



EU SYMBIOS PROJECT

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IATA, CSIC – TASK WP 2.4

Needs Analysis Report

Food Sector – Surveys & Interviews

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1. Introduction

Industrial symbiosis (IS) defined as the collaborative exchange of materials, energy, water, and by-products among industries, has emerged as a key strategy to support circular economy transitions and improve resource efficiency in the food sector. The food industry generates significant amounts of organic waste, wastewater, and underutilized by-products, which can potentially be valorized through synergies with other industrial actors (Chertow, 2000; Mirabella et al., 2014). In recent years, increasing environmental pressures, stricter regulations, and sustainability commitments have encouraged food companies to explore IS practices as a means to reduce costs, minimize waste, and create additional value streams.

Despite the recognized environmental and economic benefits, the implementation of IS within the food industry remains limited. Previous studies indicate that barriers such as lack of trust between companies, insufficient technological knowledge, logistical constraints, regulatory complexity, and limited economic incentives hinder the development of successful symbiotic collaborations (Costa & Ferrão, 2010; Albino et al., 2015). Furthermore, many studies have focused primarily on technical feasibility and policy frameworks, while less attention has been given to the perceptions, motivations, and practical needs of food industry stakeholders themselves.

Furthermore, understanding how food companies perceive industrial symbiosis is essential to identify the factors influencing its adoption and long-term viability. There is still a significant knowledge gap regarding the specific barriers faced by companies, as well as the support mechanisms and resources they require to effectively implement IS strategies. Therefore, conducting interviews with food industry actors represents an important step toward gaining deeper insights into organizational attitudes, operational challenges, and collaboration needs. Such qualitative research can contribute to the

development of more targeted policies, business models, and facilitation mechanisms that foster industrial symbiosis within the food sector. For this reason, conducting interviews with academic researchers is essential to deepen knowledge on several unresolved questions related to industrial symbiosis in the food industry. These include identifying best practices for waste reduction and by-product reuse; understanding successful examples of resource exchanges across sectors; exploring innovation trajectories such as biotechnology and circular processing techniques; analysing collaborations between food and non-food sectors; and evaluating how sustainability certifications and European Union policies influence industrial symbiosis adoption. In addition, researcher interviews can provide insights into existing studies on supply-demand matching of food waste streams, successful approaches to overcoming adoption barriers, required competences for food industry managers, and the development of adaptable industrial symbiosis models, including digital matching platforms, waste-to-value chain architectures, and replication frameworks.

Therefore, engaging directly with researchers through qualitative interviews can contribute to a more comprehensive understanding of the enabling conditions, governance mechanisms, and innovation pathways necessary to strengthen industrial symbiosis practices in the food sector. Such knowledge is fundamental for supporting future collaborative initiatives, including the development of the Symbios project model and other circular economy strategies within Europe.

2. Methodology

2.1 Overall Approach Survey for the Food Sector

The survey was sent to companies' representatives in the three countries where the SYMBIOS partners in the agri-food sector are based (Spain, Italy and Slovenia) with the aim of obtaining a minimum of 10 responses per country, in accordance with the project report

The survey was divided into 5 sections, and the analysis of the responses obtained was carried out in the following order:

Section A. Company profile

Section B. Production process

Section C. Waste management and circular practices

Section D. Regulatory barriers and constraints

Section E. Skills and training needs

The annex I shows the survey questions and their response options.

The survey was created using the Google Forms application, and the link was distributed via email to potential participants from companies in the agri-food sector. It was distributed during the first quarter of 2026. Each partner translated the survey into their respective languages to facilitate the respondents' participation. Once ten responses from each country had been collected, the data were exported to an Excel spreadsheet, translated back into English, and combined into a single sheet for joint analysis.

IBM SPSS version 30.0.0.0 was used for the statistical analysis.

2.2 Overall Approach Interviews

The research was structured into two complementary studies addressing needs analysis and stakeholder perspectives on Industrial Symbiosis in the food sector. Study I investigated the needs and perceptions of stakeholders from the food industry, whereas Study II explored the opinions of academic experts. Consequently, the Materials and Methods and Results sections are organized and presented separately for each study.

STUDY I. Needs analysis with deep interviews to food industry

Selection of Participants

The study included interviews conducted across three European countries (Slovenia: 3 interviews; Italy: 2 interviews; Spain: 1 interview) with different levels of experience and development in industrial symbiosis practices.

Qualitative Interviews

Data were collected through semi-structured interviews conducted online between the months of January 2026-May 2026. The interviews lasted approximately 45–60 minutes and were carried out in the local language, and then they were translated into English.

The interview protocol was designed to explore current practices, innovation pathways, collaboration mechanisms, barriers, and enabling conditions for industrial symbiosis in the food sector.

The questions addressed were the following:

- Can you outline best practices in industrial symbiosis within the food sector, focusing on waste reduction or by-product reuse?
- Please share examples of resource exchanges across sectors using food by-products (e.g., peels, oils, or packaging waste) that generated economic or environmental benefits.
- What are the main innovation trajectories for symbiotic practices in food production, such as biotech or circular processing techniques?
- What examples exist of building symbiotic relationships in the food industry, like collaborations between food processors and non-food sectors?

- Do studies exist analysing the supply/demand balance of food processing waste (e.g., pomace, whey, peels) versus resource needs in other industries, and how could these inform Symbios collaboration model?
- How have sustainability certifications or EU policies driven symbiotic innovations in the food sector?
- Based on your researches, what adoption challenges in food symbiosis (e.g., supply chain complexity) have been addressed successfully?
- What conditions (skills, tools, partnerships, regulatory clarity) would be most important to further develop industrial symbiosis practices?
- What core logic, mechanisms, and building blocks of food sector symbiosis could Symbios partners integrate into their project model (e.g., waste-to-value chain architectures, digital matching platforms, long-term contract templates, or replication frameworks)? Can you recommend adaptable symbiotic models from the food sector?
- What competences would equip food industry managers to operationalize industrial symbiosis?

Data Analysis

All interviews were transcribed, translated into English and analysed using thematic analysis. The collected data were subsequently grouped into broader thematic categories related to industrial symbiosis implementation in the food sector.

STUDY II. Needs analysis with deep interviews. Opinion of academics about Industrial Symbiosis in the Food Sector

This study employed a qualitative research design based on semi-structured deep interviews with academic experts working in the field of industrial symbiosis within the food sector.

Participant Selection

The study focused on three European countries with varying levels of industrial symbiosis development and food industry structures: Spain, Slovenia, and Italy.

A total of five interviews were conducted:

- Three interviews with academics based in Spain
- One interview with an academic based in Slovenia
- One interview with an academic based in Italy

Data Collection

Data were collected through structured deep interviews conducted between January 2026-April 2026. The interview guide included questions related to:

- Definitions and perceptions of industrial symbiosis in the food sector
- Existing industrial symbiosis initiatives and collaborations
- Barriers and drivers for implementation
- Policy and institutional frameworks
- Stakeholder engagement and governance
- Opportunities for cross-sector and cross-border collaboration
- Future perspectives for circular economy practices in food systems

Data Analysis

The interview transcripts in English were analysed using thematic analysis.

3. Results

3.1. Results from the survey for the Food Sector

A total of 10 responses were received from each country, making 30 in total for the purposes of the analysis. The results are presented and discussed below, organised by section.

Section A. Company profile

Of the total number of participating companies, 47% were large, 33% were medium-sized and 20% were small. The roles of the respondents were quite diverse, with a greater proportion of quality and development managers (see Figure 1)

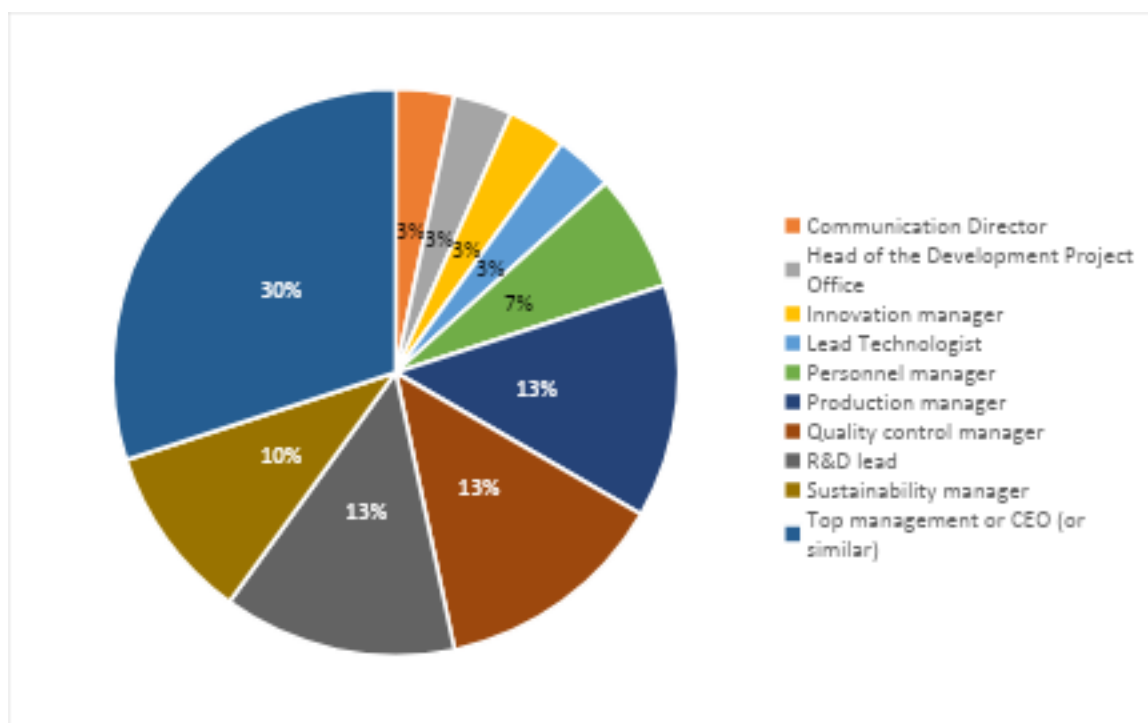


Figure 1. Respondent roles in the companies

The agri-food sectors served by the companies were also diverse (Figure 2), with the sectors of beverages, cereals, and fruit and vegetables predominating. As regards the markets served by the companies, these are primarily domestic, followed by European markets (Figure 3).

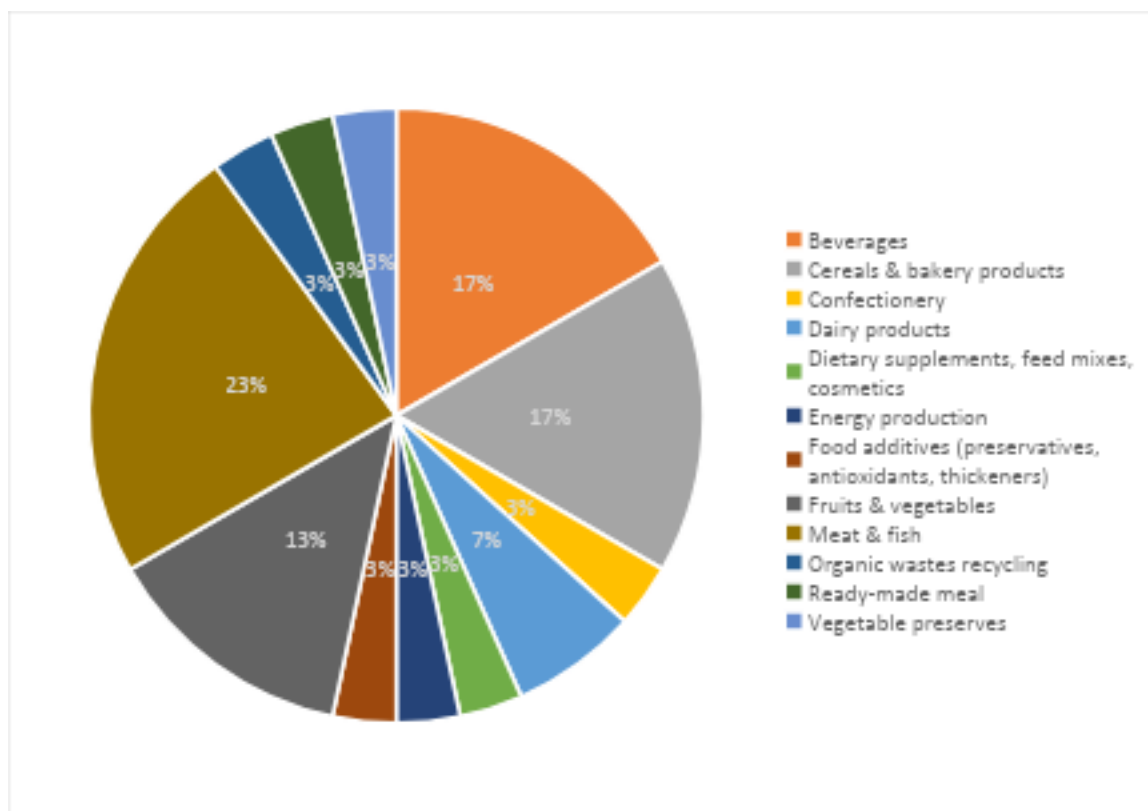


Figure 3. Food subsector of companies participating in the survey

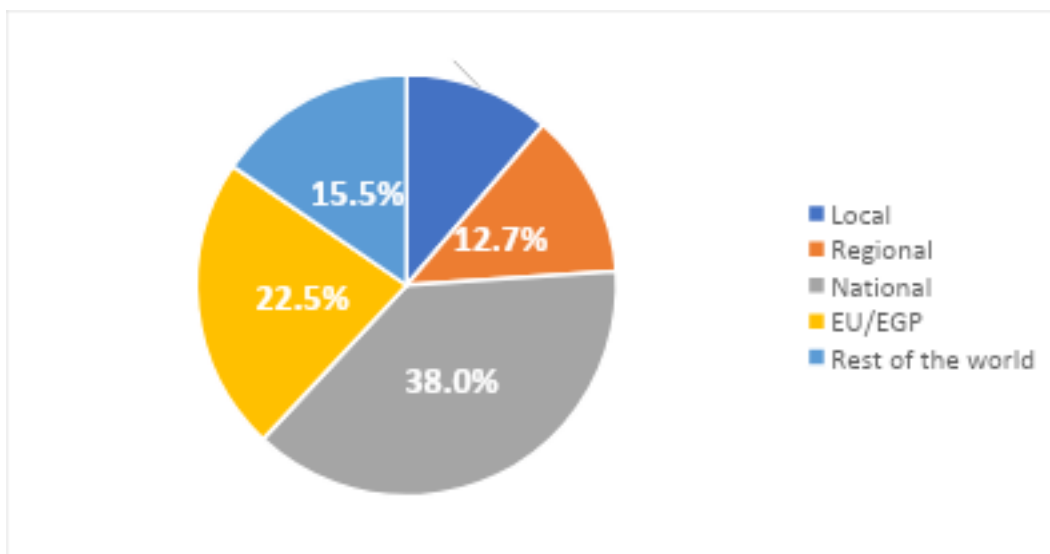


Figure 4. Main market(s) served by the company

With regard to standards, management systems or environmental schemes implemented by the companies (Figure 5), the ISO 14001 standard predominates; this is an international standard that enables companies to demonstrate their commitment to environmental protection. This commitment is demonstrated through the management of environmental risks associated with their operations. A high percentage stated that they do not implement any of these. In any case, based on this data, it is clear that companies are concerned about the environment and the wastes generated.

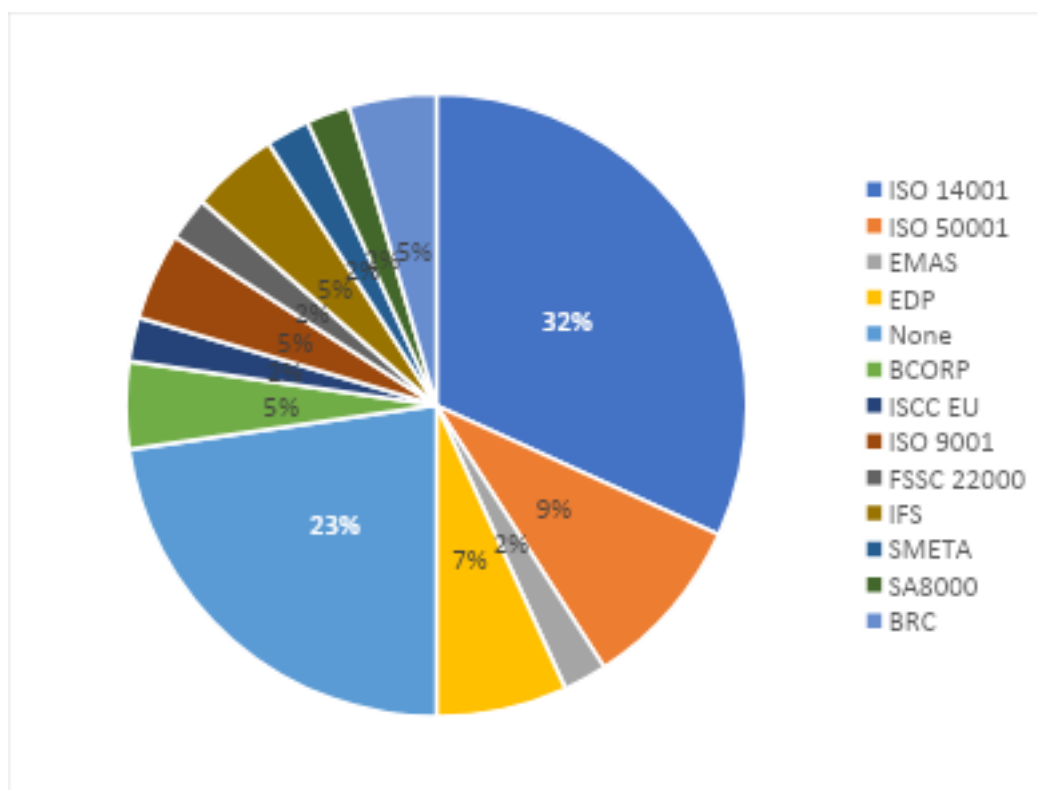


Figure 5. Standards, management or environmental schemes implemented in companies

SECTION B. Production process

With regard to the type of production process, 7% reported carrying out mixed processes, 43% primary processing and 51% secondary processing. As for the types of by-products generated, these were predominantly organic waste (39%) and packaging waste (29%), followed by wastewater (24%) and a small percentage comprising a mixture of the above.

Approximately 70% of companies reuse by-products, energy or wastewater internally (Figure 6)

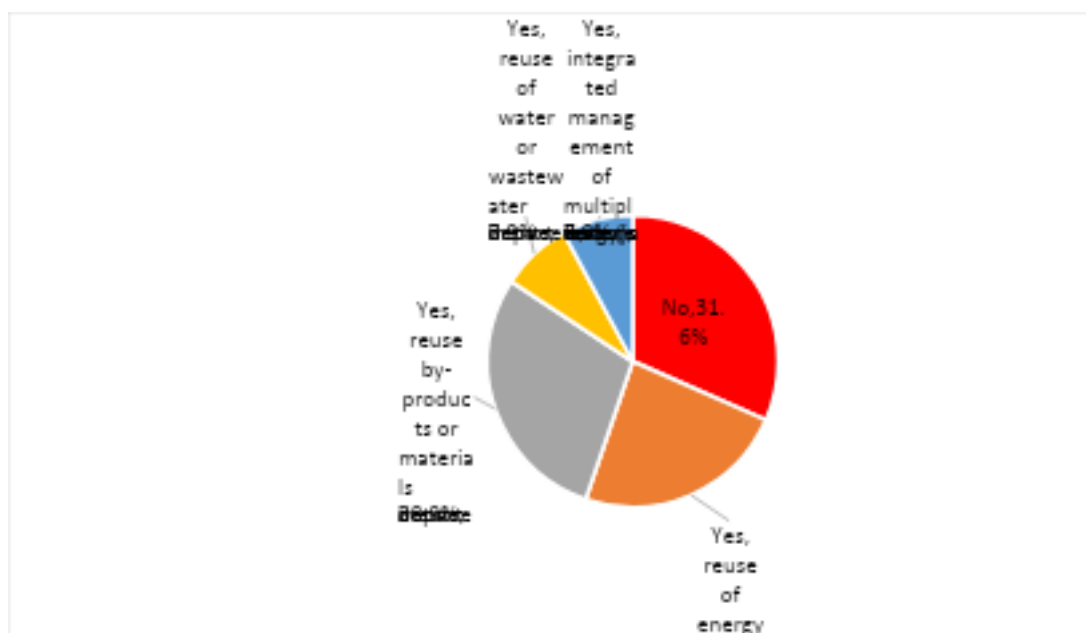


Figure 6. Implementation of internal Industrial Symbiosis practices between departments or production units

SECTION C. Waste management and circular practices

The by-products generated by companies are handled in different ways, depending on their nature and their potential for reuse and recycling. It is worth noting that only 17% are sent for disposal (Figure 7).

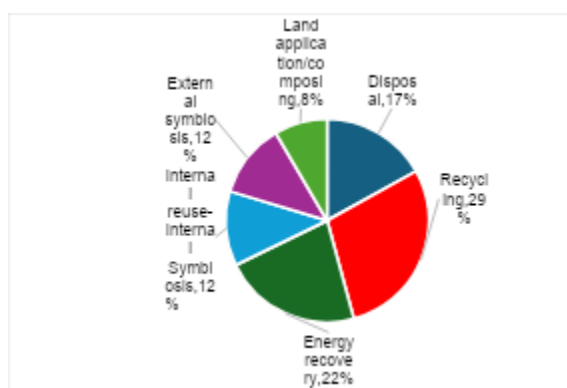


Figure 7. Current destination of the above-mentioned by-products

With regard to the existence of partnerships for by-product valorisation, only 9% stated that they had a stable, long-term partnership, 37% had formal agreements with selected

partners, and 30% replied that they only engaged in such activities occasionally and informally.

Respondents stated the level of internal monitoring of waste flows and by-product flows was advanced (53%; quantitative, systematic monitoring), 40% said they applied basic (qualitative or partial data) and in few cases (7%) implemented digitally supported monitoring systems)

Section D. Regulatory barriers and constraints

Regarding main regulatory areas affecting waste/by-product management, food safety and environmental represented a 32% and 33% respectively (Figure 8), in agreement with the previous responses.

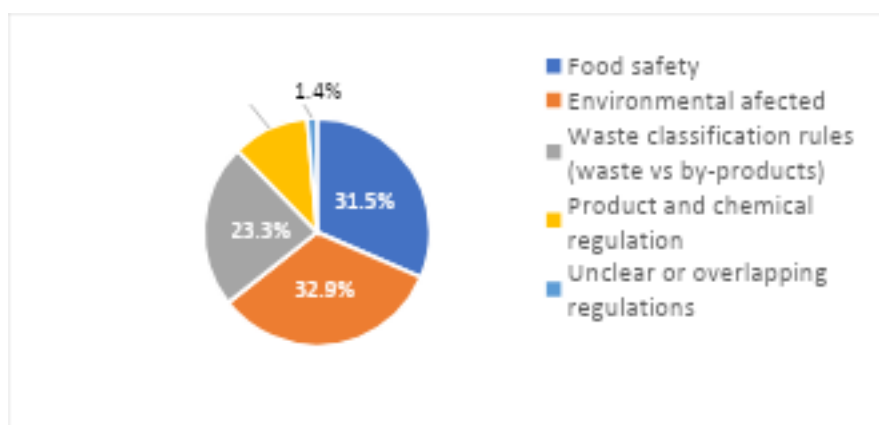


Figure 8. Main regulatory areas affecting waste by-products management

One of the main regulatory barriers is the administrative burden associated with permits and authorisations, as well as the cost of compliance (Figure 9).

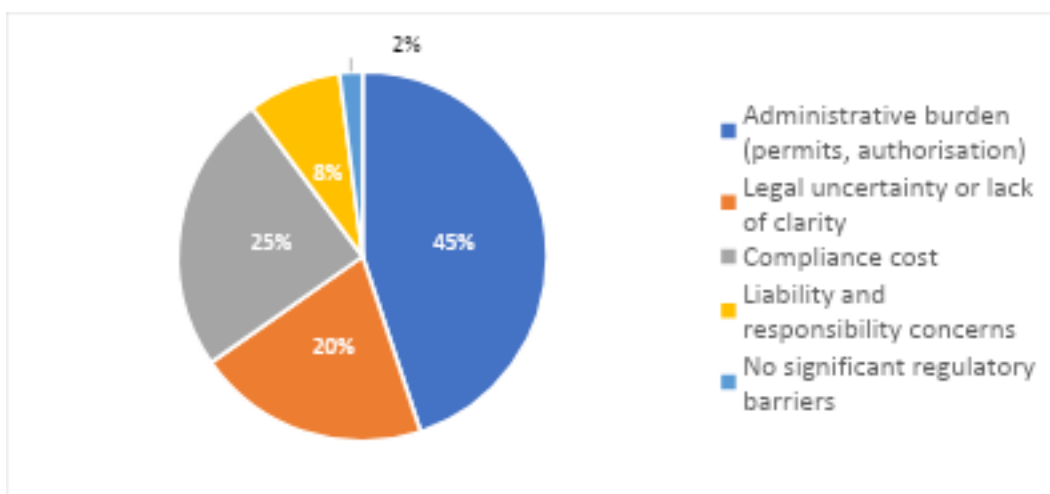


Figure 9. Main type of regulatory barrier encountered by the companies

Regarding to what extent do OSH (Occupational Health and Safety) requirements related to biological, chemical, or process-related risks) limit by-product reuse or Exchange, only 10% responded that it affects significantly (Figure 10).

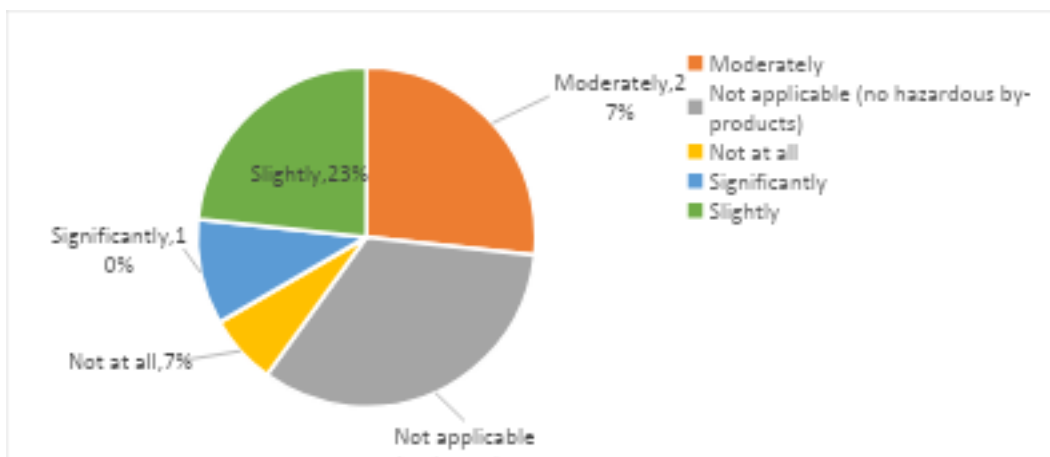


Figure 10. To what extent OSH limits by-product reuse or exchange

SECTION E. Skills and training needs

This section of the survey aimed to identify the capabilities and needs regarding training in areas related to circular economy and/or industrial symbiosis. With regard to the investment companies made in training, only 7% stated that they did so on a regular basis, 60% occasionally, and 33% not at all.

Among the factors limiting the implementation of industrial symbiosis, technical skills and expertise in regulatory issues stand out (Figure 11). These responses help to design training modules that address these gaps.

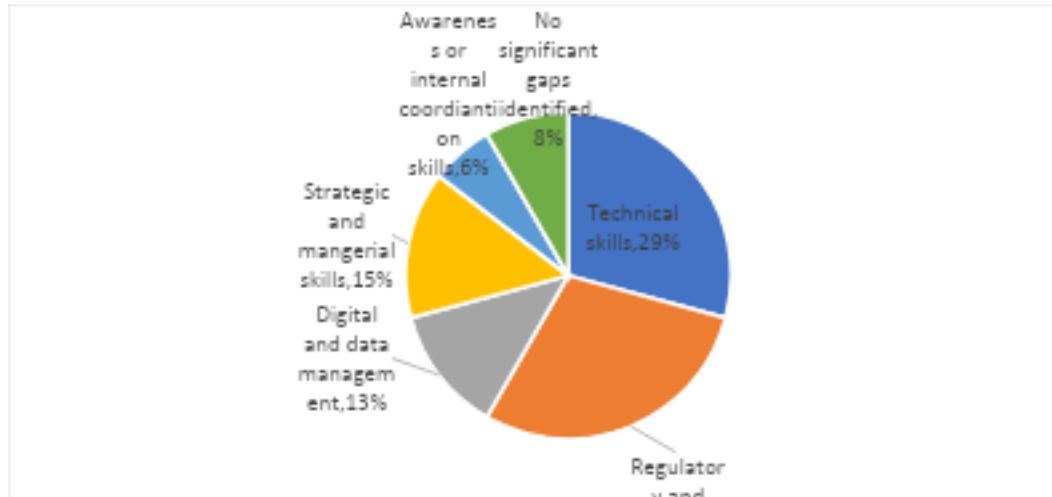


Figure 11. Main skills gaps limiting the implementation symbiotic practices

The last question of this section and last part of the survey relates to the level of competence available in the companies in the following areas:

- Industrial symbiosis concepts and model
- Practical implementation of industrial symbiosis
- Regulatory framework (waste, byproducts, OSH)
- Stakeholder engagement and intercompany collaboration for Industrial Symbiosis
- Economic assessment of circular and symbiotic solutions (cost–, benefit, business, models)
- Material, energy and water flow mapping (e.g., MFA, energy, mapping)
- ISO 14001 Environmental management system
- ISO 50001 Energy Management System
- Life Cycle Assessment
- EPD/ environmental labelling (EMAS, etc)
- Digital tools for monitoring and matching, resources
- ESG data management

- Lean management and continuous improvement (waste, reduction, process, efficiency)

According to the survey results (Figure 12), competence in the aforementioned areas can be considered, on average, to be at medium level. However, it is important to highlight the particularly low levels of competence in energy management area linked to ISO 50001 as well as in Environmental Product Declarations (EPDs), which verify and record transparent and comparable information about the life-cycle environmental impact of products. This may be closely linked to the responses regarding life cycle assessment, which also show low levels of competence. It is noteworthy that companies demonstrate greater competence regarding the regulatory framework and standards such as ISO 14001, which covers various aspects, from resource use and waste management to monitoring environmental performance. Organisations that adopt this standard can ensure they are taking proactive measures to limit their environmental footprint, comply with relevant legal requirements and achieve their environmental objectives.

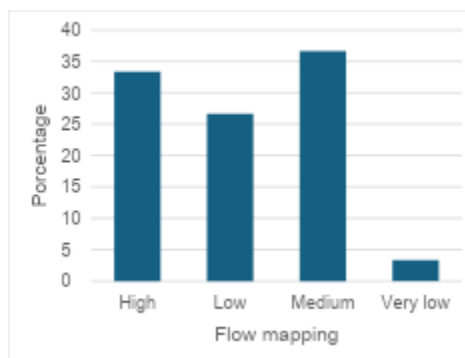
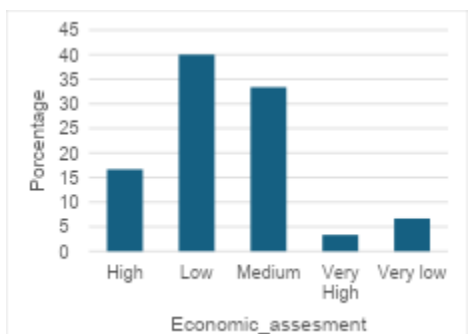
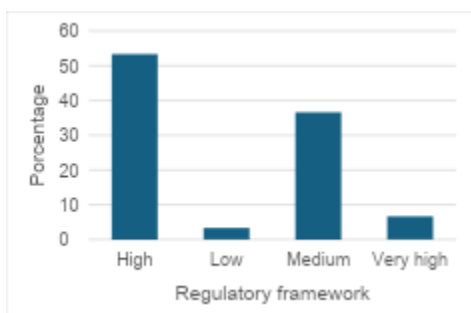
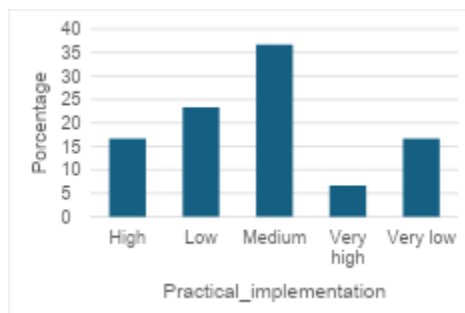
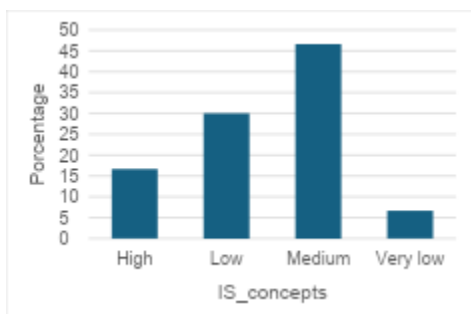


Figure 12. Level of competence available in the companies

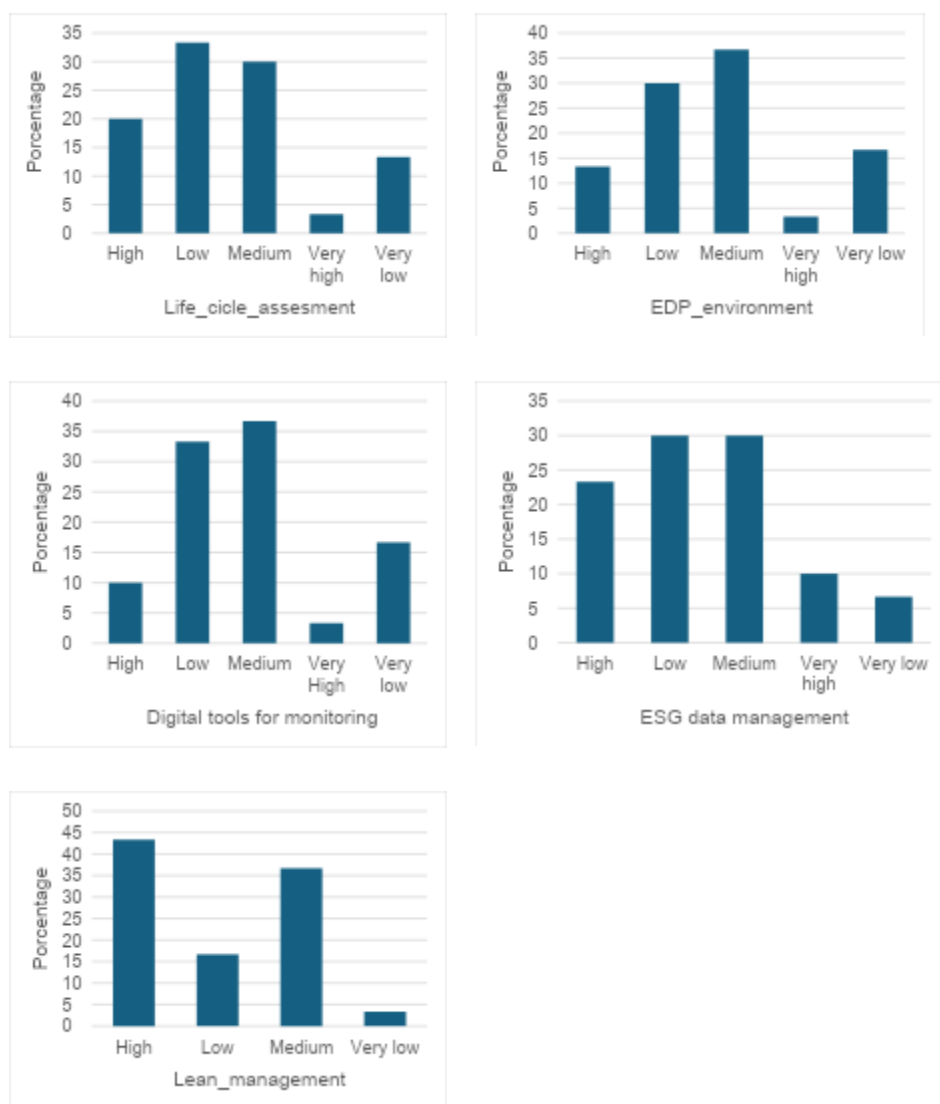


Figure 12 (continuation). Level of competence available in the companies

The analysis of the competences needed to effectively engage in industrial symbiosis revealed significant differences in the perceived levels of competence across the assessed knowledge and skill areas, according to the Friedman test (see Figure 13).

Among the evaluated competencies, respondents reported the highest levels of competence in understanding the regulatory framework relevant to resource management, waste valorization, and circular economy practices. This finding suggests that companies are generally familiar with the legislative and compliance requirements that influence industrial symbiosis activities. Lean management was identified as the second strongest competence area, indicating that many organizations have experience with efficiency-oriented approaches aimed at reducing waste and optimizing resource use. Similarly, knowledge of environmental management systems, particularly ISO 14001, was assessed relatively positively, reflecting the widespread adoption of environmental management practices across the participating companies.

In contrast, competencies related to energy management systems were considerably weaker. ISO 50001 received the lowest competence scores among all evaluated areas, indicating a limited understanding of structured energy management approaches and their potential contribution to industrial symbiosis. This result highlights a significant training gap, especially considering that energy exchange and optimization are key components of many industrial symbiosis networks.

The observed differences in competence levels suggest that while companies possess a solid foundation in regulatory compliance, environmental management, and operational efficiency, they may lack the technical knowledge required to identify and implement energy-related symbiotic opportunities. Therefore, future training programs should prioritize capacity building in energy management, resource flow analysis, and the practical application of industrial symbiosis methodologies. Strengthening these competencies would enhance companies' ability to identify synergies, improve resource

efficiency, and actively participate in circular economy initiatives at regional and international levels.

Overall, the results indicate that targeted training interventions are needed to address specific knowledge gaps and support the development of a more comprehensive skill set for industrial symbiosis implementation across the food and manufacturing sectors in Spain, Italy, and Slovenia.

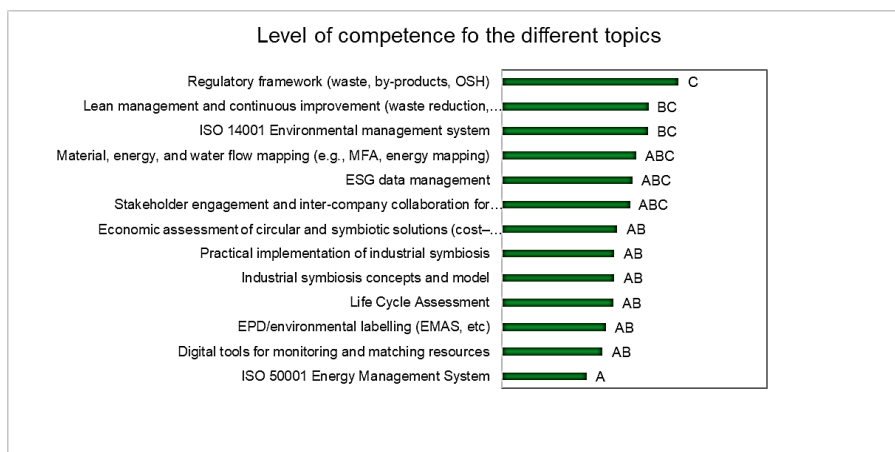


Figure 13. Level of competence for the different topics needed

Additionally, as it can be observed in Figure 14, for only three aspects, the level of competence varied significantly on the size of the company.

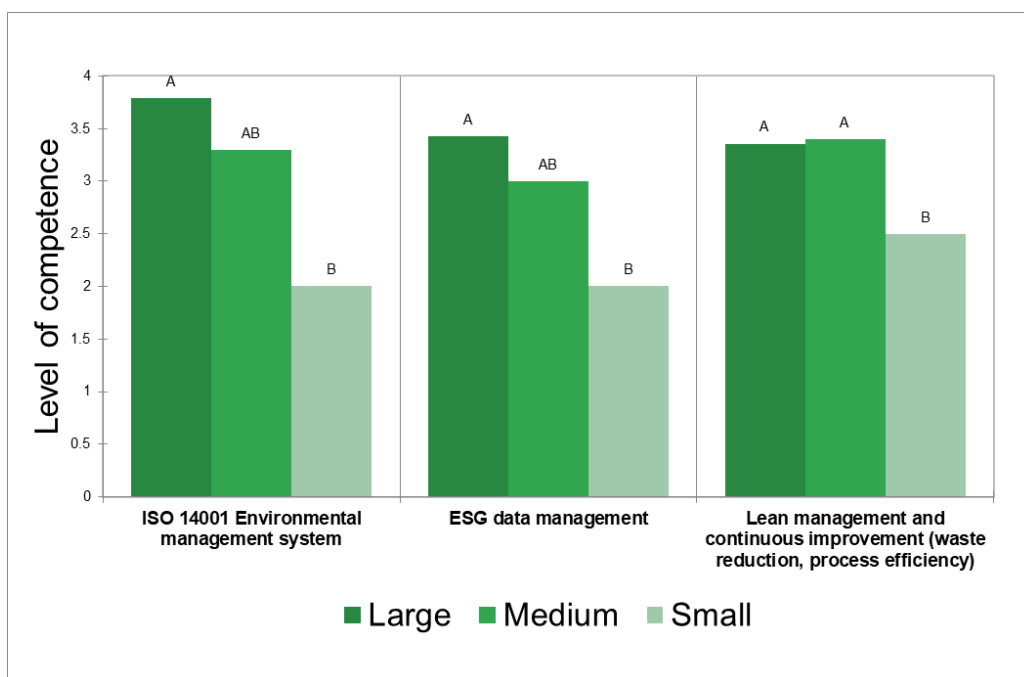


Figure 14. Level of competence needed according to the size of the company (large, medium, small) that answered

3.2. Deep interviews results

STUDY I. Needs analysis with deep interviews to food industry

Can you briefly describe your company and the main characteristics of your production process that are most relevant from an environmental or resource-use perspective?

Company 1 from Slovenia. They partner with the largest retailer in the market, for whom we produce pastries, cookies, and gourmet products. Their production is based on traditional recipes and a strong emphasis on handmade craftsmanship, which is one of their key characteristics.

They prepare most of their products by hand, which allows us greater control over quality. The production process is divided into three main stages: preparation and baking of products, packaging and labelling, and order fulfilment and distribution.

In their operations, they are highly committed to the social and natural environment. They pay special attention to recycling, collaborate with external partners on waste removal, and actively seek solutions to reduce waste. In doing so, they strive to maximize the use of raw materials, as their aim to contribute to more efficient resource utilization.

Company 2 from Slovenia. High consumption of water as well as energy is involved, and side streams are generated, such as wastewater and by-products: lactofugate, whey (sweet and sour), and spills – a mixture of product and water (these are collected and then supplied to farmers for feed use). There is nothing problematic in these materials, as they are also subject to veterinary inspection, but they do have potential for further concentration or valorisation.

There has been significant demand for these streams; however, there was once an issue where cattle were not allowed to consume them. In the long term, this may become a challenge, as demand is expected to decrease while volumes continue to increase.

These partnerships are formally registered, as they involve the handling of waste. All procedures are precisely defined, and the parameters are even stricter than those applied to final products intended for human consumption.

Company 3 from Slovenia. Incom d.o.o. was established in 1991 and has grown from an ice cream producer into the largest Slovenian manufacturer of ice cream and chocolate, employing more than 850 people. The company operates mainly from Ajdovščina and has a production capacity of up to 150 tonnes of ice cream per day, equivalent to approximately 3.2 million units daily. It is highly export-oriented, with more than 94% of revenue generated from exports to 39 countries, particularly the United Kingdom, Germany, and the United States. Alongside private label production, the

company also develops and markets its own brands, including LEONE, AL!VE, Jamaica, and Nora.

The company's production processes are highly energy-intensive due to the need for pasteurisation, cooling, and continuous cold storage. Water consumption is primarily associated with washing and cleaning production lines, while additional volumes are used in products and cooling systems. The most resource-intensive stages in terms of raw materials and packaging are production line start-ups, shutdowns, and unexpected equipment failures.

Company 1 from Spain: did not want to disclose that information.

Company 1 from Italy. Salumificio Trascinelli Pietro Srl deals with the careful selection and packaging of cold cut trimmings (cured and cooked) coming from the processing of slicing industries and intended for the filled pasta processing industry. Our company performs an important action of recovering meat-based and dairy-based raw materials throughout the territory, becoming a leader in the environmental sustainability sector.

Company 2 from Italy. A company in the food sector specializing in the production and processing of cured meats; in particular, the company produces rolled and flat pancetta, coppa and guanciale, starting from raw materials; it carries out the curing process followed by maturing, smoking or drying. The product can be sold whole, portioned, sliced or diced. They therefore use water for washing, packaging materials (plastic and cardboard) for packaging, electricity for production facilities and cold stores, natural gas for the production of electricity (cogeneration unit) and steam, wood shavings for smoking, and diesel for transport. As regards environmental impacts, the main ones are: industrial wastewater, atmospheric emissions, noise emissions, the production of special waste and animal by-products.

In the food sector, by-products are often subject to strict hygiene, safety, and quality constraints. Which food-specific characteristics (e.g. perishability, contamination risk, shelf-life, sanitary rules) most could influence decisions on reuse, valorization

In the food sector, the main factors influencing decisions on the reuse and valorisation of by-products are perishability, shelf life, contamination risk, food safety requirements, and strict sanitary regulations. Expiration date and product stability are considered particularly critical, as they significantly limit the possibilities for storage, transport, exchange, and further processing of by-products.

Food safety and product suitability for further use are regarded as essential conditions. This requires that the entire chain of by-product generation, handling, storage, and transport complies with strict food industry standards, including Hazard Analysis and Critical Control Point (HACCP) procedures, hygiene protocols, refrigerated and vacuum storage, and full product traceability. These measures are necessary to ensure food wholesomeness, extend shelf life, and minimise the risk of spoilage or contamination.

To reduce waste generation and maintain product quality, companies typically avoid large inventories of raw materials and instead rely on short-term ordering systems aligned with actual production needs. In some cases, immediate freezing in advanced cooling systems is applied to selected products or semi-finished goods to extend shelf life and improve production flexibility, although such solutions are only suitable for specific product categories.

These challenges are especially pronounced in the dairy sector, where products are highly perishable and associated with elevated safety and transport risks. In addition to regulatory compliance, consistent quality is another important requirement for successful by-product valorisation. Since by-products are directly influenced by production processes and input materials, any variation in raw materials or processing conditions can lead to fluctuations in by-product quality, limiting their potential for reuse.

Although legislation generally provides clear rules regarding the classification and handling of by-products, companies frequently report that the investments required for safe valorisation, storage, and logistics are often too high compared to the relatively small quantities generated, reducing the overall economic feasibility of such practices.

In summary:

- Food perishability, shelf life, and strict hygiene and food safety requirements strongly limit by-product reuse.
- Operations rely on HACCP-compliant handling, refrigerated storage, and product traceability.
- Short-term ordering and immediate freezing are used to reduce waste and maintain food safety.

Which by-products or waste streams are most critical for your company, and how are strategic decisions regarding their management taken?

The companies most critical by-products and waste streams include production waste, packaging waste, wastewater, whey, and meat-related by-products. Production waste consists of raw material residues (meat, trimmings, whey, ice cream mixtures) and products or semi-finished products that do not meet quality standards, while packaging waste mainly includes plastic and laminated materials. The companies prioritise recyclable and returnable packaging, separate waste collection, and compliance with environmental regulations. Greasy plastic and laminated packaging are currently disposed of through authorised waste management companies due to limited recycling options, whereas silicone-coated paper has recently been introduced into recycling streams.

Wastewater is another key waste stream, generated mainly due to the high hygiene standards required in food production. The wastewater treatment plant has been continuously improved, including the recent introduction of flotation technology to remove fats and increase treatment efficiency.

The last byproduct mentioned is waste paper, including boxes from raw materials and finished products, is collected separately and transported by authorised contractors directly to recycling facilities, where it is processed into new paper products. In addition, some companies have established agreements with suppliers for the return and reuse of paper packaging, allowing individual boxes to be used multiple times before recycling.

Strategic decisions regarding by-product and waste management are primarily driven by food safety, regulatory compliance, operational reliability, and resource optimisation. Whey processing is a major focus area, with continuous efforts to reduce energy consumption and improve efficiency. Specifically, the company concentrates whey to approximately 30% dry matter before selling it in liquid form, mainly for export, as there are currently no suitable downstream processing facilities available. Technological alternatives such as reverse osmosis have been evaluated but were rejected due to concerns regarding reliability and the ability to consistently achieve the required dry matter content.

To what extent does your company already apply internal circular practices or internal industrial symbiosis (e.g., reuse of energy, water, or materials between departments)? What enabled or limited these practices?

Companies already apply several internal circular practices and elements of industrial symbiosis, particularly in the areas of packaging management, water reuse, energy efficiency, and by-product valorisation.

In packaging management, companies promote the use of recyclable, returnable, and recycled materials, while increasing the proportion of packaging containing at least 50%

recycled or biodegradable components. Washable containers and equipment are used wherever possible, and some suppliers operate with returnable packaging systems.

Internal water reuse practices are implemented through CIP (Cleaning-in-Place) systems, where final rinse water is recovered and reused at the initial stage of the cleaning process. In addition, closed-loop systems for cooling and heating water enable water optimisation and regeneration within facilities. However, due to strict health and hygiene regulations in the food sector, treated water cannot be reused in production processes, which significantly limits further circular applications. There is also mentioned to reuse water from excess heat from cooling compressors is also recovered to heat sanitary and industrial water, reducing natural gas consumption. In addition, microbiologically safe leftover ice cream mix is stored, re-pasteurized, and reused in future production runs with the same formulation.

Companies also implement energy efficiency and energy recovery measures. Cooling and heating systems are continuously optimised to reduce energy consumption, while renewable energy generated by photovoltaic panels contributes to lowering dependence on the national electricity grid. Some companies also operate combined heat and power (CHP) units with steam generators, where recovered heat is used to produce steam and hot water for internal operations. Although effective, these technologies require substantial investment and involve long payback periods.

Material reuse between departments remains limited due to food safety and hygiene requirements. Nevertheless, some examples of by-product valorisation exist, such as the reuse of buttermilk in sweet cream production due to its high lecithin content and nutritional value.

The implementation of these circular practices is enabled mainly by internal sustainability guidelines, systematic environmental data monitoring, technical knowledge, and research activities. At the same time, further development is constrained by financial limitations, the need for system upgrades, operational reliability concerns, and regulatory

barriers, particularly regarding water reuse and material recirculation in food production environments.

What are the main contextual barriers (regulatory, safety, economic or organisational) that affect the possibility of further reuse or exchange of by-products?

The main contextual barriers affecting the further reuse or exchange of by-products are primarily economic, regulatory, safety, and organisational in nature, highlighting the economic one. Companies report that strict food safety and sanitary regulations significantly limit the possibilities for reuse and exchange, particularly in the food sector where compliance requirements are very stringent. Specifically, waste management regulations and high associated costs were highly mentioned. Legislation often requires non-hazardous waste to be handed over to authorized contractors, even when it could be reused in other processes. Although some exceptions exist, the required processing and compliance costs are often not economically viable.

Economic barriers also play a major role, as the costs associated with collection, transport, storage, processing, and adaptation of by-products are often too high in relation to the quantities generated. In addition, companies face organisational and logistical challenges, including the coordination of transport and handling systems, maintaining product quality and traceability, and ensuring timely exchanges within short shelf-life constraints. In the food industry, the reuse of by-products also involves extensive testing, certifications, and cooperation with external institutes, making such initiatives highly dependent on public funding or project support. A planned project to reuse carbohydrate-enriched waste whey, for example, was discontinued after funding was not secured, despite its strong potential.

Another important limitation is the difficulty in identifying reliable and suitable partners capable of receiving, processing, or reusing specific by-products. As a result, despite the interest in circular practices and industrial symbiosis, the practical implementation of by-product exchange remains limited in many cases.

How do external pressures (customers, supply chain requirements, ESG -related requests) influence the waste management and circular practices?

External pressures from customers, supply chain requirements, and Environmental, Social, and Governance (ESG)-related expectations increasingly influence companies' approaches to waste management and circular practices. Companies generally perceive this influence positively, as it reinforces the importance of environmental responsibility and sustainability within their operations. In response to these expectations, companies actively work to raise environmental awareness among employees while also engaging suppliers and business partners in sustainability-related practices and discussions. ESG requirements are increasingly becoming part of supplier relationships and procurement expectations, encouraging companies to improve transparency, reporting practices, and environmental performance. At the same time, companies note that regulatory and supply chain requirements remain somewhat unclear due to ongoing changes and proposed simplifications at the European level, particularly regarding reporting obligations, taxonomies, data requirements, and implementation timelines. Changes in reporting criteria have also altered the classification of some companies, with certain businesses moving from mandatory reporting categories to more flexible SME frameworks. Despite this increased flexibility, many companies continue to adopt voluntary ESG reporting practices, largely because these are increasingly expected by suppliers, customers, and other business partners. In many cases, these sustainability indicators are also aligned with companies' internal values and long-term strategic objectives.

Also, the companies, identified waste management legislation and high implementation costs as the main barriers to circular practices and industrial symbiosis. Regulations often require non-hazardous waste to be transferred to authorized contractors, even when reuse opportunities exist. In addition, the reuse of by-products in the food industry requires extensive testing, certifications, and collaboration with external institutions, making such initiatives heavily dependent on public funding. Due to the lack of financial support, some promising projects—such as the reuse of carbohydrate-enriched waste whey—were discontinued despite their potential.

→ *External ESG and supply chain pressures are increasingly encouraging companies to improve waste management, sustainability practices, and environmental reporting.*

→ *The companies identified strict waste regulations, high implementation costs, and dependence on external funding as the main barriers to developing circular practices and industrial symbiosis initiatives.*

Which skills or competences do you think are currently missing (or insufficient) to implement or scale circular economy and industrial symbiosis practices?

Companies generally consider that **the necessary technical knowledge** and sector-specific expertise **already exist** within their organisations, and many employees receive training related to sustainability and circular economy practices. However, the main limitations are not linked to basic skills, but rather to **insufficient resources**, **limited time**, and the lack of specialised competencies required to further develop and scale circular economy and industrial symbiosis initiatives.

In particular, companies identify a need for stronger research capacity, better access to comprehensive databases and information-sharing platforms, and improved collaboration mechanisms between companies and sectors. Organisational and economic barriers, including the costs associated with coordination and implementation, are also perceived as significant obstacles to deeper engagement in circular practices and industrial symbiosis networks.

Looking ahead, what conditions (skills, tools, partnerships, regulatory clarity) would be most important to further develop industrial symbiosis practices in the industrial sector?

Companies consider that the further development of industrial symbiosis practices will depend primarily on **stronger partnerships**, **greater opportunities for by-product valorisation**, and **a supportive regulatory framework**. Increasing the possibilities for valorising side streams would create stronger economic incentives and encourage companies to invest more actively in circular solutions.

Companies also emphasise the importance of **platforms** and **networks** that facilitate **collaboration, information exchange**, and the **creation of long-term partnerships** between industries. Openness to cooperation and a willingness to share selected operational information are seen as essential conditions for building effective industrial symbiosis relationships. Partnerships are particularly important for smaller companies, which often lack the scale or resources to address circular economy challenges independently.

While companies generally believe that technical knowledge and basic tools are already available, they highlight the **need for stronger inter-company connectivity** and sectoral cooperation, including partnerships with related industries to improve materials, optimise processes, and reduce plastic use.

Regulatory clarity remains another critical factor, especially regarding the classification of side streams and ensuring that potentially reusable materials are not automatically treated as waste. At the same time, companies stress that compliance with food safety, environmental, and industrial regulations must remain the foundation for any future development of circular economy and industrial symbiosis practices.

Are there any good practices or successful cases of circular economy or industrial symbiosis in food companies you have collaborated with that you consider particularly relevant or replicable?

Companies report limited direct experience with large-scale industrial symbiosis initiatives involving multiple external partners in the food sector. Most circular economy practices are currently implemented internally within company operations rather than through structured inter-company collaborations.

Some companies have participated in project-based collaborations and consortia, including initiatives related to sustainable packaging development and production. However, these collaborations have generally been temporary and project-oriented

rather than long-term or systemic industrial symbiosis partnerships, and in several cases the outcomes were not clearly assessed or communicated.

Overall, companies are familiar with collaborative approaches, but industrial symbiosis in the food sector is still perceived as relatively underdeveloped and not yet widely implemented as a continuous operational practice.

Is there any additional aspect you consider relevant to better understand circular economy or industrial symbiosis that we have not discussed?

The key challenges relate primarily to **time constraints**, which, although sometimes perceived as an excuse, have a significant practical impact. In addition, there is a lack of systemic approaches that would enable more structured and efficient solutions. Local collaboration remains limited, due to the negative perception of the industry as a contributor to environmental issues. Furthermore, rising packaging costs present an additional burden, alongside ongoing challenges related to packaging waste and its recycling.

STUDY II. Needs analysis with deep interviews. Opinion of academics about Industrial Symbiosis in the Food Sector

Can you outline best practices in industrial symbiosis within the food sector, focusing on waste reduction or by-product reuse?

Across Spain, Slovenia, and Italy, industrial symbiosis in the food sector is approached through complementary perspectives that collectively demonstrate how waste reduction and by-product valorisation can be effectively implemented.

Researchers from Spain explained that best practices are primarily oriented toward the practical and economic implementation of industrial symbiosis. The Spanish perspective emphasizes the preservation of by-product quality to enable higher-value applications, prioritizing reuse pathways in food production, biomaterials, and other value-added

sectors before considering lower-value energy recovery options. Particular importance is placed on geographical proximity, industrial clustering, and collaborative mechanisms such as intermediaries, brokers, and long-term partnerships between companies. These elements are considered essential for improving logistical efficiency, reducing operational costs, and enhancing the economic feasibility of industrial symbiosis initiatives, especially for small and medium-sized enterprises.

In Slovenia, industrial symbiosis is approached from a more technology-driven and innovation-oriented perspective. Slovenian practices focus on the identification, extraction, and transformation of valuable compounds from food-sector side streams. Emphasis is placed on advanced processing technologies and the development of innovative applications in materials, chemicals, and bioenergy. The Slovenian approach also highlights the reuse of streams traditionally regarded as waste, including sludge and residual biomass, demonstrating a strong focus on process optimization, technological integration, and cross-sector collaboration.

In Italy, best practices are closely linked to collaborative research and demonstration projects focused on food waste valorisation. Experience from participation in the Agrimax project highlighted the potential for converting food waste into value-added products through innovative biorefinery approaches. Additional collaboration with the Emilia-Romagna Agrifood Cluster within the Ecolab 2 project further demonstrated the application of industrial symbiosis principles to the valorisation of municipal and agro-industrial waste streams in the Argenta area. The Italian perspective therefore emphasizes applied research, regional innovation networks, and pilot-scale experimentation as key drivers for advancing circular economy practices in the food sector.

Please share examples of resource exchanges across sectors using food by-products (e.g., peels, oils, or packaging waste) that generated economic or environmental benefits.

The three countries highlighted the broad potential of side streams, but they differ in focus, scale, and strategic orientation, offering complementary insights.

Spain researchers adopt a practical, application-driven perspective, centred on the direct valorisation of food by-products into marketable outputs. Examples such as converting meat industry residues (bones, blood, fat) into valuable materials, using fruit and vegetable by-products for animal feed, or transforming used cooking oil into biodiesel demonstrate a strong emphasis on immediate, scalable solutions. Additionally, Spain highlights cross-sector applications, such as producing essential oils for cosmetics or converting packaging waste into construction materials. Overall, the Spanish approach prioritizes diversification of outputs and clear commercial pathways, often with relatively straightforward technologies.

In contrast, Slovenia presents a more systemic and technologically advanced perspective, focusing on resource recovery, energy integration, and circular system design. Key examples include biogas production from wastewater and sludge, CO₂ capture and reuse in breweries, and phosphorus recovery from wastewater, reflecting a strong alignment with decarbonization and resource efficiency strategies. Slovenia also explores high-value extraction processes (e.g., pectin, bioactive compounds, barrier films from whey), emphasizing innovation and long-term industrial transformation. However, it also acknowledges that while environmental benefits are clear, economic feasibility remains a critical challenge, requiring the creation of high value-added products.

In Italy, the researcher gave as an example the tomato waste, that it has been valorised to produce coatings for both paper and polymers (company: Tomapaint).

In summary, it is suggested that the most effective industrial symbiosis strategies should integrate practical market applications with advanced technological innovation, ensuring both economic viability and long-term sustainability.

What are the main innovation trajectories for symbiotic practices in food production, such as biotech or circular processing techniques?

Researchers highlight the growing role of advanced technologies and innovation in unlocking value from food-sector side streams, particularly through biotechnological and processing solutions.

Spain presents a broad and technology-driven perspective, emphasizing two major innovation pathways. First, biotechnology and bioconversion, including enzymatic and microbial processes, are used to transform low-value waste into high-value products such as proteins, bioactive compounds, enzymes, and biopolymers. Second, advanced extraction and separation technologies—such as ultrasound, microwaves, supercritical fluids, and green solvents—enable more efficient and environmentally friendly recovery of valuable components. Importantly, Spain highlights the integration of these approaches within biorefinery models, combining multiple technologies to maximize resource utilization.

Slovenia, while less broad in scope, provides as key element the valorisation of whey. It emphasizes how technological advancements have already enabled the development of higher-value, functional products, demonstrating that these innovation pathways are not only theoretical but already being successfully implemented in practice.

In Italy, the researcher highlighted the needs of paths that valorise by-products through fermentation or hydrolysis.

What examples exist of building symbiotic relationships in the food industry, like collaborations between food processors and non-food sectors?

The researchers interviewed in Spain think that organic waste is reused as fertilizers or animal feed, and by-products from fruits, vegetables, meat, and fish are redirected to sectors such as cosmetics, pharmaceuticals, agriculture, and pet food. Additionally, agrifood residues are converted into bioactive molecules for health applications,

bioenergy sources like biogas and bioethanol, and even construction materials such as insulation from packaging waste.

Slovenia shows similar principles on a more targeted scale, particularly through industrial symbiosis, where CO₂ emissions from a brewery are reused as raw material in the chemical industry, and food-sector residues are repurposed in agriculture as nutrient-rich inputs. Together, these examples highlight how both countries effectively link food, agriculture, chemical, energy, and other industries to maximize resource efficiency and minimize waste.

In Italy, the researcher added that the cosmetics sector uses products extracted from food processing residues.

Do studies exist analysing the supply/demand balance of food processing waste (e.g., pomace, whey, peels) versus resource needs in other industries, and how could these inform Symbios collaboration model?

Agriculture is a key partner, reusing residues as fertilizers or feed, while chemical and pharmaceutical sectors convert by-products into high-value compounds. Energy recovery (biogas, bioethanol) is also important. Spain emphasizes diverse applications across multiple industries, whereas Slovenia focuses on more targeted, innovative solutions like CO₂ reuse and nutrient recovery. From Italy, it was highlighted that there are some studies of industrial symbiosis, but they are mainly accessible to University researchers.

How have sustainability certifications or EU policies driven symbiotic innovations in the food sector?

EU policies and regulations—particularly the Waste Framework Directive—are seen as key drivers of industrial symbiosis, promoting waste reduction, by-product reuse, and circular economy practices. Spain emphasizes the importance of **legal clarity and certifications** in enabling collaboration and waste valorisation. Slovenia agrees that

progress has been made but highlights **remaining limitations**, especially due to insufficient certification schemes, which restrict the full utilization of side streams despite significant untapped potential. In Italy, the researchers believed that certifications and regulations have done little to stimulate the adoption of symbiotic policies, as complex procedures are required for food applications (for example, compliance with Regulation 1935/2004).

Based on your research, what adoption challenges in food symbiosis (e.g., supply chain complexity) have been addressed successfully?

In Spain, major barriers include a **lack of awareness** regarding technological possibilities and economic benefits, alongside **technical challenges such as the seasonal availability of raw materials**, which complicates consistent processing. There is also ongoing research, particularly in areas like **meat by-product revalorization**. In Slovenia, less attention has been given to issues such as **supply chain fragmentation**, indicating a potential gap in research focus compared to the more application-driven challenges highlighted in Spain. In Italy, success is achieved when transport distances are short and valorisation occurs if not in the same location, then very close to where the waste or scrap is generated.

What conditions (skills, tools, partnerships, regulatory clarity) would be most important to further develop industrial symbiosis practices?

There is a need of **technical capacity, collaboration, and supportive regulation**. In the three countries, is highlighted the need for **strong technical skills and access to appropriate processing tools**, alongside **clear and stable regulatory frameworks** to enable the use of by-products. Establishing **stable cross-sector partnerships and industrial clusters** is also essential to connect actors and create viable markets. While there is already significant knowledge and interest within industry, progress relies on better coordination, clearer rules, and structured collaboration mechanisms to fully unlock this potential. It is also pointed out that a fundamental aspect would be the availability of resources to launch innovative startups with a funded initial phase.

What core logic, mechanisms, and building blocks of food sector symbiosis could Symbios partners integrate into their project model (e.g., waste-to-value chain architectures, digital matching platforms, long-term contract templates, or replication frameworks)? Can you recommend adaptable symbiotic models from the food sector?

In opinion of the academics, effective food-sector industrial symbiosis models should combine. From Spain's perspective, adaptable models include proven value-chain loops such as brewery by-products used for animal feed, fruit residues transformed into cosmetics or nutraceuticals, and dairy whey converted into bioproducts—demonstrating replicable waste-to-value architectures. Slovenia emphasizes that the foundation of any symbiotic model is a deep understanding and mapping of a company's own side streams, which enables the identification of viable opportunities. From Italy, key elements could be information exchange logics between waste producers and companies (including non-food sectors) seeking molecules with properties found in certain wastes.

In terms of mechanisms, both perspectives suggest the importance of digital platforms, though their effectiveness depends on balancing specificity and long-term relevance, as well as ensuring high-quality data. Even simple tools like side-stream inventories can provide immediate value.

What competences would equip food industry managers to operationalize industrial symbiosis?

Academics think that food industry managers need a mix of **technical, strategic, and collaborative competences** to operationalize industrial symbiosis. Key skills include **systems thinking and sustainability knowledge**, the ability to **analyse material flows**, and expertise in **circular business models, life cycle assessment, and techno-economic evaluation**. Strong **digital and data capabilities**, along with **regulatory understanding**, are also essential.

Equally important are **soft and innovation-oriented skills**, such as **cross-sector collaboration, negotiation, openness, and problem-solving**, enabling managers to identify and act on symbiotic opportunities. Slovenia further highlights the importance of **sustainable process design** and close **industry–research collaboration**, where understanding company needs and aligning stakeholders is critical. Overall, managers must combine **analytical, technical, and partnership-building skills** to effectively implement industrial symbiosis.

4. Legislation for Industrial Symbiosis in the European Food Sector

4.1. The European Union Circular Economy and Waste Legislative Framework

At EU level, Industrial Symbiosis does not operate under a single dedicated legislative instrument. Instead, it is influenced by a combination of circular economy policies and sector-specific legislation.

The European Commission's 2020 Circular Economy Action Plan (CEAP) is a central component of the European Green Deal and seeks to accelerate the transition towards a regenerative economic model. It promotes sustainable product design, waste prevention, resource efficiency, and improved markets for secondary raw materials. Industrial Symbiosis is consistent with these objectives because it can maintain materials and resources in productive use across organisational boundaries.

The principal legal framework governing waste is Directive 2008/98/EC on waste (Waste Framework Directive), as amended. The Directive establishes fundamental concepts including the waste hierarchy, waste prevention, reuse, recycling, recovery, disposal, by-products, and end-of-waste status.

The concepts of by-product and end-of-waste are particularly important for Industrial Symbiosis.

Under Article 5 of the Waste Framework Directive, a substance or object resulting from a production process whose primary aim is not the production of that substance may be regarded as a by-product rather than waste when the relevant legal conditions are satisfied. These include certainty of further use, the possibility of direct use without processing beyond normal industrial practice, production as an integral part of the production process, and lawful further use without overall adverse environmental or human-health impacts (Directive 2008/98/EC).

This distinction has significant practical consequences. When a residual material legally qualifies as a by-product rather than waste, its circulation may be facilitated because it is not subject to the complete waste-management regime. This can make symbiotic exchanges more economically attractive. However, inappropriate classification could create environmental risks, making regulatory oversight necessary.

Article 6 addresses end-of-waste status, whereby certain wastes may cease to be considered waste after undergoing recycling or another recovery operation when specified conditions are fulfilled. End-of-waste mechanisms can facilitate markets for secondary raw materials by allowing recovered materials to return to productive economic circulation.

The legal framework therefore creates both opportunities and challenges. Clear by-product and end-of-waste rules can enable Industrial Symbiosis, whereas uncertainty over the regulatory status of materials can discourage investment and create administrative costs.

4.2. EU Agrifood-Specific Legislation Relevant to Industrial Symbiosis

Agrifood Industrial Symbiosis is particularly complex because biological resources may present risks to human, animal, or environmental health. Consequently, several specialised legislative frameworks interact with waste law.

A major example is Regulation (EC) No 1069/2009, concerning animal by-products and derived products not intended for human consumption. The Regulation establishes

health rules and categorises animal by-products according to their associated level of risk. Different categories are subject to different requirements and permitted uses.

This legislation is highly significant for symbiotic exchanges involving slaughterhouse residues, manure, catering waste under certain circumstances, and other materials of animal origin. A potentially useful resource cannot simply be transferred between companies because a technically feasible use has been identified; its collection, transport, processing, and final use must comply with the applicable animal by-product legislation.

Feed legislation creates another important regulatory interface. Food-industry by-products may sometimes be suitable for animal nutrition, potentially representing a higher-value application than energy recovery. However, their use requires compliance with EU rules concerning feed safety, hygiene, traceability, and permitted feed materials.

The regulation of fertilising products also creates opportunities for nutrient circularity. Regulation (EU) 2019/1009, laying down rules on the making available on the market of EU fertilising products, establishes requirements for different product function categories and component materials. The framework can facilitate the incorporation of certain recovered resources into fertilising products when applicable safety, quality, and component requirements are fulfilled.

This is relevant to Industrial Symbiosis because nutrients contained in agricultural and food residues could potentially replace part of the demand for virgin or conventional fertiliser resources. Nevertheless, the transition from "waste" to a marketable fertilising product requires compliance with relevant regulatory requirements and cannot be assumed solely on the basis of nutrient content.

Water reuse represents another important opportunity. Regulation (EU) 2020/741 on minimum requirements for water reuse establishes requirements for reclaimed water used for agricultural irrigation. Its provisions include minimum water-quality

requirements, monitoring obligations, risk-management measures, and responsibilities for relevant actors.

In regions facing structural water scarcity, such as parts of Spain, reclaimed-water systems could form an important component of territorial Industrial Symbiosis. Wastewater treatment facilities, food processors, municipalities, irrigation communities, and agricultural producers could participate in integrated water-management networks.

EU renewable-energy policy is also relevant to the development of symbiotic bioenergy systems. The production of biogas and biomethane from appropriate agricultural and food residues can connect farms, agrifood industries, waste-management companies, energy operators, and fertiliser users. However, environmental sustainability depends on factors including feedstock selection, methane leakage, digestate management, transport requirements, and the energy source displaced.

5. Conclusions

The combined findings from the survey, company interviews, and expert interviews provide a comprehensive overview of the current state of circular economy practices and industrial symbiosis in the European agri-food sector, with evidence drawn from Spain, Italy, and Slovenia. Overall, the results indicate that companies are increasingly aware of sustainability and circular economy principles and have made measurable progress in implementing internal circular practices, particularly in waste management, environmental compliance, packaging optimization, water efficiency, energy recovery, and by-product valorisation. The widespread adoption of internal reuse practices and compliance with environmental standards such as ISO 14001 demonstrate a positive shift toward more resource-efficient production systems.

Despite this progress, the implementation of industrial symbiosis beyond company boundaries remains limited. Stable, long-term collaborations for by-product exchange and cross-sector resource sharing are still relatively uncommon, reflecting persistent structural, regulatory, and economic barriers. Regulatory complexity, administrative

burdens, uncertainties surrounding waste classification and legal frameworks, food safety and traceability requirements, and the perishability of food by-products all constrain the development of broader industrial symbiosis networks. Furthermore, the relatively small quantities of by-products generated by many companies often limit the economic feasibility of collection, transport, storage, testing, and certification without external financial support.

The research also identifies significant organizational and knowledge-related challenges. Survey results reveal important skills gaps in technical, regulatory, and digital competencies, particularly in areas such as energy management (ISO 50001), life cycle assessment, Environmental Product Declarations (EPDs), and advanced circular economy methodologies. Limited investment in employee training further restricts companies' ability to adopt more sophisticated circular business models and industrial symbiosis practices. Expert interviews reinforce these findings by emphasizing the need for specialized technical expertise, digital tools for side-stream mapping and matchmaking, and stronger knowledge transfer between academia and industry.

At the same time, the study highlights numerous opportunities for accelerating industrial symbiosis within the food sector. Companies and experts consistently identified stronger inter-company partnerships, digital collaboration platforms, accessible databases for by-product exchange, clearer and more harmonized regulatory frameworks, and improved policy support as key enablers. Technological innovation—including biotechnology, biorefineries, advanced extraction technologies, and resource recovery systems—was recognized as offering significant potential to transform food-sector residues into high-value products while improving resource efficiency and reducing environmental impacts. Growing ESG commitments, sustainability certification requirements, and evolving European circular economy policies are also expected to further encourage investment in circular solutions.

Although each participating country demonstrates different strengths and priorities, a common vision emerges. Spain emphasizes practical implementation, industrial clusters, and market-oriented collaboration; Slovenia focuses on technological innovation and

high-value resource recovery; and Italy highlights applied research, pilot projects, and regional innovation ecosystems. Together, these complementary approaches illustrate that successful industrial symbiosis requires the integration of technological innovation, practical business models, supportive governance, and collaborative networks.

In conclusion, the findings demonstrate that the European agri-food sector has established a solid foundation for advancing circular economy practices but has yet to fully realize the potential of industrial symbiosis. Unlocking this potential will require coordinated efforts to strengthen technical skills, improve regulatory clarity, enhance economic incentives, expand digital infrastructure, and foster long-term collaboration among businesses, researchers, policymakers, and other innovation actors. Such an integrated approach will be essential for overcoming existing barriers, increasing resource efficiency, and supporting the transition toward a more circular, resilient, and sustainable European food system.

References

- Albino, V., Fraccascia, L., & Giannoccaro, I. (2015). Exploring the role of contracts to support the emergence of self-organized industrial symbiosis networks: An agent-based simulation study. *Journal of Cleaner Production*, 112, 4353–4366.
- Awasthi, M. K., Sarsaiya, S., Wainaina, S., Rajendran, K., Kumar, S., Quan, W., et al. (2019). A critical review of organic manure biorefinery models toward sustainable circular bioeconomy: Technological challenges, advancements, innovations, and future perspectives. *Renewable and Sustainable Energy Reviews*, 111, 115–131.
- Chertow, M. R. (2000). Industrial symbiosis: Literature and taxonomy. *Annual Review of Energy and the Environment*, 25, 313–337.
- Cristóbal, J., Matos, C. T., Aurambout, J. P., Manfredi, S., & Kavalov, B. (2018). Environmental sustainability assessment of bioeconomy value chains. *Biomass and Bioenergy*, 89, 159–171.

- Costa, I., & Ferrão, P. (2010). A case study of industrial symbiosis development using a middle-out approach. *Journal of Cleaner Production*, 18(10–11), 984–992.
- Ellen MacArthur Foundation. (2015). *Towards a circular economy: Business rationale for an accelerated transition*.
<https://content.ellenmacarthurfoundation.org/m/4384c08da576329c/original/Towards-a-circular-economy-Business-rationale-for-an-accelerated-transition.pdf>
- European Commission. (2020). A new Circular Economy Action Plan: For a cleaner and more competitive Europe. COM(2020) 98 final. Brussels: European Commission.
- European Parliament and Council. (2008). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. Official Journal of the European Union, L 312, 3–30.
- European Parliament and Council. (2009). Regulation (EC) No 1069/2009 laying down health rules as regards animal by-products and derived products not intended for human consumption. Official Journal of the European Union, L 300.
- European Parliament and Council. (2019). Regulation (EU) 2019/1009 laying down rules on the making available on the market of EU fertilising products. Official Journal of the European Union, L 170.
- European Parliament and Council. (2020). Regulation (EU) 2020/741 on minimum requirements for water reuse. Official Journal of the European Union, L 177.
- Lombardi, D. R., & Laybourn, P. (2012). Redefining industrial symbiosis. *Journal of Industrial Ecology*, 16(1), 28–37.
- Mirabella, N., Castellani, V., & Sala, S. (2014). Current options for the valorization of food manufacturing waste: A review. *Journal of Cleaner Production*, 65, 28–41.

For further references, please, consult:

https://docs.google.com/spreadsheets/d/1YiTrqW2bEfE9oUxxlYBayaTa_m0SFJzt/edit?gid=264532063#gid=264532063

