ShapingBio

The bioeconomy of the future

Analysis of Cross-Sectoral Collaboration

Deliverable 2.3

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List of Abbreviations

Abbreviation	Full name
APRE	Agency for the Promotion of the European Research
ART	Agriculture Research Troubsko, Ltd
ASEBIO	Asociación Española de Bioempresas
BaMS	Bioeconomy at Marine Sites
BBEPP	Bio Based Europe Pilot Plant
CAP	Common Agricultural Policy
CBE JU	Circular Bio-based Europe Joint Undertaking
CEE	Central and Eastern Europe
CORPI	Coastal Research and Planning Institute
CSC	Cross-sectoral collaboration
CTA	Technological Corporation of Andalusia
DG	Directorate-General
DG AGRI	Directorate-General for Agriculture and Rural Development
DG CLIMA	Directorate-General for Climate Action
DG ENV	Directorate-General for Environment
DG MARE	Directorate-General for Maritime Affairs and Fisheries
DG SANTE	Directorate-General for Health and Food Safety
DG TRADE	Directorate-General for Trade
EFI	European Forest Institute
EIC	European Innovation Council

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EIT Food	European Institute of Innovation and Technology in Food
EU	European Union
FBCD	Food & Bio Cluster Denmark
Fraunhofer ISI	Fraunhofer Institute for Systems and Innovation Research
GMO	Genetically modified organism
ICT	Information communication technology
IoT	Internet of Things
IUNG	Institute of Soil Science and Plant Cultivation (National Research Institute, Poland)
MAG	Multi-actor group
MedBESP	The Mediterranean Blue Economy Stakeholder Platform
R&D	Research and development
R&D&I	Research, development and innovation
SBM	Sustainable business model
SDG	Sustainable development goal
SEZs	Special economic zones
SFIN	Skåne Food Innovation Network
SMEs	Small and medium-sized enterprises
SUBNET	SUBMARINER Network
TEAGASC	The Agriculture and Food Development Authority (Ireland)
TRL	Technology readiness level
TTE	Tech Tour Europe
TTG	Tech Tour Global
WP	Work package

Executive Summary

ShapingBio project is dedicated to enabling bioeconomy innovations and facilitating the dissemination of new knowledge within the European Union (EU) and its member states. Specifically, the project aims to deliver evidence-based information, guidelines, and recommendations that foster better policy alignment and encourage stakeholder actions. This initiative is designed to support the cross-sectoral potential of the bioeconomy in Europe, aiming to diminish the fragmentation and isolation observed across different bio-based sectors and the food system, and to harmonise and streamline policies spanning various regions, domains, and governance levels.

This report D2.3 offers a comprehensive overview of the primary obstacles and identifies supportive measures that influence cross-sectoral collaboration (CSC) throughout the EU. The focus of the analysis was on existing collaborative structures across Europe, representing the main bio-based value chains: agriculture, forestry, blue bioeconomy and food sector. It draws on desk-based research including a literature review, 1:1 expert interviews and three workshops with practitioners and experts on collaboration in bio-based sectors.

The analysis reveals that numerous common factors hinder cross-sectoral collaboration across the EU, such as a lack of financing and missing culture of CSC. Governance and policy supporting the bioeconomy are important for the initiation and development of CSC. Strategies, and initiatives, ranging from regional to national to EU-wide, are necessary to collectively contribute to building robust frameworks, which encourage collaboration between different sectors and, therefore, boost knowledge exchange, resource optimization, and innovation. However, providing general support for the bioeconomy will not be sufficient to create efficient and effective CSC. Insufficient and incompatible infrastructure with strong regular disparities is also a major hurdle together with inadequate investments and lack of alignment of financing for CSC projects, which are associated with higher risk and uncertainties compared to non-CSC projects and need therefore dedicated financial instruments. Social capital additionally is identified as crucial in CSC, as trust and building effective communication channels among stakeholders from different sectors, is a key factor in establishing effective collaborative activities and networks. Furthermore, the landscape of the bioeconomy varies significantly across Europe, which implies that the key challenges and the specific sector profiles – such as the types of biomasses available, existing value chains, and policy developments – differ extensively across various member states. This diversity causes a variety of different gaps and challenges of CSC for involved stakeholder groups and necessitates tailored actions to overcome the existing barriers in the involved bioeconomy sectors.

In **agriculture sector,** CSC drives technological innovation and opens new commercial and sustainable opportunities by fostering an exchange of knowledge and practices between different market actors. Additionally, these collaborations play a key role in the circular economy and in maximising the use of agricultural resources globally. For these reasons, CSC in the agricultural sector is fundamental for innovation and competitiveness. It enables the valorisation of agricultural products from different sectors, driving key initiatives for the sustainable advancement and economic diversification of the sector. However, given conservationism, the sector faces several challenges. CSC is a key to overcome these barriers through the collaboration between experts with sufficient experience or strategies such as the creation of cooperatives where partners from different fields are integrated and where everyone takes advantage of each other's experiences.

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In **forestry sector,** CSC promotes sustainable development and supports the achievement of various environmental benefits, including reducing emissions, supporting ecosystem services, and enhancing biodiversity. However, given the limited collaboration among forest owners and industry, there is a need for an increased emphasis on collaborative efforts. This could be achieved through public-private partnerships and collaborations across the whole value chain. CSC in forestry faces challenges such as a 'silo' mentality and conflicting sectoral interests. To overcome these barriers, it is crucial to highlight and demonstrate the benefits of CSC, including market opportunities and emphasizing cost reduction through circularity.

In **blue bioeconomy sector** CSC is essential for driving sustainable development, enhancing global food security, and maximising resource efficiency. Collaborative networks and sector associations exist and should be empowered to facilitate dialogue and knowledge transfer between different value chains, fostering mutual learning and innovation. Additionally, creating a level playing field and providing equal opportunities for the blue bioeconomy, often disproportionately disadvantaged compared to the traditional bioeconomy sectors, is crucial. By setting clear goals and enabling industrial symbiosis, cross-sectoral collaboration can significantly enhance economic growth and environmental sustainability within the fish and aquaculture sectors.

In **Food sector**, the CSC is mostly in the agrifood value chain where the biggest biomass quantities are used. Biogas production in Denmark is an example of CSC big-scale success story. The drivers for CSC include new business opportunities – they want to be ahead of competitors. Start-ups often work with distributive ideas, while the big companies maintain the traditional products with large market share and make a slow transition. The collaborative structures support CSC via penta-helix collaboration approach to create awareness via events, and access to networks, help pave the way for projects, business partners and support in business development. Sector specific challenges that hinder CSC include regulatory barriers, biomass with short shelf life and market barriers and cost gaps. Way forward for enhanced CSC are more regulatory-friendly environment, focus on optimally use of bioresources via biorefinery cascade exploitation where partners have common interests, create and facilitate local industrial symbioses where different industries work together to unlock the full potential of bio-based solutions and more attractive pricing.

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1. Introduction

In the bioeconomy, CSC refers to collaborative efforts between various involved sectors or industries to promote the sustainable use of biological resources and harness the combined expertise and innovations of different sectors. This integration of knowledge, technologies and resources spans across different fields such as agriculture, forestry, blue bioeconomy, biotechnology, and environmental science. As a result, CSC can not only help to drive industrial renewal and modernize primary production systems, but also protect the environment and enhance biodiversity1.

1.1 Importance of cross-sectoral collaboration

The bioeconomy encompasses a wide range of domains and sectors, such as primary production sectors agriculture, forestry, fisheries, but also processing sectors, such as biotechnology, food, cosmetics or waste management. Each of these areas possesses its specialized knowledge, techniques, resources and stakeholder groups.

Global challenges related to climate change, increasing market demand for more sustainable products and services combined with population growth are transforming the operating environment of all the involved bioeconomy sectors (Guerrero & Hansen 2021).

Engaging in CSC allows stakeholders from different sectors to bring together their unique and complementary perspectives and expertise, as well as resources, and presents a significant opportunity for established bioeconomy sectors to develop new technologies and production processes. CSC in the bioeconomy not only enables the reduction of GHG emission and dependence on fossil-based products, but also unlocks new markets and increases EU's competitiveness (Wohlfahrt et al. 2019). For instance, advancements in biotechnology can significantly improve both the productivity and sustainability of agricultural practices, while innovative approaches from the pharmaceutical sector can enhance the efficiency of converting biological materials into novel drugs. The use of forest biorefineries to produce bioenergy, in addition to traditional products like wood, paper, and pulp, exemplifies an integrated and efficient approach to maximizing the benefits of forest biomass (Chambost et al. 2011). This fosters the creation of novel solutions that are far less likely to be developed within siloed sectors. Therefore, innovation serves an area where CSC is expected to deliver substantial benefits. Specifically, merging of technologies and approaches from disparate sectors can catalyse significant breakthroughs. Process innovations and technologies that use biogenic raw and residual materials as the starting substrate, as well as biobased processes that exploit the metabolic activities of living organisms such as microorganisms, bacteria or algae exemplifies such innovation [2]. This type of innovation necessitates ongoing cooperation between different primary production and technology sectors.

While CSC holds high potential for advancing the bioeconomy, it also faces significant challenges, many of which are universal, while others are more specific and vary depending on the country, sector, or stakeholder group involved. For example, in forestry and agriculture, cross-sectoral collaboration can

[1] https://knowledge4policy.ec.europa.eu/bioeconomy/bioeconomy-strategy_en
[2] https://www.biooekonomie-bw.de/en/bw/definition/processes-and-technologies-in-the-bioeconomy

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increase the demand for raw materials by firms in other sectors and change the role of the primary production sectors companies to mere raw material providers if not managed well (Kraxner et al. 2017).

General challenges include issues such as communication barriers, access to financing and the complexity of coordinating efforts across diverse industries and disciplines. On the other hand, specific challenges are influenced by localized factors such as the characteristics of involved sectors, the economic environment, cultural differences, and the technological and human capabilities of each sector.

Numerous studies have emphasized that CSC is needed to achieve successful implementation of the bioeconomy (Näyhä 2019). However, there is limited information on specific bioeconomy sectors to provide insights into the challenges, drivers and potential benefits of CSC. Furthermore, there is also a lack of understanding regarding the role of different collaborative structures (e.g. clusters, hubs, networks, etc.) in the transition of traditional primary production sectors to the bioeconomy (Guerrero & Hansen 2021[3]). This report aims to fil this gap.

1.2 Examples of collaboration in the EU

The EU and its member states have already implemented a range of policy instruments and funding mechanisms to enhance cross-sectoral collaboration. These include R&D programs, public-private technological platforms, tax incentives, financial support for innovation projects, and European programmes aimed at fostering international cooperation in the bioeconomy[4]. The impact of these collaborative efforts is evident by demonstrating how different stakeholders across different sectors can come together, each playing a unique role, to share resources, utilize technologies, and work towards common objectives.

According to the information gathered in the WP1 of ShapingBio, in the Baltic and Scandinavian countries, the complexities of cross-sectoral collaboration in the bioeconomy are characterized by varying degrees of cooperation among biomass producers and other stakeholders. While countries like Lithuania, Latvia, and Estonia exhibit relatively low levels of collaboration among biomass producers, preferring internal efficiency improvements, Sweden and Finland boast a rich tradition of CSC, especially in the forest industry. A positive case in the northern region is Denmark, where a strong tradition of dialogue and cooperation between public and private sectors is deeply embedded, fostering partnerships that yield innovative solutions for mutual benefit. This approach is particularly evident in value chains that derive from agriculture and the food industry, where agriculture is a significant supplier to the Danish biogas industry and the fishing industry provides raw materials to industries like pet food and fish-meal production. However, launching innovative products and developing new sustainable business models in CSC often entails overcoming various barriers. For example, the development of grass protein as a green alternative to soy protein faces challenges such as the visibility of value creation through the value chain, economic differences among partners affecting the power structure, and the lengthy and costly product approval process. By addressing these challenges through CSC, the potential for improved utilization of bioresources within biorefining and cascade utilization is vast.

[4] https://research-and-innovation.ec.europa.eu/research-area/environment/bioeconomy_en

In the Central and Eastern European countries, despite possessing valuable resources, collaboration often remains theoretical, with actual cooperation occurring primarily for securing financial grants. The BIOEAST initiative plays a crucial role in facilitating this interaction, aiding in identifying opportunities and challenges, and supporting innovative solutions for example in Bulgaria, where agriculture and forestry play significant roles in the bioeconomy. Nevertheless, there is no specific policy supporting CSC in bioeconomy. Initiatives by BIOEAST in the region support collaboration and include knowledge sharing, policy coordination, research and development collaborations, and capacity-building programs.

The Czech Republic, with substantial biomass potential, utilizes biomass for heat, electricity, and biofuels production, supported by government incentives. However, the lack of detailed data on biomass production and transformation, insufficient infrastructure, and challenges in policy and regulatory frameworks hinder the sector's growth. Strategic frameworks, funding programs, cluster initiatives, and other support measures aim to foster effective collaboration across different sectors.

In the majority of Western and Southern-European countries collaboration in the bioeconomy is focussed on aligning national strategies, fostering innovative research, and encouraging multi-level partnerships. The bioeconomy policies, often steered by ministries of agriculture, forestry, enterprise or economics, still require further collaborative efforts across sectors to harness the bioeconomy's full potential. Also, in the Western and Southern -European countries the emergence of bottom-up initiatives signifies a proactive stance among stakeholders, who are forming consortia and networks to address shared challenges and explore innovative solutions. In this regard, forestry and agriculture play significant roles in the region, providing substantial raw bio-based materials and contributing significantly to the region's bioeconomy. To stimulate CSC various policies have been implemented in the region. These policies aim to foster an environment where diverse stakeholders can collectively address challenges and drive innovation. Some examples of strategies include Ireland's Food Vision 2030, the Netherlands' Top Sectors approach, and Belgium's National Energy and Climate Plan, each targeting specific sectors and challenges to optimize collaboration and resource flow. Collaborative structures in the region include multi-stakeholder platforms, advisory boards, and working groups that facilitate connections across sectors, supporting bioeconomy development and innovation deployment. Clusters play a pivotal role in this landscape, translating collaborative research into actionable outcomes and supporting SME growth.

1.3 Key elements for collaboration

The development of the bioeconomy entails a shift towards sustainable business models (SBM) that promote circularity and replicability (Adamseged & Grundmann 2020). This transition is inherently complex, requiring dynamic collaborations across diverse actors and disciplines. These collaborations transcend silos and organizational barriers, fostering connections, which harness the unique competencies and resources of each participant. By aligning expertise, sharing knowledge, and coordinating resources, these partnerships are better positioned to drive innovation. The collaborative advantage – value that cannot be achieved independently – emerges from this synergy, where coordinated efforts lead to innovative solutions and sustainable outcomes (Hodson & Marvin 2010; Ozdemir et al. 2023; Philp & Winickoff 2017; Raftery et al. 2022; Ryymin et al. 2020).

The key elements for CSC refer to the fundamental components or 'building blocks', which contribute to the successful integration of each partners competences including expertise and resources. These elements are critical cornerstones, which foster effective partnership and achieving collaborative advantages (Hamann et al. 2011) over the long-term. However, the implication of the collaboration's key elements and their interactions vary significantly based on the context, spatial scale, and the developmental stage of the partnership (Raftery et al. 2022). The interdependencies of the elements can shape the success or hinder the development of the partnerships (Donner et al. 2021).

Bröring & Vanacker (2022) and Donner & de Vries (2023) identified significant challenges to establishment of collaborations including lack of financial capital and insufficient technical and organizational capacity of the partners. Additional barriers, such as competition between rivals and power imbalances – particularly in collaborations between large companies and SMEs – can further hinder the development and viability of these partnerships and can hinder the development and viability of collaborations (Bryson et al. 2015; Hamann et al. 2011). However, having the technical and financial capacity as well as enabling regulatory environment can encourage collaborations and support the formulation of circular business models for the bioeconomy (Donner et al. 2021; Donner & de Vries 2023). Additionally, factors such as trust between the partners, having a vision and formal agreement between partners are important for encouraging coopetition (i.e. collaboration between competitors), and supporting the success of partnerships (Bryson et al. 2006; Bryson et al. 2015). The key elements for collaborations can be categorised into a) organisational, b) financial, and c) social capital as described in Table 1. Since there is a level of interaction between the different elements, partnership success should be evaluated contextually and on a case by case.

Table 1 List of the key elements for collaboration

Category	**Elements**	**Some supporting literature**
Organisational	Common goal and strategic vision	Soliman et al., 2005; Korhonen-Sande & Sande 2014; Hamann et al. 2011; Guerrero & Hansen 2021; Mattila et al. 2016; Donner & de Vries 2023
	Leadership, motivated partners and intermediators	
	Trust, transparency and effective coopetition	
	Quadruple helix engagement	
	Flexibility, learning and adaptability	
	Openness and engagement of partners	
	Navigating power imbalances	
	Complementary skills and knowledge sharing	
	Enabling legislations and regulations	

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Category	Elements	Some supporting literature
Financial	Accessibility	Donner & de Vries 2023; Hamann et al. 2011; López- Hernández & Schanz 2019; Szarka et al. 2023
	Financial capacity	
	Availability	
	Diversity of funding sources	
	Market accessibility	
	Better investment channels	
Social capital	Interactions between partners	Dhillon 2009; Guerrero & Hansen 2021; Horlings & Marsden 2010
	Networking and internationalisation	
	Communications and common language	
	Values and norms	

Source: Author's explanation.

Organisational

In the intricate landscape of bioeconomy collaborations, multiple factors play a pivotal role in shaping the success and dynamics of these partnerships. Among these, the organisational structure of partnerships is crucial and encompasses diverse elements such as clearly defined vision, strategy for growth, intermediaries role in establishing collaborations bringing diverse actors together and trust-building (Adamseged & Grundmann 2020; Fobbe & Hilletofth 2021; Ryymin et al. 2020; Soliman et al. 2005). Despite the diverse nature of these elements, they are interlinked as illustrated in Figure 1, and their interplay has a significant impact on the success of collaborations.

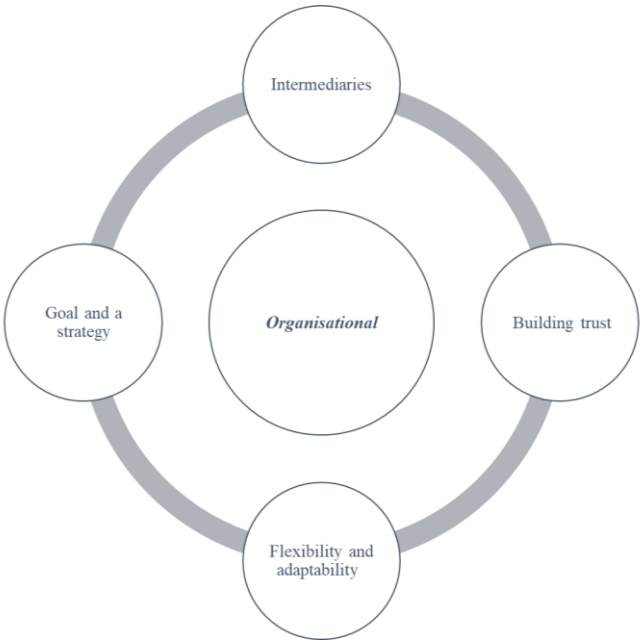

Figure 1: Interlinked relation between the organisational elements for collaboration (i.e. the goal and strategy, role of intermediates, building trust and flexibility and adaptability of partners and collaborations).
Source: Author's explanation.

1.3.1 Goal and strategy

Bioeconomy collaborations typically entail triple helix engagement, incorporating private companies, research institutions, and governmental entities (Zoritza Kiresiewa 2019). The growing momentum in including civil society and community representatives to facilitate bioeconomy growth and support just transition makes collaborations within the quadruple helix more advantageous, as reported by the BioStep project (Charles et al. 2016; Kircher 2012). This implies that project/collaboration partners often pursue a diverse range of goals and motivations, potentially leading to conflicts (e.g. profit and non-profit organizations) unless carefully managed (Fischer & Newig 2016).

Silva (2011) suggests that the success of collaborative partnership is more likely when the activities and benefits of the actors closely align with their individual activities. However, achieving this alignment can be challenging in multi-actor and cross-sectoral partnerships. Therefore, conducting thorough scoping at the early stages of collaboration is essential to define and agree upon a common goal and strategy, which align with the values and expectations of all partners. This process involves defining the objectives of the collaboration, assigning roles and responsibilities to each partner, developing a communication plan to establish the frequency of interactions, and creating a formal agreement which can enable harnessing the collaborative advantages (Bryson et al. 2015; D'Amato et al. 2022).

1.3.2 Intermediaries

Management and leadership of the collaboration play a key role in its success (Kirchgeorg 2022). Beyond the inclusion of committed actors, passionate leaders who can effectively guide and direct the partnership is essential. Additionally, the role of intermediaries in shaping the vision, goals, and strategy of collaborations is pivotal (Fischer & Newig 2016; Hamann & April 2013). Having intermediaries can steer partnership and support the further development of collaboration (Szarka et al. 2023). Intermediaries can be individuals or organisations representing various stakeholder groups working on creating bridges and connections between actors, during the early stages of the collaboration. The intermediaries facilitate the agreements between partners on structures, procedures, and formalising agreements, which is a key factor for the 'scale up' of partnerships and conflict resolution (Hamann et al. 2011; Szarka et al. 2023).

1.3.3 Building Trust

Collaborations rely heavily on knowledge exchange between partners requiring confidentiality and sometimes data sharing agreements. Knowledge sharing influences and being influenced by the dynamics between partners (Ryymin et al. 2020). This has implications on the development of the partnership and can lead to shortcomings (Bryson et al. 2015). Therefore, establishing trust between partners is considered a foundational element for collaborations even among competitors in the same field, a concept known as coopetition (Calton & Lad 1995; Guerrero & Hansen 2021; Hamann et al. 2011).

Trust is highly influenced by the dynamics and power between partners (Hamann et al. 2011; Vangen & Huxham 2003). In triple and quadruple helix collaborations, larger organizations and governmental agencies are often seen as powerful actors, capable of influencing resource mobilization, which may pose challenges to trust and collaboration development (Horlings & Marsden 2010). Also, power imbalances are evident between civil society and private companies, with the latter being considered more powerful, what may lead conflict between partners (Hamann et al. 2011). This can be alleviated through knowledge and resources sharing, transparency, and working on short-term realistic goals and ‘small wins’ which will nourish trust between partners and encourage them to collaborate (Guerrero & Hansen 2021; Ryymin et al. 2020; Vangen & Huxham 2003). In the long term, the commitment of collaborators, their openness and engagement, the involvement of intermediators, and the establishment of formal agreements strengthen and sustain trust between partners (Andrews & Entwistle 2010; Fischer & Newig 2016).

1.3.4 Flexibility and adaptability

Successful collaborations can be characterised by being flexible with the ability to adapt to changing circumstances (Hamann et al. 2011). This implies adaptability of the collaborative platform and the flexibility of the individual partners to divert from ‘their business as usual’ leading to efficient decision-making and growth (Raftery et al. 2022; Ryymin et al. 2020). Collaborators willingness to adapt and share knowledge and resources can drive trust within complex partnerships (de Montigny et al. 2019).

Financial elements

The economic benefits of collaboration in the bioeconomy are not limited to better market accessibility and investment opportunities, but also includes reductions in cost and time for innovation (Fasolino et al. 2023;

Guerrero & Hansen 2018). However, financial resources and securing funds are among the key challenges for the establishment and development of any collaboration (Hamann et al. 2011). Some collaborations can be cost-intensive given the capital and operational cost needed, and it is often secured from public sector and EU programmes and less likely from the private sector (López Hernández & Schanz 2019; Philp & Winickoff 2017). Bioeconomy collaboration structures often benefit from regulations and policy instruments such as financial subsidies and tax- reliefs. Small and medium size enterprises (SMEs) are often challenged in terms of the lack of resources and market accessibility, which is frequently mitigated through collaboration with other partners.

Financial needs may vary according to the developmental stage of the collaboration (i.e. early or advanced stages). Private investments are considered essential to boost a cluster's "chance of survival" and supporting the acceleration of scaling up and the collaboration's long-term viability (Philp and Winickoff 2017). However, private funders and companies might hesitate to invest in bioeconomy collaborations that can be influenced by limited market opportunities and low competitiveness of new bio-based products. Therefore, it is essential to seek diversified funding sources rather than relying on a single source. A mix of public, EU, and private investments can better exploit growth opportunities and mitigate financial risks (Donner & de Vries 2023; Kirchgeorg 2022; López Hernández & Schanz 2019).

Social capital

Although social capital can be defined in several ways, it generally refers to a set of social relations (Horlings & Marsden 2010; Bizzi 2015). The concept refers to multi-dimensional interactions among partners including communications, values, language and networks, which can drive positive outcomes and sustain bioeconomy collaborations (Dhillon 2009; Philp & Winickoff 2017; Ryymin et al. 2020). Multidimensional interactions of the partners can determine their influence on each other, build trust, mitigate any power imbalances and shape the outcomes of the collaborations (López Hernández & Schanz 2019).

Each collaborator brings unique insights, knowledge and competences that need to be communicated effectively to enable harnessing collaborative advantage of the partnership. Effective communication channels are essential for aligning goals and visions among diverse partners and ensuring a common understanding. This process begins early, at the establishment of the collaboration, where defining a 'common language' beyond sector-specific jargon is crucial. A shared language plays a critical role in setting collaboration goals and objectives (Hamann et al. 2011). Moreover, effective communication and coordination foster the development of shared norms and values and contribute to building trust among partners (López Hernández & Schanz 2019).

In navigating the complexity of CSCs, networks and connections serve as 'linkages' between collaborators, strengthening the innovation process and improving resource accessibility. Given the regional availability of bio-resources (e.g. biomass), and global innovation, regional and international networks evolve continuously (Szarka et al. 2023). Networking tools (e.g. online matchmaking events, pitching events) support the connecting and internationalisation of partners, which is increasingly considered a success factor of the collaboration (Lämmer-Gamp 2014; Fischer & Newig 2016).

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2. Methodology

The objective of Deliverable 2.3. is to increase the understanding of CSC involving three key primary production sectors (agriculture, forestry, blue bioeconomy) and along with the food sector to provide recommendations for successful implementation and support of CSC. Furthermore, Deliverable 2.3. presents an overview and provides analytical insights into the common and specific challenges that bioeconomy stakeholders face when engaging in CSC activities within the bioeconomy and its constituent sectors and provides actionable recommendations for stakeholders in the subsequent WP4 Recommendations, which builds on analysing results of WP2.

Within T2.3 different collaborative structures across Europe were studied, to understand the key barriers that stakeholders face across various sectors in bioeconomy in relation to CSC. To achieve this, a comprehensive analysis of 21 collaborative structures (see Table 2) (i.e. networks, hubs, clusters) across Europe has been carried out based on semi-structured expert interviews and expert workshops (see sections 2.3, 2.5 for further details). The report identifies key gaps for cross-sectoral collaboration and proposes key learnings across Europe.

Through a mixed-methods approach, the analysis examines challenges related to key elements for CSC (i.e. organizational, financial and social capital) in different sectors. By facilitating further knowledge diffusion and exchange among stakeholders, the report will provide a deeper understanding of factors contributing to successful collaboration in the bioeconomy.

In the next chapter the methodology is outlined, used to collect the data and conduct this analysis[5].

2.1 Approach

We adopted a qualitative multi-case study approach, which can be summarised in the following steps (Figure 2):

- Define the scope of the topic and in-depth analyses
- Develop selection scheme for the cases in each in-depth analysis
- Set up a multi-actor group (MAG)
- Conduct a co-creation process with the multi-actor group via workshops
- Online survey on CSC as an input for in-depth analysis
- Carry out the in-depth analyses by collecting information by desk research and interviews with selected collaborative structures
- Synthesize and interpret the findings, draw conclusions, summarise the results in this deliverable

Findings and conclusions from the analysis of collaboration can be refined, validated or disseminated in ShapingBio workshops (WP3) and provide the empirical basis for recommendations. They will be

[5] Introduction, Methodology and Conclusions of this report were checked for spelling and style by Fraunhofer´s AI-Chatbot FhGenie, see: https://arxiv.org/abs/2403.00039

elaborated in Work Package 4 of the ShapingBio project. Figure 2 gives a schematic overview of the steps of the approach.

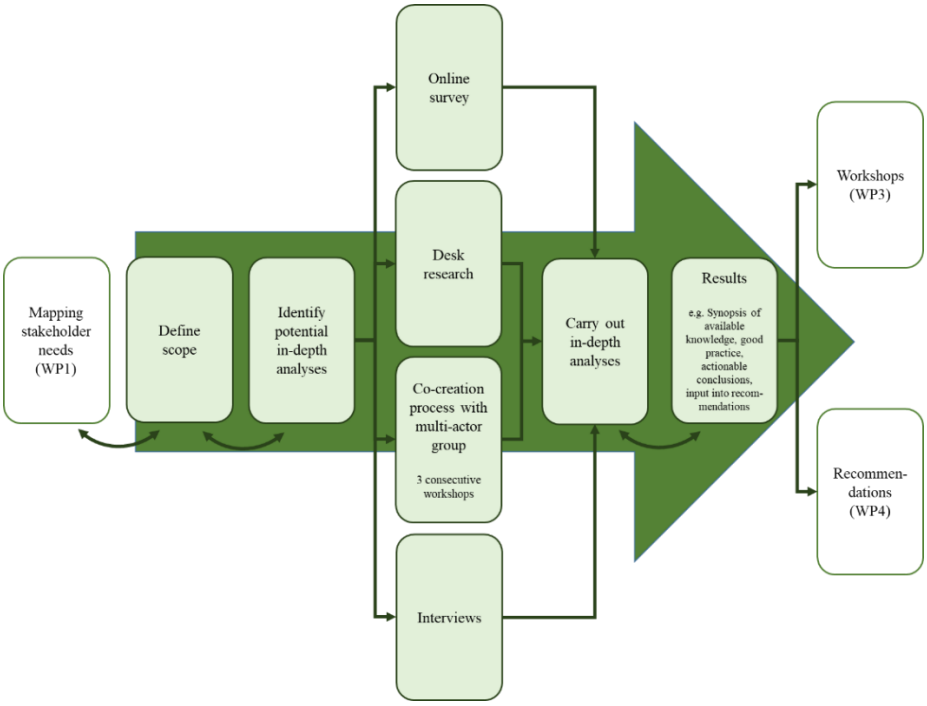

Figure 2: Steps of the approach in the analysis "Collaboration".

2.2 Scoping

First, we identified by desk research (e.g. different EU and national level project websites and official websites of national institutions) different bioeconomy collaborative structures across four sectors: agriculture, blue bioeconomy, forestry and food. These sectors were selected due to their significant impact on Europe's economy as bioeconomy primary production sectors and food as a key area next to primary production sectors in the project.

The collaborations were selected based on their wide geographical representation from different European countries and their scale of operation – regional, national, and international. This diverse selection helped in understanding the variety and depth of collaborative mechanisms across Europe. As an outcome of this stage, 60 different examples of CSC were identified. From the initial mapping of collaborative structures, we selected 4 collaborations from each sector for a more detailed analysis and interviews.

The criteria for selection included:

- Geographical diversity, as we aimed to include as many different European Union member states as possible to ensure a broad representation of CSC across the EU.
- Different scale of operation: regional, national, and international. This variety helped in understanding the scope and challenges that collaboration on different operational levels might have.

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Depending on the responses of contacted collaborative structures and their willingness to contribute to this study, eventually we conducted interviews with cluster managers or member companies of 21 different collaborative structures (Table 2).

Table 2 Overview of case studies

Sector	Structure	Country	Level	Name
Agri	Platform	EU	I	SCALE-UP
	Cluster	LT	N	AGRI-FOOD Lithuania
	Cluster	FR	R/N	Agri Sud-Ouest Innovation
	Cluster	FR	R/N	Agrophylle
	Cluster	LT	N	Vikonda
	Network	ES	R	BIOVAL
	Platform	ES	I	Technological Corporation of Andalusia - CTA
Forestry	Hub	ES	R	BioHubCAT
	Hub	ES	R	CIS-Maderia
	Platform	CZ	N	Bioeconomy Platform of Czech Republic
	Platform	NL	N	Platform Bioeconomie
	Network	EU	I	European Forest Institute (EFI)
Blue bioeconomy	Cluster	DE	R	Bioeconomy at Marine Sites (BaMS)
	Platform	EU	I	European Aquaculture Technology and Innovation Platform
	Cluster	PT	N	B2E - Blue Bioeconomy CoLAB
	Network	EU	I	Submariner Network for Blue Growth
	Platform	EU	I	The Mediterranean Blue Economy Stakeholder Platform (MedBESP)
Food	Hub	EU	I	EIT Hub

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Sector	Structure	Country	Level	Name
	Network	SE	R	Skåne Food Innovation Network (SFIN)
	Platform	NL	R	FoodValley
	Cluster	IT	N	Associazione Clust-ER Agroalimentare
	Cluster	FR	N	Innov'alliance
	Cluster	DK	N	Food & Bio Cluster Denmark

Among identified collaborative structures, not included in the 21 selected cases, an anonymous online survey was conducted, which served as an initial mapping of the situation and served as an input for more detailed analysis by interviews. An overview of the key survey and interview topics is available in the Appendix of the report.

2.3 Interviews

In the second stage of our research, we conducted between 1 or 2 (a total of 31) semi-structured interviews between April and June 2024 with representatives (i.e. cluster managers or member companies) from the 21 selected collaborative structures in the selected sectors. This included interviews with both central administration representatives of the collaborations and member companies involved in these collaborations. The purpose of these interviews was to obtain a multifaceted understanding of CSC from different perspectives.

Potential interviewees were identified from the websites of the collaborative structures and contacted via e-mail. They were informed about context, purpose and content of the interview and how the information gathered in the interview would be used. After informed consent had been collected, semi-structured interviews were conducted as recorded video calls in English, German, Danish, Italian or Spanish language and lasted about one hour. A content analysis of the notes or transcripts from the interviews was carried out.

In parallel with the interviews planning phase a short online survey was conducted (March 2024) as a preparation for interviews to gather key insights on the supporting and hindering factors for CSC. The anonymous survey was sent to the contact persons of all the collaborative structures identified in the first step of the study, which were not included in the interviews. It was made available online in March 2024 and resulted in 40 responses. The responses were then subjected to a quantitative data analysis to interpret the results. These initial findings were further discussed with the Multi-Actor Group experts to validate and refine our interpretations and use as an input for further analysis and interviews in next steps.

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2.4 Desk research

In the third stage, which ran in parallel to the interviews, we focused on gathering secondary data and reviewing existing literature related to collaborative structures in the bioeconomy. This process involved collecting relevant academic papers, industry reports, policy documents, and case studies that provide insights into the functioning and impact of collaborative structures. The aim was to contextually analyse our findings within the framework of existing knowledge and theories in the field of collaborative structures in the bioeconomy. This literature review helped in creating an in-depth analysis and situating our results within the broader academic and practical discourse on CSC.

2.5 Multi-actor group and co-creation process

A core element of the analysis of collaboration was the co-creation process with the multi-actor group (MAG). The multi-actor group consists of invited experts in bioeconomy from 14 different countries. It included cluster and private sector representatives with extensive experience and/or knowledge on collaboration-related issues in at least one primary sector (agriculture, marine and forestry) or food, who are directly or indirectly involved with CSC. A list of the participants of the MAG group is provided in the Appendix (see Table 4).

The MAG engaged in a co-creation process with the ShapingBio project team. The co-creation process consisted of a series of three workshops in which the expert group and the ShapingBio team collaborated. The workshops took place in the period January to June 2024. In between the workshops, the ShapingBio team worked on the planned in-depth analyses. The expert group helped to fine tune the planned in-depth analyses in workshop 1 and critically discussed (interim) results of these in-depth analyses in workshop 2 and contributed validation of conclusions in workshop 3 (

Figure 3).

The terms of reference for the MAG were

- Co-create the framework and key issues for the in-depth analyses with the ShapingBio team
- Provide further insights into the planned in-depth analyses, regarding
    - Status quo, challenges, shortcomings and gaps, reasons for the present (unsatisfactory) situation, which improvements are needed, potential solutions?
- Suggest and/or comment on the planned in-depth analyses, especially
    - Fine-tuning of guiding questions,
    - Experts or literature/ studies that should be consulted during the in-depth analyses
- Critically discuss (interim) results and outputs, especially
    - How relevant and helpful are the results for practitioners?
    - What can be considered good practice?
    - What are prerequisites for successful implementation, do‘s and don‘ts?
- Contribute to overall conclusions
    - What are the lessons learnt/conclusions?
    - To which extent/under which conditions can good practice and lessons learnt be successfully transferred to other contexts/implemented elsewhere?
    - What are actionable conclusions

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- Provide suggestions on how best to communicate the results and conclusions to those who should act

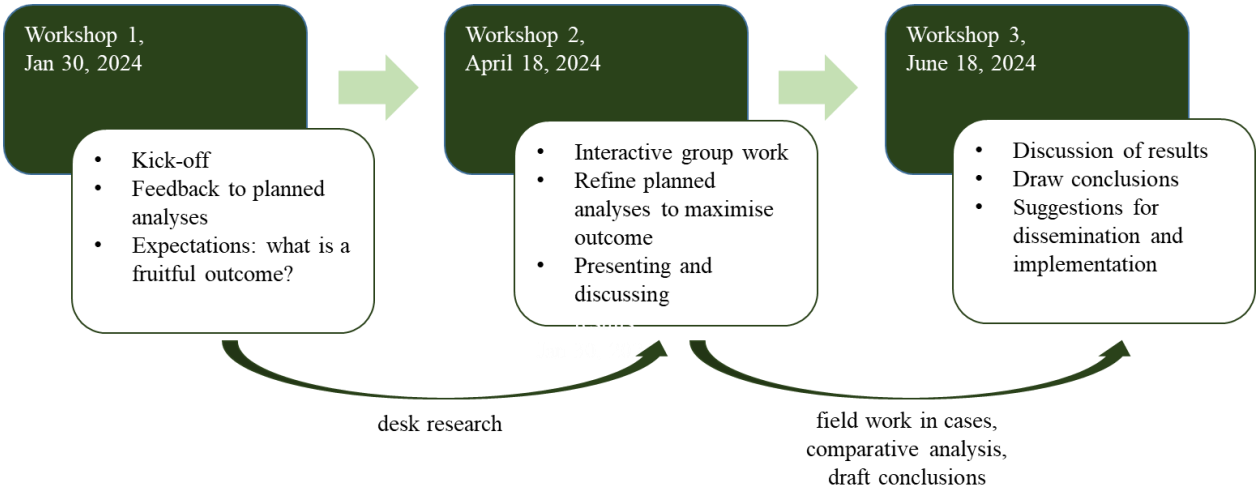

Figure 3: Co-creation process with the multi-actor group.

These meetings served as a platform to critically review and shape the research focus, methodologies, and preliminary results of the task. The interactions within the group provided valuable feedback and guided the research team in refining the approach and enhancing the relevance and accuracy of the study's outcomes.

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3. Sectoral results

The information presented in the following chapters is a synthesis of all the information gathered through online survey, interviews with representatives of collaborative structures and complemented by desk research.

3.1 Agricultural sector

The European agriculture sector plays a crucial role in the continent's bioeconomy as it delivers the raw materials for many bio-based products. Covering about 40% of the EU's land area in 2021 (World Bank Group 2021), agriculture is one of the main land uses. With 65,5% of agricultural land, Denmark has the most of its land area dedicated to this sector, while Sweden ranks last with 7,4%. The sector produces a wide range of products, including crops, livestock, and dairy (Eurostat 2020).

The Directorate-General for Agriculture and Rural Development (DG AGRI) is dedicated to fostering a knowledge-driven, evidence-based green and digital transformation aimed at creating a sustainable and competitive EU agriculture, along with vibrant rural areas and food systems. To accomplish this, DG AGRI formulates, implements, monitors, and assesses the Common Agricultural Policy (CAP) to ensure it meets its economic, environmental, and social goals, aligning with the Treaty objectives, particularly the continuous assurance of food security (European Commission 2024a).

While the agricultural sector plays a pivotal role in bioeconomy and collaboration among different actors is promoted by the EU, its innovation and collaboration potential still seem underutilised. This chapter seeks to introduce the current state of collaboration in the EU, its challenges and geographical dimension.

3.1.1 Collaborations in the agriculture sector

The agricultural sector is key to the bioeconomy as it is one of the main sectors for biomass production, although it has traditionally not been very involved in the value chain for the development of new products or services. Due to the development of bio-based business models is somewhat neglected, it is needed to implement tools such as cross-sectoral collaborations.

Cross-sectoral collaborations are a clear innovation vehicle for the agricultural sector, increasing the competitiveness of enterprises through the development of products and services that are innovative, functional and tailored to end-users. For innovation to take place, it is necessary to integrate knowledge and skills from different disciplines such as agronomy, biotechnology, digital technology, environmental or economic, among others.

For instance, nowadays, digitisation tools are particularly relevant for the agricultural sector. Experts agree that the agri-food sector is increasingly open to different technologies that are already being used in other sectors. For example, drones are already being used in agriculture, and projects are being carried out in collaboration with the photonics sector using spectroscopy.

Even so, collaborative projects in the agri-food sector are not so common in the early levels of TRL where the different actors start to develop their ideas. Rather, they start to be observed at TRL 3/4 to 8, because the

aim of most projects is to test results, developing business and exploitation plans, thus trying to bring the results of the research and innovation of the project to the market.

Currently, among the key objectives of the European Commission and Member States are providing affordable, safe and high-quality food while promoting a resilient and diversified agricultural sector that conserves natural resources and respects the environment. However, achieving both objectives simultaneously is challenging. To overcome this challenge, cross-sectoral collaboration with a particular focus on the agricultural sector has great potential to contribute to the achievement of both goals, for this reason it is crucial to foster CSC projects.

For implementing the bioeconomy projects focused on agriculture sector, the sector faces several challenges. The main challenges include a lack of funding, difficulties in scaling up research from laboratory pilot projects to industrialization, and the absence of necessary infrastructure and technologies in certain regions. Additionally, transporting and storing biomass from rural areas to processing industries presents logistical difficulties. Cross-border projects face further barriers due to cultural, linguistic, and other differences. Lastly, integrating small-scale farmers into these projects is a challenge that requires careful attention to their needs and capacities.

The involvement of all members in the project, through commitment and effective communication, is crucial to overcome these barriers. It is essential to establish efficient communication channels among consortium members, as the lack of such communication can lead to initial problems that hinder project progress. Therefore, proper coordination and management by the leader and responsible parties of different work packages are required.

To achieve this, it is fundamental that the roles of each participant are clearly defined, ensuring that everyone understands their contribution to the project, whether they are farmers, researchers, policymakers, coordinators, etc. Everyone must align with the desired outcomes.

Finally, regular monitoring of progress and evaluation of the project's impact are essential to ensure its success over time.

3.1.2 Role of collaborative structures in agriculture

As mentioned above, the agricultural sector is extremely important in collaborative projects, because it is the main producer of biomass, which is necessary for the generation of innovative products of interest to the end-user.

The importance of cross-sectoral collaboration also becomes apparent. Such collaboration can improve innovation and competitiveness of the industry by providing access to new technologies, research resources, know-how and business opportunities that drive innovation and improve competitiveness. In addition, these collaborations also contribute to job creation and increased economic benefits.

In the agricultural sector, collaborations are diverse and fundamental to technological and commercial progress. These collaborations are mainly divided into three types: commercial, scientific and farmer-to-farmer.

Commercial partnerships focus on the distribution and sale of agricultural products.
Scientific partnerships promote innovation through research and development of new technologies.

Farmer-to-farmer collaborations facilitate access to equipment and machinery needed for agricultural production.

The role of CSC in agriculture sector is crucial in two range of technology levels, TRL 2 to 4 and TRL 6 to 7.

The levels TRL 2 to 4 are a range from concept validation to the initial integration of technologies in the agriculture sector, and the levels TRL 6-7 levels, are crucial to bring innovations to market effectively.

From the perspective of the agricultural sector, advanced cross-sector collaborations, typically, not only validate ideas through applied research in real-world settings, but also valorise agricultural by-products, generating new economic and sustainable opportunities. Turning by-products such as straw into raw materials for sustainable footwear exemplifies how the CSC can maximise agricultural resources and reduce waste.

A good example of collaborative establishment in the agriculture and food industry is the case of Vikonda, one of the entities interviewed. Vikonda, a Lithuanian dairy company, exemplifies cross-sector collaboration through partnerships with various industries, enhancing its growth and sustainability. The key elements of Vikonda's cross-sector collaboration include agriculture and technology, research and development, government and regulation, and sustainability. Regarding agriculture and technology, Vikonda works with local farmers and integrates technology to modernize production, ensuring quality and efficiency. In a great example of U.S. and Lithuanian collaboration, the company Vikeda (a member of Vikonda Grupe) and UCLA Anderson School of Management created an organic ice lolly with super-berries, bioavailable minerals, vitamins, and fibre. Other examples include Vikonda growing beets, processing them in the Canary Islands, and generating products such as wet beet soup or vacuum-packaged beets to export under private labels to premium brands in the United States. Another example of Vikonda's investments includes a last-mile delivery company, which was successfully exited in 2021, and a smart agriculture company that uses spectrometry to optimize fertilizer usage and double-check human factors in their agricultural business.

3.1.3 Geographical dimension

The European Union is clearly encouraging the participation of the primary sector in funded projects. The aim is to encourage a multi-actor and multi-disciplinary approach in agriculture-related projects. To this end, the European Commission is doing a good job by holding partnership programmes, workshops, seminars and by showing all the possibilities that exist within the framework of the partnership.

Actions oriented towards sustainability and resource circularity can be seen as cross-cutting in Europe's approach to all project funding programmes. This means that awareness of the potential use of biological resources is present in a cross-sectoral way, which enhances the creation of cross-sectoral value chains.

The European Union (EU) recognises the importance of collaboration in addressing the complex challenges in agriculture. Its Bioeconomy Strategy and the Common Agricultural Policy emphasise the need for cross-sectoral collaboration to achieve objectives such as sustainability and innovation. Indeed, under the new Common Agricultural Policy, the EU is addressing the challenge of reaching out to and involving farmers and primary producers. To this end, local action groups are being set up involving farmers from different regions and countries.

There are also some funding programmes that encourage collaborative projects:

- The Horizon Europe programme devotes around €9 billion to Cluster 6 on 'Natural Food, Bioeconomy, Agriculture and Environment' for the period 2021-2027.
- The public-private partnership programme Circular Bio-based Europe (CBE JU) funds projects that develop innovative and sustainable bio-based solutions, focusing on raw materials, processing, products, as well as cross-cutting aspects of communication and environmental sustainability.
- Other programmes such as the European Innovation Council (EIC), or the European Institute of Innovation and Technology in Food (EIT Food), have calls for proposals to fund collaborative projects in the agro-industrial sector.

With these programmes, Europe provides a solid framework for cross-sectoral collaborative projects because collaboration between different sectors is promoted.

Specific policy measures will vary from country to country or region to region. However, the general trend is positive. Several policy measures have been implemented in recent years to support cross-sectoral collaboration in agriculture. Some measures examples are:

- Funding and Grant Programmes
- Training and Workshops
- Collaboration Platforms
- Knowledge exchange networks
- Policy frameworks and legislation: Many countries have adopted national and regional bioeconomy strategies that emphasise the importance of cross-sectoral collaboration as a key driver for innovation and sustainable development in the agricultural sector.

In terms of specific country examples:

- France. In France through the France 2030 project financed by the government and post COVID funds from Europe, it provides massive funding for innovation in all sectors, including agriculture and agri-food. However, there are also specific calls for cross-sectoral collaboration, particularly for industrial decarbonisation that is indirectly related to the agro-sector, e.g. for bio-based sourcing. It is worth mentioning that, in France, as there is a strong funding programme, SMEs tend to prefer to apply to national rather than European calls.
- Germany. In Germany, there is a varied programme funded by the Ministry of Environment and Research where collaboration is a key element of the programme. At regional level there are also other very active bioeconomy programmes that encourage collaboration between sectors and stakeholders. However, bureaucratic red tape sometimes limits access to innovation.
- Lithuania. In Lithuania, although there is no specific call or policy, several initiatives have been launched to support cross-sector collaboration directly targeting SMEs. Additionally, many companies face significant barriers due to lack of education on how to access the programmes and the complexity of the participation procedure.
- Spain. In Spain, policies and part of the CAP budget are dedicated to fostering cross-sectoral collaboration and collaborative innovation projects, including initiatives such as the so-called "Operational Groups" promoted by the Ministry of Agriculture and linked to the rural environment. These groups not only prioritise the bioeconomy, but promote multidisciplinary approaches between different stakeholders, and reflect the influence of European policies at regional level.

Regarding the collaboration of actors between different countries, the most common barriers are the use of language and the differences in administrative work between the different countries.

Concerning the bureaucratic procedures required to access a project funded by the European Commission, it can be challenging for those actors who have not previously participated in such projects. However, in recent years, there has been a noticeable improvement in this area, with a general feeling that the process has been simplified. In addition, to streamline bureaucratic procedures, it would be helpful to have someone in the consortium who has previous experience working with European programs, such as a project manager. Otherwise, this lack of experience can become a barrier to accessing innovation for primary producers and other stakeholders.

In summary, the European Union promotes primary sector involvement in funded projects through multi-disciplinary approaches, supported by programs like Horizon Europe and Circular Bio-based Europe. National policies vary, but overall, improvements in application processes are making it easier for stakeholders to engage in collaborative and innovative agricultural projects.

3.1.4 Opportunities for collaboration in Agriculture

Cross-sectoral collaborative projects in agriculture are a growing trend in Europe, actively promoted by the EU and national governments. These projects hold great promise for addressing challenges and creating a more innovative, sustainable and resilient European agricultural sector. In turn, it expands market opportunities, so this need for collaboration is becoming more and more widespread among all members of the value chain.

The agricultural sector, characterised by its conservatism and lack of digitisation compared to other sectors, encounters additional difficulties in adopting collaborative projects. However, nowadays, digitalisation is being introduced in the agricultural sector and is being used routinely, e.g. to check whether crops or plants need irrigation and to schedule it. Additionally, this gap presents an opportunity for investors interested in modernising and improving the efficiency of the sector.

3.1.5 Challenges hindering collaboration in Agriculture

CSC projects are a clear vehicle for innovation in the agricultural sector, enhancing the competitiveness of businesses. However, the sector also faces **barriers** when it comes to implementing these types of proposals.

3.1.5.1. Cultural and geographical challenges

Given that biomass is primarily produced in rural areas, one of the main challenges lies in the **transportation and storage** of biomass from the field to processing industries. For example, if thousands of tons of biomass need to be transported from one region to another, and there is no structured and standardized chain regulating proper storage and transportation, this task is challenging.

Another significant barrier is the **distance** in cross-border cross-sectoral projects, which face challenges in establishing trust with partners due to cultural, linguistic and other differences.

In addition, a significant portion of agricultural production comes from **small-scale farmers**. Their effective integration into bioeconomy projects is a challenge that requires careful consideration of their needs and capabilities. These farmers may be hesitant to integrate, especially considering that many bioeconomy technologies relevant to agriculture are still in their early stages of development. This could result in higher costs and uncertainties compared to technologies already established in other sectors.

Finally, some stakeholders may **not be fully aware of the benefits of collaboration** or lack the necessary incentives to participate.

The most obvious example is digitalization. The agricultural sector, characterised by its conservatism and lack of digitisation compared to other sectors, encounters additional difficulties in adopting collaborative projects.

3.1.5.2. Governance challenges

One of the key factors in CSC projects is the **involvement of all project members**, through commitment and effective communication. However, it is difficult to **involve the whole value chain** due to the different origins of the project members, farmers, researchers, policy makers, coordinators, etc.

Primarily, it is very difficult to **establish a relationship** with farmers and researchers in new agricultural products who work on a small scale and operate small agribusinesses. Their **margins** are narrow and their resources (financial and human) very limited, and this can limit their ability to engage effectively. For example, it is difficult for **a farmer to attend a training webinar** or 2 to 3 hours meetings. However, it is essential to involve the farmer as he/she is the supplier of biomass.

Additionally, sometimes project **coordination** is inefficient due to a lack of experience, which becomes a new barrier in governance.

3.1.5.3. Financing challenges

Firstly, **funding**, which is crucial to be able to carry out such projects.

Secondly, the **leap towards industrialisation**. Research for new projects is carried out on laboratory scale, and scaling up to industrialisation is still a challenge, because not all regions have a**ccess to the necessary infrastructure and technologies**.

3.1.6 Good practices for cross sectoral collaborations in the agriculture sector

As it mentioned, CSC in agriculture sector faces several challenges, although it seems that the agro sector in general is interested in pursuing such initiatives.

One of the challenges is involving the whole value chain. Therefore, it may be necessary to set up an intermediate structure that connects the farmer to the next step in the value chain. Cooperatives are a good example. For example, the production structure of the Spanish agricultural sector is based on a large number of cooperatives, which are the main example of a collaborative production system by promoting collaboration between farmers.

It is also important to have the support of institutions. One success story is the Andalusian Bioeconomy Platform founded in Spain in March 2023 under the SCALE UP project. The platform has managed to bring together public and private entities such as universities and R&D&I centres, public administrations such as the Ministry of Agriculture, cooperatives, investment funds and food companies that participate in the activities proposed by the technology centre CTA (SCALE UP's Spanish partner) as its driving force.

Some stakeholders may not be fully aware of the benefits of collaboration or lack the necessary incentives to participate. These challenges can be overcome through careful planning, capacity building initiatives and the development of effective collaboration models that address the specific needs and constraints of the agricultural sector.

Similarly, the role of SMEs and start-ups is crucial in these collaborative projects as they offer numerous advantages. The flexibility and speed of action that small businesses possess also benefit larger companies when collaborating.

CSC projects in the agricultural sector are a growing trend in Europe, actively promoted by the EU and national governments. These projects hold great promise for addressing challenges and creating a more innovative, sustainable, and resilient European agricultural sector. Furthermore, they expand market opportunities, which is why the need for collaboration is increasingly spreading among all members of the value chain.

3.1.7 Way forward to enhance cross sectoral collaboration in the agriculture sector

Cross-sectoral collaboration, through collaborative projects, provides the basis for establishing opportunities and improvements to the challenges discussed above. For this reason, several recommendations should be considered to effective CSC in the agriculture:

- Careful planning, capacity building initiatives and the development of effective collaboration models that address the specific needs and constraints of the agricultural sector.
- Training and capacity building of stakeholders from different sectors is essential to ensure successful cross-sectoral collaboration.
- A key element is to establish solid trust with other partners. Given the disparity in business cultures between sectors, this becomes a crucial point for long-term collaboration, requiring open-mindedness.
- The involvement of all members in collaborative projects, through commitment and effective communication, is equally crucial.
- It is essential to establish efficient communication channels between consortium members, as a lack of such communication can lead to teething problems that hinder project progress.
- Proper coordination and management by the leader and those responsible for the different work packages is required.
- It is essential that the roles of each participant are clearly defined, ensuring that everyone understands their contribution to the project, whether they are farmers, researchers, policy makers, coordinators, etc.
- All members of the consortium must be aligned with the desired outcomes.

- Regular monitoring of progress and evaluation of the project's impact are essential to ensure its success over time.
- Regarding coordination among consortium members, monthly online meetings of the entire consortium and a face-to-face meeting every 6 months are predominant. Concurrently, those involved in different activities hold necessary meetings for their implementation.
- Set up an intermediate structure that connects whole value chain such as Cooperatives.

3.1.8 Conclusions

In conclusion, CSC in the agricultural sector is vital for driving innovation and enhancing industry competitiveness. Cooperation among the actors in the quadruple helix of innovation – primary producers, SMEs, clusters, investors, research centres, social partners, and policymakers – is crucial for addressing complex challenges, creating new business opportunities, and staying at the forefront of innovation. Fortunately, in Europe, there is a strong interest among stakeholders in developing collaborative bioeconomy projects, which facilitates project organization.

The European Union plays a key role in encouraging the involvement of the primary sector in funded projects, supporting multidisciplinary and multi-actor approaches through programs like Horizon Europe and Circular Bio-based Europe. Despite variations in national policies and bureaucratic challenges, recent improvements in application processes are making it easier for stakeholders, including primary producers, to participate. Overall, the EU’s efforts are creating a supportive framework for collaborative and innovative agricultural projects, fostering a more sustainable and competitive agricultural sector.

3.2 Forestry

Forests cover 39% of the EU’s land area (Milicevic 2023) and they serve as a primary natural resource, contributing to biomass, bioenergy and biomaterials, while also providing ecosystem services and recreational benefits (Kraxner et al. 2017). Moreover, forests act as significant carbon sinks enabling carbon sequestration and storage, which make them a key for achieving the EU's net-zero 2050 goals. The forestry value chain encompasses several stages and activities, including production, harvesting, and processing (Haverhals 2014). The forestry sector is generally characterised by its multi-functionality, diversity of involved actors and unique ownership structure.

In many EU member states, the sector tends to be heavily industrialised with contributions to a wide range of industries beyond the primary ones like wood, paper, and pulp. The forest industry is a key supplier of raw materials used for producing chemicals, dyes, and pharmaceuticals for example. Biomass from forestry is also used for other industries such as energy generation. The wide range of applications across several domains results in the involvement of multiple decision-making authorities. At the EU level for example, different Directorates-General (DG) are engaged in forestry-related topics (e.g. DG AGRI, DG CLIMA, DG ENV, DG TRADE), with a similar structure at national, regional and even local levels (European Investment 2024).

The landscape of forest ownership in Europe varies significantly and tends to be fragmented. With the exception of some Eastern member states, private forest owners comprise 60% of Europe's forest ownership, with the remaining 40% being in public ownership. Publicly owned forests can be municipal, communal

(e.g. owned by villagers), or military owned. Private ownership can include family forests (forested land owned by families for generations), new owners of recently expanded forests, or urban owners who inherited forested land, who have never managed a forest before. For example, in Mediterranean regions, new forests are often owned by people who were farmers previously or used the land for pasture.

3.2.1. Collaborations in the forestry sector

Key stakeholders of the sector fit the quadruple helix model: policy makers, industry, researchers and society. However, forest owners are also key actors as commodity owners (i.e. biomass and wood owners). The industries span both wood and non-wood sectors (i.e. chemicals and energy, among others). Other critical players in some EU member states are the contractors and intermediaries, who act as connectors bridging the gap between forest owners and forest industries. Intermediaries often buy wood or biomass from owners and sell it to industries; they often facilitate the transactions without taking ownership. Given the significance of forests to communities, through both ownership and use, society is a key stakeholder directing how forests will be managed, contributing to the sector's multi-actor, and multi-functional dynamics.

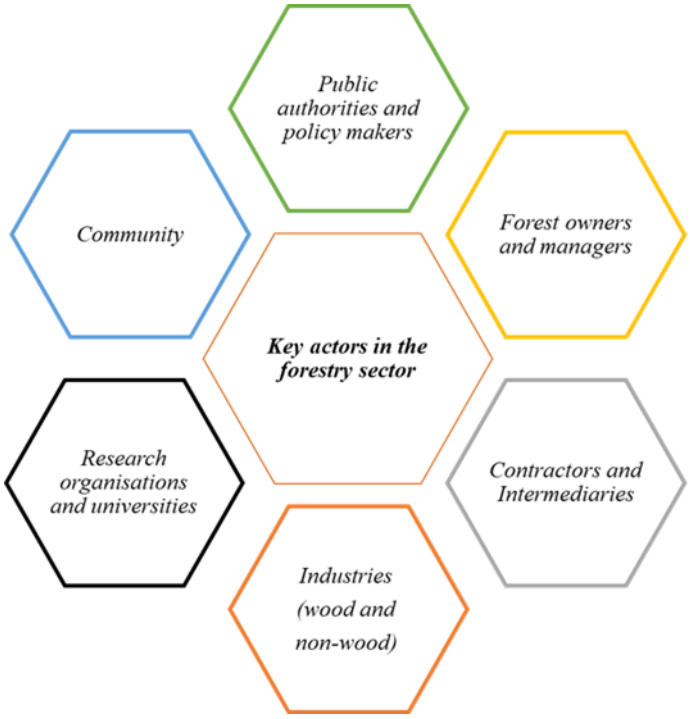

Figure 4: Overview of the key actors in the forestry sector.
Source: Author's explanation.

Collaboration within the forestry sector is driven by a growing recognition of the need to address common challenges and capitalise on emerging opportunities for innovation and profit. However, existing collaborations in forestry tend to be industrially focused, centred on downstream value chains, such as wood and paper collaborations. The few existing collaborations on the supply side (between owners) are mostly limited to agreements on pricing and production capacity. These collaboration patterns are partly influenced by; a) the traditional and conservative nature of the forestry sector, b) fragmented and small holder ownership, and c) disconnection between forest owners and industries.

Several collaborative initiatives bring together diverse stakeholders, including policymakers, industry, owner's networks, SMEs, and researchers. These collaborations primarily aim at; a) knowledge sharing, b) bridging the gap between scientific research and business practices, c) innovation and enhancing the effectiveness of production and d) establishing communication channels mostly with policymakers (Carter and Gronow 2005; Guerrero & Hansen, 2021). In recent years, there has been a noticeable rise in cross-industrial collaborations, predominantly focusing on exploring new business avenues within the bioeconomy, particularly regarding the transformation of biomass into biomaterials, bio-chemicals, and bioenergy.

Establishing robust partnerships and collaborations requires sustained effort, trust and long-term engagement. Despite the wide range of collaboration drivers, members of such platforms are often encouraged by financial incentives, connections with policy makers, networking with other actors, and perceived opportunities for growth. From an industry perspective, collaborations are opportunity-driven, bringing actors together to achieve common goals in a cost-effective manner, and providing an opportunity to explore new business streams and markets.

3.2.2. Challenges hindering collaboration

Challenges hindering collaborations in the forestry include structural, governance, social, human & financial capital and investment.

3.2.2.1. Structural challenges

The diverse ownership pattern in the sector results in fragmentation among owners, characterised by a high level of variation in resources (financial, human, etc.) and management expertise. Owners who have inherited forested land and become disconnected from their family's traditional ties to forestry may lack the knowledge and practice for effective forest management. Small-holder owners, constituting the majority of private owners and holding less than 10 hectares, often face challenges in accessing the necessary resources to manage their forests sustainably and profitably, particularly due to the costly certification process for wood. For communal forests, which hold significance for society, convincing communities about investments or changing forest management practices is particularly complex. This can make establishing shared goals difficult.

Fragmented ownership challenges collaboration and the maintenance of a dialogue with industry stakeholders. This in turn has contributed to the role played by contractors and intermediaries. Adding to this, the uneven distribution of added value along the value chain discourages engagement between owners and industries. Although owning the commodity (i.e. wood) is a key driver for the wood and biomass trading

market, the higher share of value added is generally distributed into downstream industry. An implication of this is that forest owners can be discouraged from seeking alternative opportunities to traditional wood production, making it less attractive to collaborate with innovative industry initiatives.

3.2.2.2. Governance challenges

The forestry sector is directly linked to climate change mitigation, the bioeconomy, and biodiversity, meaning that climate regulations can impact forestry regulations and vice versa. Additionally, the sector's multi-dimensional nature – characterized by the involvement of multiple decision-making authorities at various geographical levels – adds to the complexity of the regulations governing it. While some authorities prioritise growing forests in support of climate actions, others might emphasise utilisation of wood for industrial purposes (European Investment 2024). This broad and changing policy perspective poses challenges for collaborations and market development especially within forest bioeconomy. This complexity introduces uncertainty and risk for investors and SMEs who are trying to enter the market or support forestry projects (European Investment 2024).

Regulations can influence input prices, for example wood processing is an energy-intensive industry and the wood production cost can increase sharply due to changes in energy cost regulations (European Investment 2024). Another example is the wood's bulkiness complicates transportation, with varying restrictions and inconsistencies in truck dimensions and weight limits among EU member states (European Investment 2024). A lack of a clear and transparent outlook on regulations can affect the competitiveness of small and medium forest-based businesses.

3.2.2.3. *Social, human & financial capital challenges*

The forestry sector is notably conservative, in particular in Central and Eastern European countries, presenting a significant barrier to exploring and implementing new management options or adaptations. Resistance to change stems from a deep-rooted adherence to traditional practices, often influenced by familial legacies and the sentiment of "my parents, my grandparents used to do it this way". Even when facing urgent external factors like diseases, there remains hesitancy to deviate from traditional approaches.

Despite growing recognition for sustainable forest management practices, significant limitations persist, particularly in research and development funding accessibility and the translation of research into practical on-the-ground solutions. This can be caused by a lack and inaccuracy of data (e.g. biomass availability is often overestimated by industry and underestimated by researchers), which in turn can contribute to limited collaborations between research, owners and industry stakeholders.

Other challenges are shortages of skilled specialists and specialised industrial-scale biomass processing facilities, as well as limited knowledge of biomass volumes. This drives companies to seek international arrangements for biomass supply, yet these collaborations are hindered by trust, language, and cultural barriers.

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3.2.2.4. *Investment challenges*

Ownership fragmentation and small forest holdings often contribute to economic inefficiencies in forest management, leading to higher transaction and operating costs. The extended period between investment and tree harvesting, i.e. a long pay-back period, also discourages the adoption of new practices, as they may not seem financially viable. Other barriers include lack of knowledge in identifying and structuring bankable projects and monetizing forest ecosystem services using commercially viable business models due to a limited understanding of how to generate returns and grow the business through feasible investments (European Investment 2024). Limited information on the wood and biomass supply and their prices hinders new players' entry into the market and lowers competition, particularly for SMEs. Larger companies, on the other hand, tend to be more hesitant to collaborate due to their self- sufficiency in resources and capabilities, and thus lower perceived need.

Summary of the main barriers for collaboration in the forestry sector are shown in Figure 5

Structural
• Fragmentation of ownership & the prevalence of small forest holdings (90% of owners holding 1-10 hectares) discourage investment due to financial inefficiencies. • Lack of motivation of the owners to collaborate as most of the 'revenue is generated downstream with limited added value for owners'. • Dominated by big international companies and SMEs can't compete with economies of scale. • Contractors and intermediaries between forest owners and industries.

Governance
• Broad policy context leading to greater exposure to changing regulations and legislations- causing market uncertainty. • Lack of long-term overview on legislations (e.g. certification requirements).

Social, human and financial capital
• Conservative, deep-rooted adherence to traditions & resistance for change. • Lack of skilled people, infrastructure and specialised companies. • Insufficient public research and development (R&D) funding while private investment often targeted to mature technologies only. • Language, cultural barriers and trust.

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Investment
• Limited knowledge on identifying bankable projects, monetary value and profitable models, which limits investments in the sector • Limited information (supply, price, etc.,) hinder the entry of new players into the market & lower competition • Extended period between investment made and harvesting trees discourage adoption of new practices • Big companies tend to be more hesitant to collaborate due to their self- sufficiency in resources and capabilities

Figure 5: Overview of the key structural, governance, social, human & financial capital and investment challenges hindering collaboration in the forestry sector.
Source: Author's explanation.

3.2.3. Good practices for CSC in the forestry sector

While there are limited collaborations between forest owners and industry within the forestry sector, largely due to the unique structure of the sector, many collaborations bring together different stakeholders including industry, researchers and policy makers. Many existing collaborations are established based on shared interests in developing new business opportunities, knowledge sharing and providing networking and communication opportunities. Other examples are industry-based collaborations and associations such as The Irish Timber Growers Association for woodland owners and The Association of Pulp and Paper Technology in Finland. The forestry industry and CSC offers the opportunity to link biomass owners (i.e. foresters) with markets and wood and non-wood industries (e.g. chemical).

Despite the conservative nature of the sector which is characterised by notable adherence to practices passed down through generations (e.g. Eastern European countries), efforts are evident across the EU to promote collaborations through bioeconomy. EU member states have initiated collaborations across the biomass, chemical, materials, and bioenergy sectors, engaging with academia and facilitating events to connect science and business. For instance, the Uforest project promotes a cross-sectoral collaboration bringing universities, businesses and public administrations within urban planning, forestry and urban ecology, as well as information communication technologies (ICT) together to work towards innovative urban forestry projects. Another example is CircWood project that investigates the re-use and recycling of wood for enhanced circularity and SIRKTRE bringing forest owners, timber and waste industries together to create circular value chain for timber in Norway.

The Nordic model (e.g. Finland), where forest owners often have stakes in large companies that explore new materials and technologies, stands out as a unique approach not widely replicated elsewhere. This model exemplifies strong dialogue and cooperation between public and private sectors, fostering partnerships that yield innovative solutions for mutual benefit.

Figure 6 shows some examples of collaborative structures in the forestry sector, providing insights on initiatives such as bio-region facilities, which support innovation, networking, raising awareness and policy learnings for regions who are leading transformative changes towards a circular, forest-based bioeconomy.

Among the collaborative efforts are those promoting public-private partnerships, supporting regional development, creating sustainable value from forests and providing policy recommendation on forest bioeconomy strategies.

Platform BIOECONOMIE	European Forest Institute (EFI)
PBE represents "companies and other stakeholders working on the production, trade and use of bio-raw materials for various applications, including chemicals, materials, energy, transport and services". PBE aim to play a key role in accelerating the development of a fully renewable and sustainable CO_2-neutral society and promote the sustainable use of raw materials, mainly biomass and wood for bioenergy production. Among the focus areas are bio-raw materials, bioenergy and communication.	EFI is an international organisation established by European States. Members represent forest research, industry, forest owners and international forest-related organisations. EFI aim to bridge the gap between science and policy in the forestry sector. EFI supports forest bioeconomy in multiple ways, for example "Bioeconomy Programme" and "Bioregions facilities". The latter supports innovation, networking, raising awareness and policy learnings for regions who are leading transformative changes towards a circular, forest-based bioeconomy (e.g. Catalonia in Spain and North Rhine-Westphalia in Germany).
Platform for Bioeconomy of the Czech Republic	**CIS Madeira**
The platform's objective is to accelerate the development of forestry bioeconomy through research, education and supporting informed decision making. The platform brings together a range of stakeholders, including research institutions, businesses and individual to enhance dialogue on bioeconomy and its development.	CIS Madeira is a public entity aim at providing support services for innovation in the wood processing industry, increase competitiveness of the industry and contributing to the sustainable economic development of the forestry sector in Galicia. Among their key line of activities are communication, raising awareness and dissemination of technical knowledge. Sustainable valorisation of wood, new biomaterials digitalisation and cross-sectoral collaborations are key thematic areas.

Figure 6: Examples of collaborative efforts in the forestry sector in selected EU member states. Source: Author's explanation.

3.2.4. Way forward to enhance CSC in the forestry sector

Achieving harmonization in the forestry sector requires consolidated efforts, motivated actors, and the creation of strategic partnerships, among others. Establishing owners' cooperatives and associations can

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significantly enhance horizontal collaboration and streamline management efforts through knowledge exchange. This is particularly beneficial in regions like the Mediterranean, where new forest owners, resulting from forest expansion, may struggle with management practices. These cooperatives can play a crucial role in ensuring transparency in price setting, bringing owners together and linking owners to industries.

Diversifying revenue streams beyond traditional sources (e.g. timber) can enhance the economic incentive for forest owners to collaborate. This not only aligns their interests with the long-term success of these industries but also ensures a more equitable distribution of value generated from forest resources. Carbon credits for instance is another option especially in the context of climate change mitigation efforts. However, realizing this potential requires support from governments, research organizations, and other stakeholders, to explore and build systems to support the capture of alternative revenue streams.

Cross-sectoral collaboration (CSC) in the forestry sector faces significant challenges, primarily a 'silo' mentality that hinders the exploitation of synergies and conflicting sectoral interests. To overcome these barriers, it is essential to identify and leverage inter-sectoral benefits and market opportunities. For example, integrating bio-based production with climate mitigation efforts, biodiversity conservation, nature-based tourism, recreation, and non-wood forest products can broaden the appeal and viability of a forest-based bioeconomy. Showcasing opportunities for cost reduction through circularity can further incentivize CSC. Moreover, creating local and regional opportunities, particularly for small and medium-sized enterprises (SMEs), is crucial. This includes providing support for business development, resources, and financial instruments, which can facilitate collaborations between large-scale companies and SMEs across different sectors.

Given the international nature of the forestry sector, collaborations often involve partnerships with companies from various countries within and beyond the EU. This requires not only long-term engagement but also a deep understanding of different cultures and market dynamics. Building trust and navigating these complexities are essential for fostering successful and sustainable collaborations in the forestry sector.

3.2.5. Conclusions

While some challenges in fostering collaboration within the forestry sector are similar to those in other industries, the unique structure and nature of this sector present distinct obstacles that hinder cooperative efforts. For the sector's growth, it is crucial to encourage both horizontal collaborations among forest owners and vertical collaborations between owners and the broader industry. Despite some scepticism among foresters regarding the necessity of adapting to a bioeconomy – given the well-established nature of timber management – shifting towards a forest bioeconomy offers significant opportunities.

The introduction of bioeconomy and circularity models can foster greater collaboration and provide avenues for transforming industry co-products and waste into valuable resources. This transition can lead to substantial reductions in logistical costs and inspire innovative uses for both wood and non-wood products. Additionally, it offers multiple environmental benefits, such as lowering emissions, supporting ecosystem services, and enhancing biodiversity conservation.

To support these changes, it is essential to provide innovation enablers and incentives, such as industrial infrastructure and facilities, as well support the development of industrial clusters. These measures can

create a supportive environment for new ideas and practices, driving the forestry sector towards a more integrated and sustainable future.

3.3 Blue bioeconomy

The blue bioeconomy harnesses renewable, living aquatic resources such as algae, sponges, jellyfish, and microorganisms to produce a wide array of products. Innovations within the blue bioeconomy include the development of novel foods, nutraceuticals, food additives, and animal feeds, as well as pharmaceuticals and cosmetics. Additionally, it contributes to the creation of green chemicals and materials, along with enzymes used for eco-friendly industrial processing and decontamination. The blue bioeconomy plays a vital role in the European Green Deal by helping to reduce the pressure on the EU's land resources and combat climate change (European Commission 2024b).

The Directorate-General for Maritime Affairs and Fisheries (DG MARE) is responsible for developing and implementing the European Commission's policies on maritime affairs and fisheries. The Directorate-General focuses on ensuring the sustainable use of ocean resources, securing a prosperous future for coastal communities and the fishing sector. It also promotes maritime policies to stimulate a sustainable blue economy and advocates for effective ocean governance at the international level (European Commission 2024c).

By-products of the blue bioeconomy present a huge potential for sustainable bioeconomy. Though, their potential remains largely underutilised since collaboration is still hesitant. This and further challenges of the sector are explored in this chapter and good practices are presented to overcome the obstacles and to promote the enhancement of the European blue bioeconomy.

3.3.1 Collaboration in the blue bioeconomy sector

The blue bioeconomy holds immense potential for sustainable growth and innovation. The fisheries and aquaculture sectors, when implemented sustainable, offer viable solutions to meet the rising global demand for protein, particularly through sustainable fisheries and the cultivation of fish, bivalves and seaweed. Low trophic aquaculture provides a valuable low-carbon alternative protein source and contributes to environmental health by reducing the nutrient loads and improving the water quality. CSC involving quadruple helix actors – such as SMEs, large companies, fish and aquaculture farms, research institutions, and civil society – can amplify this potential by integrating innovations from related fields like biotechnology, agriculture, and waste management. Such collaborations can lead to the development of new products, more efficient resource use, and ultimately driving economic growth.

CSC in the blue bioeconomy in Europe primarily focuses on sustainable aquaculture, marine biotechnology, realising the circular economy, improving digitalisation, climate change mitigation, and the development and implementation of integrated multi-trophic aquaculture, spanning Technology Readiness Levels (TRLs) from TRL 3 to TRL 7, reflecting various stages of technology development and adoption.

How collaboration plays out across the sector depends on a myriad of factors. These factors include the size of the company or institution, the part of the value chain an organisation is working in, the cross-sectoral

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nature of the collaboration needs, and geography. The key findings on collaboration in the blue bioeconomy from the analysis and interviews in T2.3 are listed below:

Collaboration between companies and institutions working in the blue bioeconomy with other sectors, such as agriculture or biotechnology, tends to be more effective because there is no direct competition; instead, everyone involved makes profit. This dynamic allows for a more harmonious working relationship as each sector brings unique value and expertise, complementing rather than competing with one another.

Established companies from other sectors, such as food or agriculture, with a comprehensive product portfolio often show little interest in creating new ones with blue biomass producers. Their focus is typically on maintaining and enhancing their existing products. On the other hand, startups or companies in the early stages of development are more inclined to collaborate. These companies see partnerships as opportunities to expand their product offerings and accelerate growth.

Producers of blue biomass typically do not compete among themselves and trust each other more because they face similar challenges more than in other sectors. This shared experience fosters a sense of solidarity and mutual understanding, often stronger than in other industries. However, product developers are always in competition, irrespective of the scale of their operations. This competition arises from the desire to be market leaders in creating innovative new products. Consequently, product developers strive to outdo each other, driving progress and innovation in the industry.

International collaboration is particularly important in smaller blue markets like the seaweed industry. The niche nature of these markets means that companies often look beyond their borders to find partners with whom they can share resources, knowledge, and market access, enhancing their chances of success.

However, global markets can substantially impact collaboration in the blue bioeconomy. For example, the geopolitical situation in China since COVID-19 and Russia since the war in Ukraine has disrupted existing partnerships with those countries in the blue bioeconomy, highlighting the need for resilience and adaptability in international collaborations.

3.3.2 Role of collaborative structures in the blue bioeconomy

Collaborative organisations, such as industry associations, clusters, hubs and networks, are vital in fostering CSC in Europe's blue bioeconomy. They drive innovation by combining diverse perspectives and expertise, leading to the development of groundbreaking ideas and solutions that might not emerge in isolation. Additionally, they provide a buffer for investments and the risks associated with research. Collaborating entities in the blue bioeconomy can also take bigger steps in research and innovation than they could independently. This collective progress can accelerate development and strengthen trust among partners.

Furthermore, these organisations help streamline administrative processes and enhance the management of collaborative activities. They facilitate the sharing of resources and information, making it easier for participants to stay up to date with trends and leverage new opportunities for growth and development. By creating platforms for continuous dialogue and cooperation, collaborative organisations ensure that the collective efforts are well-coordinated and effective. This integrated approach not only fosters innovation but also maximises the potential for sustainable growth and development within the blue bioeconomy.

Digitalisation further enhances the benefits of collaborative structures in the blue bioeconomy by streamlining the management of activities and monitoring processes. Advanced digital tools enable efficient

reporting and sharing of results, making tracking the impact of collaborative efforts easier. This transparency and accessibility of information fosters a more connected and responsive collaborative environment. Additionally, digital platforms can create a marketplace in the blue bioeconomy, facilitating the exchange of ideas, resources, and services, thereby enhancing connectivity and collaboration opportunities across different sectors.

While many collaborative structures already exist in the blue bioeconomy (e.g. Bioeconomy on Marine Locations, Submariner Network), particularly in more mature sectors such as aquaculture, there is a clear need for strengthening these networks. Many are hindered by low awareness and participation, especially in niche areas like the seaweed industry, where collaborative structures are either in their infancy or absent. Initiating or expanding these networks, particularly in emerging blue bioeconomy sectors, could significantly enhance innovation and growth.

3.3.3 Geographical dimension

Over the last five years, the environment for CSC in the blue bioeconomy has improved significantly due to increased funding and policy support, which has facilitated larger collaborative projects. Networks and clusters have expanded, fostering better partnerships and resource sharing across sectors. Iceland excels in CSC in the blue bioeconomy due to its innovative circular bioeconomy model, particularly in the fishing industry. Initiatives like the Iceland Ocean Cluster have pioneered the use of nearly 100% of fish waste to create new high-value products such as collagen. This success is driven by strong collaboration between government, industry, and research institutions, backed up by regulatory support and investment in innovation hubs.

The Netherlands and Malta also showcase strong examples of government-backed up initiatives promoting cross-sectoral partnerships. The Netherlands promotes CSC by strong funding schemes and government incentives that encourage risk-taking and innovation. The country’s advanced technological infrastructure supports collaborations that integrate agriculture, aquaculture, and renewable energy. In Malta, the government supports the development of technology parks like the SmartCity Malta, serving as hubs for CSC. These parks provide infrastructure, including office spaces, labs, and production areas, where SMEs and start-ups can collaborate across sectors. By fostering innovation through these dedicated spaces, Malta encourages the exchange of knowledge and resources among industries such as aquaculture, bioplastics, and renewable energy. Countries with well-developed bioeconomy strategies, supportive regulatory environments, and active engagement of SMEs and research institutions tend to better foster CSC in the blue bioeconomy.

3.3.4 Opportunities for collaboration in the blue bioeconomy

The blue bioeconomy presents numerous opportunities for CSC. One of the main opportunities for collaboration in the blue bioeconomy lies in the valorisation of by-products. Europe produces about 4 million tons of fish waste annually, which could be valorised into higher value-added products, such as fertilisers. Utilising marine side streams to produce collagen presents another valuable opportunity. Currently, most "blue" collagen is derived from wild-caught fish. Developing alternative sources can tap into the high-value collagen market. This would not only reduce waste but also add economic value.

Moreover, with changing dietary preferences, there is an increasing demand for collagen and algae-based gelatine, creating new collaboration opportunities.

Further, industrial symbiosis, which involves recyclable nutrients on land and multi-trophic aquaculture at sea, also offers a great opportunity for CSC. Placing farms close to each other allows them to cross-fertilise, creating a more sustainable and efficient production system. Moreover, sharing insights on trends impacting value chains, such as climate change, and learning from other value chains can create new opportunities for CSC. This exchange of knowledge can drive innovation and foster more resilient and adaptive practices across sectors. There is also potential for collaboration related to the monetisation of ecosystem services in the blue bioeconomy, similar to practices in agriculture and forestry. Companies from other sectors could buy these services and establish new partnerships.

3.3.5 Challenges hindering collaboration in the blue bioeconomy

We have identified several challenges to CSC in the blue bioeconomy. These challenges can be categorised into three main subsections: cultural and geographical challenges, governance challenges, and financing challenges. Understanding and addressing these challenges is crucial to fostering sustainable growth, innovation, and effective collaboration across sectors.

3.3.5.1 Cultural and geographical challenges

First, the low level of public acceptance of aquaculture makes actors outside of the sector reluctant to collaborate. This hesitation stems from concerns about aquaculture practices' perceived environmental impact and sustainability. Further, the fear of competition among product developers often hinders open collaboration within the blue bioeconomy. Companies may be wary of sharing information and resources with potential competitors, fearing that it could lead to a loss of competitive advantage. This reluctance can stifle innovation and progress within the industry. Third, language is often a significant challenge to CSC in the blue bioeconomy. Misunderstandings and miscommunications can arise when partners do not share a common language, hindering the smooth exchange of ideas and information necessary for successful collaborative efforts. Fourth, collaboration becomes increasingly challenging the further apart partners are geographically. Issues such as sending samples and managing sales logistics become more complex over long distances. However, if the goal is to explore unknown territories, venturing into sectors and geographies unrelated to one’s own context can be beneficial. This approach allows for the infusion of diverse perspectives and innovative ideas that might not emerge from familiar environments.

3.3.5.2 Governance challenges

Several governance issues have been identified that hinder CSC in the blue bioeconomy. Most EU countries do not have harmonised or single regulations that apply to aquaculture, creating a fragmented regulatory environment. The absence of bioeconomy strategies and political support in some regions further limits CSC efforts. Additionally, there is a shortage of serviced, licensed operational areas and innovation hubs, such as incubators, where companies can collaborate with other sectors, such as energy, processing, and farming. The lack of continuous support for sea test beds and insufficient industrial-scale equipment for

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extraction processes also impede growth and innovation. Addressing these gaps with infrastructure and regulatory support would enhance collaboration and drive sustainable development.

The biggest governance challenge to the utilisation of by-products in the blue bioeconomy is generally related to logistics and the lack of intermediaries. This issue primarily arises because there are few systems or actors in place to collect, process, and redistribute these by-products effectively. While there are some pilot projects on upcycling, scalability is a problem within the EU. Iceland being an exception in providing such infrastructure. Moreover, the EU Waste Directive hinders the scaling up of side-stream valorisation because the valorised waste of good quality is still labelled waste. However, there is potential for improvement. In some countries, such as Italy, as waste management companies already have logistics systems that could easily be adapted to centralise waste management. Instead of fish companies bringing the waste to designated places, waste management companies could take over this responsibility. Unfortunately, these companies are not responding to this potential. Therefore, regional governments should get involved by regulating the process or providing incentives to waste management companies to encourage the development of a more efficient supply chain.

3.3.5.3 Financing challenges

Several financing issues challenge the development of CSC in the blue bioeconomy. The primary obstacle to realising CSC in the aquaculture sector is that aquaculture is generally receiving less funding and support than industries like agriculture, energy, or traditional fisheries. Consequently, startups with no equity or guarantee must go to banks to loan large amounts of money, which is very difficult. This financial constraint makes it challenging for new ventures to secure the funding necessary to participate in cross-sectoral collaborations and to drive innovation in the aquaculture sector.

Structural issues related to investment insurance and other services also hinder the further development of the sector and CSC:

The aquaculture sector has a less developed risk profile, making it difficult for investors to assess and manage risks associated with investments in this industry accurately.
Few facilities are available regarding insurance and guarantee schemes for the aquaculture sector. This lack of support mechanisms makes it harder for companies to secure the necessary financial backing for their operations and collaborative projects.
Using aquaculture licenses as leverage for lending or setting insurance rates is typically impossible because aquaculture is considered a high-risk sector due to the sector’s volatility, including risks related to environmental factors, disease outbreaks, and market instability. This limitation restricts the financial flexibility of companies in the sector, making it more challenging to obtain funding and investment for scaling up, innovative and collaborative initiatives.

Additionally, ensuring continuity for collaboration projects, such as the innovation space Bioeconomy at Marine Sites (BaMS), is difficult due to the limited period of funding (interview with BaMS). This short-term funding horizon hinders collaborative initiatives' sustainability and long-term development, affecting their ability to achieve meaningful progress and impact. Addressing these challenges is essential to enhance cross-sectoral collaboration in the blue bioeconomy.

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3.3.6 Good practices for CSC in the blue bioeconomy

Successful CSC in the blue bioeconomy is evident in various innovative practices in Europe. Iceland stands out with the Iceland Ocean Cluster, which has pioneered the near-complete utilisation of fish waste and the production of marine collagen from side streams. This innovative model is largely credited to Thor Sigfusson, the founder of the Iceland Ocean Cluster and a visionary leader in sustainable marine resource utilisation. Sigfusson's work has helped establish Iceland as a global leader in the blue bioeconomy by fostering collaboration between businesses, researchers, and policymakers to turn waste into high-value products. His efforts, alongside strong government support, have created a benchmark in recycling and waste management. The Icelandic authorities excel at uniting stakeholders across different sectors, addressing common challenges, and facilitating the steps needed to overcome them.

What also works well are initiatives on cross-sectoral collaboration at a local level, such as the Fisheries Local Action Group project, where local municipalities aim to boost companies in the blue bioeconomy in their area. Working with local industry experts helps break down resistance to new ideas and develop solutions tailored to the area. The most effective approach is to find industrial leaders open to innovation and to begin collaborating with them. Gradually, these leaders influence surrounding industries and clusters as they observe their success and begin to trust and adopt the new practices.

Moreover, there are good examples of EU and national projects combining different sectors and geographies with a common shared objective. One example is the EU Project Systemic Innovations Towards a Zero Food Waste Supply Chain, which explored alternative ways (e.g. industry, farming, end-of-life, consumer perspective) to tackle and prevent food waste and develop methods for repurposing waste into valuable products. Such projects allow participants to learn extensively from the diverse perspectives and regional contexts involved. These initiatives foster innovative solutions and enhance collaboration across sectors by integrating various industries and locations, demonstrating the value of a united approach to addressing complex challenges.

Finally, there are good examples of technology parks facilitating and promoting CSC. For instance, the already mentioned Maltese technology park SmartCity, which includes about 30-40 small industrial units. Companies can rent these spaces until they are ready to establish their own premises. This setup supports startups and fosters collaboration, driving innovation and growth across sectors.

3.3.7 Way forward for enhanced CSC in the blue bioeconomy

Several recommendations should be considered to foster effective CSC in the blue bioeconomy:

- Invest in building the necessary infrastructure to collect, process, and redistribute by-products effectively alongside creating incentives for by-product valorisation as producers typically avoid dealing with residuals and simply dispose them.
- The EU Waste Directive should enable the use of nutrients from recycled side streams and improve labelling categories.
- Secure continuity for innovative collaboration projects like BaMS by providing consistent funding.
- Establish targeted funding streams to bridge the gap between aquaculture and more heavily supported industries such as agriculture, energy, and traditional fisheries
- Develop case studies that demonstrate the benefits of CSC in the blue bioeconomy.

- Gather stakeholders, demonstrate their common challenges, and facilitate discussions on overcoming them.
- Improve aquaculture literacy among consumers and policymakers to diminish misconceptions about aquaculture practices, such as fish production and antibiotic use. Educating consumers can lead to more informed decisions about seafood products, while raising awareness among policymakers can result in better regulatory frameworks and support for sustainable aquaculture.
- Support the development of spin-offs from universities to strengthen ties between research and industry.
- Ensure that research is more accessible and aligned with industry needs and that research project results can be translated into an industrial scale.
- Streamline administrative processes in the context of CSC, R&D, and innovation projects by reducing bureaucratic burdens related to funding applications, progress reporting, and regulatory compliance and place emphasis on achieving results, developing technologies, and fostering innovations rather than paperwork.
- Develop physical spaces where companies in the blue bioeconomy can collaborate with other sectors to facilitate the exchange of ideas and resources and drive innovation.
- Designate a single contact person at public authorities to handle cross-sectoral topics efficiently.
- Incentivise and support the development of companies that are supplying industrial equipment at scale to enhance production capacity, enabling large-scale cross-sectoral collaboration, and fostering growth and innovation in the blue bioeconomy.
- Support test beds in the sea for marine technologies and ensure their continuity.

3.3.8 Conclusions

CSC in the blue bioeconomy is essential for driving sustainable development, enhancing global food security, and maximising resource efficiency. Collaborative networks and sector associations should be empowered to facilitate dialogue and knowledge transfer between different value chains, fostering mutual learning and innovation. By setting clear goals and enabling industrial symbiosis, CSC can significantly enhance economic growth and environmental sustainability within the fish and aquaculture sectors. Except for Iceland, no European country has the infrastructure to scale up waste processing of blue biomass. Public authorities must play a proactive role by regulating and setting incentives for waste processing and management, ensuring the necessary infrastructure is in place.

3.4 Food Sector

With a trade surplus of 43 billion EUR in 2021, the food sector is an important economic pillar of the EU (Eurostat 2022). However, the economic value of the sector is offset by its environmental impact. Food production is responsible for 26 % of global greenhouse gas emissions, out of which 82 % come from agricultural activities (European Court of Auditors 2021)

The European Union’s approach to the food sector is coordinated by several Directorate Generals, primarily the Directorate-General for Agriculture and Rural Development (DG AGRI) and the Directorate-General for Health and Food Safety (DG SANTE). These bodies ensure that food production aligns with

environmental sustainability goals, food safety standards, and the broader objectives of the EU's bioeconomy strategy (European Commission 2024d,e).

As the world's largest economic system, measured in terms of employment and livelihoods, it is vital to transform the food system towards a net zero system (UNEP et al. 2023). The green transition in the food sector is complex and calls for a systemic, multi-level and multi-stakeholder participatory approach to achieve shared goals. This chapter introduces the current obstacles to this objective and presents viable solutions to address them.

3.4.1 Overview of the collaboration in the food bioeconomy

Cross-sectoral collaboration is an opportunity to address new business opportunities within bioeconomy which the food sector is an integral part of. The existing CSC is mostly in the agrifood value chain where the biomass quantities are. The CSC is typically wholesale trade of side streams from the food processing industry to the ingredient, feed and biogas industry. Sales and purchases are managed via contract agreements where content, volume, price and duration are defined. There are multiple successful CSC collaborations in the biogas industry. But in general, there are few big-scale CSC examples within the agrifood value chain.

The Danish biogas sector is a strong example of CSC in practice. The Danish biogas plants (around 180 plants) ensure that waste from agriculture, the food industry and household/food waste are recycled and reused in fertilizers in agriculture. At the same, the energy content in the biomasses is utilized to produce biogas, which substitutes fossil fuels. There is an increasing understanding that biomass from the agri-food sector is a new resource to replace fossil materials but lacks the economics of scale. The main customers are still within the food industry, but we see an increasing focus on other sectors and application areas. This especially applies to plastics, added-value chemicals, construction materials, and bio-based materials for food packaging.

There are many development projects at regional, national and EU levels in cross-collaboration, with different TRL levels from 1 to 9. For instance, biogas which is a market-ready technology, where development projects today typically focus on efficiency and process optimization. When it comes to the development and use of grass protein for human nutrition, the focus is on scaling up and the technology still need to see the product enter the growth phase. For biochar, who is an emergent technology, scaling has not yet taken place. And as for biopolymer, where plant sugars are used to make plastic-like products, the technology is not yet fully developed.

3.4.2 Role of collaborative structures in the food sector

The collaborative structures in the food sector can foster the green transition forward. For many of the existing clusters, the UNs Sustainable Development Goals (SDGs) guide their strategies and activities, and circular economy among the tools that support the implementation of the UN's SDGs. These collaborations focus on pressing issues such as ensuring a sustainable green transformation of the food sector towards climate neutrality, providing solutions for sustainable food production, maximizing the value of bioresources and biomass, and digitalization (Cluster Excellence Denmark 2019). They act as

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intermediaries for all stakeholders in the food sector creating efficient platforms for collaboration and change and their general approach towards collaboration is via the Penta-helix model (see Figure 7).

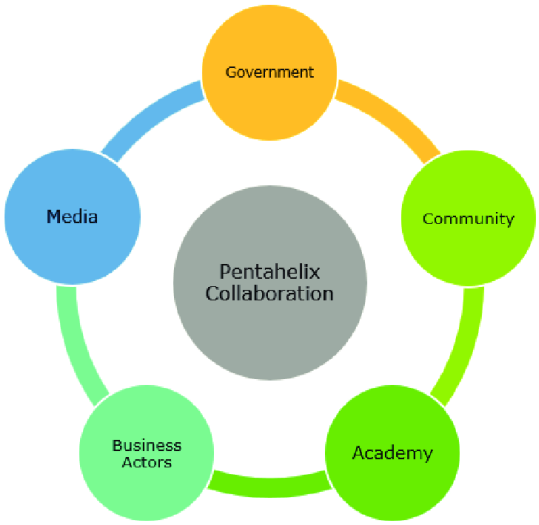

Figure 7: Penta-helix Collaborative Development Model.
Source: Author's explanation.

Collaborative structures as clusters in the food sector are helping companies access the latest knowledge, test new green business ideas and develop green innovation. To assist the circular transition, they have a variety of circular services including:

The dissemination of knowledge and awareness in the circular transition through events, workshops, and reports to bridge knowledge gaps.
Professional networks (e.g. utilization of side streams, green protein, food & beverage footprint and reporting, and sustainable packaging) that bring together professionals on circular economy. Here they can form innovation partnerships and learn from peers in a structured and confidential setting. Network groups aim to create synergy for innovative collaborations.

- Support the companies in finding the right business partners through matchmaking e.g. connecting SMEs and large companies to make circular collaboration.
- Assist the companies in funding or finding the right one– from innovation vouchers to the right smart green investors.

Many of the collaborative structures in the food sector also collaborate across sectors and value chains. Food and Bio Cluster Denmark, for example, collaborates with the 12 other national clusters in Denmark and is part of the European Clusters Alliance (https://clustersalliance.eu/).

The biggest advantages of the collaborative structures to promote and engage stakeholders in CSC are:

- Profound understanding of the agrifood sector and dealing with the whole value chain
- Member-based organizations with highly committed stakeholders

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- Access to an enormous national and international network
- Supporting implementation of national/international
- Supporting implementation of national/international policies on circular economy and are key in putting the strategy into action

3.4.3 Geographical dimension

There is an increasing focus on CSC in the food sector in the EU, here policy measures have been implemented to support such initiatives. At the national level, the Nordic Countries, France and the Netherlands have made significant advancements in downstream CSC, largely due to extensive efforts in valorizing side streams.

The importance of geographical proximity in CSC depends on the subject. SMEs are closely linked to local producers relying on them for sourcing raw materials and being part of the cultural heritage and regional traditions.

Proximity is particularly crucial for business opportunities such as biorefining and cascade utilization, as raw materials and side streams often have a limited shelf life and are expensive to transport.

However, in innovation, geographical proximity is likely less important due to the increasing prevalence of hybrid and digitized collaboration. While cultural or linguistic differences are generally not major barriers, communication in one's native language can be more convenient.

3.4.4 Opportunities for CSC in the food bioeconomy

Increased CSC offers numerous benefits for the food sector. Firstly, it fosters innovation by incorporating diverse perspectives and expertise from various sectors, potentially leading to novel solutions and products that tackle complex challenges in the bioeconomy. Additionally, CSC can enhance resource efficiency by leveraging complementary strengths and resources across sectors. Examples of opportunities for CSC in food bioeconomy include:

Biorefining and cascade utilization of biomass resources. This approach aims to utilize all the components of the biomass to their full potential in a cascade of various products (see Figure 8).

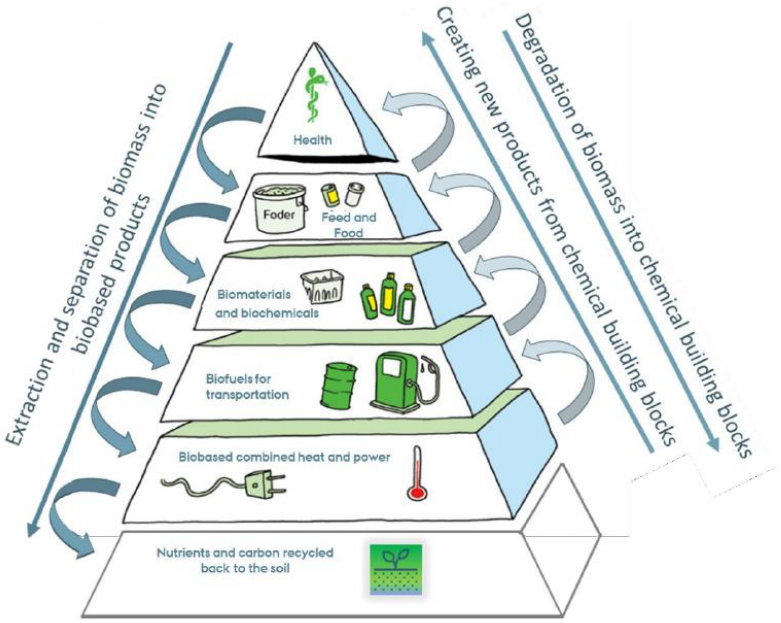

Figure 8: Product pyramid for biorefining with cascade utilization.
Source: Lange and Lindedam (2016), adapted by Ambye-Jensen (2021).

In the upper cascade layer, CSC opportunities include partnerships with the Life Science and Pharma sector in developing ingredients with health-promoting properties and the impact on the diet of diseases. The residual products from the upper cascade layers represent opportunities for entering collaborative cross-sector business models for the sustainable production of feedstuffs in the feed/pet food industry and biobased materials for the construction-, packaging- and textile sectors and biochemicals. Residues from the lower layers can be used for biofuels for transportation, heat and power.

Digitalization, data and data sharing. The European food sector exhibits varying levels of digitalization across countries and markets. Digitalization, along with data management and sharing are important elements for the transition towards a more circular economy. Widespread connectivity, satellite technologies, data science and artificial intelligence mechanisms, robotics, autonomous systems, electronics and biological sensors, virtual and augmented reality, the Internet of Things (IoT) and blockchain apps are increasing the efficiency of agriculture, food and biomass supply chains, reducing waste and resources use while increasing the quality of food and biomass (Draca et al. 2018).

CSC opportunities include insight into the value of being more data-driven and part of the data ecosystems and gaining practical experience with handling data, data sharing and AI.

3.4.5 Challenges hindering collaboration in the EU food bioeconomy

The main barriers for CSC include:

- Food safety requirements which are often challenging, in particular the long process for acquiring approvals and associated costs.
- The biomass from the food sector is perishable and the collection is costly.
- The food sector deals with biological materials where the content varies.
- Food products are often viewed as commodities, and consumers generally show a low willingness to pay a premium for more sustainable options, which indicates a need for more attractive pricing and persuasive marketing strategies.
- The narrative around the value of circularity in the food system is quite abstract. To effectively persuade consumers to choose products derived from circular practices, it is essential to translate this concept into more tangible benefits. The food sector can get aspirations from the machinery industry, where there is a wealth of transparent data available about the environmental impact of products, to improve communication and demonstrate clear, direct advantages of circularity to consumers.
- At the national level, the food bioeconomy is often fragmented across different ministries, each approaching it from their specific areas of expertise without always aligning on common goals. The food sector requires a more systematic approach to cross-sectoral collaboration, which should include coordinated decision-making at the national level. It is crucial to understand the interconnectedness of various components within the sector and to assess the impact of changes in one area on others.

Table 3 shows the main challenges hindering CSC in the food bioeconomy, the consequences, and the recommendations to overcome these challenges.

Table 3 Main challenges hindering CSC in the food bioeconomy, the consequences, and the recommendations

Challenge	**Impact on countries with this problem**	**Recommendations on how to overcome the challenge**
Regulatory barriers (novel food regulation, Genetically modified organisms (GMO) regulation, labelling, product classification, etc.)	A lengthy and costly approval process hinders the entry of modern technologies and products with new climate-friendly properties into the market, creating challenges from an investor's perspective. This bureaucratic delay can deter investment and slow down the adoption of innovative solutions that could benefit the environment.	Establish national centres of excellence with in-depth expertise in technologies and legislation for specific technologies that can provide companies with qualified guidance. Such centres must include opportunities to establish fast-track schemes and regulatory sandboxes. Work politically for more innovation-friendly EU regulations

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Challenge	Impact on countries with this problem	Recommendations on how to overcome the challenge
Biomass with a short storage stabilities	The costly collection of biomasses, which has a short shelf life from numerous SMEs spread over large geographical locations poses challenges for achieving economies of scale.	Stimulate the establishment of regional hubs that focus their production on different bioeconomy-related industries. Support investments in logistics and infrastructure. Introduce the use of food preservation and technology.
Market barriers and cost gap	Consumers exhibit a low willingness to buy and pay for more sustainable food products	Need for more attractive pricing. Introduce carbon pricing of negative emissions, VAT reduction green products, etc.
No climate label on food	It is difficult for consumers to decode the climate footprint of food.	Introduce a climate label containing a scale with five steps and colour codes like the energy labelling of white goods
Bioeconomy regulation goes across different ministries.	The ministries often have different goals and do not always have an overview of the overall consequences of climate measures.	Set up a national level committee that coordinates the food bioeconomy area across ministries

3.4.6 Good practices for cross-sectoral collaboration in the food bioeconomy

The national clusters are central instruments in the national innovation and business support systems and can advantageously be used to promote CSC.

Many positive examples of CSC in food sector already exist. For example, Food & Bio Cluster Denmark has entered a partnership with other cluster organizations on how side-streams from the agricultural and food sector can be used as functional ingredients, bio-based building materials, in sustainable packaging and solutions to the environmental impacts of textile production.

The road map for the cooperation between for example FBCD (https://www.foodbiocluster.dk/) and WE BUILD DENMARK (https://webuilddenmark.dk/english), on how to create innovation and accelerated the development within the use of bio-based building material has involved:

- Joint inspiration events such as 'Bio-based carbon for construction' with a focus on the great potential of and many possible uses of biomass, e.g. hemp and straw.

- Opportunities to apply for funding, e.g. the Land to Construction call, where SMEs could receive a maximum of DKK 100,000 with a focus on realizing the potential of how we can use biomass and side streams from wood and agriculture can be used for new building materials in construction.
- Establishment of the 2-year joint project "Closing Loops" (www.closingloops.dk), which, among other things, focuses on how side streams from the agricultural and food sectors can be used as alternative building materials and products.

The Danish authorities have supported the transition via grant schemes that set a framework for cross-sectoral collaboration to create completely new value chain collaborations.

The Bazancourt Pomacle biorefinery 15 km from Reims is another example of good practice for CSC in the food bioeconomy. Originally a cooperative sugar refinery (today, Cristal Union), the site expanded in the 1990s to include an agro-industrial complex with the building of a starch and glucose plant operated by the Chamtor company (now ADM), as well as an innovation cluster, through the launch of a research centre shared between sugar beet and cereal growers, Agro-industry Research and Development (ARD). Today, the Bazancourt-Pomacle biorefinery is a multi-company ecosystem endowed with an innovation platform covering 160 hectares and generating 2,000 direct and indirect jobs. Annually, it converts 3 million tonnes of diverse biomass into various products for the food, chemical, cosmetics and biofuel industries.

3.4.7 Way forward for enhanced cross-sectoral collaboration in the food bioeconomy.

Several recommendations should be considered to foster effective cross-sectoral collaboration in the food sector:

- The authorities should take leadership in solving the main challenges in the food bioeconomy as described in Table 3.
- The collaborative structures can help implement the CSC in the circular economy and size the growth opportunities.
- The CSC should focus on the optimal use of bioresources, via biorefinery cascade exploitation where partners have common interests.
- Create and facilitate local industrial symbioses where different industries work together to unlock the full potential of bio-based solutions.

3.4.8 Conclusions

The food sector is already an integral part of the Bioeconomy sector. Today the CSC is mostly in the agrifood value chain where the biomass quantities are. Biogas production in Denmark is an example of CSC big-scale success story. The drivers for CSC include new business opportunities – they want to be ahead of competitors. Start-ups often work with distributive ideas, while the big companies maintain the traditional products with large market share and make a slow transition. The collaborative structures such as clusters support CSC via a penta-helix collaboration approach to create awareness via events, and access to networks, help pave the way for projects, business partners and support in business development. Sector-specific challenges that hinder CSC include regulatory barriers, biomass with its perishable nature and market barriers and cost gaps. The way forward for enhanced CSC includes a more regulatory-friendly environment, focus on the optimal use of bioresources via biorefinery cascade exploitation where partners

have common interests, create and facilitate local industrial symbioses where different industries work together to unlock the full potential of bio-based solutions and more attractive pricing.

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4. SMEs situation regarding CSC

SMEs play an important role in the bioeconomy. For example, the blue bioeconomy sector is predominantly comprised only of SMEs. In the agriculture sector, SMEs account for almost 80% of the activities across the value chain. The EU food and drink industry comprises 290,000 SMEs, which generate 39,1 % and 40,7 %, respectively, of the industry's turnover and provide more than half of the jobs in the sector (FOODDRINKEUROPE 2023). These figures demonstrate the importance of SMEs in the bioeconomy development.

In bioeconomy, CSC structures offer SMEs a unique opportunity to leverage the strengths of various partners, foster innovation, expand outreach and build resilience in a competitive market. Moreover, policy makers and research institutions increasingly recognize the valuable contributions SMEs bring to collaborative projects. Due to their smaller size, SMEs can make quicker decisions and adapt more readily to new ideas – an advantage that sets them apart from larger firms in collaborative settings. Additionally, SMEs often have a deep understanding of the specific challenges and opportunities within their sector and geographical location. Their focus on innovation and growth makes them more open and inclined to participate in CSC initiatives, further enhancing their role in collaborative projects. In the next chapters key findings based mostly on interview results on SMEs situation is outlined.

4.1 Supportive factors for CSC

The percentage of SMEs involved in collaborative structures has been quite stable over the last 5 years, with many interested in joining CSC when there is a clear vision, purpose, and expected outcomes. This is especially supported by trust among the collaboration partners as it forms the basis for effective collaboration and is a prerequisite for building strong and lasting relationships.

Among the key drivers for SMEs engagement in CSC structures is access to resources and knowledge, as collaboration provides SMEs with shared resources, expertise, and technologies that might be unaffordable independently. Innovation is a strong motivator, as collaboration with diverse partners fosters innovation by combining different perspectives and expertise. Moreover, collaborative projects often have better access to funding and investment than firms alone. Also, a major motivation for joining CSCs is the commercial opportunity, as SMEs are keen to adopt new processes and products to stay ahead of competitors. Additionally, the potential for market expansion is significant, as partnering with other companies or sectors can help SMEs reach new markets and customer bases.

The nature of collaboration, however, often depends on the level of maturity of the industry. Emerging products at the early stages of development require significant investments in infrastructure, equipment, and other resources, tend to attract more risk-averse capital. On the other hand, collaborations in mature industries like biogas and fishing industry often focus on export, sales promotion, and marketing activities.

4.2 Hindering factors for CSC

Despite a growing momentum for inclusion of SMEs in collaborations as a result of industrial and innovation policy, they still face several hurdles.

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One significant challenge is the dominance of large-scale global companies, which often outcompete SMEs due to their economies of scale, resources, and market competitiveness. This dominance can lead to increased costs for SMEs and lower their market viability (European Investment 2024).

Also, collaborative activities are often led by technology centres, universities and large technology companies, with limited participation of SMEs due to administrative and financial requirements. However, SMEs can mitigate this barrier by engaging indirectly through industry associations and federations, which help translate research results into practical applications relevant to SMEs. This involvement can empower SMEs to play a greater role in shaping a more sustainable, innovative, and efficient bioeconomy.

SMEs are often inexperienced or lack human resources in project participation and find it difficult to understand how to create a project report, fill out paperwork or the dynamics of working with other entities. Funding is also often not sufficient for SMEs, which makes them reluctant to embark on a project that has uncertainty of success or risk of not scaling up to industrial scale. Especially, SMEs encounter difficulties in accessing private investment opportunities. Large companies may exhibit reluctance to collaborate, driven by factors such as self-sufficiency in resources and a preference for mature technologies with high TRL, which are ready for scaling up. This preference often discourages investments in research and development initiatives, further hindering collaborations with SMEs. Adding to this, limited accessibility and availability of information on supply and pricing dynamics challenges their market-entry opportunities. Therefore, constraining competition and impeding SMEs' ability to thrive in the marketplace. Cascade funding can facilitate the participation of SMEs in collaborative projects. Cascade funding, also known as block-chain funding or tiered funding, is a funding method used mainly in research and development projects, ventures, and in projects funded by European programmes, such as Horizon 2020 and Horizon Europe.

Factors such as fear of competition and loss of competitive advantage can make SMEs wary of sharing information and collaborating with other companies. Conflicts also arise over data publication – while universities prioritize publishing papers to credit researchers, SMEs often prefer to keep data confidential to protect valuable knowledge. Furthermore, limitations in translating research results to practical outcomes, especially for some EU projects poses challenges, as many of these projects are highly scientific and do not always yield practical results that enhance a company’s economic value or scalability which discourage SMEs collaborations.

Overall, while SMEs in the bioeconomy are strongly interested in collaboration, addressing their concerns through supportive policies, funding, streamlined processes and efficient matchmaking can further enhance their participation and drive the growth and sustainability across bioeconomy.

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5. Way forward towards enhanced CSC in the EU bioeconomy

Our findings indicate that across the EU, CSC stands as a basis for the advancement of bioeconomy, bridging diverse sectors to foster innovation, economic growth and sustainability. This collaborative approach unites stakeholders from different primary production sectors, such as agriculture, forestry, blue bioeconomy and different processing industries (e.g. food sector) and creates synergies that address complex challenges and drive the transition towards a more sustainable and resilient economy.

Furthermore, collaborative structures, such as industry associations, clusters, hubs and networks, are vital in fostering CSC in Europe's bioeconomy. They drive innovation by combining diverse perspectives and expertise, leading to the development of groundbreaking ideas and solutions that would not emerge in isolation. Additionally, collaborative structures can help to mitigate and/or share risks, providing better opportunities for investment. Collaborating entities in the bioeconomy can also take bigger steps than they could independently. This collective progress accelerates development and strengthens trust among partners.

Collaborative structures can also help streamline administrative processes and enhance the management of collaborative activities. They facilitate the sharing of resources and information, making it easier for participants to stay up to date with trends and leverage new opportunities for growth and development. By creating platforms for continuous dialogue and cooperation, collaborative organisations ensure that the collective efforts are well-coordinated and effective. This integrated approach not only fosters innovation but also maximises the potential for sustainable growth and development within bioeconomy.

However, as elaborated in further detail below, CSC across different bioeconomy sectors and geographical levels faces numerous challenges in all the "key elements" of CSC, which were identified in the literature research and elaborated earlier: Structural and Organizational (e.g. regulation, governance, legislation); Financial and economic; Social capital: communication, values, culture.

5.1 Structural hindering factors for CSC

It is clear from our analysis that all sectors express interest in implementing CSC activities. However, they all encounter at least to a certain level difficulties in engaging the entire value chain in CSC. This is especially problematic in the forestry and agriculture sector. For example in the forestry sector, limited CSC is observed, particularly during production stages. Similarly, in the agriculture sector, CSC is also often not utilized in the early stages of research and innovation, where various actors begin to formulate their ideas. Instead, CSC becomes more evident only from TRL 3-4 onwards. In agriculture, there is also a huge lack of intermediary structures that would connect the farmers with the next step in the value chain.

Fragmented ownership is also a structural hindrance for CSC. Out of the 4 sectors included in this study, this is mainly a pressing issue only in the forest sector. The key challenge is maintaining a dialogue between forest owners and industry stakeholders. This has contributed to the role played by contractors and intermediaries in linking these stakeholder groups. Additionally, the uneven distribution of margin along the value chain, discourage engagement between owners and industries in the forestry sector.

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5.2 Organizational key elements in CSC

By definition CSC encompasses a multidisciplinary field and a diverse range of actors. Hence, its governance and regulation can be very complex and involve multiple decision-making bodies at various geographical levels. Unsurprisingly, all the analysed sectors face challenges related to misaligned policies for bioeconomy and lack of support for CSC.

Often, the absence of dedicated strategies and necessary supportive political structures are missing or only remotely addressed. Such distributed regulatory frameworks and inconsistent policy objectives cause complications across all the bioeconomy-related sectors, highlighting the urgent need for improved and more centralized collaboration activities by qualifies and skilled persons, able to understand the multidisciplinary field of bioeconomy.

For example, in most EU countries harmonised or single regulations on aquaculture do not exist, creating a fragmented regulatory environment. Furthermore, in the forestry sector, some authorities prioritise growing forests in support of climate actions, others might emphasise utilisation of wood for industrial purposes. These types of missing, fragmented, or conflicting policy perspectives pose challenges for stakeholders involved in collaborations and market development. Furthermore, this complexity introduces uncertainty and risk for investors and SMEs trying to enter the market by supporting or collaborating in different CSC projects.

In the food sector, complexity of regulation can be a significant challenge for the stakeholders. A very long and costly approval process can limit the development of new technologies and products with climate-friendly properties from entering the market and can be a barrier from an investor's point of view. The food sector needs a more systematic CSC approach than any other sector in bioeconomy, including at the government level in order to consider the complex interdependencies of various actors in the CSC value chain.

In blue bio economy an additional governance challenge related to the utilisation of by-products is the lack of intermediaries. While there are some pilot projects on upcycling, scalability is a problem within the EU. The EU Waste Directive can hinder the scaling up of side-stream valorisation because valorised waste is still categorised as waste. Therefore, there is a role for regional governments to get involved by regulating the process or providing incentives to waste management companies to encourage the development of a more efficient supply chain.

5.3 Financial and economic key elements in CSC

Dedicated and well-aligned funding mechanisms are identified as one of the key elements, essential for supporting CSC in this study. The conducted analysis, however, revealed a notable deficiency in such mechanisms across all analysed sectors. This lack of suitable financial supporting instruments limits the potential for CSC and therefore. Therefore, it is crucial to develop targeted funding strategies that would facilitate collaboration and facilitate the successful uptake of CSC activities.

Oftentimes, research for new projects is conducted in the laboratories at pilot scale, where funding is less of an issue. However, the leap towards industrialization still poses a major challenge across all stakeholders,

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heavily hindering the translation of research findings to the industrial level. In general, fewer resources are allocated to CSC activities than to traditional sectors, because of higher associated risks. Consequently, start-ups and SMEs with no equity or guarantee must go to banks to borrow large amounts of money, which is very risky and difficult for them. This financial constraint makes it challenging for new ventures to secure the funding necessary to participate in CSC and to drive innovation in bioeconomy. Other barriers include lack of knowledge in identifying and structuring bankable projects, monetizing sector-specific ecosystem services using commercially viable business models due to a limited understanding of how to generate returns and grow the business through feasible investments. Additional sector-specific challenges exist in the forestry sector, with has extremely extended period between investment and tree harvesting. This heavily discourages the adoption of new practices, as they may not seem financially viable.

5.4 Social capital key elements in CSC

The analysis indicates that different social capital elements, such as communication, values and culture are considered as key elements among involved stakeholders in CSC, which are all important factors for success in CSC, but often still pose a challenge across different sector of the bioeconomy.

The lack of knowledge and the potential benefits of CSC represents a significant challenge. Stakeholders are often uninformed of the benefits of CSC and lack the necessary incentives to engage in CSC. To overcome these challenges more capacity-building initiatives, and the development, and showcasing, of effective collaboration models that address the specific needs and limitations of different bioeconomy sectors, is necessary. The forestry sector is notably conservative in this respect, in particular in Central and Eastern European countries. This kind of conservatism presents a significant barrier to exploring and implementing new management options or adaptations. By fostering a better understanding of CSC and its benefits, stakeholders could enhance their capacity for CSC and drive progress within the bioeconomy.

Building trust and speaking “common language” are additional key element identified through the analysis that are necessary for CSC across all sectors. Often a lack of skilled specialists and of specialised industrial-scale biomass processing facilities, drives companies to participate in international CSCs. Yet these collaborations are hindered even more than national or regional ones by establishing trust with partners due to longer physical distances and cultural and linguistic differences. Often, misunderstandings and miscommunications can arise when partners do not share a common language, hindering the smooth exchange of ideas and information necessary for successful collaborative efforts. Additionally, collaboration becomes increasingly challenging the further apart partners are geographically.

Finally, issues around acceptance due to low legitimacy are also hindering factors in specific sectors. For example, in blue bioeconomy, the lack of public acceptance of aquaculture makes actors outside of the sector reluctant to collaborate. This hesitation stems from concerns about aquaculture practices' perceived environmental impact and sustainability. In parallel, in the food sector, consumers have a low acceptance of bio-based products and exhibit a low willingness to buy and pay for more sustainable food products, which is due to low acceptance, caused by low legitimacy.

The report has identified a range of challenges that are either CSC specific or more general and impact the stakeholders across the entire bioeconomy. In response to these identified challenges, the study has

proposed some initial recommendations presented throughout the sector-specific paragraphs aimed at addressing these issues. However, as the project progresses, the next steps in following work packages will involve the development of comprehensive recommendations tailored to each of the topic blocks outlined in this report: structural, organizational, financial, and social capital. By addressing these multifaceted challenges in a systematic and coordinated manner, a more robust framework for collaboration will be created , in order to support innovation and economic growth across the EU's bioeconomy.

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6. Conclusions

The EU's bioeconomy encompasses a variety of sectors, ranging from primary production to industrial biotechnology. Different sectors, included in this study – whether agriculture, forestry, food, aquaculture, or fisheries – all play a vital role in driving the growth of the bioeconomy in the EU. Primary production sectors like agriculture, aquaculture and forestry provide essential raw materials in bioeconomy, while industrial sectors (e.g. food sector) transform these materials into innovative bio-based products. Integrating stakeholders across these diverse sectors within collaborative structures at different levels is key to a robust and dynamic bioeconomy. However, as our study results are in line with the findings from the desktop research and earlier studies, indicating that the development of innovative bio-based products and processes is still very strongly hampered by a lack of cooperation among relevant actors between different sectors, despite numerous efforts on national and the EU level to promote collaboration among bioeconomy stakeholders. Therefore, there is still an urgent need to take concrete actions to improve CSC in the bioeconomy on different geographical levels and along different bio-based value chains across various sectors to contribute to higher innovativeness, resources efficiency and circularity through new partnerships.

The current analysis revealed that while the dynamics and extent of collaboration varies across sectors, reflecting unique geographical and sectoral level strengths and challenges, surprisingly the key challenges for stakeholders to participate in CSC, regardless of sector, mainly overlap. In terms of unfitting policies and lack of coordination, policies, strategies, and initiatives, ranging from regional to national to EU-wide, are necessary to collectively contribute to building robust frameworks, which encourage collaboration between different sectors and, therefore, boost knowledge exchange, resource optimization, and innovation. Insufficient and incompatible infrastructure with strong regular disparities is also a major hurdle together with inadequate investments and lack of alignment of financing for CSC projects, which are associated with higher risk and uncertainties compared to non-CSC projects and need therefore dedicated financial instruments.

Depending on the specific sectoral characteristics, additional challenges arise for stakeholders. In sectors such as the food and blue bioeconomy, there is very high interdisciplinarity, which brings a number of governance challenges and highlights the need for stronger coordination by skilled personnel who can analyze and understand the specifics of these interdisciplinary fields. In contrast, the agriculture and forestry sectors both struggle with low knowledge diffusion among stakeholders, resulting in a very low innovative mindset and a lack of understanding of the benefits that CSC can offer. Furthermore, differences in culture, goals, and operational methods across sectors pose significant barriers to effective collaboration. Moreover, our analysis indicate that the collaboration process can be also extremely resource-intensive and time-consuming, limiting participation especially for SMEs across all bioeconomy-related sectors.

Therefore, considering how multifaceted the problems around CSC are, no single initiative or instrument can provide a solution alone. Transitions in many different areas and levels are needed, calling for an overarching approach that can address all the involved sectors simultaneously while taking into consideration the sectoral specificities.

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Appendix

MAG participants

Table 4 Members of the MAG group on collaboration

Surname	First name	Country	Affiliation
Bertacchi	Stefano	Italy	Assistant Professor at University of Milan-Bicocca
Blicklingova	Katarina	Slovakia	Director of the Slovakia Bioeconomy Cluster
Borzecka	Magdalena	Poland	Professor at the Department of Bioeconomy and Systems Analysis of the Institute of Soil Science and Plant Cultivation (IUNG) (research institute subordinate to the Ministry of Agriculture and Rural Development)
Brosnan	John	Ireland	Bioeconomy Executive at ICOS - Irish Cooperative Organisation Society
Garcia	Daniel	Spain	Responsible for projects and innovation at Avebiom
Gasiunaite	Zita Rasuole	Lithuania	Head and lead scientist of the laboratory of Marine Ecosystems of Open Access Centre for Marine Research and a professor at the Department of Natural Sciences of Klaipeda University in Lithuania, Founding Board Member of CORPI (Coastal Research and Planning Institute)
Hahnbak	Thine	Denmark	Innovation Consultant at Klimafonden Skive.
Hajek	Miroslav	Czechia	Researcher at Faculty of Forestry and Wood Sciences of Czech University of Life Sciences Prague
Hoxha	Ardita	Finland	Research Director at Savonia University of Applied Sciences
Ikauniece	Anda	Latvia	Head of Department of Latvian Institute of Aquatic Ecology, Agency of Daugavpils University
Kjær	Tyge	Denmark	Associate Professor at the Department of People and Technology of Roskilde University

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Surname	First name	Country	Affiliation
Matijošytė	Inga	Lithuania	Vice President and Board member of the Lithuanian Biotechnology Association (LithuaniaBIO), Head of Applied Biocatalysis Sector, Institute of Biotechnology, Life Science Center, Vilnius University
Mernitz	Gudrun	Germany	Founder and Senior Consultant of Witeno (Science and technology park North South)
Parkel	Sven	Estonia	General Manager of Tartu Biotechnology Park, General Manager of Estonian Hydrogen Cluster
Pauperio	Mariana	Portugal	Project Manager at Blue Bio Alliance
Quendler	Erika	Austria	Employee at Federal Institute of Agricultural Economics, Rural and Mountain Research
Visbech Sørensen	Lars	Denmark	Director at Food & Bio Cluster Denmark, Member of National Bioeconomy Panel
Wizemann	Axel	Germany	Founder of Wizemann Beratung: Consultancy in the areas of corporate strategy, business development, innovation processes and project management - primarily in the context of the bioeconomy

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Overview of the key interview and survey questions

Sector specific questions:

- How would your sector benefit the most from increased CSC?
- What kind of CSCs do you see most in your sector?
- On which topics and/or at which TRL level do most of the collaborations take place?
- What kind of incentives, support mechanisms or other key elements (i.e. trust, communication, open mindset, ...) are needed to support CSC in your sector?
- What are the main problems in your sector in setting up collaborations?

Type of collaborative structure specific questions:

- Could you describe your organisation's general approach towards CSC?
- What are the biggest advantages for your organisation to promote and engage stakeholders in CSC?
- What are the biggest challenges for your organisation to promote and engage stakeholders in CSC?
- How does CSC impact new product development, innovation, and competitiveness?
- How would you assess SMEs ability to join CSC?

Geographical dimension:

- How do you assess your country/region in terms of CSC in bioeconomy?
- What are the major advantages and disadvantages?
- How important do rate geographical proximity to your partners for successful CSC?
- Has the environment regarding CSC changed in your opinion over the last 5 years?
- How would you assess the performance of the government/ regulatory authorities in supporting collaborative activities in your organisation?

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References

Adamseged, M. E.; Grundmann, P. (2020): Understanding Business Environments and Success Factors for Emerging Bioeconomy Enterprises through a Comprehensive Analytical Framework. Sustainability, 12(21), Article No. 9018. Available at https://www.mdpi.com/2071-1050/12/21/9018

Andrews, R.; Entwistle, T. (2010): Does Cross-Sectoral Partnership Deliver? An Empirical Exploration of Public Service Effectiveness, Efficiency, and Equity. Journal of Public Administration Research and Theory, 20(3), pp. 679-701. Available at https://doi.org/10.1093/jopart/mup045

Bizzi, L. (2015): Social Capital in Organizations. In J. D. Wright (Ed.), International Encyclopedia of the Social & Behavioral Sciences (Second Edition), pp. 181-185. Elsevier. Available at https://doi.org/10.1016/B978-0-08-097086-8.73108-4

Bröring, S.; Vanacker, A. (2022): Designing Business Models for the Bioeconomy: What are the major challenges? EFB Bioeconomy Journal, 2, Article No. 100032. Available at https://doi.org/10.1016/j.bioeco.2022.100032

Bryson, J. M.; Barbara, C. C.; Stone, M. M. (2006): The Design and Implementation of Cross-Sector Collaborations: Propositions from the Literature. Public Administration Review, 66, pp. 44-55. Available at http://www.jstor.org.ucd.idm.oclc.org/stable/4096569

Bryson, J. M.; Crosby, B. C.; Stone, M. M. (2015): Designing and Implementing Cross-Sector Collaborations: Needed and Challenging. Public Administration Review, 75(5), pp. 647-663. Available at http://www.jstor.org.ucd.idm.oclc.org/stable/24757438

Calton, J. M.; Lad, L. J. (1995): Social Contracting as a Trust-Building Process of Network Governance. Business Ethics Quarterly, 5(2), pp. 271-295. Available at https://doi.org/10.2307/3857357

Carter, J.; Gronow, J. (2005): The Concept of Collaborative Forest Management. Recent Experience in Collaborative Forest Management, Center for International Forestry Research, pp. 1-6. Available at https://www.jstor.org/stable/resrep02186.6?seq=1

Chambost, V.; Mansoornejad, B.; Stuart, P. (2011): The Role of Supply Chain Analysis in Market-Driven Product Portfolio Selection for the Forest Biorefinery. In E. N. Pistikopoulos, M. C. Georgiadis, & A. C. Kokossis (Eds.), Computer Aided Chemical Engineering, 29, pp. 1030-1034. Elsevier. Available at https://doi.org/https://doi.org/10.1016/B978-0-444-53711-9.50206-6

Charles, D.; Davies, S.; Miller, S.; Clement, K.; Hoes, A.-C.; Hasenheit, M.; Kiresiewa, Z.; Kah, S.; Bianchini, C. (2016): Case studies of regional bioeconomy strategies across Europe. Available at https://eprc-strath.org/publication/case-studies-of-regional-bioeconomy-strategies-across-europe/

Cluster Excellence Denmark (2019): Clusters in the Circular Economy. Building Partnerships for Sustainable transition of SMEs. Available at https://clusterexcellencedenmark.dk/?lang=en

D'Amato, D.; Korhonen-Kurki, K.; Lyytikainen, V.; Matthies, B. D.; Horcea-Milcu, A. I. (2022): Circular bioeconomy: Actors and dynamics of knowledge co-production in Finland. Forest Policy and Economics, 144, Article No. 102820. Available at https://doi.org/10.1016/j.forpol.2022.102820

de Montigny, J. G.; Desjardins, S.; Bouchard, L. (2019): The fundamentals of cross-sector collaboration for social change to promote population health. Global Health Promotion, 26(2), 41-50. Available at https://doi.org/10.1177/1757975917714036

Devaney, L.; Henchion, M. (2017): Bioeconomy Research & Innovation Policy Landscape in Europe: A Review. Deliverable D3.3 of CASA (Coordination and Support Action "Common agricultural and

wider bioeconomy research agenda"). Teagasc. Available at https://scar-europe.org/images/CASA/Documents/CASA-Report_D3-3_Bioeconomy_RI_Landscape.pdf, checked on 10/21/2022

Dhillon, J. K. (2009): The Role of Social Capital in Sustaining Partnership. British Educational Research Journal, 35(5), pp. 687-704. Available at http://www.jstor.org/stable/40375631

Donner, M.; Verniquet, A.; Broeze, J.; Kayser, K.; De Vries, H. (2021): Critical success and risk factors for circular business models valorising agricultural waste and by-products. Resources, Conservation and Recycling, 165, Article No. 105236. Available at https://doi.org/10.1016/j.resconrec.2020.105236

Donner, M.; de Vries, H. (2023): Innovative Business Models for a Sustainable Circular Bioeconomy in the French Agrifood Domain. Sustainability, 15(6), Article No. 5499. Available at https://www.mdpi.com/2071-1050/15/6/5499

Draca, M.; Martin, R.; Sanchis-Guarner, R. (2018): The Envolving Role of ICT in the Economy. A Report by LSE Consulting for Huawei, The London School of Economics and Political Science. Available at https://www.lse.ac.uk/business-and-consultancy/consulting/assets/dokuments/thelvolving-role-of-ict-in-the-economy.pdf

European Commission (2024a): Agriculture and Rural Development. Available at https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/agriculture-and-rural-development_en

European Commission (2024b): Blue bioeconomy. Available at https://research-and-innovation.ec.europa.eu/research-area/environment/bioeconomy/blue-bioeconomy_en

European Commission (2024c): Maritime Affairs and Fisheries. Available at https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/maritime-affairs-and-fisheries_en

European Commission (2024d): Agriculture and Rural Development. Available at https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/agriculture-and-rural-development_en

European Commission (2024e): Health and Food Safety. Available at https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/health-and-food-safety_en

European Investment, B. (2024): Investment barriers in the European Union 2023 – A report by the European Investment Bank Group, European Investment Bank. Available at https://www.eib.org/en/publications/20230330-investment-barriers-in-eu-2023

Eurostat (2020): Agriculture, forestry and fishery statistics. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agriculture,_forestry_and_fishery_statistics

Eurostat (2022): Key figures on the European food chain. Available at https://ec.europa.eu/eurostat/documents/15216629/15559935/KS-FK-22-001-EN-N.pdf/1cb9d295-6868-70e3-0319-4725040cfdb8?version=3.0&t=1670599965263

Fasolino, N. G.; Zavalloni, M.; Viaggi, D. (2023): Chapter 12 - The role of collaboration and entrepreneurship in strengthening the participation of primary producers in the bioeconomy. In C. Keswani, C. Possas, E. Koukios, & D. Viaggi (Eds.), Agricultural Bioeconomy, pp. 231-244. Academic Press. Available at https://doi.org/https://doi.org/10.1016/B978-0-323-90569-5.00013-5

Fischer, L.-B.; Newig, J. (2016): Importance of Actors and Agency in Sustainability Transitions: A Systematic Exploration of the Literature. Sustainability, 8(5), Article No. 476. Available at https://www.mdpi.com/2071-1050/8/5/476

Guerrero, J. E.; Hansen, E. (2018): Cross-sector collaboration in the forest products industry: a review of the literature. Canadian Journal of Forest Research, 48(11), pp. 1269-1278. Available at https://doi.org/10.1139/cjfr-2018-0032

Guerrero, J. E.; Hansen, E. (2021): Company-level cross-sector collaborations in transition to the bioeconomy: A multi-case study. Forest Policy and Economics, 123, Article No. 102355. Available at https://www.sciencedirect.com/science/article/pii/S138993412030681X

Hamann, R.; April, K. (2013): On the role and capabilities of collaborative intermediary organisations in urban sustainability transitions. Journal of Cleaner Production, 50, pp. 12-21. Available at https://doi.org/10.1016/j.jclepro.2012.11.017

Hamann, R.; Pienaar, S.; Boulogne, F.; Kranz, N. (2011): What makes cross-sector partnerships successful. A comparative case study analysis of diverse partnership types in an emerging economy context, pp. 1-33. Available at https://api.semanticscholar.org/CorpusID:215776408

Haverhals, M.; Ingram, V.; Elias, M.; Sijapati Basnett, B. (2014): Gender and forest, tree and agroforestry value chains Wageningen University Center for International Forestry Research (CIFOR) Biodiversity International. Available at https://gender.cgiar.org/publications/gender-and-forest-tree-and-agroforestry-value-chains

Hodson, M.; Marvin, S. (2010): Can cities shape socio-technical transitions and how would we know if they were? Research Policy, 39(4), pp. 477-485. Available at https://doi.org/10.1016/j.respol.2010.01.020

Horlings, L.; Marsden, T. (2010): The interplay between social capital and policy arrangements in European rural regions in Europe. Nederlands Tijdschrift voor Geneeskunde. Available at https://api.semanticscholar.org/CorpusID:54104890b

Kircher, M. (2012): The transition to a bio-economy: national perspectives. Biofuels, Bioproducts and Biorefining, 6(3), pp. 240-245. Available at https://doi.org/https://doi.org/10.1002/bbb.1341

Kirchgeorg, M. (2022): Cluster, Network, Platform: Organisational Forms of the Bioeconomy. In D. Thrän & U. Moesenfechtel (Eds.), The bioeconomy system, pp. 181-193. Springer Berlin Heidelberg. Available at https://doi.org/10.1007/978-3-662-64415-7_11

Korhonen-Sande, S.; Sande, J. B. (2014): Getting the most out of cross-functional cooperation: Internal structural change as a trigger for customer information use. Industrial Marketing Management, 43(8), pp. 1394-1406. Available at https://www.sciencedirect.com/science/article/pii/S0019850114001102

Kraxner, F.; Fuss, S.; Verkerk, P. J. (2017): Is there enough forest biomass available to meet the demands of the forest-based bioeconomy?. In: Towards a sustainable European forest-based bioeconomy–assessment and the way forward. pp. 53-66. Available at https://www.researchgate.net/publication/321965038_Is_there_enough_forest_biomass_available_to_meet_the_demands_of_the_forest-based_bioeconomy

Lämmer-Gamp, T.; zu Köcker, G. M.; Nerger, M. (2014): Cluster Collaboration and Business Support Tools to Facilitate Entrepreneurship, Crosssectoral Collaboration and Growth (Ref. Ares(2015)1787744 - 28/04/2015). E. C. Observatory. Available at https://clustercollaboration.eu/sites/default/files/eu_initiatives/cluster-collaboration-and-business-support-tools-to-facilitate-entrepreneurship-cross-sectoral-collaboration-and-growth_en_0.pdf

Lange, L.; Lindedam, J. (2016): Bioøkonomiens Grundbegreber – det biobaserede samfun. Fagligt Fælles Forbund 3F, 20 pp. ISBN: 978-87-91870-21-7

Funded by the European Union

López Hernández, V.; Schanz, H. (2019): Agency in actor networks: Who is governing transitions towards a bioeconomy? The case of Colombia. Journal of Cleaner Production, 225, pp. 728-742. Available at https://doi.org/https://doi.org/10.1016/j.jclepro.2019.03.306

Mattila, O.; Hämäläinen, K.; Häyrinen, L.; Berghäll, S.; Lähtinen, K.; Toppinen, A. (2016): Strategic business networks in the Finnish wood products industry: a case of two small and medium-sized enterprises, 50. Available at https://doi.org/doi:10.14214/sf.1544

Milicevic, V. (2023): The European Union and forests. Available at https://www.europarl.europa.eu/factsheets/en/sheet/105/the-european-union-and-forests

Näyhä, A. (2019): Transition in the Finnish forest-based sector: Company perspectives on the bioeconomy, circular economy and sustainability, Journal of Cleaner Production, 209, pp. 1294-1306. Available at https://www.sciencedirect.com/science/article/pii/S0959652618332876

Ozdemir, S.; Carlos Fernandez de Arroyabe, J.; Sena, V.; Gupta, S. (2023): Stakeholder diversity and collaborative innovation: Integrating the resource-based view with stakeholder theory. Journal of Business Research, 164, Article No. 113955. Available at https://doi.org/10.1016/j.jbusres.2023.113955

Philp, J.; Winickoff, D. E. (2017): Clusters in Industrial Biotechnology and Bioeconomy: The Roles of the Public Sector. Trends in Biotechnology, 35(8), pp. 682-686. Available at https://doi.org/10.1016/j.tibtech.2017.04.004

Raftery, P.; Hossain, M.; Palmer, J. (2022): A conceptual framework for analysing partnership and synergy in a global health alliance: case of the UK Public Health Rapid Support Team. Health Policy Plan, 37(3), pp. 322-336. Available at https://doi.org/10.1093/heapol/czab150

Ryymin, E.; Lamberg, L.; Pakarinen, A. (2020): How to Digitally Enhance Bioeconomy Collaboration: Multidisciplinary Research Team Ideation for Technology Innovation. Technology Innovation Management Review, 10, pp. 31-39. Available at https://doi.org/10.22215/timreview/1401

Soliman, R.; Braun, R.; Simoff, S. (2005): The essential ingredients of collaboration. Proceedings of the 2005 International Symposium on Collaborative Technologies and Systems, 2005. Available at https://www.semanticscholar.org/paper/The-essential-ingredients-of-collaboration-Soliman-Braun/01a9a9772f00a45b26503d1f0d8775d382e5e436

Szarka, N.; García Laverde, L.; Thrän, D.; Kiyko, O.; Ilkiv, M.; Moravčíková, D.; Cudlínová, E.; Lapka, M.; Hatvani, N.; Koós, Á.; Luks, A.; Martín Jimenez, I. (2023): Stakeholder Engagement in the Co-Design of Regional Bioeconomy Strategies. Sustainability, 15(8), Article No. 6967. Available at https://www.mdpi.com/2071-1050/15/8/6967

United Nations Industrial Development Organization (2024): What are clusters and networks?. Available at https://www.unido.org/our-focus-advancing-economic-competitiveness-supporting-small-and-medium-industry-clusters/clusters-and-networks-development

UNEP; FAO; UNDP (2023): Rethinking Our Food Systems. A Guide for Multi-Stakeholder Collaboration. Nairobi, Rome and New York. Available at https://doi.org/10.4060/cc6325en

Vangen, S.; Huxham, C. (2003): Nurturing Collaborative Relations: Building Trust in Interorganizational Collaboration. The Journal of Applied Behavioral Science, 39, pp. 5-31. Available at https://doi.org/10.1177/0021886303039001001

Wohlfahrt, J.; Ferchaud, F.; Gabrielle, B.; Godard, C.; Kurek, B.; Loyce, C.; Therond, O. (2019): Characteristics of bioeconomy systems and sustainability issues at the territorial scale. A review, Journal of Cleaner Production, 232, pp. 898-909. Available at https://www.sciencedirect.com/science/article/pii/S0959652619319274

Funded by the European Union

World Bank Group (2021): Agricultural land (% of land area) - European Union. Available at https://data.worldbank.org/indicator/AG.LND.AGRI.ZS?locations=EU

Zoritza Kiresiewa, H. G.; Hasenheit, M. (2019): Framework and good practices for multi-stakeholder and cross-sector interconnections. biobridges Deliverable 2.2. Available at https://scanner.topsec.com/?d=1452&r=show&u=https%3A%2F%2Fwww.biobridges-project.eu%2Fdownload.php%3Ff%3D300%26l%3Den%26key%3D8d7b549a9def0b05d3464876047520f5&t=ebf91262936774f828118c610261b74a9f07d2a6

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