HARMONITOR

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Deliverable 2.3 (D2.3)

Methodology Handbook for Benchmarking and Monitoring

Work package 2 (WP2): Concepts and methodologies for the HARMONITOR platform

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REPORT

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CONTENTS

1. INTRODUCTION

The HARMONITOR project aims to enhance the performance of certification schemes and labels (CSLs) in various sectors of the EU Bioeconomy, making them more effective and strengthening their role as a co-regulation instrument. CSLs can address challenges faced by public regulations and fill policy gaps. The project intends to establish a participative review platform that enables CSLs to collaborate and find common ground within bio-based value chains across EU borders. This platform builds upon the innovative 'Sustainability Certification Tools' proposed by the STAR-ProBio project. The specific objectives of HARMONITOR include establishing a review platform, providing transparent data on bio-based value chains, comparing performance requirements of CSLs, developing a monitoring system, and improving the understanding of CSLs in co-regulation. The expected outcomes of the project include enhanced transparency and traceability in value chains, increased effectiveness, and robustness of CSLs through systematic monitoring, awareness of trade flows and their impacts, and potential use of CSLs as part of the EU Bioeconomy policy framework.

Deliverable 2.3 (D2.3) 'Project methodology handbook for benchmarking and monitoring' is the first of two deliverables of Task 2.3 'Project methodology hub' of Work package 2 (WP2): 'Concepts and methodologies for the HARMONITOR platform'. The second deliverable of Task 2.3 is Deliverable 2.4 (D2.4-9 'Final documentation of concepts, methodologies, and tools') due in Month 36 of the project (May 2025).

1.1 Task 2.3 description

To ensure consistent and comprehensive results in analysing CSLs, cross-Work Package (WP) coordination is necessary. To facilitate this coordination, Task 2.3 in WP2 is meant to create a methodology hub to facilitate the analysis of bio-based value chains and CSLs and ensure consistency and compatibility of results and data flows. The hub, made through the contribution of all the project partners, will coordinate the selection of methodologies that can be used across different project WPs. Its tasks will include coordinating data collection, discussing methodologies development and selection, preparing coherent results, data transferring and exchanging information with other projects with similar objectives under the ZERO POLLUTION call. The hub will serve as a platform for identifying connections between tasks and interdisciplinary project activities. Additionally, the hub will enable partners to collectively identify data sources and define methodologies for reviewing, monitoring, and assessing selected CSLs.

The methodologies used in WP1 and WP7 are excluded from this report due to the practical non-academic component that the coordination and dissemination tasks require. Therefore, the focus of this methodological handbook is on theoretical methodological research aspects. This report (D2.3 'Project methodology handbook for benchmarking and monitoring') is an interim report, written at month 12 of the project (May 2023). This means that not all tasks in all work packages have started, and that only few of the tasks (and their methodologies) are fully completed. For the tasks that have not yet started, no methodologies are included in this document. For tasks which have just begun, only preliminary methodologies are currently available. Deliverable 2.4 (D2.4) 'Final documentation of concepts, methodologies, and tools'), due in month 36 (May 2025), will contain a consolidated set of all methodologies used in the HARMONITOR project. Therefore, most methodologies described in this working document are subject to change. This document, while public, is meant primarily for internal use as a tool to take stock and assess whether the methodologies developed so far properly align with

each other and are fit for purpose. This report originally delivered in Month 12 of the project (May 2023) has been revised in June 2023 to include the results of the discussion during the General Assembly of the HARMONITOR project carried out in June 2023 in Bologna, Italy.

1.2 Connection between and description of HARMONITOR work packages

This section summarizes the envisaged connections between the seven HARMONITOR work packages (WPs) and the expected results of each WP according to the project proposal. An overview of the WP structure is provided in Figure 1.

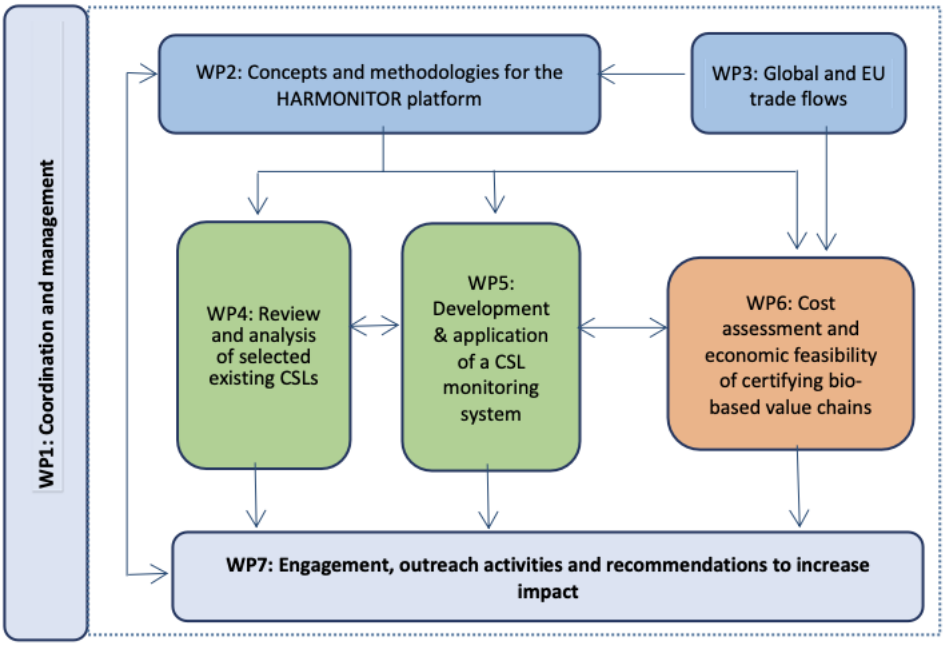

Figure 1. Overall structure of the work plan as represented in the HARMONITOR proposal.

The HARMONITOR WPs are interconnected to facilitate the collaborative development of various project products. This deliverable primarily aims to bolster this collaborative effort by providing a comprehensive description of the individual tasks and methodologies within each WP. It highlights the envisioned collaboration among WPs to collectively achieve the overarching objectives of developing a monitoring system and a CSL platform.

The envisioned flow of information between WPs, as outlined in the project proposal and illustrated in Figure 2, encompasses several crucial aspects:

- Joint selection of CSLs and value chains: The starting points defined in WP2 and WP3, involving the joint selection of CSLs and value chains, serve as inputs to the benchmarking framework (WP4), the monitoring system (WP5), and the assessment of costs and benefits associated with sustainability certification.
- Public stakeholder consultation results: The outcomes of the public stakeholder consultation process in T2.2 hold relevance not only for T2.4 (development of the CSL platform concept) but also for WP4 (Review and analysis of selected existing CSLs for biological resources, bio-based materials and products), WP5 (Development and application of a CSL monitoring system) and WP6 (stakeholder perspectives on CSLs as co-regulation instrument, their shortcomings and benefits). These results offer valuable insights into the general perception of the strengths and weaknesses of CSLs, fostering a better understanding of these aspects.
- Benchmarking framework and CSL monitoring results: The results derived from the application of the benchmarking framework in WP4 and the monitoring of CSLs in WP5 through the joint monitoring system (JMS), play a supportive role in the development of the CSL platform. These findings inform the concept development and provide the platform members with insights into the commonalities and differences between CSLs.

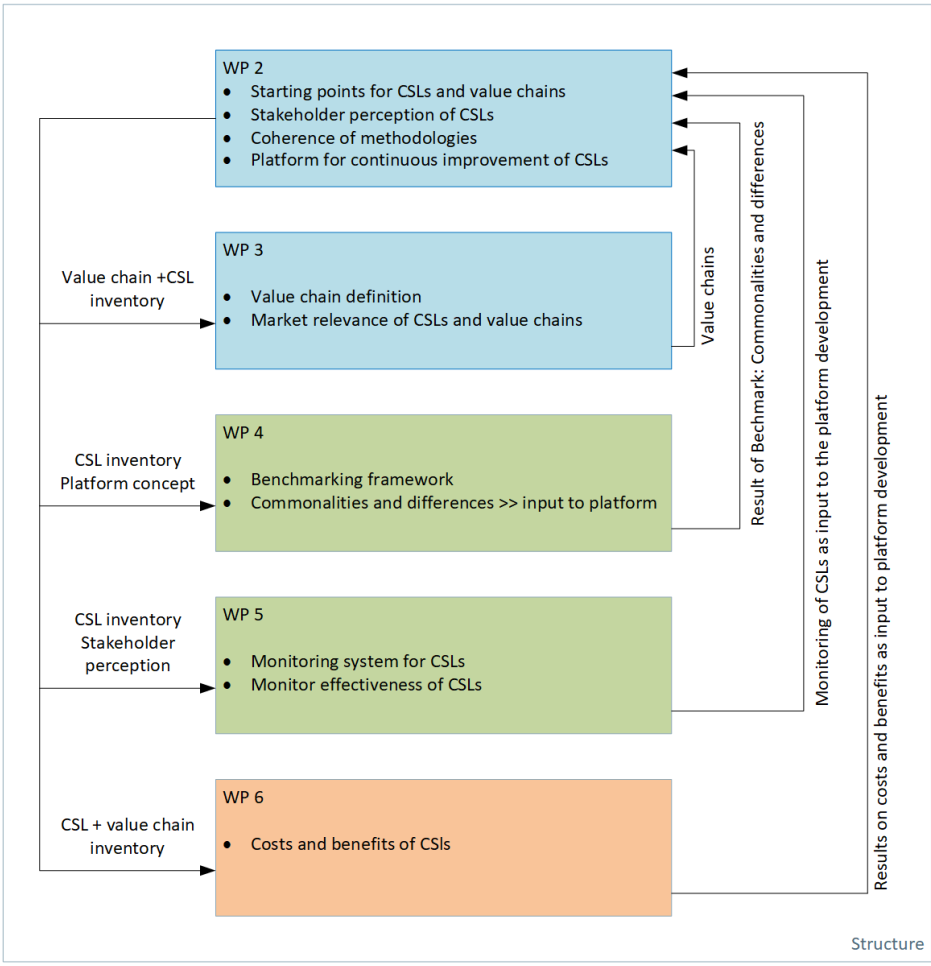

Figure 2. Envisaged flow of information between work packages.

WP2: Concepts and methodologies for the HARMONITOR platform

WP2 aims to define common starting points for analysing bio-based value chains and CSLs. In Task 2.1, an inventory overview of existing CSLs and value chains will be prepared and cover relevant biological resources used in bio-based value chains and materials/products. A final selection of CSLs will be made in collaboration with the Commission and the project's Advisory Board. Subsequently, a concept of essential elements for the HARMONITOR platform will be developed. Task 2.2 will include an open public consultation that will be conducted to gather input on critical issues affecting existing CSLs. The consultation will contribute to initiating the participative and review HARMONITOR platform to allow CSLs to find commonalities and cooperation when operating in bio-based value chains within and across EU boarders. The consultation will also contribute to defining starting points for subsequent tasks. Task 2.3 will establish a methodology hub to coordinate data collection and methodologies across the project. This is important to ensure coherence within the WPs and exchange information with other projects that have similar objectives. Task 2.4 will establish a conceptual approach, structure, and essential elements to develop the HARMONITOR platform, also using information from the other project tasks. Subtasks 2.4.1, 2.4.2, 2.4.3, and 2.4.4 will coordinate the involvement of the selected CSLs in the HARMONITOR platform. The focus will be on the development of the platform's concept and system elements (including governance options and funding for long-term operations), feedback-based testing and refinement of the conceptual basis of the platform, and the creation of a first version of the HARMONITOR platform. The active participation of CSLs will ensure its continuous operation and improvement beyond the project's duration.

WP3: Global and EU trade flows of biological resources, bio-based materials, and products

WP3 aims to collect and analyse data on the volumes and trade flows of biological resources and bio-based materials and products. The tasks will focus on distinguishing between certified and uncertified resources, materials and products by determining the scope and selection of resources (Task 3.1), assessing trade flows (Task 3.2), evaluating the level of certification and labelling (Task 3.3), and synthesizing the collected data into a report (Task 3.4). The goal of the task is to provide insights into global trade patterns and promote sustainable practices in the bio-based industry.

WP4: Review and analysis of selected existing CSLs for biological resources, bio-based materials, and products

The objective of WP4 is to conduct a comparative analysis of selected CSLs that focuses on the environmental, social, and economic impacts of bio-based products. The analysis will assess the effectiveness and robustness of the assurance and governance systems of each scheme in achieving their intended impacts. The tasks include developing an inventory of key aspects of CSLs through literature review and documentation analysis (Task 4.1), conducting a comparative analysis of each scheme's impacts, assurance systems, and governance systems (Task 4.2), and validating the findings through stakeholder consultation (Task 4.3). The final comparison study will provide a comprehensive overview of the performance of the selected CSLs and offer recommendations.

WP5: Development and application of a CSL monitoring system

WP5 aims to develop and implement a monitoring system for CSLs related to bio-based products. In Task 5.1, the monitoring system will be developed, including requirements, indicators, and verification tools to assess environmental, social, and economic sustainability aspects of CSLs. The system will be collaboratively developed by academic and market partners with input from the European Commission and other stakeholders. In Task 5.2, the monitoring system will be applied to selected CSLs to test its effectiveness and optimize its methodology. Task 5.3 involves validating the monitoring system based on the test results and making necessary improvements. The monitoring system will be continuously updated and developed under the project, and collaboration with ISEAL will be sought for further harmonization.

WP6: Costs, benefits, and economic feasibility of CSLs

WP6 outlines the objectives and tasks related to quantifying the costs and benefits of adopting CSLs in industrial bio-based value chains. The objective is to assess the direct and indirect costs and benefits of adopting CSLs in selected industrial bio-based value chains, including externalized environmental and social costs, and to identify governance options for increasing certified production. Task 6.1 aims at quantifying the direct costs of obtaining certification from selected CSLs. To achieve this, scheme owners and certification bodies will be contacted. Task 6.2 will quantify costs and benefits of meeting sustainability criteria for case studies that will represent diverse biological resources, value chains, and sourcing regions. Data collection will involve literature reviews, analysis of certification bodies' experiences, and interviews with certified companies. The analysis will consider the impact of sustainability criteria on production costs, environment, and society, including price differences between certified and non-certified products. Task 6.3 will use economic modelling to quantify the environmental and social externalities of selected biological resources and bio-based products at national and global levels. The monetary value of externalities will be determined using existing valuation methods, while the impacts of internalizing sustainability costs will be assessed, along with the potential for minimizing externalities through changes in production. Finally, task 6.4 will evaluate the overall economic feasibility and performance of certified products. Cost-benefit analysis and net present value analysis will be conducted, considering direct and indirect costs, benefits, and externalities. The analysis will identify the cost gap between certified and uncertified products and assess the feasibility of large-scale market uptake of certification in the EU. Literature reviews, interviews, and surveys with experts and stakeholders will be conducted to identify governance options for increasing certified production and improving the EU bioeconomy policy framework.

2. SUMMARY OF METHODOLOGIES PER WORK PACKAGE

The methodologies developed so far in the different work packages and tasks differ significantly in terms of how far they have progressed. For example, the methodology for task 3.1. is already finalized, whereas many other tasks are ongoing. Therefore, it was decided to provide summaries of all methodologies in this chapter, which allow for an easier comparison between the tasks. The complete methodological information for WPs 2-6 can be found in Appendixes A to E.

An overview of all work package and sub-task leads covered in this report is provided in Table 1 below.

Table 1 Overview of all WP and subtask leads.

	Lead	Organisation
WP2	Stefan Majer	DBFZ
Task 2.1	Stefan Majer	DBFZ
Task 2.2	Martin Junginger	Utrecht University
Task 2.3	Martin Junginger	Utrecht University
Task 2.4	Stefan Majer	DBFZ
WP3	Martijn Vis	BTG
Task 3.1	Martijn Vis	BTG
Task 3.2	Martijn Vis	BTG
Task 3.3	Martijn Vis	BTG
Task 3.4	Martijn Vis	BTG
WP4	Simon Windfeld Møller	Preferred by Nature
Task 4.1	Simon Windfeld Møller	Preferred by Nature
Task 4.2	Simon Windfeld Møller	Preferred by Nature
Task 4.3	Simon Windfeld Møller	Preferred by Nature
WP5	Martin Junginger	Utrecht University
Task 5.1	Martin Junginger	Utrecht University
Task 5.2	Martin Junginger	Utrecht University
Task 5.3	Martin Junginger	Utrecht University
WP6	Birka Wicke	Radboud University
Task 6.1	Simon Windfeld Møller	Preferred by Nature
Task 6.2	Birka Wicke	Radboud University
Task 6.3	Birka Wicke	Radboud University
Task 6.4	Birka Wicke	Radboud University

WP2: Concepts and methodologies for the HARMONITOR platform

Task 2.1: Definition of common starting points (Month 12) – completed

An initial inventory of existing CSLs in the EU biobased economy was generated through a comprehensive review of scientific literature and available databases. The initially identified 100 CSLs were further assessed based on their specific characteristics and filtered according to the needs of each specific WP. An internal questionnaire was developed to match the identified schemes with the requirements and expectations of the project partners. The relevance and applicability of the CSLs to the selected biobased value chains under WP2 were also considered. The result of this process was an internal longlist of approximately 50 CSLs for further analysis in the project.

To shorten the longlist, a preselection of 35 biobased value chains, including feedstock categories, intermediates, and potential products, was made. A questionnaire was used to gather additional parameters and preferences for the selection of value chains from the project partners involved in relevant WPs. Feedstock groups were clustered with appropriate intermediate and final products to facilitate the selection process. Additional selection criteria, such as the inclusion of intermediate products for downstream processing and the availability of CSLs, were applied. The elements of the value chain clusters were matched with the selected CSLs to assess their potential coverage. Based on these steps, a final selection of biobased value chains for further analysis in the HARMONITOR project was compiled. Overall, the methodology involved a comprehensive review, questionnaire-based assessments, and matching exercises to identify a range of certification schemes, labels, and biobased value chains for analysis and work within the HARMONITOR project.

Task 2.2: Open public consultation (Month 12) - ongoing

The public consultation for the survey was conducted online and developed by Utrecht and Radboud University scholars. The survey received feedback and advice from the HARMONITOR project partners, as well as from the sister projects STAR4BBS and SUSTCERT4BIOBASED, ISEAL, and ECOS, particularly regarding the application of the 10 ISEAL credibility principles. These principles define the core values of credible and effective sustainability systems and were selected since they help organizations develop standards and sustainability tools by identifying critical attributes that enhance credibility.

The survey consisted of four parts. The first part focused on respondents' background, including their stakeholder group affiliation and geographical location. The second part gathered respondents' general opinions on the advantages and disadvantages of CSLs, as well as their familiarity with EU legislation on the sustainability of biobased products, which often utilize CSLs. The third part was the central section of the questionnaire, where respondents were asked to assess the strengths and weaknesses of CSLs based on the 10 ISEAL credibility principles. They had the option to evaluate CSLs in general or specific ones, ranking them from weak to strong. In cases where weaknesses were identified, respondents were asked to provide explanations and motivations. If respondents mentioned specific CSLs, these CSLs were anonymized in the results. The final part of the survey offered respondents the choice to provide their name and contact details for follow-up interviews and to request the survey results.

The survey was disseminated through project partners, advisory board members, social media platforms like LinkedIn and Twitter, and targeted outreach to individuals and organizations involved in critically reviewing CSLs. Data collection for the report took place starting early March 2023 and is still

ongoing. Preliminary results presented at the workshop in Bologna at the EUBCE side event were based until May 7th, 2023. By that time, 68 respondents had started the survey, and 33 had completed it. As some stakeholder groups were underrepresented, the survey remained open until 16 July 2023. At this time of writing, we received 95 respondents that started the survey and 42 that completed it. The aim will be to have at least 100 survey respondents starting the survey and 50 finishing it, with ideally all stakeholder groups being covered.

After the survey is finalized, Utrecht University will follow up with in-depth interviews with a limited number of selected key stakeholders. The results of the consultation, the interviews and other activities (e.g., the HARMONITOR and its sister project workshop held in Bologna in June 2023 as side event of the EU Biomass Conference and Exhibition EUBCE 2023) will then be summarized and forwarded to the JMS working groups. In addition, the ambition is to condense the findings and publish them as a paper in a peer-reviewed open access scientific journal for further dissemination.

Task 2.3: Project methodology hub (Month 35) - ongoing

The preliminary output of methodology hub is the methodology handbook (this document). It consists of a short introduction of each WP and sub-task, a methodological part that summarizes the specific methodologies used for each task, and a final reflection section that connects the methodologies across tasks and WPs. The introductory part was based on the HARMONITOR base documents with task descriptions. The methodological part was developed from documents provided by each task coordinator, which outlined the methods used for achieving the deliverables. These were then shortened and summarized. The final flowchart connected the different methodologies across tasks and WPs to visualize the exchange of information throughout the project.

The final deliverables (D2.4) of this task will be based on D2.3 and will contain the full set of final methodologies developed within the HARMONITOR project.

Task 2.4: Development of the HARMONITOR platform (Month 36) – started

Task 2.4 has just started in month 12 (May 2023). Therefore, no methodology has been included in this document.

WP3: Global and EU trade flows of biological resources, bio-based materials, and products

Task 3.1: Determining scope and selection of resources, materials, and products (Month 6) – completed

The goal of the selection was to have a representative mix of bio-based products, using various feedstocks, covering a broad range of sectors, and relevant for EU policy making and sustainability certification analysis. Overall, the methodologies involved compiling lists of bio-based materials, pre-selecting dedicated, and drop-in products based on trade volumes, identifying main biological resources, and making the final selection based on various criteria and policy relevance. These are summarized in 5 main methodological steps:

1. Step 1: An extensive list of 350 bio-based materials and products, supplemented with wood products and other bio-based products, was created. It indicated whether the products are drop-in or dedicated bio-based materials.

2. Step 2: All dedicated bio-based materials and products for which statistical trade information is readily available, including wood-based products, were pre-selected.

3. Step 3: The 40 drop-in bio-based materials and products with the highest bio-based production volumes were selected for further assessment.

4. Step 4: The main biological resources used for the production of the selected bio-based materials and products were identified through a quick assessment of their value chains.

5. Step 5: The final selection of bio-based value chains was made considering several criteria and considerations, including market size, representative distribution between sectors, inclusion of innovative and traditional products, use of residues and wastes, inclusion of both EU and imported feedstocks, environmental and social challenges, coverage by sustainability certification schemes and labels, and relevance to EU bioeconomy policies.

For more information on what each precise step is used in this task check Appendix B.

Task 3.2: Assessing trade flows of biological resources, bio-based materials and products (Month 18) – ongoing

Task 3.2 involved assessing the trade flows of biological resources, bio-based materials, and products. The approach included mapping trade flows using existing market databases and combining statistical information with estimated percentages of bio-based production for drop-in bio-based products. The trade flows of biogenic feedstock were mapped using existing databases, with other sources used if statistical information was unavailable. The data collection process included describing the value chain, collecting statistical data, and collecting data in cases where no statistical information was available. The results aim at showing production, market, import, and export of major global regions, with a more detailed mapping of trade between EU member states where available. The deliverables included an initial assessment of trade flows at month 12 (May 2023) and the trade flows report at month 27 (August 2024). The work was divided between the Biomass Technology Group (BTG) and Utrecht University, with BTG assessing value chains with chemicals, sugar/starch, and oil crops as biomass resources, and Utrecht University handling other value chains such as wood, paper, and textiles. An uncertainty indicator was used to rank the quality of information sources, considering factors like reliability, data source, and adjustments based on circumstances.

Within the next months, data collection will focus on trade data for which no statistical data is available, such as selected drop-in chemicals. Data collection process and results will be reported in Deliverable D3.2 “Preliminary report on trade flows of biological resources, bio-based materials and products”. On a regular basis, once per 2 – 3 months, a meeting with the sister projects is foreseen to exchange our approaches and findings and to harmonise the efforts made. The next meeting will take place on 18 July 2023.

Task 3.3: Assessing level of certification and labelling of biological resources, bio-based materials and products (Month 27) – started

This task started in month 10 (March 2023). As the number of final CSLs in WP2 and 4 was just selected in month 12 (May 2023), this task will continue with methodology development from June 2023 onwards.

Task 3.3 involves assessing the level of certification and labelling of biological resources, bio-based materials and products. The share of sustainability certification of primary biological resources, e.g.,

sugarcane, palm oil, wood, can be determined at the country level by estimating the certified areas and compare it with the total grown area of this primary biomass resource. In general, such information is not readily available, but various sources need to be consulted, like information on certified areas as published by CSLs (e.g., FSC), overview studies like ITC et al. (2020) and IDH (2019) or checking the databases of published certificates. If needed, publicly available certificates could be analyzed to get qualitative insight into the level of certification. The level of sustainability certification of residues and wastes and the bio-based materials and products will be estimated by collecting data from statistics, literature, and CSLs. If no data is available on the level of certification, plausible assumptions will be made. In some cases, it may be assumed that the level of certification of the bio-based materials and products are equal to the certification level of the biological resources used. Assumptions will be documented, and the resulting numbers will get an uncertainty indicator ranging from 1 (most reliable) to 4 (least reliable).

This task started in month 10 (March 2023). As the number of final CSLs in WP2 and 4 was just selected in month 12 (May 2023), this task will continue with methodology development from June 2023 onwards. The further elaborated methodology and preliminary results will be presented in Milestone MS4 *"Initial level of level of certification and labelling"*, to be submitted on 31 August 2023. The approach will also be presented and discussed during the work package specific sister project meetings, the next one being planned on the 18th of July.

Task 3.4: Trade flows synthesis (Month 33) – not yet started

This task will start in month 30 (November 2024). Therefore, no methodology has been included in this document.

WP4: Review and analysis of selected existing CSLs for biological resources, bio-based materials, and products

Task 4.1: Literature review and inventory of key aspects of each selected CSL (Month 12) – ongoing

Task 4.1 consists of several subtasks, including subtask 4.1.1 which comprises a literature review on sustainability CSLs. This was originally planned to be carried out by the German Biomass Research Centre (DBFZ) and RINA CONSULTING but was taken up by Utrecht University. A meta-review was carried out based on scientific, peer-reviewed articles and studies that discussed the functioning of CSLs for biobased products from various angles. The literature review was conducted on Google Scholar by using the terms 'meta-analysis', 'critical discussion', 'analyzing key aspects', 'review', and 'sustainability assessment' to identify articles published during the past 6 years on critical aspects of CSLs. A particular attention was given to aspects of the governance system based on the ISEAL credibility principles (Sustainability Impacts, Collaboration, Value Creation, Measurable Progress, Stakeholder Engagement, Transparency, Impartiality, Reliability, Truthfulness and Continual Improvement) through different categories of bio-based products (e.g., consumer goods, biomass, bioplastics, etc.) or aspects of certifications, such as best practices or market mechanisms. The identified and assessed included amongst other studies that assessed the use of CSLs for demonstrating compliance with legislation, the benefits of CSLs for smallholders, the effectiveness and economic viability of forest certification (several articles) and the impact of other CSLs for specific feedstocks (e.g., palm oil), transparency of CSLs focusing on textiles, and many more topics. The main

insights from this meta-analysis will be used both for task 4.2 and for WP5, which the details of the development of the Joint Monitoring System (JMS).

Subtasks 4.1.2 to 4.1.5 focused on establishing specific inventories based on the following brief:

- Subtask 4.1.2: Inventory of certifiable biological resources, bio-based material and products covered by selected CSLs. (DBFZ, RINA CONSULTING)
- Subtask 4.1.3: Inventory of environmental, social, and economic requirements, including control points examined during audit assessments. (Preferred by Nature, RINA CONSULTING)
- Subtask 4.1.4: Inventory of assurance system requirements, relating to how compliance with the scheme requirements is ensured. This includes protocols that are meant to ensure effectiveness, robustness, and other aspects of how the scheme operates. (Preferred by Nature)
- Subtask 4.1.5: Inventory of governance system requirements, including aspects such as impartiality, transparency, stakeholder engagement, impact measurement, etc., determining overall CSL credibility. (Utrecht University)

The CSLs reviewed under WP4.1 was derived from the list of CSLs provided by WP2. This comprehensive list also designates the CSLs according to the commodity it covers. The WP4 partners shortlisted 20 to 25 CSLs from the list provided by WP2 based on; presence in the EU market, variety in feedstock type to cover as many industries as possible, partners individual experience with the CSL, and if it was covered by the Standards Map developed by the International Trade Centre. Then followed the review that completed the inventory by verifying and covering the partners' individual subtask through document review of each selected CSL.

Please note WP4.1 was due to be completed by project month 12 (May 2023) but received an extension as this deadline were not beneficial since the selection of CSLs in WP2 had not been completed prior to project month 12. Deliverable 4.1 has now been postponed until Month 16 (September 2023), as approved by the project officer.

Task 4.2: A detailed comparative analysis of each selected CSL (Month 21) – ongoing

Using the methodology provided in appendix C and the inventory of key aspects of each scheme (D 4.1), this task will conduct a comparative analysis of each selected CSL, including the extent to which each scheme assesses and certifies values regarding:

- Subtask 4.2.1: Environmental, social, and economic impacts and trade-offs. (Preferred by Nature, RINA CONSULTING, agroVet)
- Subtask 4.2.2: Assurance system requirements. (Preferred by Nature, agroVet)
- Subtask 4.2.3: Governance system requirements. (Utrecht University, agroVet)

Notable gaps across the CSLs will also be analyzed, where expected contributions to social or environmental impacts are not being realized. The methodology is based on the Scheme Evaluation Framework (SEF) developed by Preferred by Nature. The SEF consists of criteria and indicators applicable to certificate holders, certification bodies and the scheme owners themselves, aiming at addressing a) performance requirements; b) assurance system; and c) governance system.

The assessment of certification holder requirements includes land-use requirements, supply chain requirements, requirements for material control, general, quality and procedural requirements for Certificate Holders.

The SEF is developed in an excel worksheet with different tabs, dividing the evaluation requirements in different sections. It is based on a mix of literature review of publicly available documents and direct interviews and discussions with relevant scheme personnel.

The final evaluation of a CSL ultimately includes:

- A description (or summary) of the normative requirements
- A discussion of findings, including an overview of issues and risks (based on referenced sources) relevant to the indicator.
- Conclusion & Justification which shall be clearly formulated as Covered, Partly Covered or Not covered; including a summary justification of the designation to provide the rationale behind the final conclusion. E.g., "based on findings x, y and z, it is concluded that the indicator is PARTIALLY COVERED".

The methodology is already existent and has been tested, but may also be adapted further for the specific needs of the HARMONITOR project; more details can be found in Appendix C.

Task 4.3: Validation and final comparison study (Month 31) – not started yet

This task is scheduled to start later in 2023 and will build on the methodology developed in Task 3.2.

WP5: Development and application of a CSL monitoring system

Between September 2022 and February 2023, the three ZEROPOL sister projects HARMONITOR, SUSTCERT4BIOBASED AND STAR4BBS jointly developed a proposal for a joint monitoring system (JMS). The rationale for a joint JMS was to avoid internal competition and external fatigue and confusion of stakeholders. The proposal was submitted to the project officer in February 2023 and approved at the end of May 2023.

Task 5.1: Develop a monitoring system for all CSLs reviewed (Month 24) – Started

The Joint Monitoring System (JMS) for biobased CSLs aims to reduce confusion and mistrust among stakeholders by harmonizing the existing systems and providing clarity for policymakers in the transition to a bioeconomy. The benefits of a JMS include improved trust, resource optimization, and long-term funding prospects. Its purpose is to evaluate the potential of CSLs to contribute to sustainability goals and objectives set by EU policies and Sustainable Development Goals (SDGs) while harmonizing existing schemes and increasing the understanding of their effectiveness and robustness. The JMS will assess sustainability criteria, provide a baseline for evaluation, and drive continuous improvement. The primary users of the JMS are the European Commission/policymakers and certification scheme owners, with potential access for industry users, NGOs, practitioners, and the general public.

The proposed structure of the JMS includes three levels: System Level, Content Level, and Outcome Level. System indicators focus on governance and standards, content indicators clarify requirements, and outcome indicators capture impact. The indicators will be tested with relevant certification schemes, and the results will be stored in a central database. The data will be interpreted using minimum requirements and a traffic light system. The JMS will build on previous projects, existing tools, and databases.

The proposal suggests a division of responsibilities among three projects involved in the development of the JMS. Each project will coordinate one level, but all three levels are equally relevant and should be jointly evaluated. The projects will work together in developing the core JMS, interpretation, and testing phases. Stakeholder engagement and pilot testing will be conducted to optimize the JMS. For more information on this methodology, check Appendix D.

As the proposal was approved two weeks before the finalization of this report, the further methodology development has now just started. A core group consisting of project partners from the three sister projects will participate in a series of meetings that will be scheduled in the coming months to develop the draft JMS until the end of 2023. Task 2.2 (the public stakeholder consultation) as well as several workshops organized by HARMONITOR and sister projects (such as the workshop at the EUBCE in June 2023) will provide significant input for the JMS.

Task 5.2: Apply the proposed monitoring system and indicators on CSLs reviewed (Month 33) – not started yet

This task has not started yet. As part of the plan to develop a JMS, the testing phase is now foreseen to start in January 2024 (M19).

Different types of testing of the monitoring system will be carried out. First is the Stakeholder engagement which will be continued throughout the monitoring system development. The three projects will have joint workshops where they will present and ask for input/feedback on the JMS. They will jointly work on incorporating these inputs/feedbacks in optimization of the JMS.

Pilot testing: will be carried out in an early stage (preliminary version of the tool) with a small number of CSLs. In particular, within the STAR4BBS project the tool will be tested with RSB and Better Biomass, in the SUSTCERT4BIOBASED project with CU and in the HARMONITOR project the involvement of RINA CONSULTING and Preferred by Nature is envisioned. This will provide feedback in terms of practical applicability of the requirements of the JMS for further optimization.

After the pilot testing, an updated version of the JMS will be tested s on a broader number of CSLs. This testing might be divided between the 3 projects linked to the value chain selections. This selection of value chains and CSLs has not been yet finalized but the intention is that the three projects together will cover a broader range in terms of sectors in the biobased industry and most prominent CSLs. For more details, see appendix D.

Task 5.3: Validation of the monitoring system (Month 36) -not started yet

The final validation of the joint monitoring system will be based on the results of Task 5.2 / the testing phase and carried out in the final five months of the HARMONITOR project, i.e., January 2025 to May 2025.

WP6: Costs, benefits, and economic feasibility of CSLs

Task 6.1: Quantifying direct cost of certification (Month 24) - ongoing

Task 6.1 focuses on direct costs of CSLs. The *direct costs* identified include fees charged by the Certification Bodies (CBs) for conducting audits, fees charged by certification scheme owners, and any fees for trademark usage related to participating in the CSL. Additional costs such as travel and accreditation fees charged by the CBs are not considered due to limited resources and large variability (travel fees depend on the location and infrastructure, accreditation fees depend on CSL). To collect

the required information, the WP6.1 group combines two approaches. They identified partners within the HARMONITOR project who have access to direct cost data through their organizations, particularly accredited CBs like RINA SERVICES, Preferred by Nature, and Agrovet. They also planned to engage with sister-projects to identify other CBs who could contribute to certification cost estimates, e.g., Control Union who is partner in the SustCert4Biobased project. Additionally, they intend to seek guidance from scheme owners and umbrella organizations like ISEAL regarding the collected data. Furthermore, they plan to consult academic literature for any relevant cost estimates or methods. Validation of the data input after gathering several data points may also be done by engaging with scheme owners or CBs to confirm the cost ranges identified by the WP 6.1 group.

Task 6.2: Quantifying cost and benefits of achieving sustainability criteria (Month 30) – ongoing

In Task 6.2, *indirect costs and benefits* associated with meeting the sustainability criteria established by CSLs will be assessed. The approach involves conducting a literature review on the costs and benefits of certification, gathering additional information through analysis of certification bodies' experiences and interviews with certification companies. The literature review will focus on agricultural and forestry products, with specific attention given to underrepresented and relevant feedstocks such as palm oil, natural rubber, soybean, sugar cane, wood, and raw cotton. The review will follow a systematic approach based on the PRISMA guidelines for systematic reviews[1]. Relevant studies will be identified by scanning different databases and assessed based on inclusion and exclusion criteria. Both qualitative and quantitative studies will be included, with data on certification costs and benefits extracted. For the analysis of case studies, a preliminary list of data to be collected has been created based on the information gathered from the literature review. The data will help determine the direct and indirect costs of certification and will be collected at different levels, including farm and household. The review also includes gathering information on the methodologies used in previous studies, along with their limitations, to guide the analysis process.

In addition to the literature review, five case studies will be selected to examine the impact of meeting specific sustainability criteria on production costs, the environment, and society in more detail. The case studies will aim to represent the diversity of the bio-based economy. The data collection methods, such as surveys, interviews, or focus groups, are yet to be determined. The collected data will include information on location, feedstocks, certifications, year of certifications, farm size, certification area, number of employees, gender composition, family size, education levels, income, expenditures, certification and auditing fees, indirect costs of meeting sustainability requirements, production volume, yield, price of certified products, gross return, and profit. Constraints in CSL adoption and factors related to child school attendance, educational facilities, health facilities, and child mortality will also be considered.

Task 6.3: Modelling environmental and social externalities (Month 35) – starting in Month 16

The research approach for this task involves using environmentally extended multi-regional input-output (EE MRIO) analysis to quantify impacts domestically and abroad of consuming bio-based commodities in European countries. The research steps are as follows:

1. Defining relevant sectors: Sectors related to the bioeconomy are categorized as fully bio-based, partially bio-based, or non-bio-based. Two approaches, input-based and output-based, are

[1] http://prisma-statement.org/?AspxAutoDetectCookieSupport=1

considered for estimating the bio-based share of each sector. The most suitable approach will be selected.

2. Quantifying environmental impacts: An EE-MRIO model is constructed to estimate the direct and indirect impacts associated with the consumption of bio-based commodities. The Leontief equation is used to calculate the GHG emission footprint of each region based on sectoral GHG emission intensities and product flows.
3. Estimating the monetary value of impacts: The monetary values of environmental impacts will be assessed to provide a financial context. Two potential frameworks, the Natural Capital Accounting framework and the Environmental Prices handbook, will be compared to determine their suitability for estimating the monetary values of the selected environmental impacts.

For this task, only preparatory activities have taken place, e.g., ensuring feedstock selection within HARMONITOR to also fit with commodity aggregation in the MRIO database. The actual task has not yet started.

Task 6.4: Evaluating overall economic feasibility and governance options (Month 36) – to be started

This research task will synthesize the outcomes of Tasks 6.1, 6.2 and 6.3. This research task will employ cost-benefit analysis and net present value analysis, using data collected in sections 6.1-6.2. The goal is to evaluate the economic performance and feasibility of CSLs and identify governance options to enhance their feasibility and adoption. The methods for this task involve conducting a literature review, conducting 5-10 expert interviews, and administering 2 surveys. The surveys will measure whether there has been an improvement in the understanding of the opportunities and limitations of using CSLs as co-regulation instruments for the EU bioeconomy. The first survey has already been prepared and launched in collaboration with task 2.2 (open public consultation). The survey includes specific questions about value creation and the potential and limitations of CSLs as co-regulation instruments to address the identified issues. This task has not started yet.

3. DISCUSSION AND OUTLOOK

3.1 Reflection on progress

After twelve months of ongoing HARMONITOR project activities, many methodologies have been and are being developed. Therefore, this deliverable was planned to take stock after one year to evaluate whether the methodology development has gone according to plan and whether the different parts are coherent and aligned.

The first task to be completed was task 3.1. It was a crucial one, as it determined early on which value chains will be further scrutinized both in WP3 and in the remainder of the project in all other work packages. BTG completed the task successfully and has allowed the focus on specific value chains in all others work packages.

The final selection of CSLs in Task 2.1 has been a time-consuming process and has just been completed - the final deliverable was also submitted in month 12 (May 2023). The selection of CSLs was obviously only possible after the value chains had been selected, as a key criterion was that all value chains are actually covered by the selected CSLs. Other considerations were geographical coverage, coverage in terms of sustainability requirements, and which parts of the value chain are covered by the CSLs. Also, consultation with the HARMONITOR project partners and sister projects was carried out. Ultimately, a long list of about 100 CSL was reduced to a final list of 50 CSLs.

The finalisation is of particular importance, as all tasks in work packages 4, 5 and 6 depend on this selection. I minor error in original project planning that task 4.1 (inventory of sustainability criteria of the selected CSLs) was also scheduled to finish in month 12 (May 2023); this was now postponed to month 16 (September 2023).

The selection of CSLs is of great importance for WP4 (for the inventory and benchmarking), WP5 / the JMS, and WP6, as these all depend on a final list of CSLs to continue. The final selection and implications for the remainder of the project will also be discussed with project partners during the general assembly meeting in Bologna in early June.

Task 2.2 will also be continued longer than originally foreseen. In first instance, the collection of views from stakeholders was initiated as scheduled at the end of February 2023. However, while the number of respondents is satisfactory, and a full report will be submitted simultaneously to this deliverable (M12), it was decided to leave the survey open until July 16th 2023 to further increase the response rate (especially by stakeholder groups that are so far underrepresented). Also, in-depth follow up interviews are scheduled, as well as a roundtable with key stakeholders, during which many of the topics raised in the survey will be addressed as well. All of this will be valuable input for the design of the JMS, which will start in June 2023 (M13) and will be finalized by the end of 2023.

The decision (and recent approval by the project officer) to apply for a joint monitoring system by the three sister projects is a major change compared to the originally foreseen workplan. While the original activities (designing a monitoring system, testing it, and finalizing the system) will still be carried out, doing it jointly has several implications. First of all, the design of the (joint) monitoring system will start five months earlier than originally planned. Second, Utrecht University will take the lead on the assessment of the impact of CSLs. Third, the role of all other project partners participating in WP5 will also have to be adapted for an effective collaboration with the sister projects and needs to be carefully

planned. All of this has been discussed at the HARMONITOR's general assembly meeting in Bologna (June 2023).

Overall, we conclude that while a number of challenges were encountered in the first twelve months of the project, these have been identified in a timely manner, and efficiently mitigated.

3.2 Outlook: next challenges

Setting up the stakeholder platform

One of the main goals of the project in the coming months is to develop and successfully launch a participatory interaction platform for CSLs. The platform will serve as a foundation for fostering collaboration and dialogue within the certification community and engaging stakeholders from academia, industry and policy. The platform will benefit from input generated through the monitoring and benchmarking activities of HARMONITOR and its sister projects. Developing and launching a platform comes with some key challenges. First, ensuring the CSLs active participation in platform dialogue is critical to the platform's success. Second, the implementation of the platform, and ideally its continuation after the completion of the HARMONITOR project, requires careful consideration. These challenges will be addressed in the next steps of Task 2.4, to create an inclusive and sustainable platform for ongoing collaboration and knowledge sharing.

Development of the Joint Monitoring System

Developing the JMS will certainly also be a challenging task. This will require careful coordination between the HARMONITOR project partners as well as between the three sister projects (HARMONITOR, STAR4BBS and SUSTCERT4BIOBASED). A core team of the respective work package leaders (Utrecht University, Technical University of Berlin as coordinator of the STAR4BBS project, and Wageningen University and Research as coordinator of the SUSTCERT4BIOBASED project) and a number of selected other project partners from each project (including ISEAL And ECOS) will meet regularly and make sure that tasks are distributed between the members of the three projects and will also coordinate the overall methodology development. The core team will also make sure that the information produced in the various work packages of the three sister projects (such as the public stakeholder consultation, task 2.3; and the inventory of CSLs, task 4.1) will be forwarded to the system level, content level and outcome level working groups to inform and guide the design of the JMS.

Designing the monitoring system is seen as one of the most ambitious and important tasks in all three projects, and ultimately also the one with potentially the highest impact. Therefore, also close contact will be kept with HARMONITOR coordinator SQ Consult, the project officers and the advisory board to ensure that all important design choices and decisions are taken after careful deliberation.

Coordination with sister projects, especially the coordination of contacting external stakeholders

Right after the kick-off of the three projects awarded under the call 'HORIZON-CL6-2021-ZEROPOLLUTION-01-07: International and EU sustainability certification schemes for bio-based systems' (HARMONITOR, SUSTCERT4BIOBASED and STAR4BBS), the project coordinators decided to create mechanisms that facilitate synergies and effective collaboration among the three sister projects. These mechanisms include:

1. Cluster coordination
2. Interproject topic groups
3. Joint Advisory Board

Cluster coordination

The three project coordinators jointly take care of the coordination of all cluster activities. They hold the responsibility of aligning key activities across the sister projects and for the adequate flow and exchange of information across teams in the three projects working on specific topics. The coordinators are also responsible to ensure effective communication and dialogue about cluster activities with the project officers at REA. The three coordinators meet on a regular basis (usually in a time frame no longer than 4 weeks) to discuss and coordinate activities among the projects.

Interproject topic groups

Five topic groups with representatives of the three projects were formed in September 2022 to discuss methodologies and preliminary findings. The joint effort of the interproject topic groups will lead to a more coherent and impactful approach towards achieving the objectives of the sister projects. The topic groups created are:

- Selection and review of certification schemes and labels
- Bio-based value chain selection and global trade flows
- Joint monitoring system
- Analysis of costs and benefits and feasibility study
- Communication and dissemination of results

Each of these topic groups has engaged in good collaboration and meets regularly since their creation (at least once every quarter).

Joint Advisory Board

Instead of three differentiated Advisory Boards, the sister projects decided to form a Joint Advisory Board (JAB) to act as a consultation body providing each project with feedback, strategic recommendations and guidance, contribute to the project dissemination through their wider stakeholder communication channels, and to maximize and sustain the project results. The role defined by the three sister projects for the JAB is to:

- Monitor and critically review the projects' development and progress in meeting their objectives.
- Provide input and feedback to the projects based on their knowledge and expertise.
- Advise about long-term and short-term strategic decisions of the projects.

- Help the consortiums to stay up to date with the developments related to the project, whether in standards, schemes/ecolabels, legislation, industry or research on sustainability and bioeconomy.
- Facilitate connection with the targeted stakeholder groups to join the organised stakeholder engagement activities.
- Bring alignment with ongoing international efforts (especially for international organisations).
- Contribute to the wider dissemination of project results with relevant stakeholders via their network and thereby support sustainability of project outcomes beyond the project lifetime.

4. CONCLUSIONS

This report summarizes the current state-of-the-art methodologies developed as part of the HARMONITOR project. We conclude that methodology development in work packages 2 to 6 is well on its way, with the methodologies for all tasks that started within the 12 months largely in place. We also conclude that information and data exchange between the work packages is going well, and that methodologies are well-aligned. As coordination of this exchange and the coherence of methodologies both within the HARMONITOR project and with the two sister projects requires constant attention, this methodology handbook provides a useful summary of the intermediate developments. As such it will also be discussed during the upcoming general assembly in Bologna to ensure future coherence.

Overall, we conclude that despite some minor delays and also a fundamental change (the decision to develop a joint monitoring system), the methodology development in the various tasks has been progressing steadily, and data exchange and interaction has been very good.

Next steps requiring particular attention will be the development of the stakeholder platform, the joint monitoring systems with the two sister projects, and the inter-project cluster coordination. Many of the ongoing tasks in HARMONITOR (e.g., task 2.2 and 4.1) will directly inform the system, content and outcome working groups of the JMS. Also, in all work packages, further tasks will start, that will also build upon the methodologies developed so far. These will also be discussed with work packages and task leaders during regular HARMONITOR progress meetings, and ultimately included in the final report on all methodologies developed as part of the HARMONITOR project.

5. APPENDICES

Appendix A. Methodologies of WP2

Task 2.1: Inventory and characterisation of identified CSLs and selection of bio-based value chains

This section describes the methodological approach for the identification and selection of certification schemes and labels as well as bio-based value chains for the further analysis in the different work packages of the HARMONITOR project. Furthermore, the selection will be an input to Task 2.4 for the development of the platform for continuous improvement of CSLs.

The selection of both elements was organised in subsequent steps, starting with the development of a broader inventory of existing CSLs which were then matched with the value chains for HARMONITOR, selected under Deliverable 3.1. The two following subchapters summarise the different steps, which led to a longlist of CSLs and value chains which are presented in chapter 4.

Developing a CSL inventory for the HARMONITOR project

Our review and selection of CSLs included a wide range of existing elements, which we summarise under the following terms:

Labels: Labels are used for the communication of certain product characteristics to consumer and customers. A certification process can be a precondition for the labeling of a product. However, there are also products self-labeled by the producer. Further types are labels of testing organisations, testing for example products from different manufacturers in order to label the ones with the best results.

Sustainability initiatives: Sustainability initiatives are herein referred to as initiatives compiling sets of sustainability criteria and indicators for a particular purpose, e.g., the analysis of the sustainability of specific biogenic feedstocks. They might be organised as a heterogeneous group of people or institutions with different background and with different interests. The goal of this type of initiative is to reach a consensus between the different parties. In the resulting set of criteria, the different interests are covered equally. This type of initiative is often called “multi-stakeholder initiative” or “roundtable”.

The second type of initiative included in this context shall be an initiative consisting of a group of people belonging to one party. They can have a background in science and academics, governmental agencies, enterprises or NGOs. The one object, quality sustainability initiatives have in common is the outcome/product, which is a set of criteria for further unspecified or specified use. The outcome can be used internally, e.g., for the sustainability strategy of an organisation or may be picked up by other organisations in case the outcome is open source.

Certification schemes: Certification schemes are based on a normative framework, e.g., a standard or a set of criteria and indicators. The output of sustainability initiatives may be used as the basis for a certification scheme. Sustainability initiatives therefore sometimes turn into a certification scheme holder over time as it happened with different roundtables. The most important characteristic of a certification scheme, as it is understood in this context, is that it includes a third-party verification of the sustainability requirements, stipulated in the system documents. Also, the whole certification process is usually based on accreditation standards (e.g., ISO 19011 or ISO 17065), in which the separation of evaluation and certification is an important feature. As a result of the certification process, a label on a product shows compliance with the requirements set by the respective certification scheme. Certificate holders mostly participate voluntarily in a certification scheme. However, there are industries, in which holding certificate facilitates market access, which is, for instance, the case with liquid biofuels sold in European Union markets.

Process for the selection of CSLs

The process of selecting CSLs for HARMONITOR was organised in a threefold approach (compare Figure 1).

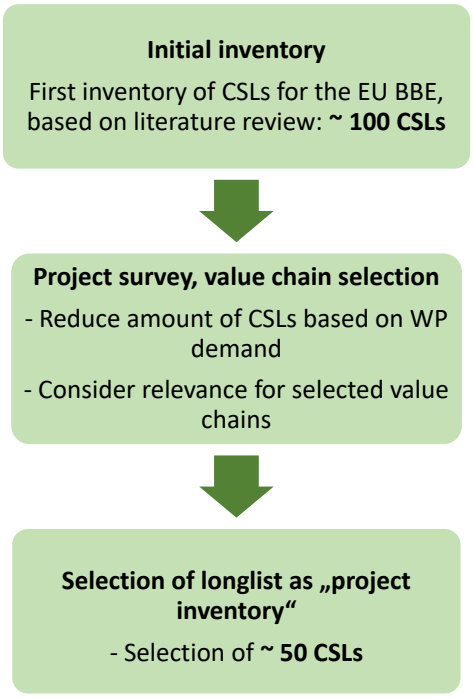

Figure 1 Process steps for the selection of the CSLs inventory in HARMONITOR. own figure.

As first step towards the development of CSL inventory, which can serve the specific needs of the different tasks within the HARMONITOR project, an **initial inventory** on the certification landscape in the EU bio-based economy was generated.

This step was based on a comprehensive review, involving literature desktop research, as well as available databases such as the ITC Standards Map (International Trade Centre 2021) and Label

Online (Label online 2023). This step revealed a list of ~ 100 certification schemes as a first, preliminary result.

To understand and assess the potential relevance of the identified schemes for the work in HARMONITOR, further desktop research was conducted on the sustainability requirements and sustainability topics included in these CSLs (compare Annex I). This step allowed to introduce filters for further selection and differentiation according to the specific needs of the different HARMONITOR WPs in a subsequent working step.

Secondly, the identified CSLs have been assessed against the specific expectations and the demand formulated by HARMONITOR partners, involved specifically in WPs 3, 4, 5 and 6. For this purpose, a comprehensive, **project internal questionnaire** was developed, including the following questions:

- Which elements of the CSLs are important for your analysis/work (e.g., the sustainability requirements, the verification procedures, risk assessment, etc.)?
- How many CSLs are you planning to analyse in your task or work package?
- To define the parameters for the selection of CSLs. Please indicate which aspects are important for you and the work in your task regarding the CSL selection (e.g., geographical focus, feedstock focus, specific market sectors in the EU bio-based economy, business-to-business focus or business-to-focus, the “ambition” of the CSL regarding the comprehensiveness of the sustainability requirements).
- Do you already have recommendations or made a pre-selection of CSLs? If yes, which CSLs should be selected from your perspective (and why)?

The results of the survey are documented in Annex II of D2.1.

Another important aspect is the relevance and applicability of the CSLs for the value chains selected under WP2. HARMONITOR will use value chains for relevant and/or innovative bio-based products to assess specific parameters (e.g., costs) regarding the effectiveness of the CSLs within certain product environments and value chains. For this purpose, the developed inventory of CSLs was matched with the specific value chain elements (compare section 0).

As a result of this activity, an internal longlist of ~ 50 CSLs, which will be used as a starting point for the subsequent activities in other work packages of HARMONITOR has been produced.

Selecting value chains as starting points for HARMONITOR

In addition to the CSL inventory, Task 2.1 selects a minimum of 5 to 10 value chains (according to the description of work in the Grant Agreement of the project) as starting points for the subsequent HARMONITOR WPs.

The identification of relevant value chains and products, which shall support the assessment and monitoring of CSLs was part of a comprehensive process under WP 3. As a result, D3.1 presents a preselection of 35 bio-based value chains, including a description of feedstock categories (e.g., starch or sugar), intermediates (e.g., sawn wooden products), potential products (e.g., bioplastics) to be produced in downstream processes as well as a characterisation of these chains regarding their markets, levels of innovation, etc. The full methodology of WP3 / D3.1 is given in Appendix B below.

Task 2.2: Summary of public consultation inputs

The public consultation was carried out based on an online survey. This survey was developed by Michele Mutchek, Li Shen and Martin Junginger (Utrecht University), Costanza Rossi (SQ Consult) and Birka Wicke (Radboud University), in close collaboration with project partners from the HARMONITOR project, as well as from the sister projects STAR4BBS and SUSTCERT4BIOBASED. In particular, partners from TU Berlin, Wageningen University, ISEAL and ECOS provided detailed feedback and advice on earlier drafts of the survey (especially on the application of the ISEAL credibility principles).

The survey consists of 4 parts:

- In the first part, respondents needed to provide their background (to which of the 10 defined stakeholder groups they belonged) and where they were based geographically.
- In the second part, respondents were asked to provide their general view on the possible advantages and disadvantages of CSLs, and a number of questions of how familiar they were with legislation covering the sustainability of biobased products in the EU (of which a number make use of CSLs to demonstrate compliance).
- Next, as central part of the questionnaire, respondents were asked to indicate the strength and weaknesses of CSLs for each of the ten ISEAL credibility principles. Respondents could indicate up front whether they wanted to answer these questions for CSLs in general, or with a specific CSL in mind. Respondents could rank CSLs for each principle from (very) weak to (very) strong. In case the selected weak or very weak, they were also asked to provide an explanation and motivation for this choice. In case respondents mentioned a specific CSL explicitly, this was anonymized in the results section.
- Last, respondents were asked if they were willing to provide their name and contact details to follow up with in depth interviews, and whether they would like to receive the survey results.

The central framework on which this consultation was based the ten 2021 ISEAL credibility principles: Sustainability impacts, Collaboration, Value creation, Measurable progress, Stakeholder engagement, Transparency, Impartiality, Reliability, Truthfulness, and Continual improvement.

The Credibility Principles define the core values of credible and effective sustainability systems. They provide the foundations for systems to deliver greater impact. The 2021 version of the credibility principles was based on an extensive global consultation. The principles help organizations develop standards and similar sustainability tools to understand which attributes of their system are critical to the credibility of their approach, and why these matters for improving sustainability performance and delivering impacts. The principles also help businesses, governments, and civil society to identify systems that can be effective partners in delivering against shared sustainability objectives. As such, they were deemed highly relevant and suitable as the basis for this consultation.

The survey was disseminated through a number of different channels:

- All project partners from HARMONITOR, STAR4BBS and SUSTCERT4BIOBASED were requested several times to disseminate the invitation for the survey through their networks to relevant stakeholders. In particular, ISEAL and ECOS also encouraged their members to fill in the survey.
- The members of the joint advisory board of the three projects were also requested to disseminate the request through their networks.

- The survey was advertised through repeated posts on LinkedIn and Twitter and other social media.
- Last but not least, a search was carried out through amongst others social and traditional online media for recent initiatives that critically reviewed and the role of CSLs for demonstrating the sustainability of biobased products. The authors of these critical studies and initiatives were then directly contacted by Silvia Seixas Lopes and invited to fill in the survey.

The data used for this report was collected from early March 2023 until 7 May 2023. At this point in time, a total of 68 respondents had started the survey, and 33 respondents had finished the entire survey. As some stakeholder groups were underrepresented, it was decided to leave the survey open to allow for additional responses. All results presented in D2.2 are based on the input received until May 7th, 2023.

Appendix B. Methodologies of WP3

Task 3.1: Selection of Bio-Based Value Chains

Executive summary

The HARMONITOR project aims to improve the effectiveness of certification schemes and labels (CSLs) in different sectors of the EU Bioeconomy and therewith strengthen their use as a co-regulation instrument. As part of this project, production and trade data will be collected on bio-based value chains and their levels of sustainability certification. As a first step, 35 value chains from biomass to bio-based products or materials needed to be selected for further assessment. Furthermore, this selection will be used for work to be performed in other tasks within the HARMONITOR project, i.e., the selection and assessment of certification schemes and labels (in short CSLs), and the assessment of costs, benefits, and economic feasibility of CSLs. The selection of 35 value chains has been performed in 5 steps:

Step 1: Starting point was an extensive list of 350 bio-based materials and products (NACE[a] 20, 21 and 22) supplemented with 188 wood products and other bio-based products (NACE 13, 16, 17), resulting in a long list of 538 bio-based products. It was indicated whether these are drop-in (identical to their fossil alternative) or dedicated (chemically unique) bio-based materials or products.

Step 2: All dedicated bio-based materials and products (...) were pre-selected.

Step 3: The 40 drop-in bio-based materials and products with the highest bio-based production volumes were pre-selected for further assessment.

Step 4: For all bio-based materials and products selected in step 1 – 3, the main biological resources used for their production were identified by a quick assessment of their value chains. Step 5: Final selection taking into account several criteria and considerations.

After a pre-screening on the representativeness of the PRODCOM and CN codes, 226 dedicated bio-based materials and products were pre-selected as well as a list of 101 drop-in bio-based products. Their biological sources were identified and, based on the production (PRODCOM) and, if needed, trade (CN) volumes, an initial selection was made. As a result of several project meetings, including a three-hour workshop on the 2nd of November in Berlin, and exchanges with sister projects, the final selection of bio-based value chains was made considering:

- Market size of value chains & coverage by existing statistics (focus of steps 1-4)
- Representative distribution between bio-based sectors
- Inclusion of both innovative and traditional bio-based products
- Inclusion of value chains using residues and wastes
- Inclusion of both EU and imported feedstocks and products
- Value chains with environmental and social challenges (where CSL play an important role)
- Coverage by sustainability certification schemes and labels
- Relevance for EU bioeconomy policies such as the CAP reform, Taxonomy Regulation, Farm to Fork strategy, EU Forest Strategy, Circular Economy Action Plan, European Regulation on Sustainable products, recast of RED, and the EU Strategy for Sustainable and Circular Textiles.

The final selection aims to be a representative mix of bio-based products, using various feedstocks (including residues and wastes), covering a broad range of sectors, relevant for EU policy making,

currently traded, and relevant for further analysis of sustainability certification schemes. The 35 selected bio-based value chains are presented in Table 1.

Table 1: Overview of selected bio-based value chains

#	Intermediary chemical	Sector	biomass type in	Products out	Intermediary included in statistics?	Feedstock: EU, import, or both?	Existing bio-based market?	Innovative bio-based product?	Feedstock: waste/ residue?
1	Acetic acid	Chemicals	Sugar/starch	PTA, VAM, acetic anhydride, acetate esters	n	both	y	y	n
2	Ethylene glycol	Chemicals	Sugar/starch	PET	n	import	y	y	n
3	Ethylene	Chemicals	Sugar/starch	Polyethylene (PE), HDPE	n	import	y	y	n
4	Butanediol (1,4)	Chemicals	Sugar/starch	Solvent, production of polyurethanes	n	both	y	y	n
5	Lactic acid	Chemicals	Sugar/starch (cane sugar)	PLA	y	import	y	y	n
6	Lactic acid	Chemicals	Sugar/starch (cane sugar)	Salts and esters	y	both	y	n	n
7	Starch polymers	Chemicals	Starch (potatoes), corn	Plastic utensils	y	both	y	n	n
8	Palmitic acid with its salts and esters	Chemicals	Palm oil	Cosmetics, surfactants	y	import	y	n	n
9	Propylene glycol	Chemicals	Oil crop (glycerol)	Propylene glycol	n	both	y	y	both
10	Poly(urethane) PUR	Chemicals	Vegetable oil - soybeans	PUR	n	import	y	y	n
11	Epichlorohydrin	Chemicals	Vegetable oil, glycerol	Solvent in resin, paints	n	both	y	y	both
12	Rayon	Chemicals	Wood	Tarn	y	EU	y	y	n
13	PHA	Chemicals	wastewater	Plastics	n	EU	n	y	y
14	(Poly)propylene	Chemicals	UCO	Plastics	n	both	n	y	y
15	Algal fatty acids	Chemicals	Algae	Cosmetic ingredient	n	both	n	y	n
16	Sawn wooden products	Wood	Wood	Several	y	both	y	n	n
17	Fibreboard (particle, MDF, etc)	Wood	Wood, waste wood	MDF, Particle board	y	both	y	n	y
18	Oriented strand board	Wood	Wood	OSB	y	both	y	n	n
19	Wooden packaging	Wood	Wood	Cases, boxes, drums	y	both	y	n	n
20	Wooden pallets	Wood	Wood	Pallets	y	both	y	n	n
21	Wood wool, wood flour	Wood	Wood	Panels, fibre cement, insulation, filler	y	both	y	n	n
22	Lignin based products	Wood	Wood	Binders and aromatic chemicals, asphalt/bitumen	n	both	n	y	y
23	Tall oil	Wood	Wood	Chemicals	n	both	y	y	y
24	Pulp	Paper	Wood, wastepaper	Graphic paper	y	both	y	n	y
25	Pulp	Paper	Wood, wastepaper	Paper board	y	both	y	n	y
26	Pulp	Paper	Wood, wastepaper	Toilet paper	y	both	y	n	y
27	Cotton fabrics	Textile	Cotton	Woven fabrics, table and bed linen, sacks and bags	y	import	y	n	n
28	Wool fabrics	Textile	Wool	Textile	y	both	y	n	n
29	Jute	Textile	Jute	Textile	y	import	y	n	n
30	Flax	Textile	Flax	Textile, table linen	y	EU	y	n	n
31	Hemp	Textile	Hemp	Textile, insulation materials	n	EU	y	n	n
32	Straw	Building	Straw	building materials	n	EU	y	y	y
33	Biowaste	Waste	Biowaste	Compost	y	EU	y	n	y
34	Leather	Textile	Animal skin	Clothing, textiles	y	import	y	n	n
35	Natural rubber	Chemicals	Natural rubber	Tyres, various products	y	import	y	n	n

1 Introduction

1.1 Background

The project *"harmonisation and monitoring platform for certification schemes and labels to advance the sustainability of bio-based systems"* (HARMONITOR) will improve the effectiveness of certification schemes and labels (CSLs) in different sectors of the EU Bioeconomy and therewith strengthen their use as a co-regulation instrument. As part of this project, production and trade data on bio-based value chains and their levels of sustainability certification will be collected. As a first step, about 35 value chains from biomass to bio-based product or materials needed to be selected for further assessment within the HARMONITOR project.

1.2 Goal

The objective of this task was to select 35 relevant value chains from biomass to a specific (group of) bio-based products or materials that will be subject to the assessment of global and EU trade flows and their level of certification. Furthermore, this selection will be used for work to be performed in other tasks within the HARMONITOR project, i.e., the selection and assessment of certification schemes and labels (in short CSLs) in Work Package 4 (WP4), and the assessment of their costs, benefits, and economic feasibility (WP6).

1.3 Scope

According to CEN EN 16575, *"Bio-based"* simply means *"derived from biomass".* In the frame of the HARMONIOR project, the focus is on industrial bio-based systems excluding food/feed, biofuels, bioenergy and cultural/recreational sectors. This allows for a better focus on the existing and emerging bio-based sectors within the larger bioeconomy. Given the relevance for the bio-based economy and the prominent role of sustainability certification in forestry, trade flows of certified and non-certified wood and forestry-based products are within the scope of the project. Primary biomass resources, bio-waste and residues intended for bio-based industrial value-chains, bio-based materials and products are included in the scope of the project. In case of resources with multiple applications, e.g., food, feed, materials and energy, for example palm oil, they will be regarded as within the scope of the assessment.

1.4 Approach

The selection of 35 value chains was performed in 5 steps:

- Step 1: Starting point is an extensive list of 350 bio-based materials and products (...) supplemented with wood products and other bio-based products (NACE 13, 16, 17)
- Step 2: All dedicated bio-based materials and products (...) will be pre-selected
- Step 3: The 40 drop-in bio-based materials and products with the highest bio-based production volumes will be pre-selected for further assessment
- Step 4: For all bio-based materials and products selected in step 1 – 3, the main biological resources used for their production will be identified by a quick assessment of their value chains 6
- Step 5: Final selection taking into account several criteria and considerations. In chapter 2 each step of this approach has been described in further detail. Chapter 3 shows which bio-based products have been selected as a result of this step wise approach.

2. Selection of bio-based materials and products

2.1 Step 1: Extensive list of bio-based materials and products

Approach

Starting point was an extensive list of 350 bio-based materials and products - mostly chemicals, pharmaceuticals and plastics, NACE 20, 21, 22, as presented in Spekreijse et al. (2019) - supplemented with wood products and other bio-based products (NACE 13, 16, 17). This list was used to provide an overview of:

1. (i) bio-based materials and products for which statistical trade information is available, and
2. (ii) bio-based materials and products for which statistical trade information is not readily available.

Next, it was indicated whether these are drop-in (identical to their fossil alternative) or dedicated (chemically unique) bio-based materials or products.

Drop-in bio-based chemicals appear in the same statistical category as their chemically identical fossil-based counterparts, making it impossible to determine the volumes of the bio-based chemical using only statistics. Although considerable effort is performed to improve statistics of bio-based materials (e.g., the BioMonitor project), additional sources are needed to determine trade flows of drop-in bio-based products. Therefore, drop-in bio-based materials were assessed in a separate step.

Result

A long list of 538 product was established including the following NACE categories:

- NACE 13: Manufacture of textiles
- NACE 16: Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
- NACE 17: Manufacture of paper and paper products
- NACE 20: Manufacture of chemicals and chemical products
- NACE 21: Manufacture of basic pharmaceutical products and pharmaceutical preparations
- NACE 22: Manufacture of rubber and plastic products.

Figure 1: Excerpt from the longlist of 538 bio-based materials and products

	A	B	C	D	G	H	U	V	X	Y	Z
1	Product	NACE	CPA	Prodcom	characteristic	type	PRODCOM text	Specific PRODCOM code?	CN Code	CN text	Specific CN code?
2	Carboxymethyl cellulose and salts	20.16	201659	20165950	polysaccharide	dedicated	Cellulose and its chemici	no	3912 31 00	carboxymethylcellulose a	y
3	Cellulose esters	20.16	201659	20165950	polyether	dedicated	Cellulose and its chemici	no	3912 90 10	cellulose esters	y
4	Cellulose ethers	20.16	201659	20165950	polyether	dedicated	Cellulose and its chemici	no	3912 39	other cellulose ethers	y
5	Alginate with salts and esters	20.16	201659	20165950	polyether	dedicated	Cellulose and its chemici	no	3913 10 00	alginic acid polymer	y
6	Pure glycerol	20.41	204110	20411000	polyol	dedicated	Glycerol (glycerine), crude	no	2905 45 00	Glycerol	y
7	Fructose	Other	106213	10621320	polyol	dedicated	Chemically pure fructose	no	1702 50 00	pure fructose	y
8	Ethanol	20.14	201474	20147400	alcohol	dedicated	Undenatured ethyl alcoh	no	2207 20 00	denatured ethanol	y
9	Mannitol	20.14	201423	20142337	polyol	dedicated	Diols and polyhydric alco	no	2905 43 00	mannitol	y
10	Coenzyme Q10 (ubiquinone)	20.14	201462	20146260	alkene	dedicated	Quinones	no	2914 62 00	coenzyme Q10	y
11	Palmitic acid with salts and esters (aka hexadecanoic acid)	20.14	201432	20143235	organic acid	dedicated	Palmitic acid, stearic acic	no	2915 70 40	palmitic acid with salts a	y
12	Stearic acid with salts and esters (aka octadecanoic acid)	20.14	201432	20143235	organic acid	dedicated	Palmitic acid, stearic acic	no	2915 70 50	stearic acid with salts an	y
13	Lauric acid with salts and esters (aka dodecanoic acid)	20.14	201432	20143280	organic acid	dedicated	Lauric acid and others; sa	no	2915 90 30	lauric acid with salts and	y
14	Azelaic acid (aka nonanedioic acid) with salts and esters	20.14	201433	20143381	organic acid	dedicated	Oxalic, azelaic, malonic,	no	2917 13 90	azeleic acid with salts ar	y
15	Sebacic acid (aka decanedioic acid)	20.14	201433	20143381	organic acid	dedicated	Oxalic, azelaic, malonic,	no	2917 13 10	sebacic acid	y
16	Tartaric acid	20.14	201433	20143381	organic acid	dedicated	Oxalic, azelaic, malonic,	no	2918 12 00	tartaric acid	y
17	Lactic acid with salts and esters	20.14	201434	20143475	organic acid	dedicated	Carboxylic acid with alcol	no	2918 11 00	lactic acid with salts and	y
18	Citric acid	20.14	201434	20143473	organic acid	dedicated	Citric acid and its salts a	combined	2918 14 00	citric acid	y
19	Lecithin and phophoaminolipids	2110	211020	21102040	phosphate	dedicated	Quaternary ammonium s	no	2923 20 00	lecithins and other phos	y
20	Methionine	20.14	201451	20145133	amino acid	dedicated	Thiocarbamates and dith	no	2930 40 10	Methionine	y

The longlist contains the product description, NACE, CPA, PRODCOM and CN code, as well as the PRODCOM and CN text. It is indicated whether the products have a specific PRODCOM and CN code. If this is not the case, the product is part of a group of products. Moreover, for all products it was determined whether it is a “dedicated” or “drop-in”. product. In case of chemicals, the type of chemical was characterized. See Figure 1.

2.2 Step 2: Pre-selection of dedicated bio-based materials and products

Approach

All dedicated bio-based materials and products for which statistical trade information is readily available (usually requiring to be identifiable at 6-digit CN code level), including wood-based products, were pre-selected.

Result

All dedicated products were taken from the longlist for further assessment. In some cases, sub-categories were combined to get a group for which statistical data is available. For example, no data is available for “lactic acid”, but data is available for “lactic acid, its salts and esters”. Not all products are well described by single PRODCOM and/or CN code. For example, “furan” falls in the category “20145225; Heterocyclic compounds with oxygen only hetero-atom(s)” containing a range of compounds including furan. In this case the bio-based product was not preselected. Given that usually compounds with smaller production or trade volumes are grouped, this approach can be justified. This

first screening resulted **in 226 dedicated bio-based materials and products** that have at least a unique PRODCOM or CN code (226).

In order to get a first impression of the size of the production and trade flows, for each dedicated product of which a unique PRODCOM is available, the highest production volume of the last three years has been obtained from Eurostat, via COMEXT. For all the other products the import to and export from the EU, as well as the import and export within the EU was obtained, via the CN codes. The list was ordered from highest to lowest production and or trade volumes.

2.3 Step 3: Pre-selection of drop-in bio-based materials and products

Approach

The 40 drop-in bio-based materials and products with the highest bio-based production volumes were selected for further assessment. Production volumes are not readily accessible from trade statistics but can be obtained from bio-based market studies and reports.

The level of detail of CN, which is used by the customs to obtain import/export tax, is generally higher than PRODCOM. Therefore, if the PRODCOM code is known, this usually means that production data (PRODCOM) and trade data (CN) is available in statistics. However, in many other cases no PRODCOM code is known, but the CN code is known, meaning that only trade data is available in statistics.

Result

Like in the case of the dedicated products, some aggregation of categories was performed, and drop-in bio- based products without unique PRODCOM or CN code removed, resulting in a list of 101 drop-in bio-based products.

Based on earlier work, especially Spekreijse et al (2019)[d] and Spekreijse et al (2021)[e], and an initial assessment of bio-based products that are currently allowed for certification under ISCC PLUS, a shortlist of about **40 drop- in bio-based products** was drawn. It was decided not to further reduce the shortlist, but to make the final selection in step 5 for the dedicated and drop-in bio-based materials and products together.

[d] Spekreijse, J, T. Lammens, C. Parisi, T. Ronzon, M. Vis (2019) Insights into the European market for bio-based chemicals, analysis based on 10 key product categories, JRC science for policy report, EUR 29851 EN, Publications office of the European Union, Luxembourg, 2019, ISBN 978-92-79-985419-8, doi:10.2760/673071, JRC112989.

[e] Spekreijse, J., K. Vikla, M. Vis, K. Boysen-Urban, G. Philippidis, R. M'barek (2021) Bio-based value chains for chemicals, plastics and pharmaceuticals, a comparison of bio-based and fossil-based value chains, EUR 30653 EN, Publications office of the European Union, Luxembourg, 2021m ISBN 978-92-76-32459-1, doi: 10.2760/712499, JRC124141.

Table 2: overview of pre-selected drop-in bio-based materials and products

Pre-selection of 40 bio-based drop-in materials and products			
Acetaldehyde	Formic acid	Poly (methyl methacrylate) - PMMA	Cyclohexanone
Acetic acid	Isoprene	Poly (vinyl acetate) - PVA	Ethane
Acetone	Poly (ethylene terephthalate) - PET*	Acrylic acid with salts	Ethylene dichloride
Adipic acid	Poly(ethylene) - PE*	Methanol	Ethylene Propylene Diene Monomer (EPDM) rubber
Butadiene	Poly(urethane) - PUR	Styrene	Methane
Butanediol (1,4-)	Propylene oxide	Acetylene	Phenol (and its salts)
Butanol (n-)	Caprolactam	Acrylamide	Poly (vinyl chloride) - PVC
Epichlorohydrin	Cyclohexane	Acrylonitrile	Propane
Ethylene*	Methyl methacrylate (MMA)	Benzene	Propylene
Ethylene oxide*	Poly (butylene terephthalate) - PBT	Cyclohexanol	Toluene

* Several drop-in bio-based products can be present in the same value chain. This is for example the case with ethylene, ethylene oxide and poly(ethylene).

2.4 Step 4: Identification of main biological resources

For all bio-based materials and products selected in step 1 – 3, the main biological resources used for their production were identified by a quick assessment of their value chains. Typical resources include wood, sugar/starch, and oil crops. Residues and biowaste streams were also selected, even if they are currently not used, in case they form suitable resources for the selected bio-based materials and products.

2.5 Step 5: Additional considerations

The final selection of value chains for further analysis should be a representative mix of bio-based products, using various feedstocks (including residues and wastes), covering a broad range of sectors, relevant for EU policy making, currently traded, and relevant for further analysis of sustainability certification schemes.

EU Policies and bio-based value chains

A Broad range of relevant EU legislation and policy expresses directly or indirectly sustainability requirements for bio-based value chains. Examples include the CAP reform, Taxonomy Regulation, Farm to Fork strategy, EU Forest Strategy, Circular Economy Action Plan, European Regulation on Sustainable products, recast of RED, and the EU Strategy for Sustainable and Circular Textiles. In the assessment of CSL and the setup of the monitoring system for assessing the sustainability of bio-based value chain within HARMONITOR, these policies will be assessed in detail. For the selection of bio-based value chains, we would like to highlight that the selected bio- based value chains should contribute to the main objectives of the European Bioeconomy Strategy:

- Ensure food and nutrition security
- Manage natural resources sustainably

- Reduce dependence on non-renewable, unsustainable resources
- Limit and adapt to climate change
- Strengthen European competitiveness and create jobs.

We have taken these objectives as follows in the selection of value chains. If bio-based value chains should ensure food and nutrition security, it makes sense to select value chains that are based on residues and wastes, which do not require additional land. *Managing natural resources sustainably*, can mean that value chains with high sustainability risks should be selected (for example cotton products), as CSLs can make the difference between sustainable and unsustainable practices. On the other hand, sustainable value chains could be selected, as CSLs gives them a platform to present their sustainability benefits (for example hemp). *Reduce dependence on non-renewable, unsustainable resources* and *limit and adapt to climate change* means that value chains with considerable production and trade volumes should be selected, as these value chains have generally more impact on use of unsustainable sources and climate change. The objective to *strengthen European competitiveness and create jobs* means that innovative bio-based value chains should be selected that create economic activity such as research, scale up and new commercial activities within the EU.

Relevance of bio-value chains for assessment of CSLs

The *Study of the environmental sustainability requirements of bio-based value chains and supply chains for bio- based industry in future EU funded R&I demonstration and flagship projects* (not published yet), identified five overarching environmental principles for bio-based value chains, i.e., mitigate global warming, conserve and protect biodiversity, conserve and protect water resources, protect soil quality and productivity, and promote good air quality. It has been assessed whether environmental or social concerns exist regarding the selected bio- based value chains, which is the case for the vast majority of selected value chains, and whether CSLs covering these concerns exist (see Table 7 on page 18).

Final selection approach

BTG has made a draft final selection of bio-based value chains considering:

- Market size of value chains & coverage by existing statistics (focus of steps 1-4)
- Representative distribution between bio-based sectors
- Inclusion of both innovative and traditional bio-based products
- Inclusion of value chains using residues and wastes
- Inclusion of both EU and imported feedstocks and products
- Value chains with environmental and social challenges (where CSL play an important role)
- Coverage by sustainability certification schemes and labels
- Compatibility with environmental requirements from EU bioeconomy policies (CBE, EU Bioeconomy Strategy).

Several meetings were organised to discussion the approach and the selection of value chains:

- On the 14th of October 2022, BTG presented the value chain selection approach in an online meeting with the two sister projects STAR4BBS and SUSTCERT4BIO-BASED.
- On the 24th of October 2022, the results of step 1 – 3 of the value chain selection procedure was presented and discussed with the HARMONITOR consortium in an online meeting.
- On the 28th of October 2022, the HARMONITOR value chain selection approach and results of step 1 – 3 were discussed with the sister projects. The sister projects will select the value chains at a later stage. Therefore, it was not possible to discuss or divide certain value chains with the sister projects. On the one hand, some overlap between the selection could support the

presentation of differences in approach between the sister projects. On the other hand, it would be worthwhile that the three projects together cover a broad range of different value chains.

- On the 2nd of November, as part of the hybrid HARMONITOR progress meeting in Berlin, the first draft of the final selection of value chains (step 1 – 5) were discussed in detail, during a three-hour workshop fully dedicated to the selection of value chains. Several suggestions for inclusion of additional value chains were made based on the final selection criteria presented above.
- On the 9th of November, based on the outputs of the workshop, BTG has sent the draft of the final selection of value chains to the consortium partners, for their final comments or approval.
- On the 14th of November, the draft final selection was presented during an online meeting with the sister projects and the EU project offers of the three projects. During this meeting, some remarks were made, for example whether value chains with import of the bio-based product were included in the selection, which is indeed the case.
- On the 18th of November, the final selection was made after having processed some final remarks from HARMONITOR consortium partners.

In the next chapter the resulting selection of bio-based value chain is further described and discussed.

3 Description of selected bio-based materials and products

3.1 Bio-based chemicals

From the list of drop-in chemicals (step 3), six significant ones were selected. All these chemicals show significant bio-based production in Europe and a large potential market (Table 3).

Table 3: Bio-based chemicals

	EU Bio-based production (kt/y)	EU Fossil-based production (kt/y)
1,4-butanediol	30[f]	n.a.
Acetic acid	24.5[g]	968[d]
Epichlorohydrin	36[d]	265[d]
Ethylene glycol	220[h]	1180[d]
Propylene glycol	20[d]	633[d]
PUR	39[d]	3500[d]

The selection was further expanded by the largest volume of dedicated bio-based chemicals (step 2). The largest PRODCOM categories are those involving starch (maize starch, modified starch, wheat starch, and potato starch, each with over 1400 kt/y produced). These categories were taken into the selection as 'starch polymers. The next largest produced dedicated bio-based chemical is glycerol (20411000, Glycerol (glycerine), crude; glycerol waters and glycerol lyes) with an EU production of 730 kt/y. However, glycerol is not a final product and can be seen as a feedstock. This feedstock is already included in the value chain for propylene glycol. The next chemical in the list is citric acid (20143473, Citric acid and its salts and esters). However, citric acid was excluded since it finds its main application in food. The next entry, Tall Oil (20147130, Tall oil; whether or not refined, 480 kt/y) was included. This results in the addition of starch polymers and tall oil to the final selection.

From the chemicals from which only the CN data can be used, ethanol scores the highest trade statistics with 1252.4 kt/y[i] traded within and across the EU borders. However, it is expected that the bulk of the bio-based ethanol will be used as fuel and is excluded from the selection. The next three groups (CN

29232000, lecithins and other phosphoaminolipids; CN 391239, other cellulose ethers; and 29181100, lactic acid with salts and esters) all show trade values between 250 and 500 kt/y. Due to its interest for CSLs, the lactic acid into PLA value chain was selected from these.

Table 4: Selected bio-based value chain in the chemical sector

Intermediary chemical	Biomass type in	Products out
Acetic acid (see tab 1)	Sugar/starch	PTA, VAM, acetic anhydride, acetate esters
Ethylene glycol (see tab 2)	Sugar/starch	PET, PE
Butanediol (1,4)	Sugar/starch	Solvent, production of polyurethanes
Lactic acid	Sugar/starch (cane sugar)	PLA (USA, Thailand)
Lactic acid	Sugar/starch (cane sugar)	Salts and esters
Starch polymers	Starch (potatoes), corn	Plastic utensils
Palmitic acid with its salts and esters	Palm oil	Cosmetics, surfactants
Propylene glycol	Oil crop (glycerol)	Propylene glycol
Poly(urethane)	Vegetable oil - soybeans	PUR
Epichlorohydrin	Vegetable oil, glycerol	Solvent in resins, paints
Rayon	Wood	Tarn
Tall oil	Wood	Chemicals

[f] Spekreijse, J., K. Vikla, M. Vis, K. Boysen-Urban, G. Philippidis, R. M'barek (2021) Bio-based value chains for chemicals, plastics and pharmaceuticals, a comparison of bio-based and fossil-based value chains, EUR 30653 EN, Publications office of the European Union, Luxembourg, 2021m ISBN 978-92-76-32459-1, doi: 10.2760/712499, JRC124141.

[g] Spekreijse, J, T. Lammens, C. Parisi, T. Ronzon, M. Vis (2019) Insights into the European market for bio-based chemicals, analysis based on 10 key product categories, JRC science for policy report, EUR 29851 EN, Publications office of the European Union, Luxembourg, 2019, ISBN 978-92-79-985419-8, doi:10.2760/673071, JRC112989.

[h] Green Chemicals Blog, https://greenchemicalsblog.com/2022/08/25/upm-gears-up-for-bio-meg-commercialization/

[i] The highest trade volumes: extra EU import, extra EU export, plus intra EU trade of the period 2019-2021 was taken using COMEXT.

3.2 Wood sector

For the wood sector (NACE 16), a similar approach was taken as for the dedicated chemicals. Since in this sector nearly all products are bio-based, and all those products are dedicated, only a list with dedicated bio-based products exists. The nine PRODCOM categories with the highest production numbers within the EU27 are presented in Table 5.

Table 5: overview of the nine PRODCOM categories from the wood sector with the highest production volumes within the EU27

PRODCOM	PRODCOM text	Production (kt/y)[a)]	Included as
16102503	Coniferous wood in chips or particles	36,000	*Excluded (fuel)*
16291500	Pellets and briquettes of pressed and agglomerated wood and of wood waste and scrap	17,926	*Excluded (fuel)*
16231900	Builders joinery and carpentry of wood (excluding windows, French windows and doors, their frames and thresholds, parquet panels, shuttering for concrete constructional work, shingles and shakes)	6,300	Sawn wooden products
16102505	Non-coniferous wood in chips or particles	5,639	*Excluded (fuel)*
16102110	Coniferous wood continuously shaped (including strips and friezes for parquet flooring, not assembled)	3,063	Sawn wooden products
16241320	Cases, boxes, crates, drums and similar packings of wood (excluding cable drums)	2,687	Wooden packaging
16102400	Wood wool; wood flour	2,080	Wood wool, wood flour
16211543	Fibreboard (excluding medium density fibreboard [MDF]), of wood or other ligneous materials, whether or not bonded with resins or other organic substances, of a density exceeding 0.8 g/cm³	900	Fibreboard (particle, MDF, etc.)
16241133	Flat pallets and pallet collars of wood	824	Wooden pallets

[a)] For each PRODCOM category the highest production volume of the period 2019, 2020 and 2021 was taken from COMEXT.

Three of the nine PRODCOM categories with highest production numbers (16102503, 16291500, and 16102505) were excluded due to their high use in fuel applications, which is out of the scope of the HARMONITOR project. The remaining products were all taken up in the selection, although with some modifications. For clarity, some categories were taken wider than the PRODCOM classification. For example, in the category fibreboard, also MDF of different sizes (16211529, 16211523 and 16211526 and particle board of wood (16211200), is included, whereas our final selection simply included all fibreboard as one product entry.

Finally, the selection of wooden products was completed with the inclusion of Oriented Strand Board (OSB) (16211316), as to provide a rather complete picture of the wooden panel sector.

3.3 Paper products

The PRODCOM classification of paper products has several PRODCOM product entries that have a high production value due to their generic description. For example, fluting (17123400) and corrugated paper (17211100) have high production volumes of 11,051 kt/y and 10,821 kt/y[j], respectively. In this selection, we gave priority to well defined products. The well-defined products with the highest production values are graphic paper, paperboard (17121439 and 17121425) with a total EU production of 9,015 kt/y and toilet paper (17221120), at a production of 4,651 kt/y. These groups were included in the HARMONITOR selection as three separate entries: graphic paper, paperboard, and toilet paper.

3.4 Textiles

The PRODCOM classification for textiles is fragmented into several categories that focus on functionality rather than material. For example, next to 'woven fabrics of cotton' (132020), cotton products can be found in, amongst others, 'Bed linen of cotton' (13921253), 'sacks and bags, of cotton' (13922130), and 'table linen of cotton' (13921353). To prevent the selection of several cotton products and to maximise the diversity in feedstocks, six textiles from different feedstocks were selected. These are cotton, wool, jute, flax, hemp, and leather.

3.5 Other additions

To adhere to all the additional considerations (step 5), several other products were added to the selection. Moreover, a selection purely based on currently large production numbers would omit important and innovative.

In order to include both EU and imported feedstocks & products, two value chains for lactic acid were selected. On one hand the production of PLA from lactic acid, which mostly takes place in the USA and Thailand. On the other hand, the production of lactic acetate salts and esters, which also takes place within the EU. Moreover, ethylene, which is mainly produced outside of the EU, was included with the value chain towards bio-based polyethylene.

The use of straw as a building material was included as innovative bio-based value chain in the construction sector. Compost from kitchen and garden waste, the production of PHA from wastewater and the production of polypropylene from used cooking oil were selected in order to increase the number of value chains that rely on rest streams. Natural rubber and leather were selected, since they were not identified in the initial list of 350 chemicals and polymers even though it is an important bio-based product, and finally, algal fatty acids were added to represent the upcoming blue economy.

3.6 Final selection

Table 6 on page 17 presents the selected 35 value chains, starting with the main intermediary chemical, sector, typical biomass resource used and outgoing products. Furthermore, it is indicated if the intermediary chemical is readily available in EU statistics. This is not the case for drop-in bio-based chemicals, and some more innovative and waste-based value chains. The next column shows whether the feedstock for the bio-based product as sold in the EU is mainly grown in the EU, imported or both. During trade flow analysis, more information will be collected on this aspect. The next columns show whether an existing bio-based market has been established, and if the product can be regarded as new/innovative bio-based product. The next column shows whether the product is a waste or residue.

Table 7 and Table 8 show whether possible major environmental and social concerns exist for the selected value chains. This does not mean that these value chains are unsustainable, but it does indicate a certain need for CSLs. Next, it is indicated whether the value chains are covered by existing CSLs. Further research is needed to investigate if and to what degree CLS are applied in these value chains. Moreover, a number of relevant CSLs are mentioned. This list may not be complete, during the project a more detailed assessment of CSLs will be performed.

Table 6: Overview of selected bio-based value chains

#	Intermediary chemical	Sector	biomass type in	Products out	Intermediary included in statistics?	Feedstock: EU, import, or both?	Existing bio-based market?	Innovative bio-based product?	Feedstock: waste/ residue?
1	Acetic acid	Chemicals	Sugar/starch	PTA, VAM, acetic anhydride, acetate esters	n	both	y	y	n
2	Ethylene glycol	Chemicals	Sugar/starch	PET	n	import	y	y	n
3	Ethylene	Chemicals	Sugar/starch	Polyethylene (PE), HDPE	n	import	y	y	n
4	Butanediol (1,4)	Chemicals	Sugar/starch	Solvent, production of polyurethanes	n	both	y	y	n
5	Lactic acid	Chemicals	Sugar/starch (cane sugar)	PLA	y	import	y	y	n
6	Lactic acid	Chemicals	Sugar/starch (cane sugar)	Salts and esters	y	both	y	n	n
7	Starch polymers	Chemicals	Starch (potatoes), corn	Plastic utensils	y	both	y	n	n
8	Palmitic acid with its salts and esters	Chemicals	Palm oil	Cosmetics, surfactants	y	import	y	n	n
9	Propylene glycol	Chemicals	Oil crop (glycerol)	Propylene glycol	n	both	y	y	both
10	Poly(urethane) PUR	Chemicals	Vegetable oil - soybeans	PUR	n	import	y	y	n
11	Epichlorohydrin	Chemicals	Vegetable oil, glycerol	Solvent in resin, paints	n	both	y	y	both
12	Rayon	Chemicals	Wood	Tarn	y	EU	y	y	n
13	PHA	Chemicals	wastewater	Plastics	n	EU	n	y	y
14	(Poly)propylene	Chemicals	UCO	Plastics	n	both	n	y	y
15	Algal fatty acids	Chemicals	Algae	Cosmetic ingredient	n	both	n	y	n
16	Sawn wooden products	Wood	Wood	Several	y	both	y	n	n
17	Fibreboard (particle, MDF, etc)	Wood	Wood, waste wood	MDF, Particle board	y	both	y	n	y
18	Oriented strand board	Wood	Wood	OSB	y	both	y	n	n
19	Wooden packaging	Wood	Wood	Cases, boxes, drums	y	both	y	n	n
20	Wooden pallets	Wood	Wood	Pallets	y	both	y	n	n
21	Wood wool, wood flour	Wood	Wood	Panels, fibre cement, insulation, filler	y	both	y	n	n
22	Lignin based products	Wood	Wood	Binders and aromatic chemicals, asphalt/bitumen	n	both	n	y	y
23	Tall oil	Wood	Wood	Chemicals	n	both	y	y	y
24	Pulp	Paper	Wood, wastepaper	Graphic paper	y	both	y	n	y
25	Pulp	Paper	Wood, wastepaper	Paper board	y	both	y	n	y
26	Pulp	Paper	Wood, wastepaper	Toilet paper	y	both	y	n	y
27	Cotton fabrics	Textile	Cotton	Woven fabrics, table and bed linen, sacks and bags	y	import	y	n	n
28	Wool fabrics	Textile	Wool	Textile	y	both	y	n	n
29	Jute	Textile	Jute	Textile	y	import	y	n	n
30	Flax	Textile	Flax	Textile, table linen	y	EU	y	n	n
31	Hemp	Textile	Hemp	Textile, insulation materials	n	EU	y	n	n
32	Straw	Building	Straw	building materials	n	EU	y	y	y
33	Biowaste	Waste	Biowaste	Compost	y	EU	y	n	y
34	Leather	Textile	Animal skin	Clothing, textiles	y	import	y	n	n
35	Natural rubber	Chemicals	Natural rubber	Tyres, various products	y	import	y	n	n

Table 7: Selected value chains – initial assessment of applicable CSLs

#	Intermediary chemical	biomass type in	Products out	Possible major environ-mental concerns	Possible major social concerns	ASCC PLUS	Better Biomass	RSB	REDCert	Bonsucro	SAI	Alliance Water	Fairtrade Int.	VCS	Nature Care Products	Recognised	SGE 21	OK biobased	TFS	ZNU	FSC	PEFC	SBP	ARSO	EU Ecolabel - textiles	Textile exchange	FAIR Rubber	GPSNR	Total # CSLs
1	Acetic acid	Sugar/starch	PTA, VAM, acetic anhydride,	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y									15
2	Ethylene glycol	Sugar/starch	PET	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y									15
3	Ethylene	Sugar/starch	Polyethylene (PE), HDPE	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y									15
4	Butanediol (1,4)	Sugar/starch	Solvent, polyurethanes	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y									15
5	Lactic acid	Sugar/starch (cane sugar)	PLA	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y									15
6	Lactic acid	Sugar/starch (cane sugar)	Salts and esters	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y	y									15
7	Starch polymers	Starch (potatoes), corn	Plastic utensils	y	y	y	y	y	y		y	y	y		y	y	y	y	y	y									13
8	Palmitic acid & salts and esters	Palm oil	Cosmetics, surfactants	y	y	y	y		y		y	y	y	y	y	y	y	y	y	y									13
9	Proplyene glycol	Oil crop (glycerol)	Propylene glycol	y	y	y	y		y		y	y	y	y	y	y	y	y	y	y									13
10	Poly(urethane) PUR	Veg oil, soybeans	PUR	y	y	y	y		y		y	y	y		y	y	y	y	y	y									12
11	Epichlorohydrin	Vegetable oil, glycerol	Solvent in resins, paints	y	n	y	y		y		y	y	y	y	y	y	y	y	y	y									13
12	Rayon	Wood	Tarn	y	n	y	y	y											y	y	y	y	y						8
13	PHA	wastewater	Plastics	n	n	y	y	y	y										y	y									6
14	(Poly)propylene	UCO	Plastics	n	n	y	y	y	y										y	y									6
15	Algal fatty acids	Algae	Cosmetic ingredient	y	n	y		y				y	y	y						y									6
16	Sawn wooden products	Wood	Several	y	y	y	y	y				y		y					y	y	y	y	y						10
17	Fibreboard (particle, MDF)	Wood, waste wood	MDF, Particle board	y	n	y	y	y				y		y					y	y	y	y	y						10
18	Oriented strand board	Wood	OSB	y	n	y	y	y				y		y					y	y	y	y	y						10

Table 8: Selected value chains – initial assessment of applicable CSLs (continued)

#	Intermediary chemical	biomass type in	Products out	Possible major environ-mental concerns	Possible major social concerns	ISCC PLUS	Better Biomass	RSB	REDCert	Bonsucro	SAI	Alliance Water Stewardship	Fairtrade Int.	VCS	Nature Care Products	Recognised	SGE 21	OK biobased	TfS	ZNU	FSC	PEFC	SBP	ARSO	EU Ecolabel - textiles	Textile exchange	FAIR Rubber	GPSNR	Total # CSLs
19	Wooden packaging	Wood	Cases, boxes, drums	y	n	y	y	y				y		y					y	y	y	y	y						10
20	Wooden pallets	Wood	Pallets	y	n	y	y	y				y		y					y	y	y	y	y						10
21	Wood wool, wood flour	Wood	Panels, fibre cement, insulation, filler	y	n	y	y	y				y		y					y	y	y	y	y						10
22	Lignin based products	Wood	Binders and aromatic chemicals, asphalt/bitumen	y	n	y	y	y				y		y					y	y	y	y	y						10
23	Tall oil	Wood	Chemicals	y	n	y	y	y				y		y					y	y	y	y	y						10
24	Pulp	Wood, wastepaper	Graphic paper	y	n	y	y	y				y		y					y	y	y	y	y						10
25	Pulp	Wood, wastepaper	Paper board	y	n	y	y	y				y		y					y	y	y	y	y						10
26	Pulp	Wood, wastepaper	Toilet paper	y	n	y	y	y				y		y					y	y	y	y	y						10
27	Cotton fabrics	Cotton	Woven fabrics, table and bed linen, sacks and bags	y	y	y	y	y				y		y						y				y	y	y			9
28	Wool fabrics	Wool	Textile	y	y	y	y	y				y		y						y				y	y	y			9
29	Jute	Jute	Textile	y	n	y	y	y				y		y						y				y	y	y			9
30	Flax	Flax	Textile, table linnen	y	n	y	y	y				y		y						y				y	y	y			9
31	Hemp	Hemp	Textile, insulation materials	y	n	y	y	y				y		y						y				y	y	y			9
32	Straw	Straw	building materials	y	n	y		y	y																				3
33	Biowaste	Biowaste	Compost	n	n	y					y																		2
34	Leather	Animal skin	Clothing, textiles	y	y	y						y		y						y				y	y	y			7
35	Natural rubber	Natural rubber	Tyres, various products	y	y	y															y	y					y	y	5

4 CONCLUSIONS

35 bio-based of value chains were selected for further assessment within the HARMONITOR project. A systematic five step approach was applied, starting with a longlist of 538 products from NACE 13, 16, 17, 20, 21 and 22. After a pre-screening on the representativeness of the PRODCOM and CN codes of the bio-based product, 226 dedicated bio-based materials and products were pre-selected as well as a list of 101 drop-in biobased products. Their biological sources were identified and based on the production (PRODCOM) and, if/needed, trade (CN) volumes, an initial selection was made. During several online meetings and a workshop in Berlin, a further screening was applied taking into account considerations such as representative distribution between bio-based sectors, inclusion of both innovative and traditional bio-based products, inclusion of value chains using residues and wastes, inclusion of both EU and imported feedstocks and products, coverage by sustainability certification schemes and labels, relevance for EU bioeconomy policies such as the CAP reform, Taxonomy Regulation, Farm to Fork strategy, EU Forest Strategy, Circular Economy Action Plan, European Regulation on Sustainable products, recast of RED, and the EU Strategy for Sustainable and Circular Textiles.

The final selection aimed to be a representative mix of bio-based products, using various feedstocks (including residues and wastes), covering a broad range of sectors, relevant for EU policy making, currently traded, and relevant for further analysis of sustainability certification schemes.

Task 3.2: Assessing Trade Flows of Biological Resources, Bio-based Materials and Products

Task 3.2 description

A mapping of the trade flows of the selected chemically unique bio-based products will be performed, primarily using existing and consolidated market databases (e.g., Eurostat, Comext, STIX, FAOSTAT). In case of drop-in bio-based products, statistical information will be combined with estimated percentages of bio-based production using databases and market studies. Associated biological resources will be obtained from statistics, sector data, existing resource assessments, etc. (Months 7 – 27).

Methodology

Within the HARMONITOR project, 35 value chains from biomass to bio-based product or materials have been selected for further assessment (D3.1). An initial assessment of the trade flows and imports of these 35 value chains with focus on statistical data collection has been performed and described in milestone report (M3) *"Initial assessment of trade flows"*, submitted on 31 May 2023. Several choices were made towards the selection of statistical data. These are as follows

- Statistical data will be collected separately for the biogenic feedstock, the different intermediary chemicals/products and the outgoing chemicals/products. Later these will be linked to each other.
- Data will be collected and presented at least for one base year, namely 2021. Eurostat trade data on 2022 is at the time of writing not expected to be complete yet.
- If statistical information is available for a series of years, data on the last 10 years will be collected. It is to be decided how this information will be presented, given the number of value chains.
- Data collection will focus on trade volumes (in tonnes) (CN), and production volumes if available in Prodcom.
- As a minimum, the trade flows between the EU and non-EU countries/regions will be shown.
- If available, the following data will be collected.
  - Import to EU countries from EU countries;
  - Import to EU countries from non-EU countries;
  - Export from EU countries to EU countries (is often slightly and in some cases very different, even if volumes are used)
  - Export from EU countries to non-EU countries.
- The focus lies on obtaining a big picture overview of the 35 value chains. Therefore, no substantial effort will be put in explaining outliers, data gaps and omissions of trade between EU countries.
- If no statistical information is available, other sources will be used, preferably sources that are regularly updated, from e.g., sector organisations.
- The quality of information sources will be ranked with an uncertainty indicator. This methodology has been developed and used in two JRC studies executed by BTG (Spekreijse et al 2019, 2021).
- The resulting trade flows will show production, market, import and export of the major global regions.
- Where available, a more detailed mapping of trade with and between EU Member States will be presented. The statistical information will be checked on obvious errors; where possible data

gaps in trade between EU and non-EU countries will be identified and filled with data from FIGARO or commercial free available trade databases (e.g., Abrams Wiki).
- The data will be presented in a comprehensive manner using tables, graphs, and highlighting the highest importing/exporting countries to obtain insights from the collected data.

Statistical data collection of (bio-based) chemicals

The two main databases used for the statistical data collection are Comext, also known as Easy Comext; and the UN Comtrade database. Comext is Eurostat's statistical database on the trade of goods and uses data from the EU Member States' national statistical administration. The United Nations Comtrade database uses trade data collected from approximately 200 countries. The Comtrade database regards the EU as one entity and does thereby not take intra-EU trade into account[2]. As such, in order to get the most desirable data, Eurostat's Easy Comext database was used for intra-EU data, while the UN Comtrade database was used for extra-EU data.

As certain products are not included in the UN Comtrade database, but are available in the Comext database, mirror data was used for certain value chains. This mirror data is derived from the declarations of the partner country. For example, for certain value chains, extra-EU imports were deduced from EU Member States' declarations of extra-EU exports and vice versa.

Differences between import and export data between the declaring countries were observed. In general, imports are usually recorded with more accuracy as these generate tariff revenues, while exports do not. The quality of the data collection can also vary among countries[3]. Data from 2021 was used, as this is the most recent year with the full data available for all value chains.

In general, the import data appears to be more complete and as mentioned above, it is often more accurate due to tariff revenues. As such, import data was used for the mapping of intra-EU trade, rather than intra-EU exports. The mapping of trade flows also includes both the extra-EU imports and extra-EU exports, as only the flows to and originating from the EU are taken into account in the data collection, giving no issues with repeated data for extra-EU countries. For the mapping, the tool 'FlowmapBlue' was used, an online flow map visualization tool, which shows the quantity of trade of the selected value chains between countries. FlowmapBlue is free to be used in non-commercial projects.

Two of the selected value chains, polyhydroxyalkanoates (PHA) and algal fatty acids were not available in either the Comext, UN Comtrade or other databases. As such, information on their trade flows and bio-based content will be derived from literature.

The trade data collected for the chemical value chains is presented below. Table 1 shows the CN code and official name of the chosen value chains, whether they are a drop-in or dedicated bio-based chemical and the database source of its intra- and extra-EU trade data. As mentioned before, for some value chains, the CN code was not included in the UN Comtrade database. Mirrored data from Comext was then used for extra-EU data.

[2] https://unstats.un.org/wiki/display/comtrade/EU+in+UN+Comtrade
[3] https://wits.worldbank.org/wits/wits/witshelp/content/data_retrieval/T/Intro/B2.Imports_Exports_and_Mirror.htm

Table 3, CN code, type and data source of chosen value chains.

Value chain and CN code	*Type*	*Trade flow*	*Database*
*291521 - **Acetic acid***	Drop-in	Intra	Easy Comext
		Extra	UN Comtrade
*290531 - Ethylene glycol "**ethanediol**"*	Drop-in	Intra	Easy Comext
		Extra	UN Comtrade
*290121 - **Ethylene***	Drop-in	Intra	Easy Comext
		Extra	UN Comtrade
*29053926 - Butane-1,4-diol or tetramethylene glycol [**1,4-butanediol**] having a bio-based carbon content of 100% by mass*	Drop-in/bio-based	Intra	Easy Comext
		Extra	Easy Comext
*390770 - **Poly"lactic acid"**, in primary forms*	Dedicated	Intra	Easy Comext
		Extra	UN Comtrade
*291811 - **Lactic acid**, its salts and esters (excl. inorganic or organic compounds of mercury)*	Dedicated	Intra	Easy Comext
		Extra	UN Comtrade
*35051050 - **Starches**, etherified or esterified (excl. dextrins)*	Dedicated	Intra	Easy Comext
		Extra	Easy Comext
*29157040 - **Palmitic acid** and its salts and esters*	Dedicated	Intra	Easy Comext
		Extra	Easy Comext
*290532 - **Propylene glycol** "propane-1,2-diol"*	Drop-in	Intra	Easy Comext
		Extra	UN Comtrade
*39095090 - **Polyurethanes** in primary forms (excl. polyurethane of 2,2'-"tert-butylimino"diethanol and 4,4'-methylenedicyclohexyl diisocyanate, in the form of a solution in N,N-dimethylacetamide)*	Drop-in	Intra	Easy Comext
		Extra	Easy Comext
*291030 - 1-Chloro-2,3-epoxypropane "**epichlorohydrin**"*	Drop-in	Intra	Easy Comext
		Extra	UN Comtrade
*540310 - High-tenacity yarn of viscose **rayon** filament (excl. sewing thread and yarn put up for retail sale)*	Dedicated	Intra	Easy Comext
		Extra	UN Comtrade
*390210 - **Polypropylene**, in primary forms*	Drop-in	Intra	Easy Comext
		Extra	UN Comtrade

Statistical data collection of wood and textile products

Similar to (bio-based) chemicals, statistical data for wood and textile products on intra-EU trade was collected from Comext and extra-EU trade was collected from the UN Comtrade database for the year 2021. Trade data in both databases are subject to variations in data quality and discrepancies. Some of these are prominent in wood product trade including inconsistencies or errors in conversion in quantities and differences in methods in assessing trade data between reporting countries. Additional data sources, such as EFI's Forest Products Trade Flow database and UNECE's Joint Forest Sector Questionnaire will be helpful in further analysis and improving data quality.

The compilation of data was based on commodity codes of the Harmonized System Nomenclature (HS) without the additional digits of the CN system (8-digit code). The present selection of product

classification varies between value chains. Cotton fabrics are presented at HS heading level (2-digit code) but should be further refined. Straw and organic waste are not included in the present dataset.

Table 4, HS code, type and data source of chosen value chains for wood and textile products.

Value chain and HS codes	*Type and products out*
4407 - Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, of a thickness exceeding 6 mm	Sawn wooden products (Several)
4411 - Fibreboard of wood or other ligneous materials, whether or not bonded with resins or other organic substances	Fibreboard (particle, MDF, etc.) (MDF, Particle board)
4410 - Particle board, oriented strand board (OSB) and similar board (for example, waferboard) of wood or other ligneous materials, whether or not agglomerated with resins or other organic binding substances.	Oriented strand board (OSB)
441510 - Cases, boxes, crates, drums and similar packings; cable-drums	Wooden packaging (Cases, boxes, drums)
441520 - Pallets, box pallets and other load boards; pallet collars	Wooden pallets (Pallets)
440500 - Wood wool; wood flour.	Wood wool, wood flour (Panels, fibre cement, insulation, filler)
380400 - Residual lyes from the manufacture of wood pulp, whether or not concentrated, desugared or chemically treated, including lignin sulphonates, but excluding tall oil of heading 38.03.	Lignin based products (Binders and aromatic chemicals, asphalt/bitumen)
380300 - Tall oil, whether or not refined	Tall oil (Chemicals)
4802 - Uncoated paper and paperboard, of a kind used for writing, printing or other graphic purposes, and non perforated punchcards and punch tape paper, in rolls or rectangular (including square) sheets, of any size, other than paper of heading 48.01 or 48.03; hand-made paper and paperboard.	Pulp (Graphic paper)
4804 - Uncoated kraft paper and paperboard, in rolls or sheets, other than that of heading No 4802 or 4803	Pulp (Paper board)
4818 - Toilet paper and similar paper, cellulose wadding or webs of cellulose fibres, of a kind used for household or sanitary purposes, in rolls of a width not exceeding 36 cm, or cut to size or shape; handkerchiefs, cleansing tissues, towels, tablecloths, serviettes, bed sheets and similar household, sanitary or hospital articles, articles of apparel and clothing accessories, of paper pulp, paper, cellulose wadding or webs of cellulose fibres	Pulp (Toilet paper)
52 - Cotton.	Cotton fabrics (Woven fabrics, table and bed linen, sacks and bags)
5105 - Wool and fine or coarse animal hair, carded or combed (including combed wool in fragments)	Wool fabrics (Textile)
530310 - Jute and other textile bast fibres, raw or retted	Jute (Textile)
5306 - Flax yarn	Flax (Textile, table linnen)
5302 - True hemp (Cannabis sativa L.), raw or processed but not spun; tow and waste of true hemp (including yarn waste and garnetted stock)	Hemp (Textile, insulation materials)

4107, 4112, 4113, 4114 - Leather further prepared after tanning or crusting, including parchment-dressed leather, of bovine (including buffalo) or equine animals (4107), sheep or lamb (4112), other animals (4113) without hair on, whether or not split, Chamois (including combination chamois) leather; patent leather and patent laminated leather; metallised leather (4114)	Leather (Clothing, textiles)
4001 - Natural rubber, balata, gutta-percha, guayule, chicle and similar natural gums, in primary forms or in plates, sheets or strip	Natural rubber (Tyres, various products)

Appendix C. Methodologies of WP4

Introduction

This document contains the methodology for developing and implementing the Scheme Evaluation Framework, which will be used to conduct the comparative analysis of Certification Schemes and Labels (CSLs), as defined in WP 4.2.

This methodology was developed by Preferred by Nature.

General description of objectives

WP4: Review and analysis of selected existing CSLs for biological resources, bio-based materials and products.

This document outline of the methodology for benchmarking used in Work Package 4 (WP4).

The lead beneficiary of WP4 is Preferred by Nature (formerly NEPCon). The objective of WP 4 is to "conduct a comparative analysis of the selected CSLs regarding certified environmental, social, and economic impacts including trade-offs, as well as the robustness and effectiveness of the assurance and governance systems that support each scheme in achieving those intended impacts."

The Scheme Evaluation Framework will be used to assess the scope of normative requirements, as well as the robustness and effectiveness of selected CSLs. This deliverable is produced from the

Summary of WP 4

The methodology contained in this document forms part of WP 4, summarised below.

WP 4 consists of 3 tasks as detailed here; (I) Task 4.1 Develop an inventory of key aspects of CSLs, (II) Conduct a comparative analysis of selected CSLs and, (III) Validation and final comparison study.

Task 4.1 - Develop inventory of key aspects of CSLs. (Preferred by Nature, DBFZ, Utrecht University, RINA CONSULTING).

A scientific and other literature review will be conducted regarding sustainability of CSLs, focusing on schemes for bio-based products. This will include insights from recent studies reviewing individual value chains etc., tools and practices that focus on measuring the effectiveness and robustness of CSLs. The review will focus on quantitative aspects (how long has the certification scheme existed, number of certificates, etc.) and qualitative (e.g., easiness of certification procedures, communication effectiveness, etc.). Desktop research will review system documentation available for selected CSLs, serving as a basis for producing an inventory of key aspects for the CSL comparative analysis (task 4.2). Implications about the transparency of CSLs will be derived, as key gaps in available documentation will also be identified. (Months 5-12).

- **Subtask 4.1.1:** Literature review of sustainability CSLs. (DBFZ, RINA CONSULTING)
- **Subtask 4.1.2:** Inventory of certifiable biological resources, bio-based material and products covered by selected CSLs. (DBFZ, RINA CONSULTING)
- **Subtask 4.1.3:** Inventory of environmental, social, and economic requirements, including control points examined during audit assessments. (Preferred by Nature, RINA CONSULTING)
- **Subtask 4.1.4:** Inventory of assurance system requirements, relating to how compliance with the scheme requirements is ensured. This includes protocols that are meant to ensure effectiveness, robustness, and other aspects of how the scheme operates. (Preferred by Nature)
- **Subtask 4.1.5:** Inventory of governance system requirements, including aspects such as impartiality, transparency, stakeholder engagement, impact measurement, etc., determining overall CSL credibility. (Utrecht University)

Task 4.2 - Conduct comparative analysis of selected CSLs. (Preferred by Nature, Utrecht University, agroVet, RINA CONSULTING).

Using this methodology defined in Task 2.3 (this document), and inventory of key aspects of each scheme (D 4.1), this task will conduct a comparative analysis of each selected CSL, including the extent to which each scheme assesses and certifies values regarding:

- **Subtask 4.2.1:** Environmental, social, and economic impacts and trade-offs. (Preferred by Nature, RINA CONSULTING, agroVet)
- **Subtask 4.2.2**: Assurance system requirements. (Preferred by Nature, agroVet)
- **Subtask 4.2.3**: Governance system requirements. (Utrecht University, agroVet)

Notable gaps across the CSLs will also be analysed, where expected contributions to social or environmental impacts are not being realised (Months 10 - 21).

Task 4.3 - Validation and final comparison study. (Preferred by Nature, Utrecht University, DBFZ).

Draft results of the comparative analysis will be open for consultation with stakeholders, including scheme owners. This activity is closely coordinated with tasks 2.2 and 7.1, where CSLs are engaged to ensure proof of concept. This step is crucial to avoid misunderstandings, follows best practices, promotes transparency, and adds to the overall credibility and sustainability of results. The findings will become an important part of the HARMONITOR Platform (task 2.4). After consultation, the final comparison study will include:

(i) description of the methodology used (based on outputs from task 2.4);
(ii) results of comparison analysis of each selected CSL;
(iii) results of the stakeholder consultation process;
(iv) synthesis on how selected CSLs perform as a group; and
(v) overall conclusions and recommendations. (Months 21-31),

Preparation of the Scheme Evaluation Framework

The Scheme Evaluation Framework (SEF) is the Framework that will be used to conduct the comparative analysis of each of the selected CSLs.

The SEF has been developed with the objective of reviewing and analysing sustainability certification schemes and labels using a systematic and comprehensive approach to assess the credibility and effectiveness of the schemes.

Below are the key steps that were followed in the development of the SEF itself:

1. Define the objectives: The formulation of the criteria and indicators of the SEF was based on Specific Objective 3: "*To review and compare performance requirements (criteria and indicators) and assurance and governance systems for comprehensive sustainability coverage of international and EU CSLs for bio-based systems*."

2. Review existing frameworks: Certification systems typically consist of three key components: the requirements placed on certificate holders, certification bodies, and the certification scheme itself. Here is a brief overview of each:

    a. Requirements placed on certificate holders: Certification systems establish certain criteria and standards that certificate holders, such as companies or organisations, must meet to obtain and maintain certification. These requirements vary depending on the certification system's specific sustainability goals and objectives. They may include compliance with environmental regulations, adherence to social responsibility standards, implementation of sustainable practices, and transparency in reporting.

    b. Certification bodies: Certification bodies are independent entities responsible for evaluating and verifying the compliance of certificate holders with the certification scheme's requirements. They play a crucial role in assessing and certifying the sustainability performance of organisations. Certification bodies should be accredited, meaning an accreditation body has formally recognised them for their competence and impartiality. They follow specific protocols and procedures to ensure consistent and reliable evaluations.

    c. Certification scheme: The certification scheme encompasses the overall framework, guidelines, and rules governing the certification process. It defines the specific requirements, criteria, and indicators used to analyse and assess the sustainability performance of certificate holders. The scheme may include documentation requirements, on-site inspections, data collection, verification processes, and periodic audits. It also establishes the terms and conditions for obtaining, maintaining, and displaying the certification and any fees or costs associated with the certification process.

    It's important to note that certification systems' structure and specific details can vary significantly depending on the specific sustainability domain, such as organic farming, energy efficiency, or fair trade. Different sectors and industries may have their own unique certification requirements and schemes tailored to their specific needs and challenges.

3. Identify key criteria: The criteria that will form the basis of evaluation are aligned with internationally recognised sustainability principles and cover various dimensions, such as environmental impact, social responsibility, economic viability, and governance, as well as the qualitative aspects of scheme implementation and oversight. The indicators covering sustainability requirements are derived from the Preferred by Nature Sustainability Framework.

    Based on the objectives, literature review, and stakeholder engagement, develop specific evaluation criteria for each stakeholder group. Consider the following aspects:

a. Certificate holders: Criteria that assess the sustainability performance of the organisations seeking certification. This includes their environmental impact, social responsibility, governance practices, supply chain management, stakeholder engagement, and transparency in reporting.

b. Certification bodies: Criteria that analyse the competence, independence, and integrity of the certification bodies. This may include their accreditation status, adherence to recognised evaluation methodologies, training and qualifications of evaluators, quality assurance mechanisms, and ethical conduct.

c. Scheme owners: Criteria that assess the robustness and effectiveness of the certification scheme itself. This may include the clarity and transparency of the scheme's guidelines, accessibility to different stakeholders, management of conflicts of interest, stakeholder engagement in decision-making, continuous improvement mechanisms, and monitoring and enforcement procedures.

Establish evaluation indicators: The criteria have been translated into measurable indicators or metrics. Indicators are developed to be clear and specific. They allow for quantitative or qualitative assessment of the performance of each CSL.

Overview of the Scheme Evaluation Framework requirements

As described above, the SEF consists of criteria and indicators applicable to certificate holders, certification bodies and the scheme owners themselves, aiming at addressing a) performance requirements; b) assurance system; and c) governance system.

The SEF is developed in an excel worksheet with different tabs, dividing the evaluation requirements in different sections.

The CSLs reviewed under WP4.1 shall be based on the list of CSLs provided by WP2. This comprehensive list also designates the CSLs according to the commodity it covers. The WP4 partners selected the CSLs for WP4.1 based on; presence in the EU, variety in feedstock type to cover as many industries as possible, partners individual experience with the CSL, and if it was covered by the Standards Map developed by the International Trade Centre.

A: Certificate holder requirements

This component corresponds to subtask *"4.1.2 Inventory of environmental, social, and economic requirements, including control points examined during audit assessments"*

The certificate holder requirements shall be used to analyse the normative requirements of the specific CSL, relevant for the certificate holders.

The Certificate Holder requirements are labelled A1 through A5 in the Excel sheet and include the following sections:

A1: Land-Use Requirements

This list contains the SEF requirements for CSLs' sustainability – the objective is to analyse the scope of how the CLSLs define sustainability issues and how well their normative requirements are defined.

These requirements are derived from the Sustainability Framework and cover the following sustainability aspects:

1. Management and business practices are responsible.
2. People's well-being and human rights are respected.
3. Nature and the environment are protected.
4. Climate impacts are reduced and mitigated.

A2: Supply chain requirements

These requirements include fundamental sustainability requirements for CSLs, aimed at the supply chain entities. The objective is to analyse how well the standards of the Schemes include subjects particularly related to human rights issues in processing, trade and manufacturing.

The key question the evaluation of these requirements should answer is if the scheme includes a complete and comprehensive set of requirements enabling the evaluation of compliance with applicable sustainability issues by the certificate holder?

A3 Requirements for material control

Does the scheme include requirements to ensure that material from unknown sources is not mixed into the product flow included in the scope of the certification? This may be via a CoC system using different forms of physical separation or risk-based supply chain management approaches. It should be underlined that it is not a requirement of the SEF that schemes have a specific type of CoC system, but there does need to be performance requirements that assure the absence of mixing.

A4 General requirements for Certificate Holders

These requirements relate to evaluating how the CSLs include measures to control potential conflicts and manage corruption risks within the Certificate Holder's operations.

A5 Quality and procedural requirements for Certificate Holders

The SEF contains criteria that shall be used to assess how the scheme ensures that Certificate Holders have in place systems, capacity and qualifications to continually meet the Scheme requirements.

B: Certification body requirements

This component corresponds to the following subtask: "*4.1.3 Inventory of assurance system requirements, relating to how compliance with the scheme requirements is ensured. This includes protocols that are meant to ensure effectiveness, robustness, and other aspects of how the scheme operates.*"

- General Certification Body requirements
- Certification Body requirements for auditing and certification

These criteria are formulated to assess the system of the Scheme that should be in place to manage processes like accreditation, oversight, competence and resources in relation to Certification Bodies.

C: Scheme requirements

This component corresponds to the following subtask: "*4.1.4 Inventory of governance system requirements, including aspects such as impartiality, transparency, stakeholder engagement, impact measurement, etc., determining overall CSL credibility.*"

The criteria are defined as follows:

- Transparency
- Standard setting
- Accreditation
- Certification process

These criteria are formulated to assess the system of the Scheme that should be in place to manage Standard setting and revision, as well as ongoing scheme maintenance and development, including scheme transparency, managing complaints etc.

Template tools

Assessment of certification schemes shall follow *this procedure*, and use the following documents:

- Certification Scheme Evaluation Framework (SEF);
- Certification Scheme Benchmarking template (Scheme specific version of the SEF)
- Certification Scheme Evaluation Report (SER) template;
    - SER shall be in excel
    - A summary of SER shall be developed in Word and provided with a narrative describing the project and short intro to the scheme.

Steps of the Evaluation process

The Scheme Evaluation process has a number of distinct steps that shall be followed. These comprise, in the following approximate order and are discussed in turn:

1. Application of the SEF by experts (*Evaluators*),
2. Quality review,
3. Consultation – including scheme owners

1.2.1 Step 1: Application of the Scheme Evaluation Framework

This step shall include communication with the Scheme owners/managers to inform them of the evaluation, as well as to ensure that the Evaluators have access to the correct and sufficient information about the scheme functioning.

The application of the Evaluation Framework shall be applied on two levels:

- Evaluation of the Scheme at the overall (international) level
- Consideration of how the Scheme will be implemented at the local (national) level. The purpose is that national-level evaluation is to provide data and findings that feed in as evidence into the central-level evaluation.

Following the methodology described below, the draft evaluation report shall be developed. The evaluation shall be done in the excel based SEF template, and the result shall be presented in a separate Word report based on the Excel SEF.

1.2.2 Step 2: Quality review

The Evaluator (Preferred by Nature team responsible for the application of the Evaluation Framework) shall ensure quality checks of draft scheme assessments before the report is shared with the Scheme owner.

The objective of the quality review is to ensure:

- the assessments have complied the method described in this document;
- the rigour of the evaluation process, as well as;
- the consistency of the evaluation approach across all Scheme evaluations.

The results of the review shall be provided by reviewers in writing to the Evaluators, who shall make sure to store all comments, as well as integrating the comments into the Evaluation itself.

1.2.3 Step 3: Consultation – including scheme owner

Stakeholder consultation shall be implemented, using the draft evaluation of each scheme. This activity is closely coordinated with tasks 2.2 and 7.1.

Scheme owners shall be directly contacted and supplied with the draft evaluations and have the time (minimum three weeks) to review and provide comments. Also, one (or more, where necessary) call with scheme owners shall be arranged to present the draft findings and allow the scheme owners to ask questions and provide feedback. It shall be underlined that direct and clear communication with the scheme owners is paramount to the evaluation process.

Evaluation Methodology

The main step in this process is the evaluation of how the Scheme is aligned with the requirements of the Framework. This consists of a desk review of documentation about the Scheme's requirements, systems, and operations. Also, additional sources of information will be used beyond what can be provided by the Scheme owner itself.

This section describes the evaluation methodology that will be employed:

In the process of scheme evaluation, the performance requirements of the existing sustainability schemes are benchmarked against the generic the individual requirements of the SEF. The comparison is made **on the indicator level**.

For the scheme standard, we aim to use the **most granular level of auditable requirements**. Often these would be indicators, but the term varies between schemes.

The following outlines the method to be used in the evaluation:

Information gathering

The assessment of each indicator should be conducted primarily using these sources of information:

- Publicly available information from the scheme itself
- Direct interviews and discussions with relevant Scheme personnel
- Stakeholder input via the Stakeholder Consultation

These are addressed in turn below:

1.2.4 Publicly available information from the scheme itself

Identify a clear description of the Scheme normative requirement(s) or other core documents[4] that are considered to cover a corresponding SEF indicator, and record these in the report template.

[4] These may be Scheme guides, interpretations, directives, policies, procedures or advice notes

Note: The Evaluator may contact the Scheme owner and ask them to support filling in relevant information. However, the evaluator has ownership and remains responsible for the content and quality of the input. To this end, all information completed by others shall be checked by the Evaluator.

For each indicator, the following shall be considered by Evaluators, using a systematic approach, to ensure complete coverage of the Scheme in the analysis:

- Relevant types of certification standard
- Models of certification
- The use of approved temporary or interim standards
- Approved final versions of standards/guidance, where the new document has not come into force or is still in a transitional phase

Identify a clear description of the Scheme GUIDANCE or other tools or resources that describe how requirements should be interpreted, which are considered most relevant to the SEF indicator.

Sources referenced in the Scheme Evaluation Report (SAR), shall be described in the following way: i) Certification Scheme (if not indicated in the Standard Code); ii) Standard Code or name; iii) Version; iv) relevant criterion or Indicator; iii) link on the Scheme website. Example:

PEFC ST 2002:2013 2015-12-07 Second Edition, criterion 5.4.1: https://cdn.pefc.org/pefc.org/media/2019-02/023fae13-c278-4104-93e0-bf48b123bc8b/5aa3f8bc-30c3-5f99-951e-e6a8f6d1d01b.pdf

Provide a description (or summary) of the normative requirements and guidance/interpretations.

Other sources of public information will also be considered. This will include insights from recent studies reviewing individual value chains etc., tools and practices that focus on measuring the effectiveness and robustness of CSLs.

The literature review should focus on key aspects of bio-based Certification Schemes and Labels (CSLs). The review is conducted on Google Scholar using specific terms and criteria to find articles published within the past six years. The terms included in the search are: 'meta-analysis', 'critical discussion', 'analysing key aspects', 'review', and 'sustainability assessment'. The governance system of CSLs based on the ISEAL credibility principles is explored, with attention given to different categories of bio-based products and aspects of certifications, such as best practices and market mechanisms.

We will also include conclusions and information available on schemes publicly and on international databases such as the UN Standards Map.

1.2.5 Direct interviews and discussions with relevant Scheme personnel

Interviews with Scheme personnel (and, where relevant, related bodies such as assurance providers, accreditation bodies and certificate holders) are expected to provide the assessment team with information about the intended functioning of schemes and deepen the understanding of the activities of the scheme participants.

At the outset of each Scheme assessment, an 'initial list' of information required from the Scheme may be elaborated, to be presented as soon as possible to Scheme personnel.

The subject matter for future interviews with Scheme personnel, shall vary according to the questions that remain or gaps that require filling in the assessment.

Questions should be formulated by email and written responses with evidence (additional data, information, guidance or normative documents…) requested in return. This will reduce the time for notetaking and ensure accurate records of the Scheme response are recorded.

If necessary, follow-up interviews or calls can be conducted by either phone or online, to clarify questions or responses in the email exchange. Where possible, they should be carried out in the language of the interviewee.

Returned written responses (and/or interview notes) should be saved (with a systematic file name) in the relevant file.

Sources referenced in the Scheme Evaluation Report (SER), shall be described in the following way: i) Certification Scheme; ii) Interview/email date; iii) Interviewee (position).

E.g., BV call-14/10/2020-Head of Accreditation.

E.g., FSC email responsel-09/12/2020-Head of Accreditation.

Evaluation of coverage

The **objective of the analysis** is to understand how well a Scheme is aligned to meet requirements of the SEF.

Sections A1 to A3 may be relatively straightforward to analyse, as they mostly address performance requirements and coverage of the definition of timber legality as far as the EUDR is concerned.

However, sections A4, A5, B and C address issues of quality. As a result, it may not necessarily be the case that a gap (*Partially Covered* or *Not Covered* conclusion) in relation to a single criterion may not necessarily always result in the need to report a significant deficiency or gap in the Scheme as a whole, but rather just point to a potential vulnerability in relation to the Scheme's robustness or potential weakness.

Provide an **appropriate justification** for coverage by the Scheme of the specific indicator in the SEF, as necessary. This will follow the following approximate format:

- Description (or summary) of the normative requirements
- Discussion of findings, including an overview of issues and risks (based on referenced sources) relevant to the indicator. Include any Outcomes or impacts data or information (as per 8.6 above).
- Conclusion & Justification which shall be clearly formulated as **Covered**, **Partly Covered** or **Not covered**. Include a summary justification of the designation to provide the rationale behind the final conclusion. E.g., "*based on findings x, y and z, it is concluded that the indicator is PARTIALLY COVERED*".

Record any variations in conformance between types of certification standard, or certification models. Examples:

> "An area of customary rights may be included within the PEFC FM standard, but does not form part of the definition of legality in the PEFC COC Controlled Sources section of the COC standard"
>
> "FSC FM certification and FSC (FM) Controlled Wood standards may cover an indicator, whereas SLIMF certification does not."

Record the level of conformance of the Scheme with the indicator. Options[5] include: 1. Covered, 2. Partially Covered or 3. Not covered.

For A1, conclusions may be made at CRITERION level. In this case, an additional category, "Intent Covered" can be used where the scheme standard meets the intent at a criterion level, even if some indicators may not be fully covered.

An aspect is considered covered if the performance requirements are not simply stated but operationalised with corresponding criteria and indicators, e.g., specific indicators for legal compliance should exist. Each indicator in the SEF is analysed separately for indicator-level comparison. Sometimes there is a one-to-one match between indicators. However, one indicator in the SEF often links to several ones in the benchmarked standard. For example, suppose one indicator from the SEF corresponds to three indicators from the benchmarked scheme. If all of them together cover the SEF indicator, all are marked as "covered". When all three indicators collectively still do not fully address the one from the SEF, all are denoted as "partially covered". The following **issues are considered in the analysis process**:

When the scheme standard includes optional requirements, which are not mandatory (and will not become mandatory in the certification cycle), they are not considered part of the comparison. When there are stepwise requirements (e.g., indicators that become mandatory by a certain year in the programme), they are regarded as normative and will be included in the comparison.

If a scheme standard requires a procedure, we assume that it will be implemented and followed. On the other hand, if the Sustainability Framework requires a specific performance level or outcome, we assume that a relevant system/approach is implemented to achieve the result.

A single general indication in the scheme standard on a topic may not be considered sufficient to fully address the topic. An example would be a single generic statement about legal compliance. If there is such a general requirement, we consider if the scheme defines the scope of the legislation that is regarded as normative and applicable within scheme documentation (i.e., required to be followed). The scope should at least indicate general topics relevant to the criteria where we have legal compliance requirements.

When a SEF indicator does not have a corresponding one in the scheme standard, it is linked to the closest relevant criterion, and if it is not available either, it is linked to the applicable principle. If the criteria directly and explicitly address the indicator, then yes. Otherwise, it is marked "not covered".

When a Sustainability Framework indicator corresponds with an indicator and criterion from the scheme, only the indicator is linked.

In instances where the criterion is not applicable (e.g., animal welfare criterion for some commodities), the criterion is marked as non-applicable. However, when some critical aspects are missing and need to be addressed, the overall criteria are marked as such, indicating that they are a part of the checklist for field evaluation and need to be considered.

The definitions of the options are as follows:

Conclusion	Definition	Explanation
Covered	When available Scheme requirements and information - and any impacts evidence available -	Coverage is the ability of the Scheme to provide assurance that material traded via the Scheme has a low (negligible) risk of being illegally harvested,

[5] As a result of having only three possible scores, the option of trying to divide partial coverage into a number of different levels is avoided, which carries a significant risk of becoming subjective.

	indicate the *coverage* of the SEF indicator.	traded in line with the legality definition of the EU Timber Regulation.
Intent Covered	There may be differences or gaps in individual indicators within a criterion, however overall intent is addressed.	Intent is covered at a criterion level
Partially Covered	When available Scheme requirements and information - and any impacts evidence available - indicate only *partial coverage* of the SEF indicator. Alternatively, special concerns about Scheme standards, credibility, rigor or coverage may exist. NOTE: It is important to justify the partial coverage and indicate where the issues are which result in a Coverage conclusion not being given.	Partial Coverage means the Scheme is only partly able – or may be compromised in one or more ways – to provide assurance that material traded via the Scheme has a low (negligible) risk of being illegally harvested, traded in line with the legality definition of the EU Timber Regulation.
Not Covered	When available Scheme requirements and information - and any impacts evidence available - indicate that there is *no coverage* of the SEF indicator. NOTE: It is important to justify a no coverage conclusion.	The Scheme is not – or inadequately – able to provide assurance that material traded via the Scheme has a low (negligible) risk of being illegally harvested, traded in line with the legality definition of the EU Timber Regulation.
Not Applicable (N/A)	When, for whichever reason, the SEF indicator does not apply.	

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Appendix D. Methodologies of WP5

Task 5.1: Draft monitoring system

As explained in the main report, the aim to develop a monitoring system separately was abandoned and replaced by a proposal by the three ZEROPOL sister projects to develop a joint monitoring system (JMS). The proposal shown below was approved by the project officer and European Commission in mid-May 2023. The JMS methodology wil be developed form June -December 2023.

Joint Monitoring System for Bio-Based Certification Schemes and Labels

Proposal to the EU Commission from HARMONITOR, STAR4BBS, and SUSCERT4BIOBASED

Introduction

This document presents a proposal for a Joint Monitoring System (JMS), providing information on the proposed set-up of the JMS, resources & time planning, and intellectual property rights (IPR). It includes following main sections: i) benefits of having a JMS; ii) the purpose, audience, and scope of the JMS; iii) proposed structure of the JMS; iv) a description of the specific focus of each project; v) time planning, resources and IPR management.

I. Benefits of a Joint Monitoring System

A key benefit of a JMS is to reduce confusion, divergences, and mistrust among stakeholders since having three different systems with potentially slightly varied results can impede trust and application of these systems beyond the project. A JMS has a better chance of bringing harmony and coherence to the space and clarity for policymakers driving the transition to a bioeconomy in the EU. This is also important for the value of the JMS beyond the project where there could be a specific harmonized tool that can be used to analyze the performance of other CSLs (Certification Schemes and Labels). Instead of 3 potentially competing systems that would be developed from the projects, it is aimed in this way to develop a joint, overarching system.

Having three projects working together on the development of the JMS would allow us to build on each other's knowledge and experience, effectively subjecting the system to a higher level of scrutiny during the development and testing stages. By joining forces, we would be able to maximize the effective use of the resources at our disposal to gain more depth on every aspect of the system. It will allow a higher comprehensiveness of the system in its scope and usefulness to a wide range of stakeholders. Indeed, with a JMS we will be able to streamline stakeholders' consultations, pooling our networks and reducing stakeholder fatigue.

In addition, the inter-project collaborative process of conceptualizing and developing the JMS will eliminate competition among the three projects, while maximizing synergies and impacts of the results. It will also facilitate and increases the chances to secure long-term funding of the tool, beyond the life of the three projects. By joining forces, more than 30 institutions will be involved in the development, testing and validation of the tool. This will allow a broader comprehensiveness of the coverage and applicability of the tool and will increase the chance to identify a potential institution willing to host and adopt the tool. In addition, the higher number of institutions involved represents an important advantage

in terms of stakeholder engagement in the development, optimization and exploitation of the tool. Last but not least, we expect that a single tool, supported by a large number of institutions will have a better chance of being adopted than three individuals, competing tools. Although the creation of a JMS would require greater coordination between the projects, we believe that it is not only feasible but also worthwhile to work together, providing a more comprehensive and detailed tool, covering a wide range of bio-based sectors and products.

II. Purpose, Scope, and Audience of the Joint Monitoring System

Purpose

The JMS aims to provide the European Commission and certification schemes and labels owners with a framework to evaluate the potential of CSLs (certification schemes and labels) and their accompanying standards to contribute to objectives and sustainability goals prioritized in EU relevant policies and SDGs (Sustainable Development Goals). It intends to facilitate the potential harmonization of existing certification schemes and labels of biobased systems in terms of shared sustainability and governance criteria. The JMS will further increase the understanding of the effectiveness and robustness of the existing sustainability certification schemes and labels for biobased systems in the European market.

The subsequent application of the JMS (and its further elaboration through recommendations, additional guidance, and standardization) will provide a baseline for the assessment of certification schemes and labels, which is key to informing stakeholders about the strengths and weaknesses of CSLs at the system, content, and outcome levels. This information could potentially be used to improve CSLs performance.

The JMS will provide comprehensive criteria needed for biobased systems to be qualified as sustainable and together with its accompanying roadmap, drive continuous improvement towards an aspirational performance. It will increase the understanding of the effectiveness and robustness of the existing sustainability certification schemes and ecolabels for biobased systems in the European market. The JMS will be developed by following established guidelines ensuring schemes are not only credible but tangible impacts can be achieved through their appropriate implementation.

Scope

The JMS will be developed for analyzing sustainability certification schemes and labels for biological resources intended for industrial biobased value-chains and to biobased materials and products. Industrial biobased systems do not include food/feed, biofuels, bioenergy, and cultural/recreation sector. The entire value chain will be considered, capturing all aspects of a product's life cycle (with each main stage of the value chain being covered separately). While the JMS will be applicable to products traded within the EU, the evaluation of entire value chains of biobased products will cover other geographical regions involved in the production and handling of the products (i.e., production of feedstock and all upstream and downstream operations within the supply chain).

Direct Audience/Users

The JMS will be developed for two direct audiences: the European Commission/policy makers and the certification schemes and labels owners (see the Table below). Indirectly, the JMS will be also accessible for industry users, NGOs, practitioners and general public. The methodology of the JMS and the assessment/validation examples will be made public.

The European Commission/ Policy Makers	The JMS will increase transparency regarding performance of existing CSLs for biobased systems, including an evaluation of their effectiveness and robustness. The commission could use the tool as an Implementation mechanism to fulfil regulations (in analogy with REDII for biofuels/bioenergy).
Certification Schemes and Labels Owners	The CSLs owners would have access to a harmonized system that would cover entire value chains as well as have a transparent evaluation system. CSLs owners could potentially use the JMS as a benchmark to address the gaps in their own systems, with the aspiration performance defined in the JMS.

III. Proposed Structure of the Joint Monitoring System

At the center of the JMS is a **set of indicators** designed to collect key information about the robustness and effectiveness of the certification schemes and labels. This will be built in three levels: I) System level; II) Content Level and III) Outcome Level. 'System indicators will focus on system characteristics, such as how a scheme is governed and how the standards or labels are developed. 'Content indicators' will clarify the requirements of the certification scheme or label vis-à-vis specific EU environmental, social, economic and circularity priorities and targets. Minimum requirements that all CSLs should adhere to will be defined with a life cycle perspective. 'Outcome indicators' will enable to capture impact made by the schemes and labels. Outcome indicators will include life-cycle assessment comparison indicators and continual improvement indicators.

The indicators will be tested with the most relevant bio-based certification schemes and labels in use today, capturing results in a central **database** (Figure 1). On their own, the usefulness of these indicators and accompanying database for end users is limited. The data needs to be interpreted to mean something to them. Therefore, another key component of the JMS will be a layer of **interpretation** (e.g., minimum requirements, a traffic light system and rankings), which will provide the assessment results of the application of the indicators of the database in a schematic and clear way. In particular, this interpretation stage, building on the applied evaluation methodology and related minimum requirements for each indicator, will define a rating and scoring mechanism, which will allow a final visualization of the results.

While the JMS will be a new and unique tool, it will build on previous projects results (among others STAR-ProBio where 3 projects were involved), existing assessment/benchmarking tools (e.g., FAO SAFA, WWF CAT) and/or databases (e.g., ITC Standard Map). SUSTCERT4BIOBASED produced the deliverable D3.1 in Nov 2022 containing a review of existing monitoring approaches which will provide input for the JMS development. In addition, STAR4BSS is currently conducting a specific task on the review and analysis of existing monitoring system (D1.4 due August 2023). The HARMONITOR project will soon launch a dedicated public consultation on the (strength and) weaknesses of existing CSLs. All of these activities will be bundled and used for the JMS.

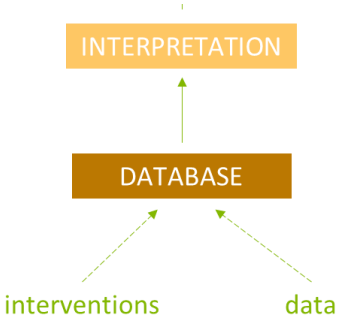


Figure 1. Skeleton of the Joint Monitoring System

Proposed Division of Responsibilities among the 3 Projects

Database

A. Coordination at the Three Levels - Division of Project Management Responsibilities:

All three projects will work on the conceptualization and development of all the elements and levels of the JMS, respecting the work packages and tasks described in the grant agreement of each project The development of a JMS among the three projects will require intensive coordination of efforts coming from teams involved in the three projects. In order to systematically collect the inputs from the three projects in a strategic way, we considered it important to have each project coordinate one level. Although each project could potentially coordinate each area, we propose an allocation of the coordination role, based on the strengths of each project and its partners involved. STAR4BBS will coordinate the development of the System Level, the knowledge and practical experience of project partner ISEAL in defining credibility in sustainability systems. ISEA´s Codes of Good Practice cover many relevant aspects such as standard-setting and credible assurance processes.... SUSTCERT4BIOBASED will be leading the Content Level this is in agreement with the focus of the project on the sustainability and circularity criteria where partners WR and ECOS are heavily involved. WR has been working on review and analysis of circularity criteria for biobased products where we would like to see progress seen in CSLs. As an environmental protection organisation working on EU sustainable product policy (such as the Ecodesign for Sustainable Products Regulation), ECOS has a strong expertise on environmental and circularity aspects. Between 2020 and 2022 ECOS was also a member of the Platform on Sustainable Finance, and appointed as circular economy expert, following various bioeconomy related activities to be included in Taxonomy delegated acts. HARMONITOR will be leading the Outcome Level as the WP leader Utrecht University as an academic organization has activities planned in their project to tackle assessment of the effectiveness aspect. This is also linked to the fact that Utrecht University has hired a PhD student, who will use part of the HARMONITOR work as foundation for a PhD thesis. As assessing the outcome level is currently the least explored and as such allows for methodology development and to venture beyond the current scientific state of the art.

We emphasize that all three levels are equally relevant for the intended users. Assessing and monitoring CSL on system, content and outcome level are all relevant aspects for both policy makers and CSLs themselves and should be jointly evaluated.

- System Level – STAR4BBS (coordinator)
- Content Level - SUSCERT4BIOBASED (coordinator)
- Outcome Level - HARMONITOR (coordinator)

B. Division of Labor Across All Three Levels – Full Participation at All Three Levels:

Each sister project will work jointly in the development of the core JMS. Under the coordination of one project in each level, each sister project will provide inputs on the conceptualization of the content of each level and will be responsible for the development of a subset of indicators using their project proposal as a guide to determine what aspects to focus on. Where there is an overlap between projects, projects will work together to further split the work and broaden the coverage in terms of sustainability thematic areas to be covered. This efficiency will allow more time to be spent on customizing the JMS during the testing phase to account for the nuances between different stakeholders and/or value chains (Section C below).

C. Division of Labor in the Joint Monitoring System Pilot Testing Phase: definition of the focus of each project based on the analysis of different Value Chains

It is expected that the JMS can have so-called add-ons to reflect the unique aspects of different value chains that are not covered in the core system (Figure 2). Each sister project will work on these add-ons linked to the specific resources or product categories depending on their value chain selection defining additional requirements for these. Based on the testing, feedback will be used to improve the JMS.

Interpretation

The three projects will work jointly in the Interpretation component of the JMS, proposing for each indicator minimum requirements and an overall evaluation mechanism to be applied for scoring/rating the analyzed CSLs. Stakeholder engagement will be a requirement for the development of this layer.

Testing (Pilot and general testing)

Different types of testing of the monitoring system will be carried out. First is the Stakeholder engagement which will be continued throughout the monitoring system development. The three projects will have joint workshops where they will present and ask input/feedback on the JMS. They will jointly work on incorporating these inputs/feedbacks in optimization of the JMS.

Pilot testing: will be carried out in an early stage (preliminary version of the tool) with a small number of CSLs. In particular, within the STAR4BBS project the tool will be tested with RSB and Better Biomass, in the SUSTCERT4BIOBASED project with CU and in the HARMONITOR project with RINA CONSULTING and with PreferredbyNature. This will provide feedback in terms of practical applicability of the requirements of the JMS for further optimization.

After the pilot testing, an updated version of the JMS will be tested s on a broader number of CSLs. This testing might be divided between the 3 projects linked to the value chain selections. This selection of value chains and CSLs have not been yet finalized but the intention is that the three projects together will cover a broader coverage in terms of sectors in the biobased industry and most prominent CSLs.

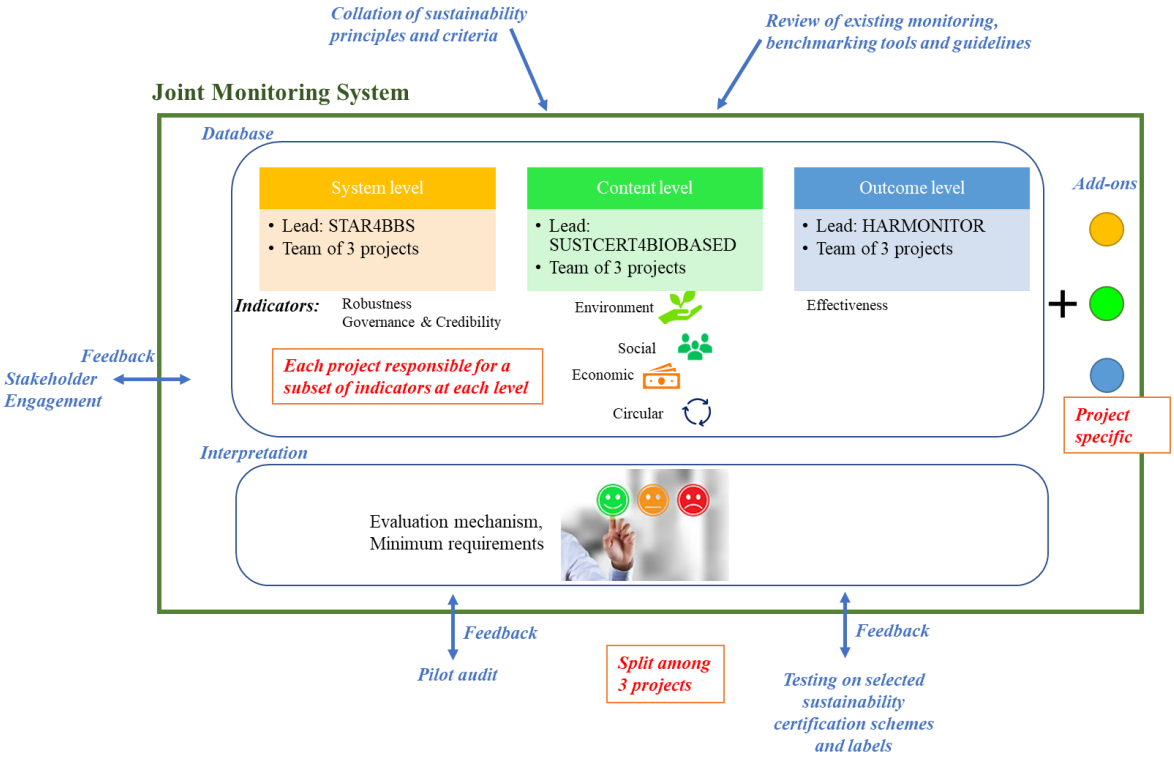


Figure 2. Graphical representation of the JMS

IV. Proposed timeline, Resources and IPR management

Proposed time planning for the JMS

Task	Timelines
JMS proposal development	Dec 2022 - January 2023
JMS proposal presentation to EC Project Officers	February 2023
JMS proposal refinement and finalization, based on POs input	February/March 2023
Development of draft criteria (system, content, outcome)	March 2023 – January 2024
Co-creating workshop selection of CSLs. Partially linked to the JMS (STAR4BBS)	May/June 2023
Stakeholder engagement – joint side event as part of EUBCE in Bologna. At this event, we plan to amongst others present the outcomes of the HARMONITOR stakeholder consultation and collect further input on the requirements for the JMS	June 2023
First draft of the JMS	January 2024
EC Policy officers' workshop on draft JMS (proposed, to be coordinated with project officers)	January 2024 (proposed)
Testing of the JMS (Stakeholder engagement* + Pilot Audit + Testing on CSLs) + Improvement of the JMS with Feedback	Feb 24 – May 25
Final version of the JMS	May 2025

We emphasize that the list of workshops presented here is preliminary. As part of the stakeholder engagement, it is very likely that additional events will be planned, depending on the needs for stakeholder engagement and opportunities to link it to relevant events. This may for example include another workshop at the EUBCE in early summer 2024, but this will be planned in due time.

Resources

There will not be a need for additional resources nor a shift of budget between partners. There could be internal shifts in the timing of the resources spent in specific tasks and possibly more effort in terms of coordination between the three projects.

IPR

The JMS will be jointly owned by the cluster of the 3 sister projects. The final JMS will be publicly available. We will jointly strive to find an organization to host the JMS as a tool after the end of the three projects. If the commission approves this plan, the three sister projects will take the following actions:

- Each project will include the joint ownership of the JMS in their own Exploitation plan.
- Each project will hold a General Assembly and check acceptance of all project partners of developing and owning the JMS jointly, and this will be formally recorded.
- Each project will also check if any amendment of the Consortium Agreement would be needed accordingly.

Annex 1

HARMONITOR

Milestones and Deliverables:

Original planning in the grant agreement and proposed new planning, including Milestones and Deliverables:

	Original planning	Proposed new planning
Milestones:		
None defined for WP5		
Deliverables:		
D5.1 Draft monitoring system	May 2024 (M24)	Jan 2024
D5.2 Monitoring system test results	February 2025 (M33)	February 2025
D5.3 Validated monitoring system (Joint Deliverable)	May 2025 (M36)	May 2025
Tasks:		
Task 5.1: Develop a monitoring system for all CSLs reviewed	Nov 2 23-May 2024 (M18-24)	Oct 2022 – Jan 2024
Task 5.2: Apply the proposed monitoring system and indicators on CSLs reviewed	Feb 2024 -Feb 2025 (M21-33)	Jan 2024 – Feb 25
Task 5.3 Validation of the monitoring system	Nov 2024-May 2025 (M30-36)	Mar 2024 – May 2025

STAR4BBS

Original planning in the grant agreement and proposed new planning:

	Original planning	Proposed new planning
Milestones:		
MS4 Final selection of metrics and thresholds for the indicators	Jun 25	Jun 25
MS5 Monitoring system developed	Feb 25	Feb 25
Deliverables:		
D3.1 Report on sustainability indicators for the monitoring system based on Life Cycle Assessment	Aug 23	Aug 23
D3.2 Report on additional indicators of monitoring system	Nov 23	Nov 23
D3.3 Report on metrics, thresholds and minimum requirements for sustainability indicators	Aug 24	Aug 24
D3.4 Final Sustainability requirements for the monitoring system	Jun 25	Jun 25
D4.1 Concept of the monitoring system ® (also ranking & interface)	Aug 23	Aug 23
Monitoring Tool System (draft)	Aug 24	Aug 24
D4.2 Monitoring Tool System	Feb 25	Feb 25
Additional Joint Deliverable: Final version of the JMS*		May 25
D4.3 Report on the testing and ranking	Aug 25	Aug 25
Tasks:		
T3.1 Identification and development of sustainability indicators	Sep 22 – Aug 23	Sep 22 – Aug 23
T3.2 Identification of additional non-LCA indicators	Nov 22 – Nov 23	Nov 22 – Nov 23
T3.3 Minimum requirements for the selected indicators	May 23 – Jun 25	May 23 – Jun 25
T4.1 Conceptualization of the monitoring system	Oct 22 – Aug 23	Oct 22 – Aug 23
T4.2 Development of the monitoring system	Aug 23 – Feb 25	Aug 23 – Feb 25
T4.3 Testing and applying newly developed monitoring system	Feb 24 – Apr 25	Feb 24 – Apr 25
T4.4 Reporting on final assessment of SCS and labels	Aug 24 – Aug 25	Aug 24 – Aug 25

*Adding an extra joint deliverable

SUSTCERT4BIOBASED

Original planning in the grant agreement:

	Original planning	Proposed new planning
Milestones:		
MS6 Draft monitoring system developed	May 23	May 23
MS8 Best-in-class schemes and labels selected	Mar 24	Feb 25
MS9 Pilot audits completed	Oct 24	Oct 24
Deliverables:		
D3.2 Evaluation of existing schemes and labels	Mar 24	Feb 25
D3.3 Description of the monitoring system (Joint Deliverable)*	Nov 24	May 25
Tasks:		
T3.2 Developing a new monitoring system	Oct 22 – Aug 23	Oct 22 – Jan 24
T3.3 Testing the developed monitoring system on reviewed schemes and labels	May 23 – Mar 24	May 23 – Feb 25
T3.4 Carrying out pilot audit for testing the monitoring system requirements	May 23 – Oct 24	May 23 – Feb 25
T3.5 Implementing feedback and optimizing the monitoring system and indicators	Mar 24 – Nov 24	Mar 24 – May 25

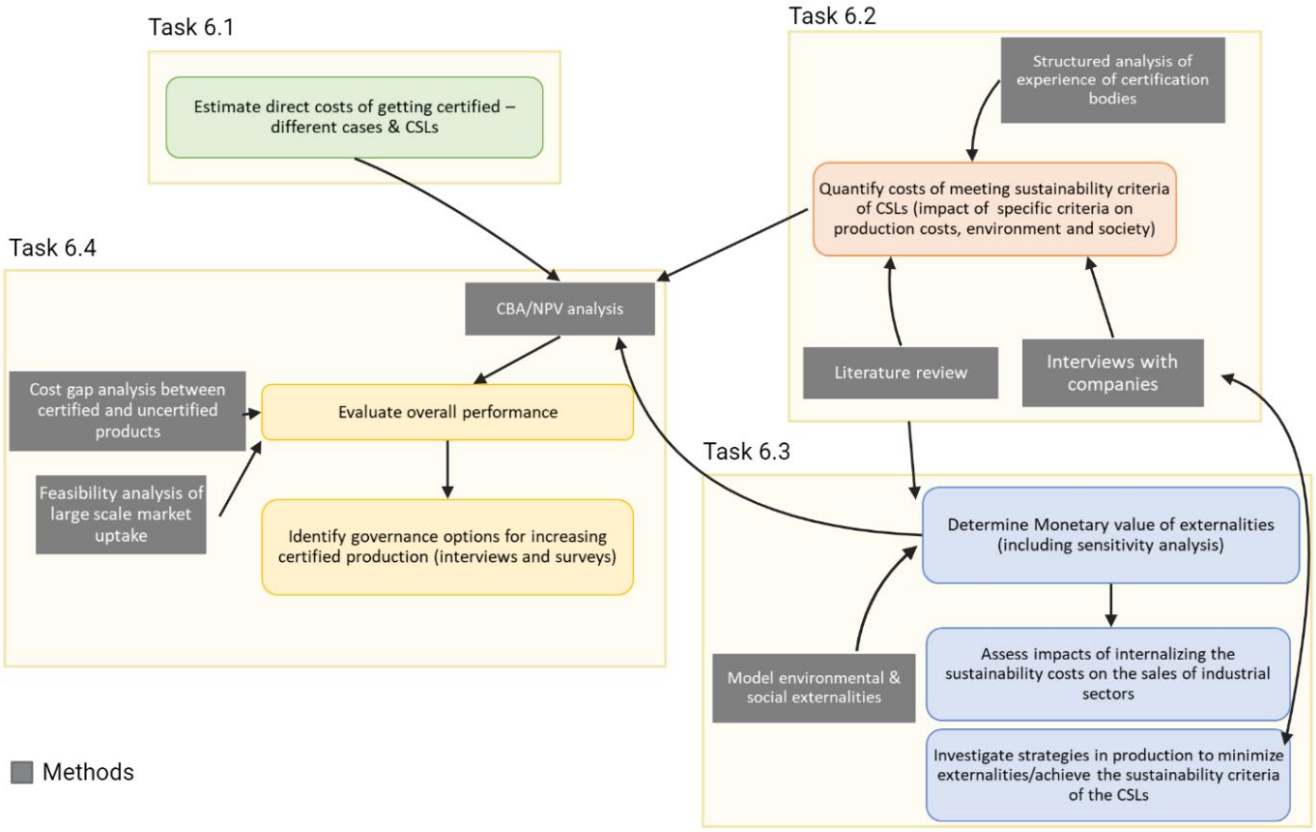
* Proposed as a joint deliverable describing the final and optimized joint monitoring system after testing

Appendix E. Methodologies of WP6

WP6 methods

Certification of biological resources and bio-based value chains entails costs and benefits that depend on the type of CSL, the level of stringency in terms of sustainability criteria and assurance system, the quantification and monetization of externalities, and case-specific characteristics such as e.g., biological resource, agricultural or forestry management practices, value chain, and location. Questions on better understanding the economic feasibility of CSLs can come from diverse backgrounds. For example, a policy maker may want to know the costs of certification at an ambition level of sustainability requirements as a co-regulation instrument in the policy framework of the EU bio-based economy. A market actor may want to know the direct and indirect costs for getting certified and getting access to the EU market, or whether increased costs from getting certified can be recovered by increased benefits from the certification. A certification scheme operator may ask what the costs are from transitioning a scheme with minimum sustainability requirements towards more stringent requirements for specific aspects or for the entire scheme. So far, there is still a lack of detailed understanding of the economic feasibility of CSLs, including the variability of results depending on the biological resources, value chains and uncertainties in method and data, and the net effect of certification, i.e., internalizing and monetizing positive and negative externalities for giving a comprehensive overview of costs and economic feasibility of CSLs.

To determine the feasibility and economic performance of CSLs, it is important to distinguish and understand the different associated costs and benefits. For costs, there are: (a) the **direct costs of getting certified** by a CSL (Task 6.1); and (b) the **cost of achieving the sustainability criteria** set by the CSL (Task 6.2). The direct costs consist of, for instance, certification and audit fees, whilst the indirect costs are associated with upgrading the management and production system to meet the sustainability criteria. At the same time, certification promises numerous benefits such as (increased) access to certain end user markets, higher prices for certified products or co-benefits from increased ecosystem services. The latter are called externalities and are not normally valued in monetary terms. They will be quantified to estimate the **co-benefits of CSLs** (Task 6.3). Taking the different direct and indirect costs and benefits from the previous steps, the **overall feasibility and economic performance** of CSLs will be evaluated (Task 6.4).



Task 6.1 Quantifying direct costs of certification

This section outlines the discussion and approach taken by the WP6.1 working group assigned to quantify the direct cost of certification. The group comprises Preferred by Nature (lead), RINA SERVICES, Agrovet, Utrecht University, and Radboud University.

The direct costs of certification are identified as:

- the fees charged by the certification body (CB) to conduct the audit;
- fees charged by the certification scheme owners; and
- any fees for trademark usage incurred for participating in the CSL.

The WP6.1 group also considered taking a more detailed view of the cost charged by the CB to e.g., including travel and accreditation costs, as both could be considerable depending on the CSL. This was, for the time being at least, deemed unattainable with the resources allowed for this task.

The method for determining the direct costs contains the following elements:

- Identify which partners in the HARMONITOR project have access to direct costs through their organizations. These are likely to be accredited Certification Bodies (CBs); in HARMONITOR, these are RINA SERVICES, Preferred by Nature and Agrovet. It is expected the mentioned partners will be able to provide ranges on the cost of certification schemes.
- Engage with the sister-projects to identify if any of their partners are working in the capacity of CBs and which could also contribute with certification cost estimates.

- Inquire scheme owners and umbrella organizations such as ISEAL if they can provide guidance on the data points the group has collected. This is likely to be done in the half of 2024.
- Consult academic literature to explore if academia offers any cost estimates or methods that can be useful. An early impression of this option is that scientific articles are more focused on case studies that only represent specific geographies or are otherwise limited in scope.

The discussion also included validation of the data input. After gathering a number of data points, this topic will be considered again. One option would be to engage with scheme owners or CBs to confirm the cost ranges the WP6.1 group has found.

Another metric that has not been decided on is setting a common denominator for comparing the CSLs i.e., could it be relevant to average the cost per hectare or output volume of the product should this make a beneficial comparison. This discussion is saved for when the WP6.1 partners have hands on the data collected.

Task 6.2 Indirect costs and benefits of getting certified

In task 6.2 the indirect costs and benefits of achieving the sustainability criteria set by CSLs are quantified. First, a review of the existing literature on costs and benefits of certification will be conducted. Then, additional information will be collected through a structured analysis of the experience of certification bodies involved in the project and interviews with certification companies. The information gathered will then be used to select and examine 5 case studies to determine the impact of meeting specific sustainability criteria on the production costs, environment, and society. The studies will be chosen trying to represent the diversity of the bio-based economy as much as possible.

Methods literature review

The aim of the literature review is to determine the direct and indirect costs and benefits of getting certified. The focus of the review will be on the agricultural and forestry products, and within these sectors specifically address currently underrepresented and relevant feedstocks, such as palm oil, natural rubber, soybean, sugar cane, wood, and raw cotton. The study will follow a systematic approach based on the PRISMA guidelines for systematic reviews (Page et al., 2021). Different databases will be scanned to find relevant studies. The eligibility of the studies will be determined in two phases (scanning titles and abstracts, and full-text reading) based on a set of inclusion and exclusion criteria. A preliminary list of exclusion criteria is:

- Full-text not available
- Not in English
- Only focused on environmental impacts of certification (no socio-economic impacts mentioned)
- Not on feedstocks of interest for the review (i.e., coffee, tea)

Both qualitative and quantitative papers will be included and synthesized; for quantitative studies, data on costs and benefits of certification will be extracted, as well as information on data collection and analysis. This will then be used as a guideline for the analysis of case studies.

Methods for analysis of case studies

Based on the information gathered so far in the literature review, we drafted a preliminary list of data to be collected to determine the direct and indirect costs of getting certified, as well as suggested collection methods (Table 1). Data can be collected at different levels, depending on the focus of the analysis (farm, household) and will be collected for certified and uncertified farms (to build a counterfactual). The collection methods are yet to be determined, but will probably be surveys, interviews, focus groups, or any combination of those.

Data	Level
Location	Farm
Feedstock(s)	Farm
Certification(s)	Farm
Year of certification(s)	Farm
Farm size	Farm
Certification area	Farm
Number of employees	Farm
Male/female employees	Farm
Family size	Household
Male/female led	Household
Years of education members	Household
Income	Farm/household
Income from sale of certified product	Farm/household
Expenditures	Household
Certification fees	Farm
Auditing fees	Farm
Indirect costs of meeting sustainability requirements	Farm
Recurring costs	Farm
Operational costs	Farm
Labor cost	Farm
Production volume	Farm

Certified production volume	Farm
Yield	Farm
Price certified product	Farm
Gross return	Farm
Profit (benefit-cost)	Farm/household
Constraints in CSLs adoption	Farm
Child school attendance	Household
Educational facilities	Certified area
Health facilities	Certified area
Child mortality	Household
…	

It is not clear which methodologies will be used for the data analysis. We are currently collecting information on the available methodologies used in previous studies, as well as their limitations.

Task 6.3 Modelling environmental and social externalities

Description

While the growth of EU's bio-based economy in recent years[1] might be viewed a positive development towards sustainable production and consumption, there are environmental challenges (such as climate change due to GHG emissions, and the use of water and land) associated with producing bio-based commodities and services.[2] These production side impacts refer to the direct impacts of production activities, for instance, the use of water for cultivating wheat in France or Germany, independent of where the biomass is used. To manage and reduce the environmental damage, it is, however, not sufficient to estimate the environmental impacts solely from the production side. Accounting for the environmental impacts caused upstream of supply chains due to the consumption of bio-based commodities in the EU region is also necessary if the environmental footprint of the EU bioeconomy is to be reduced.

Relevant terminology

We use the term "domestic" to refer to any impact caused within the geographical region of focus, and the term "external" to refer to any impact caused outside the region. The consumption of a bio-based commodity by end users in a region can have two kinds of associated impacts- "direct" and "indirect". Direct impacts are those that occur domestically due to the production of a bio-based commodity for consumption by end users within a region. Indirect impacts are the impacts associated with the production of intermediate commodities that are required as inputs to the production of a commodity for end use (or "final demand"). These can be domestic, i.e., when the upstream inputs are produced domestically, as well as external, i.e., when the upstream inputs are imported from other regions. For

instance, soy grown in Brazil has some amount of water use associated with it. The soy may be exported to the Netherlands as feed for livestock. The livestock is consumed by people, i.e., the final demand is for livestock. The water used for growing the soy in Brazil that is an input to the Dutch livestock sector is an indirect external upstream impact of the Dutch livestock sector. Further, the impacts associated with commodities that are imported directly for final consumption (and not as inputs to domestic production processes) also fall under this category. For instance, wheat may be imported into a country to be sold directly to consumers.

Approach

We will use the technique of environmentally extended multi-regional input-output (EE MRIO) analysis to estimate the direct and indirect impacts associated with the consumption of bio-based commodities in all countries belonging to the European region. The impacts will be estimated at the country level and at the level of individual countries' economic sectors, as well as at the total EU region level and its economic sectors.

Research steps

1. **Defining relevant sectors (bio-based sectors)**

The first step is to define all sectors that are relevant to the bioeconomy. From the chosen MRIO database, first, the sectors that comprise of biological resources and bio-based products are identified. All sectors are categorized into 1) fully bio-based 2) partially bio-based, and 3) non-bio-based sectors.[1] The bio-based shares of the partially bio-based sectors will be estimated. For this categorization and bio-based shares estimation, we have identified two ways from the literature, namely the input-based approach[3,4] and the output-based approach[1,5].

In the input-based approach, the bio-based share of a sector is determined based on the share of biological resources that goes into the production process of that sector. All resource inputs to a sector are first classified as into bio-based and non-bio-based. In previous studies, this classification has been done based on expert opinions or based on official production statistics from national accounts.

In the output-based approach, first, the biomass contents of bio-based products are obtained based on experts' estimates. Bio-based products are defined as those made of both biomass as well as fossil, mineral or synthetic feedstock. For example, the manufacture of textiles, wood products, chemicals, pharmaceuticals, electricity, etc. Using national or regional statistics on total production volumes of these products, the total bio-based share for each product is estimated. These products are then mapped to aggregate sectors, to obtain the bio-based shares of economic sectors.

We will compare the two approaches to understand which of them is the most suitable in the context of input-output modelling and select one.

2. **Quantifying the environmental impacts**

Treating region-wise sectoral environmental impacts (say, GHG emission intensities) as the satellite account of the Leontief MRIO model[6], we construct an EE-MRIO model as represented by the following equation. [Equation]

In this Leontief equation, $\boldsymbol{G_r}$ represents the total consumption based GHG emission footprint of region r. $\boldsymbol{g}$ represents the GHG emission intensities of each sector of each region contained in a row vector.

$(I-A)^{-1}$, is called the Leontief inverse and also represented by L. y_r is a column vector that contains the product flows from all regions to the final demand of region r.

I is an identity matrix. A is a square matrix, known as the direct requirement coefficient matrix or technical coefficients matrix. Each element a_{ij} of A indicates the direct requirement of products from sector i to produce one unit of total output in sector j.

An element l_{ij} of the Leontief inverse matrix $L = (I - A)^{-1}$ is the value of both direct and indirect requirements of products from sector i to produce one unit of final demand for sector j. The product $(I-A)^{-1} * y_r$ therefore, is a column vector which contains the total outputs of sectors in region r.

In this Leontief model, the production activities in an economy are considered to occur in order to meet final demands of regions. These final demands are considered to drive upstream production activities and the environmental impacts associated with them. Therefore, emissions are attributed to regions who finally consume goods and services. In addition to GHG emissions occurring due to consumption from domestic sectors, emissions embodied in imports to satisfy a region's consumption are included. The emissions embodied in exports are deducted. This net emissions value is the region's emission footprint, G_r. In this study, the focus is on the final demand of EU countries for bio-based materials.

We will use the or Exiobase MRIO database[7], which also includes environmental extensions. Monetary MRIO tables will be used, whereas the satellite accounts will be in mixed units (e.g., tonnes of GHG emissions per unit monetary output of a sector). The results will be in physical units (e.g., tonnes of GHG emissions to meet the final demands of bio-based sectors of EU countries). Environmental extensions such as emissions of CO_2, CH_4 and N_2O to air, blue and green water withdrawal and consumption, and land use (cropland, pastures, forests area, etc.) are available from Exiobase as well. These environmental impacts from various sources or processes are mapped to economic sectors of the MRIO tables to form the environmental satellite accounts.

3. **Estimating the monetary value of impacts**

To bring into a financial context the extent of the impact of EU's bioeconomy on the environment, we will estimate the monetary values of each environmental impact driven by the sectors of the EU countries. Such a financial assessment can facilitate more effective communication to decision-makers who are likely to be influenced to a greater degree by economic values as opposed to physical units of environmental damage.

Up to this point, we are aware of a couple methodological choices available to estimate these monetary values. One of them is the Natural Capital Accounting framework of the The Economics of Ecosystems & Biodiversity used in their joint study with Trucost on environmental externalities of businesses.[8] A resulting dataset from this study contains company-level measurements of environmental impacts that may be used to estimate environmental costs and further assess environmental risks. The other possible database is the Environmental Prices handbook by CE Delft[9] which contains monetary values for emissions (i.e., price of pollution in Euros per kilo of emission) of over 2,500 pollutants across countries and regions. We will compare these frameworks to understand how they can be used in the context of input-output modelling and the selected environmental impacts.

Possible extensions

1. **Social impacts**

Social impacts of the European bioeconomy, for instance the effects on national employment levels, national gross domestic products, and human health, may be assessed. The EE-MRIO system will first be set up with the altered trade values based on bio-based shares of European sectors for estimating the environmental impacts. The same set up can be used along with social satellite accounts available from Exiobase for carrying out this step.

2. **Internalizing externalities**

To further contextualize the environmental impacts in financial terms, we can assess how the profitability of economic sectors would be affected if they had to bear the costs of their direct and upstream environmental impacts. In present global policy scenarios, the environmental impacts are generally considered to be external to the economy and are also called "externalities". There are efforts to "internalize" these externalities, for instance, carbon pricing through carbon taxation or emissions trading. A previous study[10] on the environmental externalities of the Netherlands' economy found that its associated environmental damage amounted to as much as Euro 50 billion (or 7.3% of the national GDP) in the year 2015. For this step, we will additionally need to identify data sources for the annual profits of economic sectors of EU countries.

Task 6.4 Evaluating overall economic feasibility and governance options

The goal of this task is to evaluate feasibility and overall performance of certified products. Direct and indirect costs and benefits of certified and uncertified products will be calculated using cost benefit analysis and net present value analysis (van Eijck et al. 2014), as well as data collected in 6.1-6.3. After assessing the economic performance and feasibility of the CSLs, governance options to improve feasibility and adoption of CSLs will be defined. This task is fundamental to broaden the discussion on how to improve the sustainability of the bio-based economy through policy implementation. The methods for this task include a literature review (see 6.1, 6.2), 5-10 interviews with experts, and 2 surveys to measure if the understanding of the opportunities and limitations of using CSLs as co-regulation instruments for the EU bioeconomy has improved.

Methods for survey

The first survey has been prepared and launched in collaboration with T2.2 (open public consultation). Specific questions on value creation and potential and limitations of CSLs as co-regulation instruments were asked to address these issues.

Based on the outcome of this survey and tasks 6.1, 6.2 and 6.3, the methodology for Task 6.4. will be developed further over the course of 2023.

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