionally, the scope of analysis varied by case. For example, the plastic chain was assessed from cradle to factory gate, while the cotton chain was evaluated from cradle to farm gate. The CBA analysis is from a very small sample size due to the difficulties of getting company-specific data. All these aspects should be considered when interpreting the results.

3. Targeted stakeholder recommendations derived from the project

This section compiles the recommendations derived from the deliverables of the SUSTCERT4BIOBASED project. These recommendations are categorised by the stakeholder groups that were identified as the four target audiences of the SUSTCERT4BIOBASED project: policymakers, standard writers and scheme owners, industrial actors, and regional actors. Additionally, the applicability of the recommendations to other stakeholders, such as researchers and civil society, were identified and indicated.

Some recommendations target several audiences, so the same recommendation might appear in more than one section.

A recommendations matrix can be found in the Annex, where all the recommendations are listed and the relevant stakeholder groups marked for each, as well as the deliverable the recommendation was derived from. This matrix also includes the researchers and civil society stakeholder groups and details the recommendations relevant to them.

3.1 Policymakers

Recommendation 1 for policymakers (RP1): Sustainability should be considered a key aspect when identifying the most beneficial uses for biobased resources

A wide range of biological resources can be utilised in different sectors and in a variety of biobased products. Consequently, it is essential to continue investing in identifying the most beneficial uses of biological resources, considering both environmental and social sustainability.

Other audiences: Industrial actors (RIA1), Civil society, Researchers

RP2: Already partially biobased sectors should be leaders in the biobased transition

It is recommended that the production of biobased counterparts of conventional products should be increased in industries that are already partially biobased. These sectors include chemicals, textiles, plastics, and construction. Biobased materials can reduce greenhouse gas emissions and dependence on fossil fuels, as well as enable new product characteristics. A conversation regarding the increase should be opened at different levels to identify the most effective actors to advance the increase in production.

Other audiences: Industrial actors (RIA2), Civil society

RP3: Stronger implementation and enforcement of regulation needed for certifications

The role and importance of certification schemes has increased steadily, and schemes are also being incorporated into co-regulation. However, the scope, purpose, ambition and implementation of schemes and labels vary widely and lack harmonization. It is, therefore, important to create direction for certification schemes and labels (CSLs) and increase their ambition through legislation and guidelines and ensure the effectiveness and ambition of existing regulation by, for example, supporting implementation and enhancing monitoring.

Other audiences: Civil society

RP4: All aspects of sustainability, including circularity, should be considered in assessments

A wide array of considerations must be included in the evaluation of the sustainability of biobased products and resources. Sustainability should be assessed not only from an environmental standpoint but also considering circularity and social and economic matters. Especially circularity is inadequately covered by certification schemes and labels. Scientific findings, market trends, and technological development related to circularity and other inadequately covered social and economic matters must be utilised to address current gaps and to drive continuous improvement among schemes and labels. Some of these issues will be addressed by various EU regulations, such as the Green Claims Directive.

Other audiences: Scheme owners and standard writers (RSS1), Civil society, Researchers

RP5: The global impact of EU policies should be considered in regulatory processes

It is important to appreciate that EU-based policy has sustainability implications outside of the Union. Many certification schemes and labels have a global scope as a result of biological resource production or other supply chain considerations. This should, therefore, be considered not only in the legislative process but also in the regulation of schemes and labels.

Other audiences: Civil society

RP6: Inherent sustainability of a biobased economy must not be assumed

While the overall benefits of a biobased economy have been extensively reported, potential trade-offs and negative impacts must also be investigated. It should not be assumed that the biobased economy is inherently sustainable. In-depth analysis should be conducted on the impacts of each value chain from environmental, economic, and social perspectives to assess the sustainability of the value chain as well as unintended negative side effects.

Other audiences: Industrial actors (RIA3), Civil society, Researchers

RP7: Common definitions and metrics needed to support the bioeconomy transition

A successful transition to the bioeconomy includes defining a set of standardised metrics for various products and industries and applying a multidisciplinary approach to the design and implementation of novel value chains. This could include establishing definitions for concepts that are often used interchangeably, such as “circular bioeconomy”, “circular economy”, “bioeconomy”, and “sustainability” through, for example, stakeholder consultations.

Other audiences: Industrial actors (RIA4), Researchers

RP8: Research should be undertaken to fill in gaps in sustainability knowledge

Social aspects, circular product design, and the definition of final use for biobased product streams are underrepresented and highly fragmented in bioeconomy literature. This is a critical gap in research that must be addressed to effectively account for all relevant sustainability aspects.

Other audiences: Researchers

RP9: Use of locally sourced feedstock should be increased to support local economies

The sustainability of some sectors would benefit from expanding the use of locally sourced feedstocks (e.g. textiles from flax instead of cotton in the EU), potentially boosting local economies, creating jobs, and allowing for easier control and regulation.

Other audiences: Industrial actors (RIA5), Regional actors (RRA1)

RP10: Adaptation to local context, cross-sector collaboration, and information standardisation must be promoted to support the transition to a bioeconomy

The transition to a sustainable bioeconomy should be facilitated by industry and policymakers by adapting the bioeconomy concept to local contexts, taking into consideration regional characteristics, weaknesses, and strengths; intensifying cooperation with the waste management sector to ensure integration of biobased products into collection, separation, recycling and composting schemes; and standardising all sustainability-related information, making regulation and monitoring easier as well as facilitating the implementation and acceptance of novel value chains by stakeholders (e.g., governments, industrial actors) and by society.

Other audiences: Scheme owners and standard writers (RSS4), Industrial actors (RIA6), Regional actors (RRA2), Civil society, Researchers

RP11: Direct resources and support towards value chains with the most potential for sustainability contributions

According to studies conducted by the project, the value chains that have the most potential to contribute to sustainable development in the EU include several types of value chains related to biomass residues. Supportive policies should be directed towards these value chains to effectively advance sustainable development priorities.

RP12: Supply bottlenecks of biobased products must be eliminated to meet demand

In some sectors and regions, the demand for novel biobased production is often much higher than production, which is hampered by supply chain complexity, low feedstock availability, and the technological immaturity of conversion processes. For these sectors and regions, policies should be developed to remove unnecessary red tape and drive resources towards finding solutions to remove supply bottlenecks.

Other audiences: Industrial actors (RIA7)

RP13: Investment and incentives should be directed towards value chains with potential for high positive impact

Financial support and policy incentives should be directed to value chains and sectors that can contribute the most to sustainable development in the EU, such as mulch film from organic waste, refabricated buildings from wood and wheat straw, and adhesives from tall oil.

RP14: Sectors with low biobased innovation must direct resources towards R&D

To drive the development of novel bio-based value chains and maximise positive impact, research should be directed towards innovation in sectors that currently have a low impact due to their lack of biobased innovation. Investing in research can drive the sectors' transitions from primary dedicated raw materials to alternative biological resources, fostering sustainability and reducing the EU's dependency on imports.

Other audiences: Industrial actors (RIA8), Researchers

RP15: Significant institutions should establish systems for gathering data on certified and sustainable production

At the moment, it is challenging to gather high-quality information regarding the certification rate of traded intermediate and final bio-based products at the sector and regional levels. This could be improved through two solutions: 1) Scheme owners should join forces to improve data collection and monitoring of the certification rate of production at a regional level (e.g. Africa, Europe) for specific sectors (e.g. plastics, chemicals). 2) Sources providing general data to the public (e.g., Eurostat, FAO) should establish, in collaboration with national statistic offices, a monitoring system to collect market data on sustainable production at a regional level. This would ease the efforts of researchers, civil society, and other stakeholders to access market data. Certification scheme owners could contribute by providing data on certified companies and/or certified biobased production at a sector- and geography-aggregated level.

Other audiences: Regional actors (RRA3), Researchers

RP16: Policy instruments needed to help curb deforestation at biomass cultivation phase

A large part of tropical deforestation is caused by an increasing demand for agricultural land, driven by other countries' demand for commodities, such as beef, palm oil, soybeans or wood. Import tariffs, carbon pricing and regulation could serve policymaking in consumer countries to curb this phenomenon. Additionally, research and monitoring could provide insights to support policymaking, while awareness-raising campaigns and capacity building could also contribute to achieving the expected outcomes regarding deforestation.

Other audiences: Civil society, Researchers

RP17: Development of an improved environmental impact methodology needed

There is a need for improved methodologies that can capture environmental impacts such as water depletion, indirect land use change, effects on ecosystem quality, and biodiversity. Overall, having a better understanding of the environmental impacts of bio-based products on the local economy and beyond is key to developing proper certification systems that ensure biomass sustainability at the production level, which eventually would lead to sustainable trade of both biomass feedstocks and bio-based products.

Other audiences: Scheme owners and standard writers (RSS7), Civil society

RP18: Development of improved social impact methodology needed

There is a need for improved research methodologies, such as methodologies for monetising externalities, that can capture social impacts such as labour conditions, land management, cultural heritage, and health and safety. Overall, having a better understanding of the local and global economic and social impacts of bio-based products is key to developing certification systems that ensure sustainability at the production level. This would eventually lead to more sustainable trade of both biomass feedstocks and bio-based products.

Other audiences: Scheme owners and standard writers (RSS8), Civil society

RP19: Accounting for differences in the scopes of certification schemes is critical

When assessing schemes and labels with the BIOBASEDCERT Monitoring Tool (BMT) to inform policies, it is essential to carefully consider differences in scopes, e.g., regarding value chain actors, feedstocks and sustainability principles, to avoid unfair and inaccurate comparisons between the performances of certification schemes.

Other audiences: Scheme owners and standard writers (RSS13), Civil society, Researchers

RP20: The BMT should be used by a variety of stakeholders to fulfil information needs

The BMT can be used by several stakeholders, including EU policymakers, the schemes themselves, civil society, and researchers. EU policymakers can use it to improve their knowledge about the credibility and robustness of the sustainability schemes currently active in various markets. Sustainability certifications can use it as a self-assessment tool, as a gap analysis, and as a supportive tool to identify future development opportunities and ambition roadmaps. Civil society can use it as a tool when looking into the requirements and robustness of certification schemes standards, and hold schemes accountable if baseline requirements are not met. Researchers can use the BMT as a research and assessment tool and utilise its results to understand the certification schemes landscape better.

Other audiences: Scheme owners and standard writers (RSS14), Civil society, Researchers

RP21: Considering externalities in monetary terms is vital to mitigating negative impacts

Internalising externalities is vital for establishing sustainable models. Externalities should be included in financial statements to advance the mitigation of negative externalities because effects that are not managed cannot be controlled.

Other audiences: Scheme owners and standard writers (RSS15), Industrial actors (RIA10), Regional actors (RRA4)

RP22: Further research is needed to support the availability of data on external costs and benefits of certifications

To produce data on external costs and benefits, more research is needed into the extent of conformity with the required core criteria of certification scheme standards and the drivers of and barriers to certification adoption.

Other audiences: Researchers

RP23: Standardisation of cost and benefit metrics would support externality research

Developing standardised, transparent metrics for external costs and benefits (e.g., greenhouse gas emissions, water use, social impacts) across different certification schemes would enable more accurate comparisons and better monetisation of externalities. To improve the transparency, feasibility, and equitable distribution of certification benefits across value chains, policymakers and scheme owners should work together to develop standardised and incentivised frameworks for the collection of externality data, particularly on social and environmental impacts.

Other audiences: Scheme owners and standard writers (RSS17), Regional actors (RR16)

RP24: Incentives for externality data collection should be established and researched

It is recommended to conduct further research into the types of support, incentives, and motivations (e.g., business case elements) that would most effectively enable companies to collect and monitor such data, especially in under-researched areas like social impacts. Standardised and incentivised data collection is essential to fully understand the costs and benefits, and thus the feasibility, of certification for different operators.

Other audiences: Scheme owners and standard writers (RSS18), Industrial actors (RIA12), Researchers

RP25: The integration of certification schemes into public procurement should be based on robust, evidence-based decision-making

Evidence from the timber sector in the Netherlands, Germany, and Belgium suggests that integrating certification requirements into procurement criteria can create market incentives for producers to seek certification. This approach appears to support broader uptake of social and environmental practices required by certifications through linking certification to market access and potential competitive advantages. Given this possible link, policymakers should make informed decisions if incorporating certifications into public procurement requirements, ensuring that the certifications recognised are robust, credible, and effective.

3.2 Scheme owners and standards writers

Recommendation for scheme owners and standard writers 1 (RSS1): All aspects of sustainability, including circularity, should be considered in assessments

A wide array of considerations must be included in the evaluation of the sustainability of biobased products and resources. Sustainability should be assessed not only from an environmental standpoint but also considering circularity and social and economic matters. Especially circularity is inadequately covered by certification schemes and labels. Scientific findings, market trends, and technological development related to circularity and other inadequately covered social and economic matters must be utilised to address current gaps and to drive continuous improvement among schemes and labels. Some of these issues will be addressed by various EU regulations such as the Green Claims Directive.

Other audiences: Policymakers (RP4), Civil society, Researchers

RSS2: Resources beyond forestry and agriculture should be increasingly considered in certification schemes

Sustainability certification schemes related to forest and agricultural products are common in the biobased economy. However, certification focused on other resources such as waste and residues, as well as add-ons to existing certification schemes, should be considered for value chains in the production of biobased products (e.g. textiles).

RSS3: Businesses must take a circular/non-linear approach to achieve sustainability success

Following a linear, business-as-usual approach, i.e., not considering circularity principles and limited natural resources, can lead to unsustainable value chains regardless of their biobased character. Circular and non-linear principles must therefore be integrated into processes and business models, and more attention should be directed towards end-of-life or cascading use aspects of biobased products.

Other audiences: Industrial actors (RIA13)

RSS4: Adaptation to local context, cross-sector collaboration, and information standardisation must be promoted to support the transition to a bioeconomy

The transition to a sustainable bioeconomy should be facilitated by industry and policymakers by adapting the bioeconomy concept to local contexts, taking into consideration regional characteristics, weaknesses, and strengths; intensifying cooperation with the waste management sector to ensure integration of biobased products into collection, separation, recycling and composting schemes; and standardising all sustainability-related information, making regulation and monitoring easier as well as facilitating the implementation and acceptance of novel value chains by stakeholders (e.g., governments, industrial actors) and by society.

Other audiences: Policymakers (RP10), Industrial actors (RIA6), Regional actors (RRA2), Civil society, Researchers

RSS5: Certification companies should gather & publish more information about certified production and trade

It is challenging to find high-quality information regarding the certification rate of traded intermediate and final bio-based products. Partly, this is because certification providers publish lists of companies but do not publish or monitor certified production and trade in terms of volume. Certification providers should be required by, for example, the scheme owners' association to monitor this information more widely and report on it publicly. Certification bodies should also better report the breakdown of certificates per sector/product and region in their annual publications as well as report on currently valid certificates in addition to awarded ones.

Other audiences: Industrial actors (RIA9), Researchers

RSS6: Schemes should improve product accounting to improve transparency

The ways in which many certification schemes conduct accounting hinder the gathering and use of data regarding the volume of certified biobased products. To improve accounting, schemes should not mix intermediate and final products in certification accounting. Similarly, mass balance and segregated methods should be separated; currently, they are mixed up.

RSS7: Development of improved environmental impact methodology needed

There is a need for improved methodologies that can capture environmental impacts such as water depletion, indirect land use change, effects on ecosystem quality, and biodiversity. Overall, having a better understanding of the environmental impacts of bio-based products on the local economy and beyond is key to developing proper certification systems that ensure biomass sustainability at the production level, which eventually would lead to sustainable trade of both raw biomass feedstocks and bio-based products.

Other audiences: Policymaker (RP17), Civil society

RSS8: Development of improved social impact methodology needed

There is a need for improved research methodologies, such as methodologies for monetising externalities, that can capture social impacts such as labour conditions, land management, cultural heritage, and health and safety. Overall, having a better understanding of the local and global economic and social impacts of bio-based products is key to developing certification systems that ensure sustainability at the production level. This would eventually lead to more sustainable trade of both raw biomass feedstocks and bio-based products.

Other audiences: Policymakers (RP18), Civil society

RSS9: Schemes should consider a wide audience and range of stakeholders

Certification schemes should address stakeholders from both the country of origin and the country of destination while considering the local environmental and social conditions of those areas in which biomass is produced. This will lead to common awareness raising and understanding of the positive role that certification schemes can have.

RSS10: Certification rating and scoring systems must balance nuance and concrete usability

There is value in a certification scheme having a nuanced rating and scoring system because it can yield richer information. It also takes into account that some themes might be of higher importance than others. Thus, differentiation can lead to a more credible assessment. However, it must be balanced with the fact that a more nuanced system can also lead to the system being too complicated to be implemented in practice.

RSS11: The BMT assessment results can lead to valuable improvements in schemes

Scheme owners are recommended to examine the strengths, weaknesses and opportunities for improvement derived from the assessment of their scheme/label with the BMT, with the aim of further enhancing its comprehensiveness, robustness and effectiveness.

RSS12: Transparency regarding certification scope is mutually beneficial

CSL owners are recommended to include a section in their standards/website clearly explaining the scope of their scheme/label. Although this information is available, it is often scattered throughout documents. Providing a clear, brief overview of the scope of the standard is expected to facilitate benchmarks (such as with the BMT), but also operators seeking to get certified and policymakers seeking to understand the applicability of schemes/labels.

RSS13: Accounting for differences in the scopes of certification schemes is critical

When assessing schemes and labels with the BIOBASEDCERT Monitoring Tool (BMT) to inform policies, it is essential to carefully consider differences in scopes, e.g., regarding value chain actors, feedstocks and sustainability principles, to avoid unfair and inaccurate comparisons between the performances of certification schemes.

Other audiences: Policymakers (RP19), Civil society, Researchers

RSS14: The BMT should be used by a variety of stakeholders to fulfil information needs

The BMT can be used by several stakeholders, including EU policymakers, the schemes themselves, civil society, and researchers. EU policymakers can use it to improve their knowledge about the credibility and robustness of the sustainability schemes currently active in various markets. Sustainability certifications can use it as a self-assessment tool, as a gap analysis, and as a supportive tool to identify future development opportunities and ambition roadmaps. Civil society can use it as a tool when looking into the requirements and robustness of certification schemes standards and hold schemes accountable if baseline requirements are not met. Researchers can use the BMT as a research and assessment tool and utilise its results to understand the certification schemes landscape better.

Other audiences: Policymakers (RP20), Civil society, Researchers

RSS15: Considering externalities in monetary terms is vital to mitigating negative impacts

Internalising externalities is vital for establishing sustainable models. Externalities should be included in financial statements to advance the mitigation of negative externalities because effects that are not managed cannot be controlled.

Other audiences: Policymakers (RP21), Industrial actors (RIA10), Regional actors (RRA4)

RSS16: Newly developed cost-benefit analysis (CBA) method should be used for other sectors as well

The cost-benefit analysis method that includes externalities (developed in WP4), can also be used for other sectors in addition to the bio-based sector. It can produce valuable, cross-sectoral and sector-specific insights into the benefits and costs of certification.

Other audiences: Researchers

RSS17: Standardisation of cost and benefit metrics would support externality research

Developing standardised, transparent metrics for external costs and benefits (e.g., greenhouse gas emissions, water use, social impacts) across different certification schemes would enable more accurate comparisons and better monetisation of externalities.

Other audiences: Policymakers (RP23), Regional actors (RR16)

RSS18: Incentives for externality data collection should be established and researched

To improve the transparency, feasibility, and equitable distribution of certification benefits across value chains, policymakers and scheme owners should work together to develop standardised and

incentivised frameworks for the collection of externality data, particularly on social and environmental impacts. We also recommend further research into the types of support, incentives, and motivations (e.g., business case elements) that would most effectively enable companies to collect and monitor such data, especially in under-researched areas like social impacts. Standardised and incentivised data collection is essential to fully understand the costs and benefits, and thus the feasibility, of certification for different operators.

Other audiences: Policymakers (RP24), Industrial actors (RIA12), Researchers

3.3 Industrial actors

Recommendation 1 for industrial actors (RIA1): Sustainability should be considered a key aspect when identifying the most beneficial uses for biobased resources

A wide range of biological resources can be utilised in different sectors and in a variety of biobased products. Consequently, it is essential to continue investing in identifying the most beneficial uses of biobased resources, considering both environmental and social sustainability.

Other audiences: Policymakers (RP1), Civil society, Researchers

RIA2: Already partially biobased sectors should be leaders in the biobased transition

It is recommended that the production of biobased counterparts of conventional products should be increased in industries that are already partially biobased. These sectors include chemicals, textiles, plastics, and construction. Biobased materials can reduce greenhouse gas emissions and dependence on fossil fuels, as well as enable new product characteristics. A conversation regarding the increase should be opened at different levels to identify the most effective actors to advance the increase in production.

Other audiences: Policymakers (RP2), Civil society

RIA3: Inherent sustainability of a biobased economy must not be assumed

While the overall benefits of a biobased economy have been extensively reported, potential trade-offs and negative impacts must also be investigated. It should not be assumed that the biobased economy is inherently sustainable. In-depth analysis should be conducted on the impacts of each value chain from environmental, economic, and social perspectives to assess the sustainability of the value chain as well as unintended negative side effects.

Other audiences: Policymaker (RP6), Civil society, Researchers

RIA4: Common definitions and metrics needed to support the bioeconomy transition

A successful transition to the bioeconomy includes defining a set of standardised metrics for various products and industries and applying a multidisciplinary approach to the design and implementation of novel value chains. This could include establishing definitions for concepts that are often used interchangeably, such as “circular bioeconomy”, “circular economy”, “bioeconomy”, and “sustainability” through, for example, stakeholder consultations.

Other audiences: Policymakers (RP7), Researchers

RIA5: Use of locally sourced feedstock should be increased to support local economies

The sustainability of some sectors would benefit from expanding the use of locally sourced feedstocks (e.g. textiles from flax instead of cotton in the EU), potentially boosting local economies, creating jobs, and allowing for easier control and regulation.

Other audiences: Policymakers (RP9), Regional actors (RRA1)

RIA6: Adaptation to local context, cross-sector collaboration, and information standardisation must be promoted to support the transition to a bioeconomy

The transition to a sustainable bioeconomy should be facilitated by industry and policymakers by adapting the bioeconomy concept to local contexts, taking into consideration regional characteristics, weaknesses, and strengths; intensifying cooperation with the waste management sector to ensure integration of biobased products into collection, separation, recycling and composting schemes; and standardising all sustainability-related information, making regulation and monitoring easier as well as facilitating the implementation and acceptance of novel value chains by stakeholders (e.g., governments, industrial actors) and by society.

Other audiences: Policymakers (RP10), Scheme owners and standard writers (RSS4), Regional actors (RRA2), Civil society, Researchers

RIA7: Supply bottlenecks of biobased products must be eliminated to meet demand

In some sectors and regions, the demand for novel biobased production is often much higher than production, which is hampered by supply chain complexity, low feedstock availability, and the technological immaturity of conversion processes. For these sectors and regions, policies should be developed to remove unnecessary red tape and drive resources towards finding solutions to remove supply bottlenecks.

Other audiences: Policymakers (RP12)

RIA8: Sectors with low biobased innovation must direct resources towards R&D

To drive the development of novel bio-based value chains and maximise positive impact, research should be directed towards innovation in sectors that currently have a low potential for impact due to their lack of biobased innovation. Investing in research can drive the sectors' transitions from primary dedicated raw materials to alternative biological resources, fostering sustainability and reducing the EU's dependency on imports.

Other audiences: Policymakers (RP14), Researchers

RIA9: Certification companies should gather & publish more information about certified production and trade

It is challenging to find high-quality information regarding the certification rate of traded intermediate and final bio-based products. Partly, this is because certification providers publish lists of companies but do not publish or do not monitor certified production and trade in terms of volume. Certification providers should be required by, for example, the scheme owners' association to monitor this information more widely and report on it publicly. Certification bodies should also better report the

breakdown of certificates per sector/product and region in their annual publications as well as report on currently valid certificates in addition to awarded ones.

Other audiences: Scheme owners and standard writers (RSS5), Researchers

RIA10: Considering externalities in monetary terms is vital to mitigating negative impacts

Internalising externalities is vital for establishing sustainable models. Externalities should be included in financial statements to advance the mitigation of negative externalities because effects that are not managed cannot be controlled.

Other audiences: Policymakers (RP21), Scheme owners and standard writers (RSS15), Regional actors (RRA4)

RIA11: Success factors and challenges of certification adoptions should be considered in certification CBAs

When quantifying the costs and benefits of adopting a certification scheme, both internal and external success factors should be considered. Challenges faced by companies when adopting certification schemes, such as lack of resources, cannot be ignored as these challenges can increase the cost of adoption.

Other audiences: Researchers

RIA12: Incentives for externality data collection should be established and researched

To improve the transparency, feasibility, and equitable distribution of certification benefits across value chains, policymakers and scheme owners should work together to develop standardised and incentivised frameworks for the collection of externality data, particularly on social and environmental impacts. We also recommend further research into the types of support, incentives, and motivations (e.g., business case elements) that would most effectively enable companies to collect and monitor such data, especially in under-researched areas like social impacts. Standardised and incentivised data collection is essential to fully understand the costs and benefits, and thus the feasibility, of certification for different operators.

Other audiences: Policymakers (RP24), Scheme owners and standard writers (RSS18), Researchers

RIA13: Businesses must take a circular/non-linear approach to achieve sustainability success

Following a linear, business-as-usual approach, i.e., not considering circularity principles and limited natural resources, can lead to unsustainable value chains regardless of their biobased character. Circular and non-linear principles must therefore be integrated into processes and business models, and more attention should be directed towards end-of-life or cascading use aspects of biobased products.

Other audiences: Scheme owners and standard writers (RSS3)

3.4 Regional actors

Recommendation 1 for regional actors (RA1): Use of locally sourced feedstock should be increased to support local economies

The sustainability of some sectors would benefit from expanding the use of locally sourced feedstocks (e.g. textiles from flax instead of cotton in the EU), potentially boosting local economies, creating jobs, and allowing for easier control and regulation.

Other audiences: Policymakers (RP9), Industrial actors (RIA5)

RA2: Adaptation to local context, cross-sector collaboration, and information standardisation must be promoted to support the transition to a bioeconomy

The transition to a sustainable bioeconomy should be facilitated by industry and policymakers by adapting the bioeconomy concept to local contexts, taking into consideration regional characteristics, weaknesses, and strengths; intensifying cooperation with the waste management sector to ensure integration of biobased products into collection, separation, recycling and composting schemes; and standardising all sustainability-related information, making regulation and monitoring easier as well as facilitating the implementation and acceptance of novel value chains by stakeholders (e.g., governments, industrial actors) and by society.

Other audiences: Policymakers (RP10), Scheme owners and standard writers (RSS4), Industrial actors (RIA6), Civil society, Researchers

RA3: Significant institutions should establish systems for gathering data on certified and sustainable production

At the moment, it is challenging to gather high-quality information regarding the certification rate of traded intermediate and final bio-based products at the sector and regional level. This could be improved through two solutions: 1) Scheme owners should join forces to improve data collection and monitoring of the certification rate of production at a regional level (e.g. Africa, Europe) for specific sectors (e.g. plastics, chemicals). 2) Sources providing general data to the public (e.g., Eurostat, FAO) should establish, in collaboration with national statistic offices, a monitoring system to collect market data on sustainable production at a regional level. This would ease the efforts of researchers, civil society, and other stakeholders to access market data. Certification scheme owners could contribute by providing data on certified companies and/or certified biobased production at a sector- and geography-aggregated level.

Other audiences: Policymakers (RP15), Researchers

RA4: Considering externalities in monetary terms is vital to mitigating negative impacts

Internalising externalities is vital for establishing sustainable models. Externalities should be included in financial statements to advance the mitigation of negative externalities because effects that are not managed cannot be controlled.

Other audiences: Policymakers (RP21), Scheme owners and standard writers (RSS15), Industrial actors (RIA10)

4. Conclusion

This report (D5.1), presents a collation and synthesis of the key findings and recommendations generated across work packages 1-4. It provides an overview of the project's research journey, encompassing the development of classification systems for biological resources and bio-based products, the establishment of methodologies for reviewing and evaluating sustainability certification schemes and labels (CSLs), the analysis of bio-based value chains in relation to sustainability goals and trade flows, the development and testing of the BIOBASEDCERT Monitoring Tool (BMT), and the exploration of cost-benefit analysis (CBA) that incorporate externalities.

Building upon derived findings, the report details a wide range of recommendations, categorised for primary target audiences including policymakers, scheme owners and standard writers, industrial actors, and regional actors, while also identifying relevance for researchers and civil society.

Several high-level observations emerge from the recommendations.

- The interconnectedness of the bio-based economy is evident; numerous recommendations are applicable to multiple stakeholder groups, underscoring the necessity for coordinated action and collaboration.
- Persistent challenges across the biobased industry are highlighted. There is a clear need for enhanced data collection, monitoring, reporting, and overall transparency related to certified products and their sustainability impacts throughout the value chain.
- A holistic approach is needed; stakeholders should look beyond traditional sustainability aspects and integrate, for example, circularity principles alongside social and economic dimensions in sustainability assessments and CSLs.
- The need for greater standardisation – encompassing definitions, metrics, and methodologies – can enable better comparison, analysis, and decision-making.

Finally, the recommendations reflect the practical outputs of the project, encouraging the adoption and further development of tools like the BMT and the adapted CBA framework to improve scheme robustness and feasibility assessments.

The findings and recommendations outlined in this synthesis report, developed under Task (T)5.1, serve as useful input for other activities within WP5. The findings and the recommendations presented provide input material for other tasks in WP5. This material supports the project team in developing targeted dissemination materials, including policy briefs for policymakers (T5.2), and specific thematic briefs aimed at standards writers and scheme owners (T5.3), industrial bio-based value chain actors (T5.4), and regional bioeconomy actors (T5.5). The recommendations derived in T5.1. have been used in workshops targeted at industrial actors and regional actors to gather feedback and ensure real-world applicability.

Annex: Recommendations matrix

Table 7 Recommendations matrix

Recommendation	Policy-makers	Scheme owners and standard writers	Industrial actors	Regional actors	Civil society	Research-ers	Source
Sustainability should be considered a key aspect when identifying the most beneficial uses for biobased resources.	X		X		X	X	D1.1 *Classification of biological resources and biobased products*
Already partially biobased sectors should be leaders in the biobased transition.	X		X		X		D1.1 *Classification of biological resources and biobased products*
Stronger implementation and enforcement of regulation needed for certifications.	X				X		D1.2 *Review of sustainability certification schemes and ecolabels for biobased systems*
All aspects of sustainability, including circularity, should be considered in assessments.	X	X			X	X	D1.2 *Review of sustainability certification schemes and ecolabels for biobased systems*
The global impact of EU policies should be considered in regulatory processes	X				X		D1.2 *Review of sustainability certification schemes and*

							ecolabels for biobased systems
Resources beyond forestry and agriculture should be increasingly considered in certification schemes.		X					D1.2 *Review of sustainability certification schemes and ecolabels for biobased systems*
Businesses must take a circular/non-linear approach to achieve sustainability success.		X	X				D1.2 *Review of sustainability certification schemes and ecolabels for biobased systems*
Inherent sustainability of a biobased economy must not be assumed.	X		X		X	X	D1.3 *Analysis of synergies and trade-offs*
Common definitions and metrics needed to support the bioeconomy transition.	X		X			X	D1.3 *Analysis of synergies and trade-offs*
Research should be undertaken to fill in gaps in sustainability knowledge.	X					X	D1.3 *Analysis of synergies and trade-offs*
Use of locally sourced feedstock should be increased to support local economies.	X		X	X			D1.3 *Analysis of synergies and trade-offs*
Adaptation to local context, cross-sector collaboration, and information standardisation must be promoted to support the transition to a bioeconomy.	X	X	X	X	X	X	D1.3 *Analysis of synergies and trade-offs*

Direct resources and support towards value chains with the most potential for sustainability contributions.	X						D2.1 *Identification of the most representative biobased value chains*
Supply bottlenecks of biobased products must be eliminated to meet demand.	X		X				D2.1 *Identification of the most representative biobased value chains*
Investment and incentives should be directed towards value chains with potential for high positive impact.	X						D2.1 *Identification of the most representative biobased value chains*
Sectors with low biobased innovation must direct resources towards R&D.	X		X			X	D2.1 *Identification of the most representative biobased value chains*
Significant institutions should establish systems for gathering data on certified and sustainable production.	X			X		X	D2.2 *Data collection and filling in gaps on global trade flows for (un)certified biobased value chains*
Certification companies should gather & publish more information about certified production and trade.		X	X			X	D2.2 *Data collection and filling in gaps on global trade flows for (un)certified biobased value chains*
Schemes should improve product accounting to improve transparency.		X					D2.2 *Data collection and filling in gaps on global trade flows for (un)certified biobased value chains*

Policy instruments needed to help curb deforestation at biomass cultivation phase.	X				X	X	D2.3 *Analysis of effects of certification on EU trade of bio-based value chains*
Development of improved environmental impact methodology needed.	X	X			X		D2.3 *Analysis of effects of certification on EU trade of bio-based value chains*
Development of improved social impact methodology needed.	X	X			X		D2.3 *Analysis of effects of certification on EU trade of bio-based value chains*
Schemes should consider a wide audience and range of stakeholders.		X					D3.1 *Review of existing monitoring approaches for schemes and labels*
Certification rating and scoring systems must balance nuance and concrete usability.		X					D3.1 *Review of existing monitoring approaches for schemes and labels*
The BMT assessment results can lead to valuable improvements in schemes.		X					D3.2. *Evaluation of existing schemes and labels*
Transparency regarding certification scope is mutually beneficial.		X					D3.2. *Evaluation of existing schemes and labels*
Accounting for differences in the scopes of certification schemes is critical.	X	X			X	X	D3.2. *Evaluation of existing schemes and labels*
The BMT should be used by a variety of stakeholders to fulfil information needs.	X	X			X	X	D3.3 *Description of the monitoring system*

Newly developed cost-benefit analysis (CBA) method should be used for other sectors as well.		X				X	D4.1. *Review of methodologies for cost-benefit analysis and internalising externalities for sustainability certification*
Success factors and challenges of certification adoptions should be considered in certification CBAs.			X			X	D4.1. *Review of methodologies for cost-benefit analysis and internalising externalities for sustainability certification*
Considering externalities in monetary terms is vital to mitigating negative impacts.	X	X	X	X			D4.1. *Review of methodologies for cost-benefit analysis and internalising externalities for sustainability certification*
Further research is needed to support the availability of data on external costs and benefits of certifications.	X					X	D4.1. *Review of methodologies for cost-benefit analysis and internalising externalities for sustainability certification*
Incentives for externality data collection should be established and researched.	X	X	X			X	D4.3 *Data collection template for cost-benefit analysis*
Standardisation of cost and benefit metrics would support externality research.	X	X		X		X	D4.4 *Assessment of feasibility of certification adoption in selected value chains*

The integration of certification schemes into public procurement should be based on robust, evidence-based decision-making.	X						D4.4 *Assessment of feasibility of certification adoption in selected value chains*

About SUSTCERT4BIOBASED

SUSTCERT4BIOBASED is an EU funded (Horizon Europe) project aiming at defining and promoting the adoption of effective and robust sustainability certification schemes and business-to-business labels for industrial biobased systems to support tracing the sustainability (environmental, social, economic) of biobased products along the value chains and trades within the EU and globally for responsible production and consumption. This objective is realised by the development of a monitoring system, mapping of the current situation in global trade flows of biological resources and biobased products, and feasibility assessment from the adoption of certification schemes and labels considering actual economic as well as internalized environmental and social costs and benefits. The results of the project are leveraged to provide recommendations to four key target groups: policy makers, sustainability system community, industrial biobased value chain actors, and regional bioeconomy stakeholders. These ambitions are addressed by a strong, well-balanced and multi-disciplinary consortium comprised of 5 complementary partners. SUSTCERT4BIOBASED thereby supports the development of harmonized system requirements, continuous improvement of sustainability certification schemes and labels and contributes towards establishing a circular, climate-neutral and sustainable biobased industry.

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