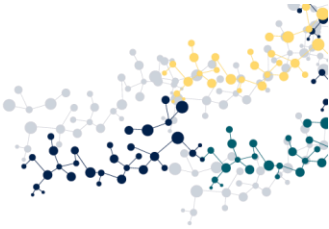
1.1

D2.1 Inventory of opportunities, challenges and needs of the agrifood sector related to the implementation of biotech including reports on regional multi-stakeholder brainstorms



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PROJECT ACRONYM	**Biotech4Food**
GRANT AGREEMENT NUMBER	**1011153135**
PROJECT NAME	***Acceleration of new promising circular agri-food value chains and sustainable industrial interregional investments in SMEs, by integration of advanced biotechnology***
DELIVERABLE NUMBER & NAME	**Deliverable 2.1** **Inventory of opportunities, challenges and needs of the agrifood sector related to the implementation of biotech including reports on regional multi-stakeholder brainstorms**

CONTENT TABLE

2. EXECUTIVE SUMMARY

The scope of this report is to establish an initial structured overview of the needs and challenges of the agri-food industry, relative to biotechnology and biomanufacturing, at the regional level of the Project's Partners, by generating ideas for the application of biotech in the food value chain.

The Project's Partners chose to work on **8 geographical territories** covering 21 NUTS2 regions:

Regions	Partner
Wallonia (BE)	WAGRALIM
Flanders (BE)	FLANDERS' FOOD
Galicia (ES)	ANFACO
Navarre (ES)	CNTA & NAGRIFOOD
Normandy / Pays de la Loire / Brittany (FR)	VALORIAL
Auvergne Rhône-Alpes / Provence-Alpes-Côte d'Azur (FR)	INNOV' ALLIANCE
Emilia-Romagna (IT)	CLUST-ER AGRIFOOD
Central Macedonia (GR)	ATECLUSTER & RCM

A quick overview of the state of biotechnology and biomanufacturing worldwide and in Europe is being presented along with European strategies and initiatives in order to provide the canvas for the regions to gather the required information and channel the brainstorming sessions during the workshops.

Initially, the available information in each region has been collected and analyzed according to the following:

- Opportunities, challenges and needs of the agri-food sector (focus on SMEs) regarding the use of biotech in the food value chain This includes an inventory of the training and support needs of SMEs.
- Regional biotechnological strengths and expertise This involves identifying relevant research and technology organizations (RTOs), companies, etc., that are capable of addressing the challenges of the agri-food industry and enabling biotechnological solutions related to food ingredients, process excellence, resource efficiency, and more.
- Existing boundaries and hurdles that hamper quick implementation of biotech in the agri-food sector.

- Availability and equipment of living labs, pilot facilities and technology platforms and the needs of agri-food and biotechnology SMEs in this perspective.
- Regional strategy towards biotechnological developments (overall or specific for the agri-food industry), relevant projects and available regional funding.

The Partners initially defined an overview of the biotech actors and competences in their regional ecosystems and had direct access to regional authorities, other cluster organizations, relevant sector federations, RTOs and lead companies.

In order to collect the crucial information from each region, a structured, in-depth on-line questionnaire has been set up relevant to the 5 above-mentioned points. Each regional partner had their designated companies, suppliers and RTOs completed this survey and organized stakeholder interviews to get hold of the missing data. All this information has been analyzed with special attention to the needs and challenges of the agri-food companies and with a clear focus on SMEs. More information on the methodology can be found in Annex A.

A SWOT analysis has highlighted the strengths and weaknesses of each region specifically and of the interregional consortium. Opportunities and threats have been analyzed to define a strategic vision for establishing new value chains with a focus on implementing biotech for agri-food companies.

The data and the conclusions of the regional brainstorming workshops have been incorporated into the report.

Finally, the information gathered under this report will be used to facilitate and guide the development of new cross-sectoral, cross-border industrial value chains related to the implementation of biotech in the agri-food industry, to provide an answer to the needs and the challenges they face, a clear strategic vision and implementation roadmap will be defined and thematic priorities to focus on will be determined.

3. BIOTECHNOLOGY IN THE FOOD INDUSTRY

3.1. Introduction

Biotechnology and biomanufacturing provide transformative solutions to many of the greatest challenges facing the world, such as agriculture and food production, climate change, food and nutrition insecurity, and pests and diseases in agricultural plants and animals.

Biotechnology plays a crucial role on a global scale by addressing some of the most pressing issues in the agri-food sector. It offers the potential to significantly reduce external dependencies in various regions, enhances health and environmental protection by minimizing crop and food losses, and promotes the efficient use of natural resources and input materials such as chemicals, synthetic pesticides, and mineral fertilizers.

Biotechnology also enables the development of feed and foods products with improved characteristics, such as reduced saturated fats, allergens, or increased disease-fighting nutrients. Innovations in this field are pivotal in reducing the overall environmental footprint of agri-food production systems, making them more resilient and better aligned with global efforts to achieve sustainability and healthier food supplies.

The application of biotechnology in the food industry has far-reaching implications for the global population. It holds the potential to address future food needs and mitigate the risk of mass starvation. Through biotechnology, food productivity can be increased, nutritional content enhanced, and organoleptic properties improved, making food not only more abundant but also more nutritious and appealing.

In food processing industries worldwide, biotechnology is instrumental in enhancing production efficiency. It is employed to increase food yield, improve nutritional value, extend shelf life, enhance organoleptic properties, and ensure food safety through processes such as fermentation. These advancements are revolutionizing the food processing sector, leading to products that are both sustainable and high-quality.

Bio-based products, derived wholly or partially through biotechnology, from biological materials such as animals, enzymes, and microorganisms, are transforming industries and leading to a more sustainable economy. These innovations are setting the stage for a future where sustainability is at the forefront of economic and industrial practices.

The global biotechnology market was valued at EUR 720 billion in 2021, with an annual growth rate exceeding 18%. The United States leads this market, contributing 60% of the global value, followed by the EU with 12%, and China with 11%.

Characterized by intense technological competition and high R&D intensity, successfully applying biomanufacturing and biotechnology in food and agriculture requires strategic and sustained investment in technology platforms. Such investments can shorten the time to commercialization and reduce risk for new product development, so innovators can successfully manage the costs

of innovation prior to marketing and revenue generation. Furthermore, investment and support are essential to expand the availability and deployment of existing solutions. Additional needs include support to research and build marketplace demand, expand the workforce, ensure abundant feedstock supplies, build or repurpose physical infrastructure, and develop other partnerships and processes necessary to grow the bioeconomy.

3.2. Biotechnology in the food industry worldwide: A brief overview

3.2.1. USA

The U.S. Department of Agriculture (USDA) has outlined an ambitious vision for bioeconomy research and development (R&D) that fits into three themes: (1) improving sustainability and resource conservation while increasing agricultural productivity; (2) improving food nutrition, quality, and consumer choice; and (3) protecting plants and animals against environmental stressors.

- Theme 1: Improving Sustainability and Resource Conservation While Increasing Agricultural Productivity
  - Goal 1.1 Increase Agricultural Productivity
  - Goal 1.2: Increase Climate-Smart Feedstock Production and Biofuel Usage
  - Goal 1.3: Reduce Nitrogen Emissions
  - Goal 1.4: Reduce Methane Emissions
  - Goal 1.5: Reduce Food Loss and Waste
- Theme 2: Improving Food Nutrition, Quality, and Consumer Choice
  - Goal 2.1: Develop New Food and Feed Sources
  - Goal 2.2: Enhance Nutrient Density in Foods
  - Goal 2.3: Reduce Foodborne Illness
- Theme 3: Protecting Plants and Animals Against Environmental Stressors
  - Goal 3.1: Increase Capacity to Detect and Mitigate Pests and Pathogens
  - Goal 3.2: Improve Resilience to Biotic and Abiotic Stress

Achieving these bold goals will require actions from the private sector, public-private partnerships, and effective coordination with domestic and international partners. The United States has long been a global leader in agricultural research and development to improve productivity and promote more efficient use of natural resources in agriculture. By leveraging innovation in biotechnology and biomanufacturing, we can expand the toolbox for farmers, ranchers, and other producers to meet the many challenges in food and agriculture.

The Federal government has a coordinated, risk-based system to ensure that new biotechnology products are safe for the environment and human and animal health. Established as a formal

policy in 1986, the Coordinated Framework for Regulation of Biotechnology describes the Federal system for evaluating products developed using modern biotechnology. The Coordinated Framework is based upon existing laws designed to protect public health and the environment. The U.S. government has written new regulations, policies, and guidance to apply these laws to biotechnology-derived products. One of the main differences in this regulation compared to Europe is the regulation towards GMO where in Europe it is not allowed that food products contain GMO products.

3.2.2. Asia

Asia is in the midst of rapid economic growth and now offers exciting possibilities in research, particularly in the area of biotechnology. Just two decades ago, advanced biotechnology research was centered primarily in the U.S. and Europe and many researchers and students from Asia went there to pursue postgraduate studies.

With the booming Asian economy and increasingly vibrant research climate, many of those researchers have now returned, bringing their expertise with them. They have gone on to establish biotech forces in both academia and industry, as well as form a large network of connections between researchers in Asia and around the world.

Leading the growth in biotechnology in Asia are China, Japan, South Korea, and Singapore. But also, in Southeast Asia countries like the Philippines and Myanmar the biotech industry is growing. Although each country has pursued unique research directions, interest has centered on three key areas:

- biomanufacturing of chemicals and biomaterials for various industries, including food and agriculture
- diagnostics and biomedical technologies
- synthetic biology

Government support also plays an important role in driving the direction of biotechnology research. For example, synthetic biology in Singapore, China, South Korea, and Japan has much support at the national level, including the establishment of state-sponsored programs and national institutes, and the development of core research capabilities.

In China, government-sponsored programs offer large incentives to create biotech infrastructure, develop biotech and life-science parks, and recruit overseas talent. Legislation is continuously being developed to encourage innovation in China. Biotechnology is named as a Strategic Emerging Industry and plans such as Made in China 2025 and the 13th Five-Year Plan prioritize its development. More partnerships are happening between academic institutes and biotech companies within and outside China.

Singapore is also known as a biotechnology hub. The Singapore Government has invested over $220 million in the agrifood sector. Singapore is currently leading in government-sponsored initiatives for alternative proteins and cultured meat

3.3. Biotechnology in the Food Industry in Europe

3.3.1. Introduction

Biotechnology is a key driver in the European food industry. Employing over 4 million people and contributing significantly to the economy. Innovations in genetic engineering, fermentation and synthetic biology have driven advancements in the agrifood sector. The market for industrial biotechnology-derived products in Europe is projected to grow from 28 billion euro in 2013 to 50 billion euro in 2030, representing a CAGR of 7%. This highlights the sector's potential to address major socio-economic and environmental challenges.

Despite the positive outlook, the European biotechnology sector faces major challenges. The biggest issue is staying competitive in terms of cost, both compared to fossil-based alternatives and to international competitors. If these challenges are not addressed, there is a risk that the growing demand for biotechnology products in the EU will be met by suppliers outside of Europe, resulting in lost economic opportunities worth tens of billions of euros.

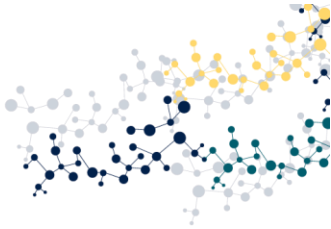
To fully seize the opportunities that biotechnology offers, Europe needs to establish clear regulations, launch strategic initiatives, and continue investing in research and development. This report provides an overview of the current situation in European biotechnology, focusing on both the opportunities and the challenges ahead.

3.3.2. EU strategies & initiatives exclusively on Biotechnology

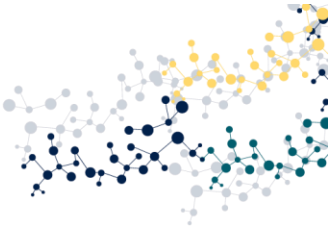
In Europe there are several strategies and initiatives that were set up to support the implementation of biotechnology in different sectors, including the food industry.

Since there was no general European policy or strategy regarding bioeconomy and biotechnology, the European Commission set up the EU biotech and biomanufacturing initiative. In March 2024 they published the document '**Building the future with nature: Boosting Biotechnology and Biomanufacturing in the EU**' which outlines a set of actions:

- **Leveraging research and boosting innovation:** To help to identify drivers and bottlenecks of innovation and of technology adoption, the Commission has launched a study to investigate the EU's position compared to other global leaders in emerging biotechnology generation and transfer to the biomanufacturing industry. To facilitate a more productive use of Research Infrastructures, the Commission will explore ways to accelerate the development and use of the Industrial Biotechnology Innovation and Synthetic Biology Accelerator (EU IBISBA) as a trusted digital repository and service network for the sector.



- **Stimulating market demand:** To succeed on the market, bio-based products need to prove their lower environmental impact when compared, for instance, to petrochemical products. The Commission will review the assessment of fossil-based and bio-based products to ensure equivalence of treatment and incorporate methodologies for carbon storage in construction materials. To accelerate the substitution of fossil feedstock and to **stimulate the demand and market uptake of bio-manufactured products**, the Commission will conduct an in-depth impact assessment of the feasibility of **bio-based content requirements in specific product categories and in public procurement**. Furthermore, the Commission will explore how bio-manufactured non-food products could profile themselves better through labelling of bio-based products.
- **Streamlining regulatory pathways (including permitting and authorization):** The Commission will assess how EU legislation and its implementation could be further streamlined to reduce any fragmentation, explore potential simplification, and **shorten the time to market** for biotech innovations; as well as regulatory obstacles that arise at national or other governance levels which impede an effective single market. The study will lay the foundations for **a possible EU Biotech Act**. The Commission will also work towards establishing an **EU Biotech Hub**, an operational tool for biotech companies to navigate through the regulatory framework and identify support to scale up, by end of 2024. The Commission will further promote the establishment of **regulatory sandboxes** that allow to test novel solutions in a controlled environment for a limited amount of time under the supervision of regulators, as a way of bringing more of them quickly to the market.
- **Fostering public and private investments:** The EU has a broad range of financing instruments to support biotechnology and biomanufacturing such as Horizon Europe, including the Circular Bio-based Europe Joint Undertaking (CBE JU) and the Innovative Health Initiative Joint Undertaking (IHI JU); EU4Health; the Innovation Fund; and now also the Strategic Technologies for Europe Platform (STEP). **To develop and scale up innovations** with the potential to create new markets, the Commission will advocate the inclusion of specific challenges on biotech and biomanufacturing in the European Innovation Council (EIC) accelerator Work Programme 2025. In line with the recent Eurogroup statement on Capital Markets Union, the Commission will launch **a study by the end of 2024 to identify barriers and ways to support the consolidation of investment funds, stock exchanges and post-trading infrastructure** in order to enable the development of the necessary scale, enhance the knowledge base, create deeper pools of liquidity and help lower the cost of financing for high-growth companies.
- **Strengthening biotech-related skills:** Large-Scale and Regional Skills Partnerships can play a significant role in providing **upskilling and reskilling opportunities on biotech and**



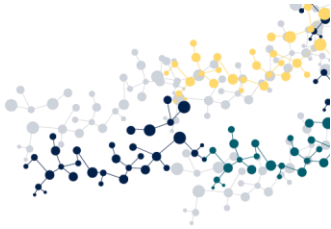
biomanufacturing. A specific large-scale partnership for biotech and biomanufacturing could be explored, which can be co-financed through the Blueprint Alliances activity of the Erasmus+ programme. The expanding number of dynamic European Universities alliances and Erasmus+ partnerships and alliances for innovation can also strengthen the development of skills required by the biotech sector.

- **Elaborating and updating standards:** The Commission will continue to encourage the elaboration and updating of European standards for biotechnology and biomanufacturing to facilitate market access and innovation.
- **Supporting collaboration and synergies:** The Commission will encourage the deployment of technologies related to biotechnological processes and biomanufacturing across EU regions through relevant Regional Innovation Valleys.
- **Fostering engagement and international cooperation.** The Commission will explore the possibility of launching international biotech and biomanufacturing partnerships with key international partners, such as the US, India, Japan, and South Korea, to collaborate on research and technology transfer, and to explore possibilities for strategic cooperation on regulatory and market access-related topics. Through the Global Gateway and in line with its Global Health Strategy, the Commission will advance existing partnerships with Africa, Latin America and the Caribbean on manufacturing health products aiming to diversify global supply chains, overcome shortages of critical health products and reduce the global burden of disease.
- **Using AI and generative AI:** the Commission will support structured exchanges with stakeholders to accelerate the uptake of AI, and in particular Generative AI, in biotech and biomanufacturing (in the context of GenAI4EU). The Commission will also raise awareness of facilitated access to the EuroHPC supercomputers for AI startups and the science and innovation community, in the course of 2024.
- **Reviewing the Bioeconomy strategy:** The Commission will review the EU Bioeconomy Strategy by end 2025. The review will take into account the current societal, demographic and environmental challenges, reinforcing the bioeconomy's industrial dimension and its links to biotechnology and biomanufacturing to contribute to a stronger EU economy.

3.3.3. EU strategies & initiatives promoting Biotechnology

Although not specific to biotechnology alone, there are several other strategies, policies and initiatives in Europe where the implementation of biotechnology is related to the topic:

- The **European Green Deal** and the **New Circular Economy Action Plan** represent an ambitious environmental policy agenda and exemplify EU efforts towards sustainable digitalization, namely, the gradual, eco-friendly integration of digital technologies into the economy.



- In May, 2020, the Commission announced both the **Farm to Fork (F2F) Strategy** and the **EU Biodiversity Strategy for 2030** as roadmaps for enhancing food and agricultural sustainability by 2030 under the EU Green Deal.1 On page 10 of the F2F Strategy, the Commission specifically notes:

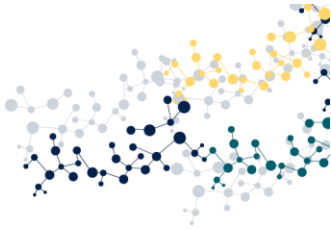
  > *"New innovative techniques, including **biotechnology** and the development of bio-based products, **may play a role in increasing sustainability**, provided they are safe for consumers and the environment while bringing benefits for society as a whole. [...] Farmers need to have access to a range of quality seeds for plant varieties adapted to the pressures of climate change".*

- The ***EU Twin Transformation (Digital & Green) Initiative***, understood as two interconnected and simultaneous processes of change toward two related but distinct goals, emphasizes on promoting both digital advancement and sustainability, underscoring a crucial point in EU's trajectory towards a Green and Digital Europe. As it navigates the twin transition, the intersection of technology and environmental responsibility offers profound opportunities for progress and resilience.
- The European Industrial Strategy: aims to strengthen the competitiveness and sustainability of EU industries, including those involved in producing bio-based products. It includes measures to support innovation, investment, and market uptake of bio-based products.
- The Green Deal Industrial Plan: Enhances the competitiveness of Europe's net-zero industry and accelerates the transition to climate neutrality.
- The Net-Zero Industry Act: Aims to scale up the manufacturing of clean technologies in the EU, including biotech climate and energy solutions.
- The European Critical Raw Materials Act: This policy is the basis for building up the EU's capacities and strengthening the resilience of its critical raw material supply chains.
- The Common Agricultural Policy (CAP)**:** CAP includes the bioeconomy as a core objective, promoting employment, growth, social inclusion, and local development in rural areas alongside sustainable development.

There are also several strategies and initiatives that aim to support the research related to the development and implementation of biotechnological applications in the food industry and other sectors:

- ***Food 2030*** is the EU's research and innovation policy framework supporting the transition towards sustainable, healthy and inclusive food systems, that respect planetary boundaries.

  Food 2030's policy framework supports the transformation of food systems and ensures everyone has enough affordable, nutritious food to lead a healthy life. It joins up research



and innovation activities in different areas and across disciplines to find answers to interconnected challenges.

Food 2030 covers the entire food system, linking multiple sectors from primary production by land and water to food processing, retail and distribution, packaging, waste and recycling, catering services and consumption.

Food 2030 is in line with, and supports the goals of the European Green Deal, Farm to Fork strategy and Bioeconomy strategy. It is underpinned by the need to foster a multi-actor and systemic approach to research and innovation capable of delivering co-benefits for people's health, our climate, our planet and communities.

The FOOD 2030 framework is built on the following four key Food and Nutrition Security priorities:

- NUTRITION for sustainable and healthy diets
- CLIMATE smart and environmentally sustainable food systems
- CIRCULARITY and resource efficiency of food systems
- INNOVATION and empowerment of communities

- The ***Circular Bio-based Europe Joint Undertaking (CBE JU)*** is a €2 billion, public-private partnerships (PPPs) in plant biotechnology, between the European Union and the Bio-based Industries Consortium (BIC) that funds projects advancing competitive circular bio-based industries in Europe. CBE JU is operating under the rules of Horizon Europe, the EU's research and innovation program, for the 2021-2031 period. The partnership is building on the success of its predecessor, the Bio-based Industries Joint Undertaking (BBI JU), while addressing the current challenges facing the industry. The partnership was established by the Council regulation (EU) 2021/2085.

  Research, relative to food and agriculture (indicative list)

  - Bio-based value chains for valorization of sustainable oil crops
  - Bio-based dedicated platform chemicals via cost-effective, sustainable and resource-efficient conversion of biomass
  - Bio-based value chains for valorization of sustainable natural fiber feedstock
  - Sustainable microalgae as feedstock for innovative, added-value applications
  - Selective and sustainable (co)-production of lignin-derived aromatics
  - Innovative conversion of biogenic gaseous carbon into bio-based chemicals, ingredients, materials
  - Biotech routes to obtain bio-based chemicals/materials replacing animal-derived ones
  - Sustainable, bio-based alternatives for crop protection
  - Innovative bio-based food/feed ingredients

- The ***Interregional Innovation Investments (I3)*** Instrument financed from the European Regional Development Fund (ERDF) represents an opportunity to support interregional portfolios of companies' investments bringing innovation to the market at high technology readiness levels (TRL 6-9) and reshaping EU interregional value chains. The cohesion dimension is very pronounced under the I3 Instrument scheme and the interconnection of regional innovation ecosystems along the Smart Specialization Strategies (S3) priorities. It gives the opportunity to less developed, transition and outermost EU regions to catch up with the more developed regions.
  The general objective of the I3 Instrument is to promote innovation, innovation diffusion, and the reinforcement of EU and regional value chains, through cooperation based on shared priorities and complementary capabilities. This instrument is not thematically specified but can be used for projects to support the implementation of biotechnological applications, like the ***Biotech4Food project***.

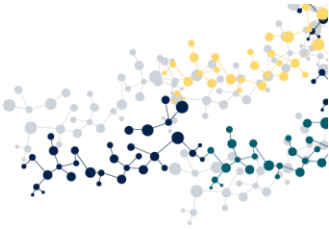
Finaly, there are a few S3 Partnerships that promote the use of biotechnology through the projects and actions they undertake.

- The ***I4CE – Ingredients for Circular Economy***, a European S3 partnership of agrifood Cluster and RTOs promotes the use of biotechnology for developing new ingredients from food or food waste. (https://i4ce.eu/)

3.3.4. Overview of key regulatory frameworks.

The regulatory landscape for biotechnology in the European food industry is governed by several key frameworks designed to ensure the safety, environmental sustainability, and ethical considerations of biotechnological applications. The most significant regulations include:

- **Genetically Modified Organisms (GMO) Legislation:** The EU has established some of the strictest regulations globally for GMOs, including Directive 2001/18/EC and Regulation (EC) No 1829/2003. These rules require comprehensive risk assessments, stringent labeling, and traceability to ensure the safety of GMOs in food and feed, safeguarding both consumers and the environment.
- **Novel Food Regulation:** This regulation governs the approval and marketing of novel foods, including those developed through new biotechnological methods. It requires a thorough pre-market safety assessment by the EFSA before these products can be sold in the EU.



4. REGIONAL INNOVATION ECOSYSTEMS: FACTS & FIGURES

4.1. Belgium

4.1.1. Wallonia

4.1.1.1. Food industry

According to the annual economic report of Fevia, the food industries in Wallonia in 2022 is represented by over 1 648 companies and 25 300 direct employments. The food industry is the largest industrial sector in Wallonia, representing 20,2% of the total turnover (10,5 billion euros). The industry is represented mainly by SMEs (97% of SMEs <100 employees and 95% od-f SMEs<50 employees). Investments are also increasing (+ 3,4 % in 2022 compared to 2021 representing 499 million euros).

Traditional fermentation represents a significant part of the processes used in the Walloon food industry: bread making, breweries, wine making, dairy products, charcuterie.

The bread and baked goods industries represents over 34 % of the food industry in terms of employment. Actors such as Puratos develop ingredient, partially through biotech processes.

There are a lot of opportunities in the plant-based food sector such as extraction of plant proteins and fibre.

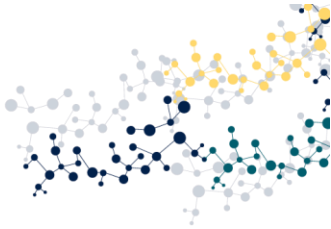
The probiotic and food supplement sector are also well-established in Wallonia.

It has also been highlighted that when talking about biotechnologies, transversal steps (upstream and downstream processing) must be considered as they are part of the entire processing scheme and must be adapted to the given products and substrates.

4.1.1.2. Biotechnology application suppliers

Biotechnological applications are already deeply integrated into various sectors of the agrifood industry, especially in traditional fermentation processes: long-standing practices in brewing, winemaking, baking, sausage production and dairy processing. Enzymatic technologies are used for the hydrolysis and extraction of carbohydrates and fibres, as well as microbial biomass production (probiotic, starter cultures)

- **Plant-based food sector and protein alternatives:** biotechnologies offer exciting opportunities in the rapidly growing plant-based food sector and the development of alternative protein sources. Through biotechnological interventions, companies can create plant-based products with improved taste, texture, and nutritional value, catering to the rising demand for sustainable and ethical food options.
- **Enzyme technologies:** the application of enzymes for the extraction of fibers, proteins, and bioactive compounds holds great potential for enhancing the nutritional profile and functional properties of food products. By leveraging enzyme technologies, companies



can innovate and differentiate their offerings while addressing consumer demand for healthier and more sustainable options.

- **Precision fermentation:** This technique opens new possibilities for creating high-value food products with precise attributes, particularly micro-organisms secondary metabolites and enzymes.
- **Probiotics production:** Probiotics offer potential health benefits and can be incorporated into various food and beverage products, including dairy, fermented foods, and functional beverages.
- **Production of bio-surfactants and emulsifiers** for their applications in baked goods (bread), meat products, sauces, etc.
- **Traditional fermentation**: it remains a big application of biotechnologies applied to agri-food.

Key actors in biotechnology application providers are active in:

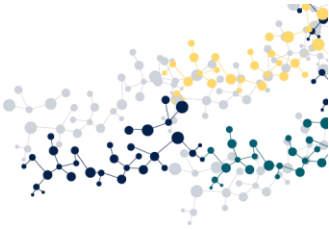
- The production of fermentation starter cultures (THT)
- The production of probiotics (THT)
- The production of biostimulants for agricultural uses
- Extraction of natural plant enzymes

We can cite :

- **Cosucra** uses enzymatic hydrolysis, fermentation technologies and genomic techniques.
- **Artechno** selects microorganisms, study them, and cultivate them in fermenters and need the integration of physico-chemical analyses, genetics, and biochemical engineering.
- **THT** uses fermentation and provide downstream processes including separation, purification, and drying
- **Agricells** grows bacteria through bio fermentation, has downstream steps: purification, drying (spary dry, lyophilization) and formulation. The company does genomic and metagenomics. Lactoresearch : fermentation
- **Minagro** : formulation, extraction, in-can preservation
- **Herdera** 22 : strain collection maintenance, culture and extraction operations
- **Enzybel** : fermentatio, extraction, protein hydrolyses
- **Biores** : biotransformation
- **Bellavie** : Freeze-drying of living strains

4.1.1.3. RTO's

- **Gembloux Agro Bio-tech**, Faculity of Uliège -Terra center
  TERRA is a research and teaching unit dedicated to the study and development of biological engineering in agri-food, agriculture, biotechnology, environment, and forestry. The research done within the 'Microbial technologies' axis of the Terra center aims at the implementation of microorganisms for specific applications (industrial production, behavior in a particular ecosystem, pathogenicity,...). We work on different aspect: Screening of micro-organisms and their interactions, Synthetic biology and metabolic engineering of microorganisms to produce specific secondary metabolites and process engineering
- **University of Mons**: Research on microbial processes and biotechnologies. The proteomics ad Microbiology Unit is specialized in studying the structure-function relationships of proteins, focusing on bacteria as cell models. They aim to understand the various aspects of a cell (functional, structural, and quantitative proteomics) through experimental approaches. From field sampling to laboratory cultures, combined with genomic analyses, the laboratory is currently developing proteomic approaches to better understand and model bacterial consortia and their evolution in different conditions. They work on different bacteria. Regarding food applications, they work on purple bacteria, which have the advantage of being very versatile, as they can use a wide range of carbon source as subtract. They also work on cyanobacteria for the synthesis of bio stimulants. They are mainly focused on fundamental research on bacteria. But with one of our new projects (PROTEBoost), we are analysing the potentiality of using purple bacteria protein alternatives.
- **Meurens Natural :** Meurens Natural specializes in cereal enzymatic hydrolysis, using enzymatic activity to hydrolyze both soluble and insoluble fibers from raw materials like rice flour, oat, wheat, manioc, spelt, corn, barley, malt, and fruits such as figs, prunes, and dates. They also conduct tests on food by-products like wheat bran, exploring further valorization of these ingredients, which often differ significantly in composition, being typically starch-depleted.
- **CELABOR :** This center offers scientific and technical support to companies in the fields of agri-food, environment, packaging, paper/cardboard, and textiles. With a multidisciplinary team of around forty scientists, CELABOR aims to develop a lasting relationship based on trust. Our agri-food department offers a comprehensive range of technologies, including fermentation and enzymatic technologies, transversal techniques (upstream and downstream), membrane filtration, and drying. They also specialize in water and CO2 supercritical gas extraction. Their agri-food department is equipped with a unique technological platform in Wallonia, featuring an ATEX-certified explosive-proof room and a test hall with extraction machinery. Our team develops



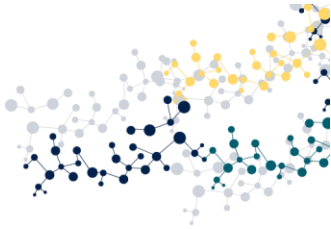
extraction processes with a focus on 'green' methodologies, preparing natural plant ingredients for the food supplements, cosmetics, and phytotherapy markets.

- **CER Groupe**: CER Groupe provides companies, universities, institutions and individuals with high-quality services in the life sciences and agricultural sectors. The group stands out by providing an end-to-end, pre-clinical solution in a regulated environment (ISO, GxP) and helping innovative companies to incubate, grow and take off in Belgium and abroad
- **Materia Nova :** Materia Nova works with and for companies to develop innovative and collaborative projects capable of meeting societal and environmental challenges.
- **Smart Gastronomy lab** : The Smart Gastronomy Lab is a Walloon Living Lab. A structure dedicated to food in the broad sense of the term, it focuses its activities around 2 poles: business services and research and development. You can also find our past events on raising awareness of current food trends and healthier and more sustainable eating through the different workshop formats. This lab is linked to the University of Liège.
- **CRA-W : Walloon Agricultural Research Center,** The CRA-W brings together scientific research, service and support functions in support of Walloon farmers, stockbreeders, horticulturists, forestry producers and operators in the agri-food sector.

4.1.1.4. Regional strategies & initiatives

We have not identified strategies directed directly towards biotechnologies, but strategies that include them more or less directly.

- The Smart Specialisation Initiatives of the Walloon S3 strategy towards “Future agri-food value chains and Innovative environment management”:
  - Protewin (“Deployment of plant based and alternative protein value chains3)
  - Wasabi 2.0
  - Foodbooster (“Enhancing the competitiveness of the 'ingredients/functional foods' sector in the Walloon Region” - Probiotic, pre-biotics, bioactive peptides)
  - Digibiocontrol (“Strengthening the Walloon ecosystem of biocontrol by interconnecting the digital world (applications, sensors, robots, etc.) with biological pest control methods through three pillars: innovation/R&D, training, and entrepreneurship.
- FoodWall initiative (Win4Excellence program): financing of three agri-food collaborative projects



4.1.1.5. Regional brainstorm report

General Information	
Region	Wallonia
Responsible Cluster	Wagralim
Workshop Date	11/04/2024
Number of Participants	62
Workshop Method	World café Wagralim launched the workshop with the presentation of the project Biotech4Food, by explaining the results of the survey. It was asked to the participants to challenge the survey results by including them into the discussions and by taking them as a basis. Wagralim drafted 6 questions to facilitate the workshop and draw conclusions from it, 2 related to B4F 1. Valorisation of co-product: a trending topic with limited success stories. How can Europe aid in boosting the development of new products utilizing additional agri-food side streams? 2. Which technologies are lacking to enhance innovation, sustainability, and resilience within the European agri-food system?

Report

Description of Item	Analysis – Major Points of Discussion
The most important challenges	- **Clarifying defenitions**: Establishing a clear definition of 'technology and biotechnology' - **Understanding regional needs:** Identification of the specific needs of regional actors. - **Role of RTO's:** Concern of Research centers being used as mere subcontractors (for their equipment) for the companies . - **ConsumerTransparency:** The need for greater transparency aboutfood products for the consumer - **Legislation and regulations:** lack of a common legislation, sometimes complicated to implement (novel food)

	- Technologies : how to stabilise co-products ? - **Logistics issues** : For the valorisation of sidestreams, co-products, the logistic aspect of bringing for example the 'raw materials' to the company is not so easy - **Pricing:** The price of biotechnology products is often considered to be (too) high. - **Consumer perception :** it is difficult for consumer to accept that they are eating 'co-products' it is seen as a waste for companies these co-products are not integrated in the value chain : companies don't integrate the valorisation of co-products in their strategy at the beginning, that's why companies don't think to valorise co-products, by integrating this step in their value chain process, or don't think to find a solution, for example by establishing a collaboration with another company which will take this co-product' as raw material - **Market competition**
Interregional cooperation & strategies	**Leveraging existing biotechnologies:** The regions should cooperate and focus on maximizing the use of already known and used biotechnology rather than seeking new ones **Developing common food labels:** Creation of common food labels to guide the consumer, although the effectiveness fo these labels is sometimes questioned by scientists.
Measurements & actions	**Enhancing consumer understanding:** Facilitate the consumer understanding by creating easy-to-read labels, especially regarding sustainability. **Stimulate innovation:** Facilitate the use of RTO facilities to stimulate the innovation in food industry
Cooperation research and industry	**Strengthen the collaboration** between RTOs and industry to provide rapid service delivery and not just focussing on "projects" Increase cooperation with the RTOs using cutting-edge technology and small-scale production facilities to facilitate innovation for companies

4.1.2. Flanders

4.1.2.1. Food industry

The food industry is the largest industrial employer in Flanders (57,420 FTE) and is one of the few sectors with a positive trade balance. The sector is also doing very well in terms of turnover (€ 63.2 billion in 2023, + 27% compared to 2022) and investments (€ 1.5 billion). Investments in the food industry are increasing faster than in the rest of the industry. Belgian food products are known worldwide for their quality, diversity and innovation. Export is therefore the growth engine for the food industry in Flanders. In 2023, Belgium exported 28.6 billion euros in food and beverages (+ 18% compared to 2022).

There are 3200 employers in the food industry in Flanders. However, more than half of those are micro-enterprises (less than 5 employers), such as local butchers and bakeries. These companies contribute very little in terms of employment. In the next 10 years, the number of this type of micro-companies is expected to decrease (as in the rest of Europe). With 57.420 FTE which result in 69.500 jobs, the food sector remains the largest industrial employer in Flanders. The food industry is an SME sector although due to acquisitions this number is decreasing. Important sectors in terms of turnover and employment are the meat and beverage industry, the processing of fruit and vegetables and the manufacture of bakery products and pasta.

To remain competitive and resilient, biotechnology applications can play an important role in certain sectors.

At this point there are already a few sectors where biotechnology is part of their daily operations in the form of traditional fermentation or the use of enzymes to alter certain food properties.

The (industrial) bakery sector in Flanders is the largest in terms of jobs in Flanders and traditional fermentation is of course very important in the bakery industry. In Flanders most of the research done on traditional fermentation in the bakery sector is related to sourdough.

Traditional fermentation is also important in the brewery sector. In Flanders there are 420 breweries in 2023, compared to 133 in 2010. A lot of them are small microbreweries but there are also global leaders as AB Inbev, Duvel Moortgat,

There are some large players active in dairy fermentation (Milcobel, Friesland campina) or plant-based alternatives of dairy (Alpro).

Newer biotechnology applications are often related to protein diversification but also alternative fats and sugars. The production of microbial protein and the use of precision fermentation to produce specific components that can be used to make alternative products to animal-based products are in the lift.

4.1.2.2. Biotechnology application suppliers

Flanders is a significant hub for biotechnology application suppliers in the food industry, with companies offering a wide range of innovative solutions. These suppliers are instrumental in enhancing food quality, safety, and sustainability, addressing industry needs. Different applications are targeted.

- **Enzyme Applications:** Enzymes are used to break down complex molecules in food processing, improving texture, flavor, and nutritional value. For example, enzymes in baking enhance dough quality and extend bread freshness.
- **Probiotic and Prebiotic Ingredients:** These ingredients support digestive health and boost the immune system. They are commonly added to dairy products, beverages, and functional foods to enhance their health benefits.
- **Natural Food Colors and Preservatives:** Natural colors and preservatives derived from biotechnological processes are replacing synthetic additives, meeting consumer demand for clean-label products.
- **Food Safety Solutions:** Biotechnology provides advanced solutions for detecting and controlling pathogens, ensuring food safety and compliance with regulatory standards.
- **Flavor Enhancement:** Biotechnology enables the development of natural flavor enhancers that improve taste profiles without the need for artificial additives.

In Flanders fermentation is a technique that is strongly incorporated in the food industry. Both in traditional fermentation in the baking, brewing and meat sector. There is for example the company lesaffre who is active in yeast production.

Next to traditional fermentation Flanders is also active in fermentation for microbial biomass with companies as Naplasol, Biolynx, Avecom, Calidris Bio but also precision fermentation for the production of specific functional ingredients like the companies Paleo, Those Vegan Cowboys, NovelYeast, Inbiose.

It is not always easy to make the differentiation between biotechnology application suppliers and food companies. Since their technology might result in ingredients for the food industry, which makes them an ingredient supplier.

4.1.2.3. RTO's

There are a lot of research institutes and pilot facilities that work on biotechnology applications in the food industry. There are certain organizations that have a pure focus on biotechnology applications but also some were this is a part of their research, but they also focus on other.

- **Bio base Europe pilot plant:**
  BBEPP is an independent, state-of-the-art facility that operates from a laboratory level to a multi-ton scale. BBEPP is a service provider for process development, scale-up and custom manufacturing of biobased products and processes. It enables the conversion of renewable feedstocks into biochemicals, biomaterials, biofuels and other bioproducts by

using technologies such as biomass pretreatment, biocatalysis, (gas)fermentation, green chemistry and product recovery and purification. Along with private, bilateral projects, BBEPP is currently involved in many consortium-based projects. About 50 % of their research and bilateral project at the moment is related to food industry and they've seen a large increase in this number during the last years.

- **ILVO/Food Pilot:**
  The Food Pilot helps companies, labs and governments with their agri-food challenges: product development, process optimization or troubleshooting technical production problems. Within a co-creative process, they bring solutions in the form of advice, lab analyses and/or pilot trials performed on semi-industrial processing equipment. The Food Pilot is a collaboration between ILVO and Flanders' FOOD. They work both on traditional fermentation processes related to dairy and meat but also on the use of micro-algae and they have small scale fermenters for the production for e.g. microbial protein. They can characterise these new ingredients and help explore their potential in food applications.
- **VIB: Flanders institute for Biotechnology**
  The Flemish Institute for Biotechnology (VIB) is an example of the Flemish government's commitment to promoting research in the life sciences. As a member of EU-LIFE, VIB is committed to promoting excellence in the life sciences field and harnessing research results for economic growth.
- **University of Gent**
  - Department of biotechnology (different research groups): They do research about the following topics: Precision fermentation for proteins, specialty sugars, flavours & fragrances, colors & enzymes, biomass fermentation for colors and proteins.
  - VIB UGent Centrum voor Plantensysteembiologie
- **University of Antwerp**
  DuEL (Sustainable Energy, Air and Water technology): The research team endeavours to alleviate tensions in the nutrient-energy-water nexus through a dedicated focus on novel resource-efficient nutrient management biotechnology. In this context the core expertise lies in the production of Single Cell Protein (SCP), which is the protein rich biomass of microorganisms, and more particular in the design of bioreactors and process configurations. Next to this our research focuses on the development of dedicated microbiome steering tools with the eye on the nutritional optimization of the produced biomass in terms of essential amino acids, essential fatty acids, bulk protein,...
- **Free University of Brussels**
  Flanders Research Consortium on Fermented Foods and Beverages (Fermented food pilot): The alliance research group aims at the unravelling of new, undiscovered, fermented food ecosystems for: (i) Screening for and isolation/identification of food-grade microorganisms, and description of new taxa (lactic acid bacteria, acetic acid bacteria,

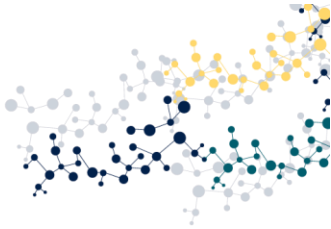
staphylococci, bacilli, yeasts, ...) (ii) Study of the species diversity, community dynamics, and metabolite analysis of fermented foods and beverages in the dairy, meat, bakery, vegetable, cocoa and fermented beverage sectors. (iii) Functionality analysis of new, efficient, functional starter cultures (simulation media, mathematical modelling, validation by means of quality and challenge tests, ...)

- **KU Leuven**
  - VIB-KU Leuven Centre for mircobiology (CFM):
    The research team uses yeast as a model to study genetic and epigenetic regulation, inheritance and evolution in eukaryotes. The research combines theory and experiment, including molecular biology, genetics, synthetic biology, genomics, bioinformatics, and mathematical modeling. Apart from striving for scientific insight, They are also exploring applications of their findings, most notably by optimizing yeasts for food fermentation (beer, wine, bread, chocolate...), biofuels, bioplastics and production of functional proteins, lipids and other complex biomolecules through precision fermentation and synthetic biology.
  - LFCB (food chemistry and biochemistry):
    LFCB main focus is on research about cereal (e.g. wheat, barley, maize, rye, rice) and pseudo-cereal constituents (e.g. starch, proteins, non-starch polysaccharides, minerals and lipids) and enzymes and chemical agents impacting cereal constituents. LFCB also studies protein sources which coexist with cereals in common food products (e.g. egg, soy, whey) and the functionality of yeast and yeast metabolites in the production of fermented cereal products.

4.1.2.4. Regional strategies & initiatives

In Flanders there are different initiatives and strategies that are related to the implementation of biotechnology in Food:

- **Flemish Protein strategy**
  The Flemish protein strategy is an initiative from the Agency for Agriculture and Fisheries and aims to achieve a more sustainable, diverse and future-oriented protein supply by 2030 and increase European self-sufficiency in proteins. They also focus on novel proteins like microbial protein and try to stimulate production and building value chains.
- **Vlaanderen Circulair, agenda bio-economy**
  Circular Flanders is the hub and the inspiration for the Flemish circular economy. It is a partnership of governments, companies, civil society, and the knowledge community that will take action together. They have a strategic agenda Bio-economy which aims to accelerate circularity in various sectors with renewable bio-based raw materials.
- **The Proteinn Club**



The ProteInn Club is a collaboration between Bio Base Europe Pilot Plant, UGent, CAPTURE and ILVO and identifies, connects, support and inspires the entire value chain for alternative, fermentation-based protein.

- **Flanders Bio**
  Flanders Bio is a member organisation that represents the Flemish innovative life sciences sector. Recently they started focusing more on the biotechnology application suppliers active in the food industry.
- **Biotope**
  Biotope by VIB is an incubator program for biotech startup teams wanting to turn their agrifood innovation into an investment-ready business.
- **Pitch Perfect Bio-economy**
  The 'Pitch Perfect and Boost the European Bioeconomy' event is a two day event in Brussels of intense cross-border and cross-sectoral pitching, matchmaking and networking, with the aim to link industry to innovative (biobased) technologies, innovators to investors and to create new partnerships for the future and the further development of innovative, cross-border and cross-sectoral industrial value chains in the biobased economy. It is also an initiative that Biotech4Food could collaborate with.
- **Subsidy institutions like VLAIO but those are not specific for biotechnology in food**
- **bio.be/essenscia**
  bio.be/essenscia is the Belgian federation representing companies active in the biotech and life sciences industry. It is the recognised voice of the biotech community and operates under the umbrella of essenscia, the sector federation of the chemical and life sciences industry. Therefore there focus is less on biotechnology in the food industry

4.1.2.5. Regional brainstorm report

General Information	
Region	Flanders
Responsible Cluster	Flanders' FOOD
Workshop Date	19 June 2024
Number of Participants	
Workshop Method	The Biotech4Food project and first results of the regional ecosystem analysis were presented in a plenary part. Afterwards the session was divided into two groups, primarily composed of members from RTOs and SME's. Group one also included a representative from the governmental institution FOD Land and Fishery. These groups discussed the main

	challenges facing the biotechnology in the food industry. The discussion highlighted the roles of various stakeholders, including society, RTOs, government, and companies, in addressing these issues. Possible actions and solutions for each theme were identified and debated.

REPORT

Description of Item	Analysis – Major Points of Discussion
The most important challenges	• **Legislation** An application to apply for the authorisation of a novel food at EFSA is expensive and takes a long time due to the stop the clock principle. There is also the GMO law that is quite restrictive in Europe. Therefore, knowledge that is build up in Europe gets valorised in Asia and US. The legislation is not always consistent and sometimes different across Europe (for example the new law in the Netherlands for tasting sessions of novel foods. It is difficult to find out which rules apply exactly for your product. • **Finding investments for start-up/scale-up/production** It is not easy to find enough investment for every step of the implementation process. You need investment for R&D and process optimization or adaptation, for scale-up and for industrial production. • **Building up technological knowhow** Implementing new technologies in the food industry requires a lot of R&D. Not only to develop the new technologies but also how to apply them in which food products. Personnel might need to have new skills that they need to learn • **Consumer acceptance** A crucial step for success of biotechnology applications in food will be besides taste and price, consumer acceptance. It will be key to inform them correctly and transparent but in a way the consumer will accept the product
Interregional cooperation & strategies	It is interesting to collaborate on sharing general knowledge on how to apply for novel food authorisation, how to find investors, but also to lobby for e.g. faster legislation procedures.

Measurements & actions	• Legislation: - Better communication and transparency are needed regarding the exponential growth in technological and R&D developments with legislators. We should involve MAPPs and policy officers as much as possible through letters, invitations to events, brainstorming sessions, meetings, etc. - It would be good if there was a clear 'information desk' since there should also be advice instead of just administrative support. Companies (especially SMEs/start-ups) encounter a wall of expectations without the opportunity to ask questions. Additionally, there is a lack of transparency in the procedure, often leaving them unaware of why something was rejected. - We need to create more consistency and transparency in the legislation. For example, experimental tasting is allowed in the Netherlands, while there are strict regulations in Italy. There needs to be overarching legislation from Europe. We could better collect concrete data at submission regarding the procedure, number of applications, obstacles, etc. that explains why something was not approved. This could be done by clusters. - Europe needs to adopt positions more quickly to avoid the innovation gap with the US from widening further. A more active approach is necessary. Legislation is always retro-active. - We need to spread the word about success stories/ Greater public support needs to be cultivated. Often, misinformation leads to incorrect conclusions among the population. This is crucial because public opinion often influences legislation and politics. • Investments: - A consistent legislation helps to take away uncertainties for certain investments - Funding programs for the use of pilot facilities and scale-up would be good. There should be enough RTO's with pilot scale infrastructure but companies are now often not able to pay for these tests. The use of these pilot facilities should not be bound by borders. The ecosystem analysis in this project that gives an overview

	of interesting RTO's should be spread broadly to interested organisations. - Making an overview of financing possibilities in Europe, so that companies can look further than only regionally. - Public private partnerships for funding are interesting. If a government shows that they are investing in certain technologies, this can also create a push to private investors. • Technological knowhow: - It is important that RTO's align their research with industry to gain knowledge that is also relevant for further valorisation. - A long term strategy on policy level across different regions will assist companies and research institutions in making more targeted decisions and investing in research and development within those specific domains. - It is important that society is properly informed and has a basic understanding of key topics related to food, to minimize prejudices. Fact-checking and media/social media campaigns can play a significant role in this. Therefor it is important that projects as Biotech4food go for a quadruple helix approach. - It is important to stimulate companies to collaborate with other companies and with RTO's and to share general good practices. The B4F project can play a rol here. • Consumer acceptance There is significant confusion and misinformation about biotechnology in food. - Both RTO's, companies and clusters should share correct, transparent information and success stories to the consumer. - The government can positively influence consumer acceptance by implementing a clear policy and communicating transparently. Providing clear guidelines and regulations regarding labels and certificates is essential.
Cooperation research and industry	Interaction between RTO's and industry is essential to support a faster implementation and commercialization.

	It is also important that both parties are aware of IP protection and that they have a framework in the beginning of their cooperation.

4.2. France

4.2.1. Northwest France (Brittany, Pays de la Loire and Normandy)

4.2.1.1. Food industry

The food industry is one of the most developed industries in the west regions of France (especially Brittany, Normandy and Pays de la Loire). There is a ton of actors of varying sizes, from very small players (<10 employees) to big group companies (>15000 employees).

The agro-industry is the first employer in France, with a total jobs of +320'000 jobs (in 2020). On tenth of the total jobs are based in Brittany and Pays de la Loire.1 The turnover generated by the agro-industry is also one of the biggest in France, with around 113 million euros (in 2022)2.

There are more than 2'000 companies identified in those three regions.

The biggest part of the agro-industrial turn-over in these regions comes from different activities:

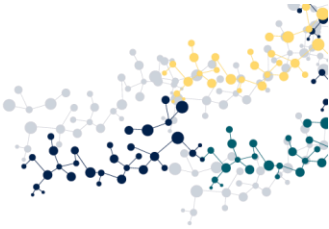
- In Brittany and Pays de la Loire more than 40% of the total turnover comes from meat industries,
- In Normandy more than 25% of the total turnover comes from the dairy industry.

Most of the biotechnologies are used in the agri-food industry in the 3 regions, but these technologies are also widely used for feed, nutraceuticals, pharma (health)...

A lot of food companies use biotechnologies for their production process, but are not specialized in biotechs, and these technologies represent a very small part of their process. Yet, more and more companies specialized themselves in biotechs, but the major part of these actors are startups or small companies. There is also some small biotech companies part of big agro-industrial companies (subsidiaries).

4.2.1.2. Biotechnology application suppliers

As the 3 regions covered by Valorial are deeply involved in the agri-food sector, a lot of suppliers are present in Western France as well. Even if biotechnology applications may be more focused on the pharma/chemistry sectors at the moment, a lot of agri-food actors are starting to look at potential solutions.



These suppliers offer different services to SMEs, such as

- Enzymatic technologies (hydrolysis…)
- Sensory and nutritional analysis of food ingredients
- Fermentation technologies/applications
- Development of biosolutions
- Micro/macro algae (production, extraction…)
- Probiotics and prebiotics

Traditional fermentation is widely used in Western France, from bakery, to brewery, dairy or fermented products.

Apart from traditional fermentation, new biotech applications start emerging: alternative proteins are interesting large dairy companies; algae is particularly studied in Brittany for all the potential biotech applications coming from it; valorizing by-products is a big trend as well…

4.2.1.3. RTO's

Universities and research labs:

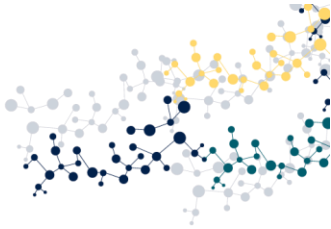
- INRAE
- CNRS
- INRIA
- ANSES
- Ifremer
- Institut Agro
- Universities (Unilasalle, Caen, Nantes, Rennes, Le Havre, UCO, etc…)

RTOs:

- IDmer
- Vegenov
- CEVA
- ADRIA
- Actfood
- CTCPA
- Actalia
- Praxens

These RTOs and research labs do not focus only on biotech applications, but mainly on agri-food. For some of these actors they are not specifically working on the agri-food sector, but more generally on innovation, research and development regarding various fields.

According to the survey answers and the interviews conducted, these actors are usually known by the agri-food actors, especially the startups and innovative SMEs that often solicitate them for their support in R&D/R&I activities.



4.2.1.4. Regional strategies & initiatives

Different strategies and initiatives are proposed by various actors within the 3 regions.

Valorial, as a cluster specialized in agri-food innovation, set ups collaborative projects for the actors, to help and support the companies' R&D or R&I program. The objective is to gather big companies with important financial resources to finance smaller companies and academic actors, to work in collaboration on different fields, such as biotechnology applications.

Also, some European projects are set up by clusters or other organisations, but not always specialized on the biotech field. Usually, it depends on the needs of the regional actors. Some of the interviewed companies are well aware of the European of regional projects initiatives, but some of these actors are not always eligible due to the size of their companies.

Some of the most known initiatives are the regional call for projects, the EMFAF (European Maritim, Fisheries and Aquaculture Funds), the ANR projects (French National Research Agency), Horizon Europe, and France 2030 (a national investment plan set up by the current presidency).

Apart from specific European projects specialized on biotechnology applications, according to the ecosystem there is no specific regional initiatives or strategies for biotechnologies.

4.2.1.5. Regional brainstorm report

General Information	
Region	Bretagne, Pays de la Loire, Normandie (France)
Responsible Cluster	Valorial
Workshop Date	20/06/2024
Number of Participants	16
Workshop Method	Roundtable discussion Initially, this event was supposed to be held in Valorial's office in Rennes, but since our stakeholders are based in 3 different regions, it was easier to host an online event. The first part of this online workshop was about the implication of biotechnologies in European projects, and the benefits for our members. The objective was to present the different EU programs, and then more in detail the two next call for application for the I3 projects (Strand 1 and 2a). Once done, we presented the Biotech4Food project. Once presented, we started with 2 roundtables on 2 questions regarding EU projects and biotechnologies:

	- What are the challenges/hurdles you are facing when implementing biotechnologies in your organizations / what do you think they are if you are not implementing biotech? - What would be your needs as part of a EU project / What are you expecting coming from EU projects? To allow everyone to speak and participate to the question, an online and interactive white board was setup. For each question, participants had 3-4 minutes to think and write some ideas, followed by a 10-15min roundtable to discuss the inputs. The second part of the webinar was dedicated to presenting Biotech4Food's survey and interviews results. To finish with this webinar, two last questions were asked, and we kept the same method for the interaction and the roundtable: - What are the regional promising opportunities, and how to support them? - How can industrials/academics support/participate in R&I/R&D of SMEs ?

REPORT

Description of Item	Analysis – Major Points of Discussion
The most important challenges	- **Consumer perception and knowledge:** a lot of consumers are reluctant/don't dare to buy these products, because they are not aware of what biotechnologies are. There is a real need to raise awareness. - **Regulation:** too many regulatory barriers (R&D and Go to market), Novel Food classification can be a barrier as well for some products. Additionally, there is a need to **Harmonize regulations** across Europe.**Funding Visibility:** There is a noticeable lack of funding visibility, both in France and in European **programs.**
Interregional cooperation & strategies	- Before starting collaboration with European biotech stakeholders, it's important for the organisations to **understand** and **identify the regional actors**. The collaboration must start on a regional/national level before going any further. If companies are familiar, and sometimes already working with RTOs/labs, there is a real lack of

	collaboration between companies. Generate more collaborative projects? - There is also a **lack of visibility** regarding the European biotech stakeholders. Maybe a mapping of the strengths/needs of each region could help finding synergies between companies. - **Federate/generate** new consortium or working groups in Europe to facilitate connections and collaborations between the stakeholders.
Measurements & actions	Should focus on: - **Consumers:** inform about the use of biotech, facilitate their understanding (labels, awareness campaigns…) - **Legislation:** facilitate and clarify the legislation, and try to harmonize on a national level. This is one of the biggest barriers to developing new biotech solutions - **Fundings:** increase fundings focusing on specific thematic (a lot of project fundings, but very wide) related to biotech à may increase collaboration between research facilities/RTOs and companies - **Expand and facilitate** (via fundings) the work of researchers (don't feel considered enough) - **Create a mapping** of the Biotech stakeholders to facilitate collaboration (firstly regional, then extend it to a national level)
Cooperation research and industry	- **Facilitating collaboration** between RTOs, Research Labs and companies, through collaborative projects – increase fundings, focus on similar thematics - **Living labs:** a topic that came out several times during the brainstorming session. Some regional actors would be interested in developing a living lab focussing on biotech in Western France. A new meeting will be setup in September - **Creation** of places where startups, SMEs, industrials and R&D centres can innovate/collaborate together

REGION SPECIFIC ISSUES (optional)

Description of Item	Analysis – Major Points of Discussion

Micro-algae as a very promising source of innovation	- In France, the Bretagne region is one of the (if not the) most advanced region in terms of using and exploiting algae for the agri-food sector. So far, 90% of the seaweed used is collected on the coast or in the sea, and isn't cultivated yet at large scales. - A supply of seaweed from sea or pond cultures could ensure the quantity and quality required for new, high value-added applications. - However, it's crucial to pay attention to the negative impact of this kind of culture on the ecosystem disruption (proliferation, water resource management...) - In the adjacent regions, the legislation in terms of using algae is different from the one in Bretagne, which impeaches them to produce locally, or use the seaweed resource of their region.

4.2.2. Provence Alpes-Côtes d'Azur and Auvergne-Rhône-Alpes

4.2.2.1. Food industry

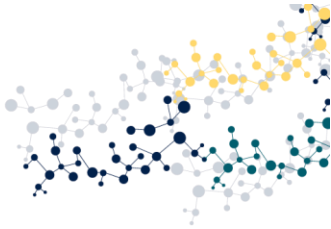
The French agri-food industry is composed of ±16.000 food industrials, ±38.000 commercial artisans, and ±23.000 agri-food wholesalers. Second only behind Germany, France is a leading European country in terms of turnover in the agri-food industry (with more than 350 billion euros across the whole food production industry). Its ±16.000 food industrials have a turnover of ±197.5 million euros, and represent ±440.000 full time jobs (MASA, 2022).

Five regions in France make up 54% of the full-time jobs: Brittany, Auvergne-Rhône-Alpes, Nouvelle-Aquitaine, Pays de la Loire and Île-de-France. Regarding the two regions of the South-East represented by Innov'Alliance in Biotech4Food, the Auvergne-Rhône-Alpes region represents some 2.200 agri-food industrials and ±28.000 full time employees, and the Provence-Alpes-Côte d'Azur represents ±1.600 industrials and ±9.500 full time employees (MASA, 2022).

France remains a significant European player in the FoodTech ecosystem, and also benefits from the global increase (+245%) in investment in the realm of transformation, and investments in 'foods for the future' such as alternative protein sources (+178% investment).

Biotechnology, and more specifically fermentation, is seen as a major tool for the development of France's 'future food habits'; transformation of vegetables using lacto-fermentation is a recognised method of 'innovation' in the French food landscape (MASA, 2022).

The following table gives an overview of the food industry (with a focus on companies utilizing biotechnologies) in the relevant project regions of AURA and PACA (as well as one player in



Occitanie, the inclusion of the region explained in the methodology). This overview comes from the combination of results stemming from the surveys and interviews, and a general overview arising from online research. There being little information available online, the overview given below does not provide an accurate mapping of all possible actors.

	AURA	PACA	OCCITANIE
Companies identified using biotechnology in their food processes	COCONT/Solaine Brin de Foli Bon Vivant Philibert Savours Les cruculents Les Beaux Crus Longonya Les Fabuleurs Végétal Vivant La pendue Bakery companies 390 breweries (source) Meat-salting companies 190 Cheese refineries (source) Les Fromageries Occitanes Micro canneries	Crukles Atelier du Fruit Skobi Lökki 100 cheese refineries (source) Vinification 138 breweries (source) Micro canneries	100 cheese refineries (source) 260 breweries (source)

4.2.2.2. Biotechnology application suppliers

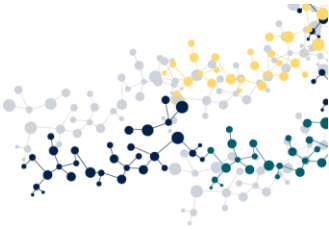
As with biotechnology food industry actors, information regarding biotechnology application suppliers is difficult to find for the French South-East regions of AURA and PACA. Indeed, there exists little to no *formal* mapping of these actors, and as such, the information presented below may not accurately encapsulate the whole of the current state in the region. However, the surveys, interviews, as well as the regional brainstorm activity, have helped to give a better idea of the active actors in the sector.

	AURA	PACA
Companies identified offering biotechnology applications solutions or ingredients	Neobiosys Greentech / Greencell Naturamole Afyren I&L Biosystems	Atelier du Fruit OENOtropic Eurodia Sartorius

	Philibert Savours Chromacim Bon Vivant Processium	

The companies identified from both the research and surveys cover a variety of different biotechnology applications and ingredients:

- Eurodia (PACA): biotechnology solutions provider. Development of electrodialysis, membrane filtration and chromatography technologies for use in various sectors, including food sector.
- Sartorius (PACA): biotechnology solutions provider. Offers various lab products and bioprocessing solutions, including bioreactors,fermenters and cell culture media.
- Atelier du Fruit (PACA): biotechnology solutions and ingredients provider. Development of ingredients using enzymes and fermentation technologies.
- Greentech/Greencell (AURA): ingredients provider. Production of active ferments and functional ingredients.
- Naturamole (AURA): ingredients provider. Naturamole specialises in the development of ingredients (mostly esters) for applications in the food, feed, fragrances, cosmetics and fine chemicals sectors. They use various biotechnological processes to develop their ingredients, notably enzymatic catalysis, and microbial fermentation.
- Afyren (AURA): ingredients provider. Produces carboxylic acids using fermentation; these ingredients have multiple applications, including in the food sector.
- Philibert Savours (AURA): ingredients provider. They have a range of yeasts and ingredients for the bakery, chocolate and gastronomy sectors.
- BGene (AURA): ingredients provider. They use bacterial fermentation, precision fermentation and enzymes to assist in the production and development of aromas and fragrances.
- Chromacim (AURA): analysis. Chromacim are specialists of high-performance thin layer chromatography, useful in the analysis of, *for ex*., lipids and carbohydrates, as well as microorganisms (yeasts, bacteria, etc.).
- Bon Vivant (AURA): Ingredients provider. Using food-sector yeasts and precision fermentation, Bon Vivant produces vegan milk-based proteins. These milk proteins are sold to clients in the agri-food sector.
- Processium (AURA): applications specialist. Processium offers a range of services, including advisory and technological testing services, notably using enzymatic and fermentation technologies.



4.2.2.3. RTO's

	AURA + OCCITANIE/OTHER
Principal subject	Bee health, honey, and hive products Food fermentation, development of microbial solutions for human and animal health, and food industry Development of bio-procedures with various microorganisms (bacteria, yeasts, algae, ...), computer-assisted pathways of synthesis by metabolic engineering Development of fermentation procedures (bacteria, yeasts, micro-algae, MGM, ...), bio-catalysis and enzyme production, downstream processing

The following institutions and research groups were identified for the South-East area of France. These RTOs focus on either biotechnology as a whole, or biotechnology within the realm of food.

PACA:

- LUMA Arles's Biolab: a biotechnology research lab houses in a workshop collective. The biolab focuses on experimentation on algae and mycelium. It also houses a library of different (microorganism) strains, and a basin for the culture of algae.
- Atelier du Fruit: whilst operating as an ingredient and services provider, AdF also provides a place for research in development of new products and procedures using enzymatic and fermentation technology. They are one of the members of the *Ferments du Futur* ecosystem (which focuses on the acceleration of research and innovation on ferments, fermented foods, and biopreservation).

AURA:

- VetAgroSup: a higher education facility geared towards veterinary studies (but also offering an agronomic engineering diploma). They are also a member of the *Ferments du Futur* ecosystem.
- BIODYMIA: a research unit at the higher education and research institute ISARA, BioDyMIA focuses on the microbial ecology of fermented foods. They study the link between the typology of fermented foods and their microflora, the valorization of agrifood by-products through fermentation, the use of lactic bacteria for preservation purposes, amongst others.
- Université Clermont Auvergne: University, provider of higher education and in co-tutelage of multiple research groups. Two of these co-tutelages concern the *Unité Mixte de Recherche* (Mixed Research Unit) Fromage (cheese) and Nutrition Humaine (human nutrition). They are also a member of the *Ferments du Futur* ecosystem.
- UMR Fromage: One of the two co-tutelages of the Université Clermont Auvergne focused on biotech. Their primary research focus is on cheese, and the microbial diversity in cheeses. They are also a member of the *Ferments du Futur* ecosystem, as well as the European research network PIMENTO (*Promoting Innovation of fermented fOods*).

- UMR Nutrition Humaine: One of the two co-tutelages of the Université Clermont Auvergne (with the INRAE). They focus on the human health and nutrition impacts of foods and diets, and have multiple research topics concerning foods derived from biotechnology (notably plant-based proteins resulting from fermentation).
- Laboratoire Interprofessionnel de Production: An interprofessional group focuses on cheese. They propose ferments and strains, and realize strain multiplication services, including the provision of ferments for the INRAE. They are also a member of the *Ferments du Futur* ecosystem.

The following RTOs were identified for the Occitanie region (South-West of France):

- TOULOUSE WHITE BIOTECH: a pre-industrial demonstrator covering the realm of industrial biotechnology (*i.e.*, white biotechnology). It is under a triple co-tutelage by the INRAE, INSA and CNRS. The demonstrator proposes different collaborative research and development projects to various companies, and its primary focus is on the development of new sustainable production chains through the use of innovative biotechnology (enzymes, microorganisms) and economical procedures. A private-public consortium governs the demonstrator, with names such as:
- Industry: Naturamole, Michelin, Processium, L'Oréal, Green Spot Technologies, Bon Vivant, Lesaffre
- Investors: INRAE transfert, bpi france
- Public partners: INSA, Bioeconomy for Change, Agri Sud-Ouest Innovation, CNRS, INRAE
- IBISBA: a pan-European research infrastructure for industrial biotechnology. The group has several platforms where R&D in the development of bioprocedures (with various microorganisms) occurs. Eleven of these platforms are found in Occitanie and PACA; two of these belong to Toulouse White Biotech (TWB Strain Engineering and TWB Culture biotransformation).
- CRITT BIO INDUSTRIES OCCITANIE: a regional center for innovation research and technology transfer. Their competencies focus on biological tools (microorganisms and enzymes) as well as the tools for their implementation or obtention (bioreactors and bioseparators). They are another platform of the IBISBA network.

Whilst the Occitanie region is not strictly covered by the Biotech4Food project, it was nevertheless included within the surveys and research as some Innov'Alliance members are found and operate in Occitanie (and simultaneously operating in the relevant South-East regions of AURA and PACA).

4.2.2.4. Regional strategies & initiatives

Few specific regional strategies and initiatives have been found – there exist, however, national strategies that invite calls for projects. The ANR (national agency for research) has developed a

national strategy around sustainability and health-favouring diets, with a first part focusing on proteins in legumes (first call in December 2021), and a second part on the diversification of value chains for food protein sources (in algae, co-products, insects, micro-organisms) (call ended May 2023). These strategies, focusing on various protein sources, cover the subject of biotechnology in the food industry; indeed, the national plan aims to "mobilise the potential of France on the subject of innovating proteins originating from plant-based productions as well as new protein sources such as micro-algae, insects and proteins originating from biotechnologies" (translated from French; ANR, 2022).

Various initiatives have since multiplied. In 2021, a webinar co-organised by the IAR (a French cluster dedicated to bioeconomy[1]), ANIA (National association of the food industries) and Protéines France (a French consortium of companies working on the development of proteins from various sources) was held, in line with the national strategy of Sustainability and health-favouring diets (and its protein focus).

The French government published in February 2023 an article focusing on a French biotech food company: Green Spot Technologies. The article put forward Green Spot Technologies' work as a transformer of food waste, using fermentation. The article put forward Green Spot Technologies' work as a leading example of fermentation, highlighting the subject as the "new sesame of healthy food regimes", additionally stressing the current research and innovations occurring in the realm of fermentation, including the project 'Ferments du futur' (ferments of the future), an INRAE and ANIA initiative (Gouvernement, 2023).

This Ferments of the Future initiative, described as a 'Grand Challenge', is co-piloted by the INRAE (national institute of research in agriculture and the environment) and ANIA, and financed (48,3 million €) through the 'France 2030' framework. The goal of the initiative is to encourage development of fermented foods with a focus on legumes, fruits and vegetables. Launched in 2022, it groups together "some thirty public and private actors, from academic research to cooperatives, start-ups to large companies". The 6 public members are the INRAE, AgroParisTech, Institut Agro, Université Clermont Auvergne, Université Paris-Saclay, VetAgroSup. The 21 private members are: "Agrial, Atelier du Fruit, Axéréal, Bel, Biogroupe, C&DAC, Danone, Eurogerm, Grandiose, Green Spot Technologies, Greentech, Lallemand, Les Nouveaux Affineurs, Lesaffre, LIP, Nutrition & Santé Nutropy, Revobiom, Philibert Savours, ShakeUpFactory, Toopi; i.e. 8 start-ups, 7 SMEs and mid-sized businesses, and 6 very large companies". Seven associate members make up the rest of the partners: "ACTIA, ADEPALE, ANIA, CNIEL, FEDALIM, SYFAB, Vitagora" (INRAE, 2022). Innov'Alliance counts a few members within this initiative.

The European COST-type action, PIMENTO (Promoting Innovation of fermented foods), launched in 2021, and focusing on spearheading innovation around fermentation and food in Europe, includes various French actors. Its action chair is led by the INRAE, with two WG also lead by the INRAE. Other French partners include researchers from the INRAE, Université de Lorraine,

Université de Montpellier, ADIV, IRD, VetagroSup, UMRF 0545 INRAE (survey respondent), amongst others, various food companies (JiBio, Atelier du Fruit, Nutrifizz, Végétal Vivant, ShakeUpFactory, etc. (PIMENTO, 2024).

In sum, whilst few specific regional strategies exist, the various national strategies do demonstrably succeed in bringing together various actors from regions across France (and not only in already advanced biotechnology regions such as Île-de-France). Beyond these focused strategies, there exist various actors (facilitators, clusters, etc.) working closely with (food) biotechnology actors within their operating regions.

Within the PACA region, Innov'Alliance is a major (food) cluster working with such food biotechnology actors. The Grasse Biotech enterprise 'hotel' offers companies the "ideal conditions to develop their scientific activity" (Grasse Biotech, 2024). Within the AURA region, the two aforementioned food clusters Innov'Alliance and Végépolys Valley also operate. Four other networks of enterprises operate in the region, with either a strict biotechnology focus, or with biotechnology as a major innovation subject. These four identified "poles" are Arbios, the Biopôle Clermont-Limagne, Axelera and the Naturopôle.

4.2.2.5. Regional brainstorm report

General Information	
Region	Auvergne-Rhône-Alpes and Région Sud
Responsible Cluster	Innov'Alliance
Workshop Date	17/05/2024
Number of Participants	10
Workshop Method	A presentation of the project context and state-of-the art-results followed by a roundtable discussion about an ideal world without barriers and concrete actions.

REPORT

Description of Item	Analysis – Major Points of Discussion
The most important challenges	One of the main barriers identified during the interviews, and confirmed by the participants of the brainstorm was **legislation**, notably the realm of production of *novel foods*. Put forward as

	significant (sub) barriers are the lack of clarity regarding legislation, the definition of *novel foods* (what is or isn't considered novel), and the lack of a central (European) authority that could directly clarify if a particular process or ingredient enters within this legislation. Consultants in the realm of *novel foods* sell services and are thus not necessarily considered impartial. Furthermore, the duration of the *novel foods* application process, from the initial authorisation to the commercialisation, typically lasting three years, is put forward as a significant sub-barrier to food innovation. Indeed, these time frames are considered too long for agri-food industrials. Considering the potential delays and costs linked to the application, many agri-food companies wholly avoid developing new foods that may be considered *novel*, or simply avoid processes which may enter said legislation. Another barrier identified during the interviews, and once again confirmed by participants, is the barrier linked to **consumer perception** (and the use of biotechnology in the agri-food industry/the products arising from the application of biotechnology in the agri-food industry). There often lacks a dedicated consumer for an ingredient or final product, and this often results in a catch-22 situation. Indeed, the consumer has a weak perception of products arising from the use of biotech, and this weak perception translated to a weak demand. As long as the consumer does not demand (food) products arising from biotech use, industrials do not produce them. The industrial will also wait for this demand before investing in new products or new production sites – as long as they are not proposing new products to the consumer, the consumer will keep having a weak perception of the products. A major barrier for actors of the agri-food industry in the French South-East is the **lack of adequate infrastructure for the development of biotechnologies**. Indeed, participants confirmed that the industrial-level production capacity, notably in the realm of fermentation, is rather weak in the French South-East, especially relative to stronger production regions such as the Great East, Île-de-France or Normandy. The brainstorm allowed for the sharing of information regarding the presence of private production sites using biotech – or proposing biotech

	solutions within the region – but these lack either visibility and/or accessibility. During fermentation, low temperatures are required on the industrial/production sites in order to facilitate relevant processes. Climate change, especially regarding temperature increases, and especially within the regional frame of the French South-East, is major sub-barrier to the increase in production capacity. Low temperatures of industrial sites, required to battle these increasing external temperatures, result in higher energy consumption, and generates additional costs relative to industrial sites in more temperate regions. According to participants, adequate production sites, such as those required for drying, simply do not exist in the AURA or PACA regions – or, these do not offer the necessary industrial-scale capacity. A final barrier identified and once again confirmed by participants in the brainstorm are **the costs related to activity and lack of funding**. Indeed, the large volumes of biomass necessary to conduct certain processus with require biotechnology are significant and often costly. The costs necessary to set up a production site, as well as the costs necessary for *novel foods* applications (and their follow-through) must be taken into account in the larger context of agri-food biotechnology. The state of the art of biotech use in agri-food has allowed for the comparison between the different situations of the countries within the Biotech4Food partnerships. This has made evident the presence of a national French strategy regarding food, nutrition, and the development of alternative proteins obtained using biotechnology – but also the absence of similar strategies at the regional level within the French South-East. This is one of the differences found relative to other regions (such as Flanders), which propose opportunities and financing for biotech agri-food actors.

Interregional cooperation & strategies	It is necessary to work in networks with other partners (regional and European) to exchange good practices, help emerge common projects, and mutualize knowledge and methods. This can be done via the setting-up of regular brainstorms, the creation of consortia, the participation in projects (regional/national/European), the development of new (interregional) platforms for mutualization. The creation of consortia would be a solution to develop new projects, new processes, or procedures – it seems necessary to federate actors from the public and private spheres (notably research) to bridge the knowledge gap existing between these various actors. The replication of a plant such as the Bio Base Europe Pilot Plant would be a sure way to federate interregional actors as described above.
Measurements & actions	It was found necessary to map actors of the agri-food biotech ecosystem in order to facilitate their federation. Both clusters and the regions (via their representatives) have a role to play in this capacity. The creation of pilot facilities within the territories of the regions, such as the Bio Base Europe Pilot Plant, would be a useful tool to better federate actors wishing to mutualize resources and knowledge. During the brainstorm, an actor having brought forward a project thanks to the Bio Base Europe Pilot Plant, shared precisions regarding the latter. The plant is a facility borne from a cross-border collaborative European project (a Belgian/Dutch INTERREG), and it is today a real reference at the European level within its domain. During the meeting, the following strong points of the facility were remarked upon: its non-profit status, the fact that it is fully funded, and the fact that intellectual domain remains within the hands of project developers. A mutualized platform (both in infrastructure and services) exists in the Auvergne-Rhône-Alpes region, OSIRIS, but it is chemistry-focused. According to participants, it would be pertinent to replicate such a model but with an agri-food biotechnological purview, notably to satisfy demands of the actors present at the brainstorm. The regions would have a significant role to play in the facilitation of the development/creation of these types of pilot facilities.

	Difficulties in finding industrial-valuable land was cited as a barrier to such installations. The redevelopment of industrial wasteland, and their transformation into valuable production sites was put forward as a potential solution to said barrier – especially if this is done in mountainous areas – of which the French South-East has plenty. Colder temperatures and land availability are rare resources of primordial importance that need to be capitalized upon within the French South-East. This could represent a real game-changer in the larger realm of territorial development and the diversification of economic activities (from tourism to industry).
Cooperation research and industry	As with interregional collaboration, there is a strong need to maximize collective work and knowledge between research and industry. Federating actors for consortia of interregional actors includes actors from both the private and public spheres (including and especially research). Various work needs to be done around consumer perception. Consumers can be reticent to consume products arising from the use of 'biotechnology' – even though the vast definition of "biotechnology" includes traditional fermentation, and that products such as cheese, wine or beer are already largely consumed. The relationship of the consumer with fermented products has fluctuated over the course of human food history, with strong consumption of fermented products (and positive perception) until the instar of social hygienics. Nevertheless, consumers are re-appropriating fermentation. Consumer studies, and consumer acceptability studies could allow for the identification of the current average consumer perception of biotech agri-foods, what the consumer accepts to eat. It may simply be a question of semantics around the use of certain words that the consumer associates with reluctance.

REGION SPECIFIC ISSUES (Optional)

Description of Item	Next steps
Further brainstorms	Participants shared a strong interest in renewing the brainstorm sessions around agri-food biotechnology in the French South-East, notably in regular, small-format group meetings of short duration (i.e., max 1.5 hours). This would allow for the sharing of experiences and problems, the exploration of joint solutions, the exploration of collaboration opportunities, and the development of relationships between industrial actors, research and public authorities. Innov'Alliance would have a role to play as a facilitator of such meetings/exchanges – which are indeed planning and will be pursued, notably within the context of the Biotech4Food project.
Webinars/courses	Participants also evoked an interest in participating in webinars/information sessions/short courses on the different themes explored during the brainstorm, notably to delve deeper into the details of certain subjects (e.g., clarification regarding *novel foods* legislation).

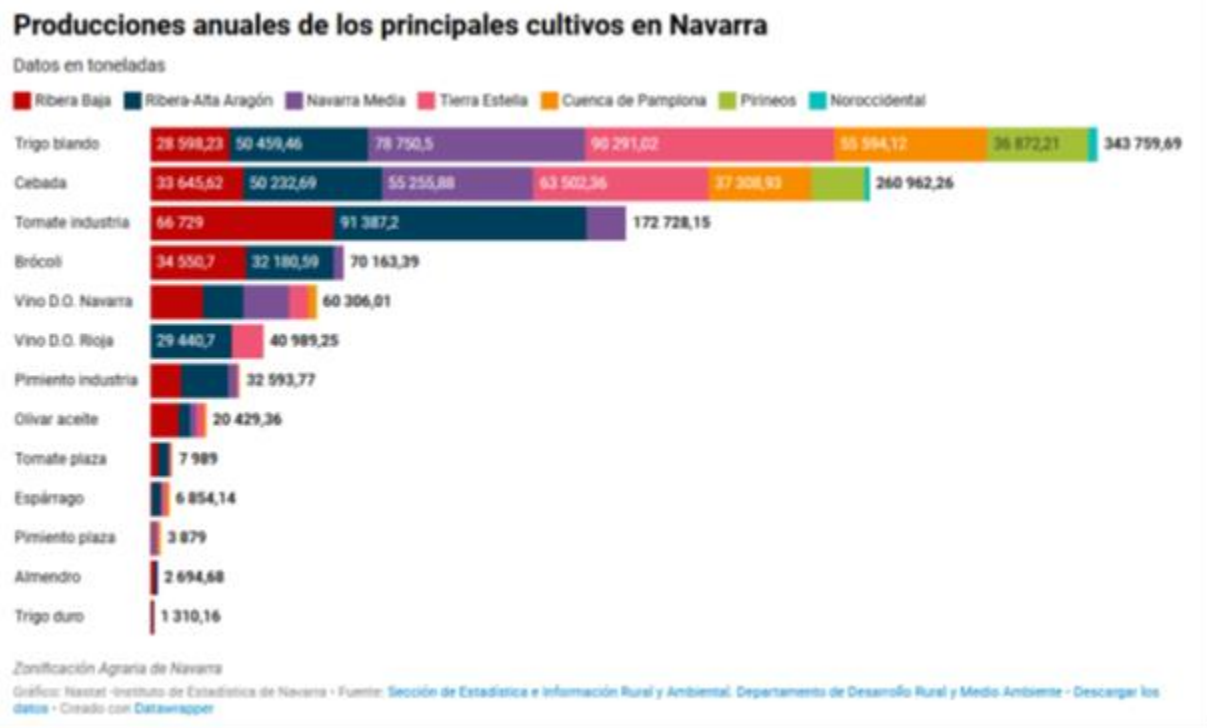
4.3. Spain

4.3.1. Navarre

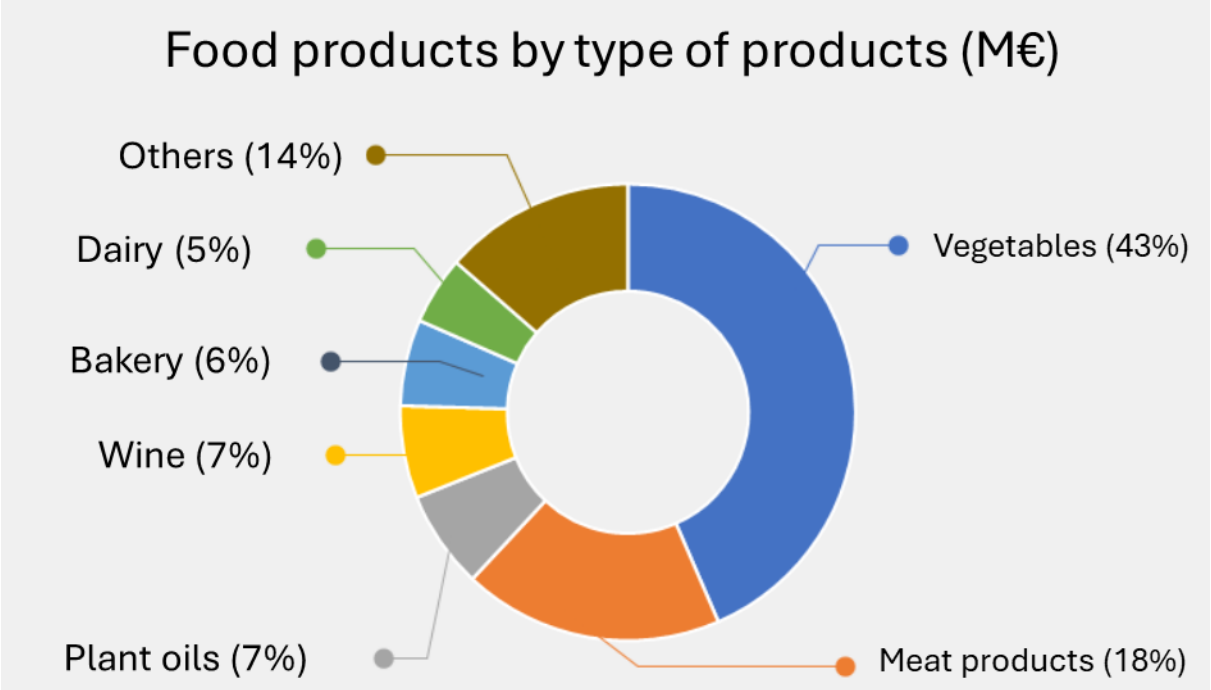
4.3.1.1. Food industry

The agri-food industry is a fundamental actor in the food chain, since it acts as an intermediate link, providing added value to primary production as well as being the main client for the agricultural sector. throughout the recent years of economic crisis, the agrifood sector has remained relatively unaffected, maintaining its level of sales in most products and its employment rate thanks, among others, to the significant level of internationalization of companies in the sector.

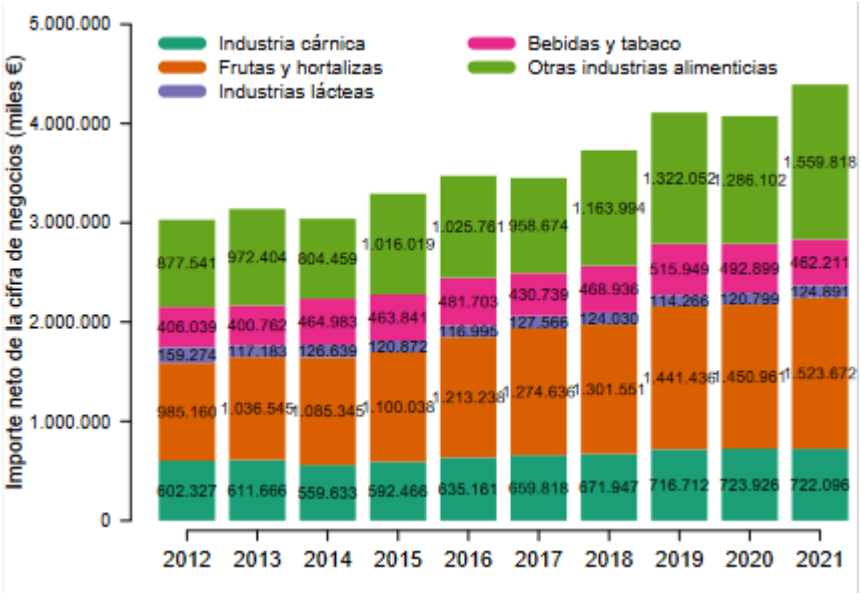
According to data from the Government of Navarra, the agri-food industry of Navarra reaches 2,455,504 tons of annual production (2022) and 1,397,261 heads of livestock (2022), 1,405 agri-food companies (2023), 13,776 farms (2023) and around 24,222 direct jobs (2023), which represents 8.1% of total employment in the region (EPA 2023). The sector in Navarra constitutes a true agri-food power that projects itself to the world through exports to more than 50 countries on all five continents.



It has a processing industry of 1,405 companies, highlighting the important weight in our region of products like fruits, vegetables, meat products, wines, oils, dairy products and the growth of fresh cut and frozen products.



The agri-food sector is a leader in Navarra due to its strong presence in the region. The GDP of Navarra in 2021 amounted to 20,379 million euros, and the food and beverage manufacturing industry sector represented a production of 4,301 million euros, representing 21.1% of the GDP of Navarra.



The food chain, primary sector and agri-food industry, accounts for 7.5% of the regional GVA, according to data published by the INE, of which 3.25% corresponds to the primary sector and 4.6% to the agri-food industry. And a productivity growth of 16.6%. The agri-food sector represents 10.2% of Navarra's total production.

Therefore, the Navarrese agri-food sector, with recognized know-how and prestige, is a strategic sector for the balanced development of Navarra since it generates activity and wealth throughout

the entire territory. The agri-food sector is one of the leading sectors in Navarra and has a rich business network with a very important weight and dimension compared to the entire industry.

Within this sector, Navarra has a significant presence of foreign companies in the region, including some of the most important internationally (Florette, General Mills, Gelagri, Fromageries Bel. and Mondelez International) as well as a wide variety of regional cooperatives, agricultural and local companies dedicated to the harvesting and processing of food, some of which are leaders at the state and international level.

4.3.1.2. Biotechnology application suppliers

In Navarre, the range of biotechnology solution providers, though somewhat limited by the region's size, encompasses a diverse range of activities. Valorisation of fruits and vegetable side streams and residues are well presented in the region, as corresponding to the region's core activities, represented by companies like Ingredalia, MOA Foods, or Egg Novo, which focus on the production of alternative proteins or added-value compounds. Other actors in the region focus on the production of postbiotics/probiotics, health-promoting and organoleptic traits agents, like Pentabiol or Isanatur. Fermentation and associated processes are also represented, for example in the activities of Nulab or in those of Recombina, which deals with genetic engineering, vaccine development and production of recombinant proteins. Encapsulation approaches and processes are also a field of work covered by Nucaps, whereas the area of personalized foods for niche populations is covered by companies like Bread Free and Sanygran, which develop innovative products through biotechnological approaches.

4.3.1.3. RTO's

Universities:

- **UPNA**
  The Public University of Navarre (UPNA) has campuses in Pamplona and Tudela. UPNA offers a comprehensive range of academic programs across various fields, including Engineering, Sciences, Health Sciences, Social and Legal Sciences, and Arts and Humanities. It is a significant player in research within Navarre, supported by its six research institutes and partnerships with industry. The university has a vibrant research community of over 1,000 members and more than 500 researchers, actively engaged in cutting-edge projects and spin-offs.
- **UNAV**
  The University of Navarra is a prestigious private institution recognized for its academic excellence and research focus. It offers over 40 undergraduate degrees and numerous postgraduate programs across diverse faculties, including Medicine, Economics and Business, Law, Architecture, and Communication. The university is also home to

significant research centers such as the Center for Applied Medical Research (CIMA) and the Institute of Tropical Health.

The department of Food Sciences and physiology focuses on three main research areas: **Molecular Nutrition and Personalized Nutrition**, exploring mechanisms behind obesity and metabolic disorders; **Functional Foods and Food Safety**, aimed at developing healthier foods to combat chronic diseases; and **Nutritional Epidemiology**, studying diet quality in various populations

Research centers:

- **CNTA**

  The National Center for Food Technology and Safety (CNTA) is a non-profit private association aimed at becoming a national benchmark and significantly improving the competitiveness and quality of the food sector. This technological center focuses on two main types of activities: knowledge acquisition and technology transfer. Technology transfer is achieved through research and development (R&D) projects, specialized technological services, and training programs. CNTA is committed to staying at the forefront of innovation, achieving technological excellence, and directing its activities towards concrete results.

- **CENER**

  The National Renewable Energy Centre (CENER) conducts applied research in renewable energies and provides technological support to companies and energy institutions in five key areas: wind energy, solar thermal and photovoltaic, biomass, energy transition in cities, and grid integration, electrical storage, and hydrogen. CENER is a highly prestigious and active technological center, recognized both in Spain and internationally.

  The activities of the biomass department are focused on the development and optimization of processes for producing bioproducts, solid biofuels, advanced liquid and gaseous biofuels, and biorefinery concepts. The main areas of focus include solid biofuels, bioprocesses, and evaluating the sustainability of developed processes and products.

- **INTIA**

  INTIA, the Navarre Institute of Agrifood Technologies and Infrastructures, is a public entity under the Government of Navarre dedicated to research, development, and innovation in the agrifood sector. Established with the aim of supporting the modernization and sustainability of agriculture and livestock in Navarre, INTIA specializes in providing technological and technical solutions to enhance the efficiency and competitiveness of the sector.

  The institute offers services that include technical advice, applied research, and project development in areas such as water resource management, crop improvement, food technology, and environmental management. INTIA works closely with farmers, livestock

producers, and industry companies, as well as with research centers and universities, to promote knowledge transfer and the implementation of innovations.
Through its activities, INTIA plays a significant role in helping the agrifood sector adapt to current challenges, such as climate change and sustainability, supporting the agricultural community in achieving greater productivity and sustainability.

- **IDAB-CSIC**
  The Institute of Agrobiotechnology (IdAB) is a Joint Research Institute co-owned by the Spanish National Research Council (CSIC) and the Government of Navarre.
  IdAB is also part of the IRIS Digital Innovation Hub and the SIESS Community, focusing on strategic areas like the Food Chain, Renewable Energies, and Health, with Biotechnology as a key enabling technology.
  The Applied plant biotechnology group initially focused on the biochemical and molecular mechanisms of starch production in plants, which is crucial for energy storage and industrial processes. They also study glycogen production in bacteria and discovered that various microorganisms produce compounds that improve plant growth, starch accumulation, and stress resistance. Their research includes exploring microbial bio-stimulants to enhance plant yields and understanding how plants respond to these substances. This commitment to applied research led to the creation of "Idén Biotechnology," a company that facilitates the transfer of their developed technologies.

4.3.1.4. Regional strategies & initiatives

- **S4 strategy of Navarre (agrifood is a strategic sector)**
  Navarre's S4 Strategy identifies agrifood as a key strategic sector, leveraging its rich agricultural heritage and strong research ecosystem. The strategy aims to enhance innovation, sustainability, and competitiveness in agrifood through targeted support and funding. This approach includes fostering advanced biotechnological solutions that can improve crop yields, enhance food safety, and create sustainable agricultural practices. The region supports a robust network of biotech solution providers and research institutions, ensuring that cutting-edge advancements are integrated into the agrifood sector.
  https://s4navarra.es/
  https://s4navarra.es/wp-content/uploads/2022/01/S4EstrategiaNavarra%20_castellano.pdf
- **Strategic and R&D projects (funding for individual, transference, and big collaborative projects).**
  This initiative aims to promote industrial research and experimental development (R&D) projects to boost technological advancement, thereby enhancing competitiveness in

Navarra. The focus includes key sectors like agri-food, with additional subsidies for being an S4 sector.

These grants aim to facilitate knowledge transfer through collaborative R&D projects between companies and entities within the Navarre R&D&i System (SINAI), as defined in Article 7 of the Foral Law 15/2018 on Science and Technology.

The supported projects encompass "industrial research" and "experimental development," with eligible project types including individual projects, collaborations between companies, and knowledge transfer initiatives. These involve projects conducted by one or more companies in partnership with one or more SINAI agents.

Additionally, according to the 2024-2027 call for proposals for strategic R&D projects aligned with S4 and Horizon Europe, selected challenges include promoting healthy and sustainable food (ALPES VII), innovative solutions in biotechnology (SIBERIA VI), and emerging disruptive ideas applications (IDEA VI).

https://www.navarra.es/es/tramites/on/-/line/ayudas-para-realizar-proyectos-de-i-d-convocatoria-2024

https://www.navarra.es/es/tramites/on/-/line/ayudas-para-realizar-proyectos-estrategicos-de-i-d-en-2024-2027

- **Regional funding to hire R&D personnel.**

  One of the aids is directed at hiring research and technological personnel to improve their training through participation in R&D&I activities and support performed by companies.

  These funds aim to support the hiring of personnel engaged in research and development (R&D), promoting innovation and technological advancement in the region. The financial aids are provided as incentives to reduce the cost of hiring qualified personnel in strategic areas for economic and technological development.

  This summary outlines the key aspects of the regional funding program aimed at hiring R&D personnel, emphasizing specific benefits and funding amounts available based on Social Security contribution groups in Spain.

  RESOLUCIÓN 8E/2024, de 16 de febrero, de la directora general de Ciencia, Tecnología e Innovación, por la que se aprueba la convocatoria de "Ayudas para la contratación de personal investigador y tecnológico 2024". Identificación BDNS: 744388

  https://www.navarra.es/es/tramites/on/-/line/ayudas-para-la-contratacion-de-personal-investigador-y-tecnologico-2024

  Additionally, there is an aid for hiring research personnel under the MRR Investigo program. The purpose of these aids is to subsidize the hiring of young, unemployed, and job-seeking individuals for research and innovation tasks, to integrate young research personnel and strengthen RTO's, CTO's and university research and innovation capacities.

https://www.navarra.es/es/tramites/on/-/line/ayudas-para-la-contratacion-de-personal-investigador-Programa-MRR-Investigo

Another subsidy for regional funding supports the hiring of R&D personnel. This subsidy aims to promote the hiring of young unemployed individuals under 30 years old for internships, with a minimum duration of 6 months, either full-time or part-time (more than 50% of full-time hours). The internship must align with the individual's academic or professional training and offer a minimum gross annual salary based on their academic qualifications.

https://www.navarra.es/es/tramites/on/-/line/Subvenciones-para-el-fomento-de-la-contratacion-de-personas-jovenes-desempleadas-menores-de-30-anos

- **Tax benefits for R&D activities.**
  There are social security contribution reductions available for companies involved in R&D, specifically for **hiring research personne**l.

  Bonificación Personal Investigador (bonificacionpersonalinvestigador.es)

  https://www.boe.es/buscar/act.php?id=BOE-A-2023-625#df-10

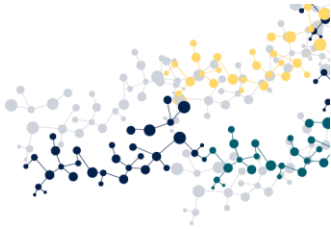
  In addition to the **tax deductions** on corporate income tax for **R&D activities**, the following distinctions are made:

  Deduction for carrying out research, development, and technological innovation activities:

  Lexnavarra , ley foral https://www.lexnavarra.navarra.es/detalle.asp?r=38307#Ar.61

- **Non-specific funding programmes encompassing the aim of the B4F project (biotech-agrifood sector).**
  There are no specific funding programs for the biotechnological agrifood sector in the Navarre region. However, such projects are covered under broader funding schemes at the national and European levels.

  For projects in the biotechnological agrifood sector like Biotech4food, several non-specific funding programs are suitable. **Horizon Europe**, the main EU program for research and innovation, supports projects addressing global challenges, including biotechnology and agrifood sectors, with a focus on sustainability and technological innovation. **EUREKA** is another relevant option, facilitating international cooperation in industrial research and development, including biotechnology and advanced technologies. **National Research and Development Programs**, such as Spain's State Plan for Research, provide funding for priority projects in biotechnology and agrifood, covering applied research and the development of new technologies. Additionally, the **SME Instrument**, part of Horizon Europe, is designed to support innovation in small and medium-sized enterprises, facilitating access to funding for biotech and agrifood



innovations. **European Structural and Investment Funds (ESIF)** promote regional development and competitiveness, funding innovative projects in biotechnology and agrifood. The **LIFE Program** of the European Union, focused on environment and climate action, supports projects that enhance sustainability in the agrifood sector. Lastly, the **Horizon 2020** program, although succeeded by Horizon Europe, remains relevant for some ongoing projects, offering support for research and innovation in biotechnology**.**

4.3.1.5. Regional brainstorm report

General Information	
Region	Navarre
Responsible Partner	Nagrifood & CNTA
Workshop Date	5/5/2024
Number of Participants	14
Workshop Method	The brainstorm started with a presentation of the Biotech4Food project and a SWOT analysis, followed by a brainstorm session in the form of a round table with an animator.

REPORT

Description of Item	Analysis – Major Points of Discussion
The most important challenges	• Difficulties in industrial scaling • Investment in technological facilities for industrial scale-up is difficult. There is a lack of an intermediate step between small scale and large scale; Many projects do not reach this stage due to insufficient resources and infrastructure. • Shortage of generational replacement and staffing in certain jobs • Raise awarenesss about biotechnolgy applications and related jobs. • Legislation and regulations (novel food), as some companies struggle with the legal requirements, they need to fulfil to get their products authorised to reach the market. Other example mentioned refers to the choice of regulatory pathway, as some of these innovative products can fall

	under different regulations, which complicates the legal process. • Consumer perception (some companies have detected that consumers are reluctant to buy or adopt products developed with novel technologies and would rather stick to what they know). • Impact, sustainable, social (some players struggle to have international impact due to economical and infrastructural barriers, as big investments are required if they want to be able to compete with other players in their segment).
Interregional cooperation & strategies	• Strong regional cooperation • Entities agree with SWOT strengths (great opportunities, promising in valorisation of industry residues and side streams field, healthy products…) • first regional level and step by step European level • Working together on an interregional level, public-private cooperation? • Cooperation between small and big companies for large scale (TRL5+)
Measurements & actions	• Improve and expand research facilities and infrastructure to support innovation and competitiveness. • Facilitate and clarify the legislation, common problem • Promote the benefits of biotechnology in terms of sustainability, efficiency, and quality of food products. • New centre for large scaling-up • Developing policies and regulations that support the adoption of biotechnology in the food sector, including tax incentives and specific support programs. • Promoting educational and training programs that develop specific skills in biotechnology to meet sector needs
Cooperation research and industry	• Facilitate the exchange of knowledge and expertise between researchers and industry professionals • Leveraging EU funding programs and initiatives that support cross-border collaboration and innovation in agrifood biotechnology. • Develop robust project proposals that outline clear objectives, methodologies, expected impacts, and a

	detailed work plan. Emphasize collaborative efforts between research and industry partners to ensure comprehensive project implementation and successful outcomes. • Promoting effective collaboration between research institutions, businesses, and public agencies to facilitate the transfer of knowledge and technologies.

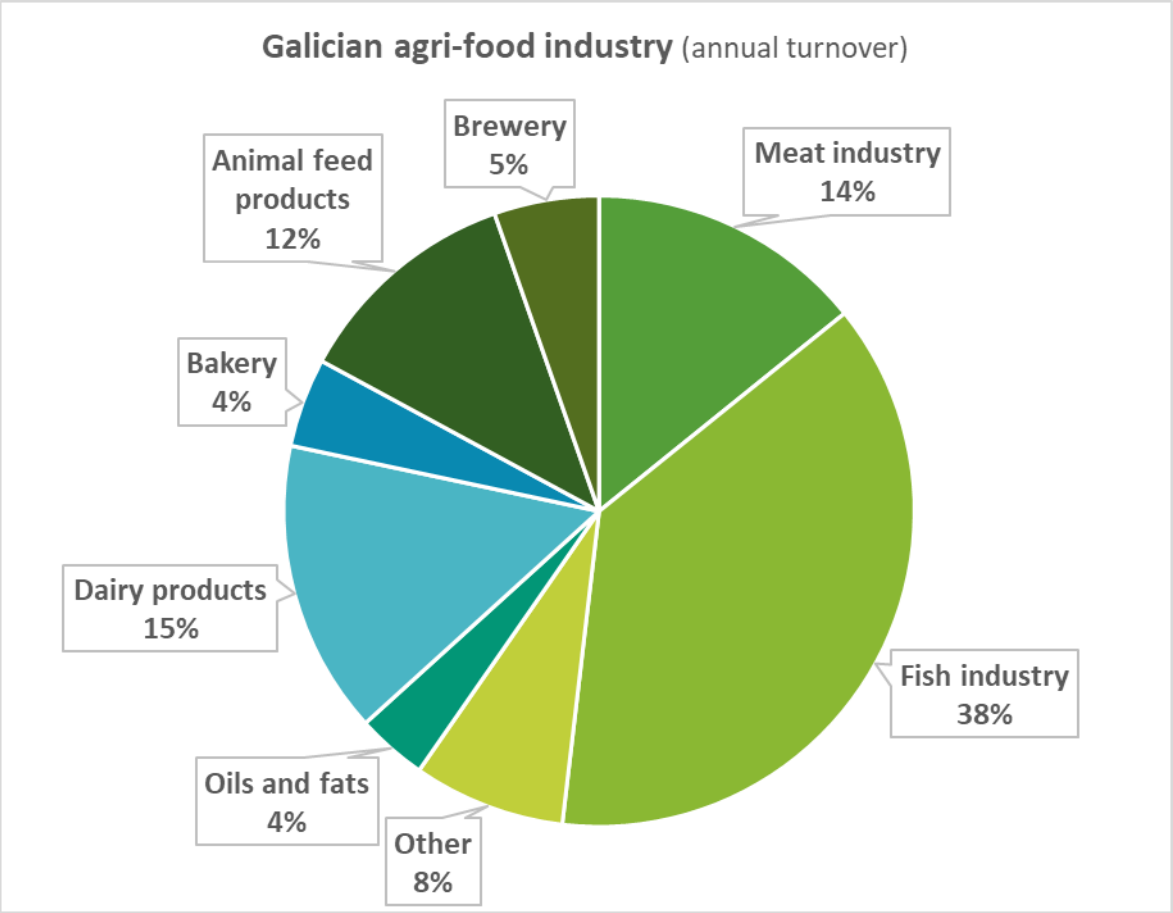
4.3.2. Galicia

4.3.2.1. Food industry

According to the statistics of the Ministry of Agriculture, Fisheries and Food (2021), the agri-food industry represents 22.8 % of the Galician total industrial turnover and 22.2% of employment (36,003 direct employments). This represents 7.8 % of Spanish agri-food industry employment and also 7.8 % of the annual turnover.

The most important subsectors within the Galician agri-food industry in terms of annual turnover are the following:

- Fish industry: 37.7 %
- Dairy products: 15.1 %
- Meat industry: 14.2 %



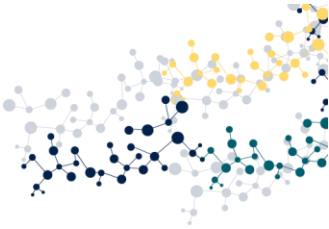
In relation to the total Spanish production, the most represented food segments in Galicia are:

- Fish industry: 55.6 % (73.3 % of Spanish aquaculture production; 85 % of canned products production)
- Dairy products: 15.7 % (milk production: 29.5 %)
- Brewery: 15.4 %

Finally, the most exported agrifood products in terms of value are the following:

- Seafood (fish, crustaceans, molluscs): 40.9 % of Galician agri-food production (45.9 % of Spanish exports)
- Canned fish and meat: 22.5 % (40.6 % of Spanish exports)

Galicia represents 6.3 % of the total agri-food products exported from Spain.



4.3.2.2. Biotechnology application suppliers

The most active sectors in biotechnology are:

- **Valorisation of marine resources (by-products and underexploited resources:** fish, shellfish, seaweed and microalgae, low-trophic species...): biomass/precision fermentation to produce alternative proteins, ingredients/enzymes, nutritional supplements and other added-value products (feed, cosmetics, pharmacy, biomaterials, biofuel...).
- **Development of functional and nutraceutical products:**
  - **Dairy sector (besides traditional fermentation, also in wine, brewery and bakery sectors):** prebiotics and probiotics, optimization of fermentation, valorisation of lactic whey...
  - **Use of microorganisms to valorise plant biomass or extraction of compounds** (ingredients with antioxidant activity,...)

More widely, the priority sectors in biotechnology in Galicia are:

- Marine and aquaculture value chain.
- Agriculture, livestock and foodtech value chain.
- Innovation in health, welfare and pharmaceuticals.
- Environment, bioeconomy and forestry innovation.

4.3.2.3. RTO's

Universities

- University of Vigo (UVI) – Sea Campus of International Excellence
  - Marine Research Centre (CIM)
  - Center for Research in Nanomaterials and Biomedicine (CINBIO)
- University of Santiago de Compostela (USC) - Life Campus of International Excellence
  - Singular Research Center in Biological Chemistry and Molecular Materials (CiQUS)
  - Center for Research in Molecular Medicine and Chronic Diseases (CiMUS)
  - Cross-disciplinary Research Center in Environmental Technologies (CRETUS)
- University of Coruña (UDC):
  - Interdisciplinary Center of Chemistry and Biology (CICA)

Research centers:

- ANFACO-CECOPESCA
- CETIM - Multisectoral Research Technology Center
- Institute of Marine Research (IIM-CSIC)
- Health/Biomedical Research Foundations

4.3.2.4. Regional strategies & initiatives

At the public level, the most remarkable initiative is the **Consolidation Strategy for Galicia's Biotechnology Sector 2021-2025**, led by the Regional Government (Xunta de Galicia) through the

Galician Agency for Innovation (GAIN), as a continuation of the Strategy to Promote Biotechnology in Galicia 2016 – 2020. It covers all the biotech sectors, not only food. Its primary focus lies in fostering public-private partnerships. Six priority subsectors have been identified for action, including:

- Management and utilization of marine resources.
- Functional and nutraceutical food for health and active ageing.
- Agricultural, livestock and forestry production and utilisation.

It is also worth noting the Smart Specialization Strategy RIS3 2021-2027 in Galicia, a continuation of the 2014-2020 RIS3 Strategy, also led by GAIN. It implements 3 major priorities in different prioritization areas, and one of these areas is the agricultural, marine, industrial and ecological biotechnology.

At the private level, it is It is worth highlighting the existence of **BIOGA**, the Galician Life Sciences Technology Business Cluster, representing the organisations integrated in the value chain of the biotechnology sector with activity in Galicia (also non-food), with 135 members, at least 22 of them directly focused on the agri-food sector.

Other clusters with activity in the biotechnology sector are:

- Galicia Food & Drink Cluster (CLUSAGA)
- Galicia Health Cluster (CSG)
- Aquaculture Cluster in Galicia (CETGA)
- Galician Cluster of Environmental Solutions and Circular Economy (VIRATEC)

4.3.2.5. Regional brainstorm report

General Information	
Region	Galicia
Responsible Cluster	ANFACO-CECOPESCA
Workshop Date	28/06/2024
Number of Participants	11
Workshop Method	Galicia organized its workshop at the premises of ANFACO-CECOPESCA in Vigo. Different stakeholders were invited to participate, and although the final number of participants was not very high, all the different groups of stakeholders were represented: - B4F partner (RTO) and industrial partner. - Food companies. - Biotech solution providers. - Regional authorities (policy makers).

	The workshop had a duration of 2.5 hours, with the following Agenda: • Welcome to the participants - Gonzalo Ojea (ANFACO) • Participants presentation • Biotech4Food presentation - Gonzalo Ojea (ANFACO) • Industrial partner presentation - Claudia Fernández (Hifas Innovation HUB S.L.) • Short presentation on the results of the regional survey and interviews - Gonzalo Ojea (ANFACO) • Interactive brainstorming • Final conclusions • Coffee/networking The workshop was organized following the methodology of a discussion roundtable where the stakeholders presented their opinions, with an "animateur" regulating the discussion towards the issues addressed.

REPORT

Description of Item	Analysis – Major Points of Discussion
The most important challenges	The participants generally validated and agreed with the main challenges and risks of implementing biotechnology in the food industry identified in the previous stage (Task 2.1). These insights were gathered from surveys, interviews, and additional information sources. The key challenges highlighted by the participants are: • **Costs:** Developing biotechnological products is a lengthy and expensive process, especially for small companies. Although it eventually becomes profitable during commercialization, the initial high costs can be a barrier. • **Food regulations:** The strict and complex regulations for developing novel foods result in significant compliance costs. • **Lack of financing:** To cover the high costs until commercialization, companies need access to financing. While there are public funding opportunities, few proposals are submitted, according to regional authorities. • **Food safety:** Ensuring the safety of new food products is essential, posing a significant risk for producers. • **Social impact/consumer acceptance:** Consumers often hesitate to accept products developed with new

	technologies, and they frequently receive inadequate information from unreliable sources. • **Lack of facilities:** There is a shortage of pilot facilities and production plants for industrial scaling.
Regional measurements	The following key measures have been identified at the regional level to enhance the implementation of biotechnology in the food industry: • **Access to funding:** There are public funding opportunities and instruments available at regional and national levels for SMEs and large companies to support the development of biotech solutions and their integration into the food industry. However, efforts must be made to improve companies' access to this information. Intermediate entities, such as clusters and technology transfer organizations, can assist authorities in this process. • **Compliance with regulations:** New support instruments should be established to help companies better understand and comply with regulations. • **Role of intermediate institutions:** These institutions can significantly assist regional authorities by communicating the needs and challenges faced by companies. Activities within the Biotech4Food project, for example, can help authorities adjust their strategies and funding calls to meet current demands.
Interregional cooperation	Interregional cooperation can be advantageous and help resolve some of the challenges and needs identified, such as access to pilot facilities and production plants for industrial scaling that are not available in the region.
Cooperation research and industry	In many cases, companies are often unaware of the activities conducted by RTOs. However, regional authorities have recently introduced instruments to enhance their interaction, thereby strengthening the use of biotechnology in food systems. One such initiative is the InnovaREDE platform, a network within the Galician Innovation Ecosystem. This platform promotes collaboration between various technological demand and supply agents by connecting the capabilities of RTOs and other knowledge agents with the needs of companies. Its goal is to bridge the gap between R&D and the market, particularly benefiting SMEs.

4.4. Italy

4.4.1. Emilia-Romagna

4.4.1.1. Food industry

The Emilia-Romagna region has a significant number of companies in the agri-food sector; as of 2019, there were 84,926 local units active in the sector (not including catering), of which 4,758 firms which accounted for 7.7% of food processing firms in Italy and 11.3% of the manufacturing firms in the region. The region is home to 6,190 companies involved in the production of regional PDO and PGI-labelled food products. The agri-food sector in Emilia-Romagna employed 193.1k people in 2021, making it one of the main regional employers. In 2019, the import value of the agri-food sector was 7.36 billion euro, and the export value was 9.24 billion euro. The agri-food value chain exports from the region amounted to around 7 billion euro in 2016, representing 16.5% of the national total.

The Emilia-Romagna High Technology Network comprises 82 industrial research laboratories and 14 innovation centers operating in various fields, including agri-food. Although agrifoodtech is a relatively young sector, a growing trend of new companies being formed and investment in the field at national level can be observed. For example, Northern Italy undisputedly dominates the panorama of national Foodtech start-ups: the leading region, Lombardy, with around a third (30.5%) of start-ups is closely followed by Emilia-Romagna with 11.1% of all foodtech start-ups in the country. Almost half of the start-ups (43%) are active in Food Production and Processing and focus on the creation of new products with innovative ingredients[1], and 70% of start-ups show a remarkably high level of autonomous development, highlighting solid technological maturity. Looking at the most used technologies, artificial intelligence emerges as the predominant one, used by 42.86% of the start-ups; followed closely by machine learning, with a usage rate of 37.14% and **biotechnology with a usage rate of 32.38%.**

The issue of the wide diversity of legislation, laws and regulations regarding the safety and labeling of biotechnological foods from one European country to the other and the lack of a clear positioning of the Italian state on some biotech related issues makes it extremely difficult for companies to navigate the regulatory landscape and obtain necessary approvals to develop new products and scale up. For example, in Italy legislation does not support the commercialization of some types of alternatives food products, such as cultured meat.

Examples of private sector companies in the region include:

- Food & Flavours engineering srl: is an SME that deals with the study of the chemical-physical properties of products from the food and beverage industry for the search for new possible applications in the perspective of a complete circular economy.

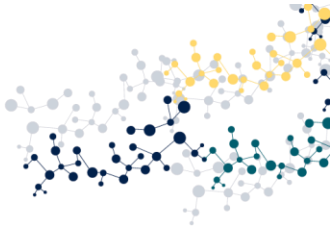
- Phenbiox Srl Set up in 2006 in Bologna (Italy) by researchers specialized in Industrial Biochemistry, Phenbiox now operates in more than 20 countries worldwide, producing and marketing over 1600 plant-based ingredients for the food and cosmetics industry, obtained through a number of production technologies. (https://www.phenbiox.it/).
- ERGO CONSULTING srl: is a spin-off of the university of Bologna established in 2001 and developing systems for precision fruit growing.
- GENPROBIO srl: this SME develops novel probiotic products with solid scientific validation metagenomic profiling, metatranscriptomics, shotgun sequencing, de-novo sequencing and targeted gene expression quantification.
- GRIFFA: A food genomics SME focused on animal products.
- Hi-food spa: a successful start-up company recently bought by an international Fund ("Investindustrial") making it a leading organisation in the development of functional ingredients through careful and methodical studies and experiments, aiming at providing specific technological functionalities to natural ingredients, especially those of sustainable origin.
- Barilla spa: is an Italian company, still owned today by the family that founded it in 1877. Barilla deals with the production of semolina pasta and ready-made sauces. It is also present in over 100 countries. They are actively involved in white biotechnologies to identify novel ingredients are always thriving to meet the needs of their consumers.
- Granarolo spa: Represents an Italian integrated production chain where the entire process is controlled and managed in close collaboration with local producers.

4.4.1.2. Biotechnology application suppliers

In Emilia Romagna, a variety of biotechnology companies are active, focusing on different aspects of biotechnology. These companies range from those involved in innovative therapeutic solutions and biomedical devices to those dedicated to research and development in life sciences, including genetic engineering and stem cell research, and clearly also foodtech. Some of the notable companies include Theras Group, Bioplantec Srl, Generon S.P.A., Sidam S.R.L., Rigenerand Srl, Samo Spa, Tecnopolo Mario Veronesi, and others, with employee numbers ranging from a few individuals to over 50 in some cases (AeroLeads). These companies and the regional focus on innovation highlight Emilia Romagna's significant role in the biotechnology sector, contributing to various fields from health care to agricultural biotechnology and beyond.

4.4.1.3. RTO's

In Emilia Romagna there are four University (Piacenza, Parma, Reggio Emilia/Modena, Bologna/Cesena) focused on food science and technology research and plenty is already going on in areas like:



- Integrated and sustainable management of processes for the recovery of energy and materials from waste and residues deriving from agri-food production.
- Environmental contamination by nano-materials and nano-particles, including aspects relating to human health; the concept of production sustainability and production level safety;
- Agro-biotechnological research aimed at evaluating the possibility of functionalizing biochar with useful microorganisms;
- Genetic improvement of yeasts for industrial fermentations. Selection of high-metabolite-producing mutants. Microbial fermentations for the recovery of industrial processing by-products. Phenotypic and molecular characterization of the microbial component in sourdoughs;
- Improvement of quality of typical products;
- Development of new plant-based food.

Hereafter is a list of some of the main research actors in these areas:

- Emilia Romagna (Italy): Emilia-Romagna boasts prestigious universities with strong agricultural research programs. These institutions might collaborate with private companies or public bodies to explore biotech applications in the regional food sector.
- University of Parma (siteia-Parma) has a sound experience in Food Science and Food Technology, from primary production, to nutrition, to food processing and consumer behaviour analysis. In particular: Safety and Quality; methods for assessing the quality, safety and traceability of raw materials and finished products; evaluation of the relationship between nutrition and health. Products and Processes; functional food products; innovative food processes and performance optimization; technology transfer for innovation in SMEs
- University of Bologna (ciri-Agroalimentare) offers major skills in the Agri-food domain with a special focus on nutritional ingredients. CIRI agroalimentare in particular, the research activities focus on the evaluation of the quality, including nutritional, of food products, verifying that it remains unchanged or is even improved by passing from the state of raw material (including the management of post-harvest) to that of the processed product, also considering the conservation phase.
- University of Modena-Reggio Emilia (biogest-siteia) the skills offered concern the development of new products and processes for the optimization and improvement of existing ones and for the characterization and selection of raw materials. Among other things, the laboratory deals with the nutritional functions of plant molecules for health purposes.
- Università Cattolica del Sacro Cuore (DiSTAS, Department for Sustainable Food Process): lignocellulosic fractionation processes for the recovery of fibrous and antioxidant

fractions from pruning residues, stalks and pomace; extraction with integrated solvent with microwaves, foams and enzymes for the recovery of antioxidants; encapsulation processes by spray drying of the obtained extracts; use in the food and materials sector of the obtained extracts and fibrous fractions; modelling and simulation approaches for process control and optimization.

Accelerators and DemoHubs:

- Fenga Food Innovation: Consultancy expert in supporting the formulation of innovative products, currently very active in the field of product development from the conception, formulation (including with non-conventional ingredients), attention to specific consumer claims (including by using functional ingredients), choice of plants and start-up of production of products for intolerant people, for athletes, special medical needs, functional and health purposes in general.
- SSICA: The Experimental Station for the Food Preserving Industry (SSICA), operating through its headquarters in Parma has been promoting the scientific and technical progress of the Italian food-preserving industry for the sectors of fruits, vegetables, meat and fish products through activities of research, consultancy, training and dissemination of information. Regarding functional and novel ingredients, they deal with the development / optimization of new formulations in the laboratory, thanks to the equipment that allows the production cycles to be fully reproduced, supporting companies.
- Agrofood BIC Granarolo: Is a cross-company innovation hub with a number of key players (Granarolo, Gellify, Camst, Conserve Italia, Cuniola, Eurovo) acting as a start-up accelerator in the food & beverage and agro-industrial sectors capable to promote innovation, converting innovative ideas into concrete business initiatives, with adequate operational and strategic support.

Policy and programme implementer:

- ARTER: ARTER is the Consortium for innovation and technology transfer of Emilia-Romagna. Its partners are the Emilia-Romagna Regional Government, the six Universities and the National Research Centres located in the region (the National Research Council-CNR, the Italian National Agency for New Technologies, Energy and Sustainable Economic Development-ENEA, the National Institute for Nuclear Physics-INFN), the Regional Union of Chambers of Commerce, working in collaboration with regional Business Associations and Innovation Centres.

4.4.1.4. Regional strategies & initiatives

While there isn't yet a single, overarching political strategy dedicated solely to biotech in Emilia-Romagna's food sector, the region does participate in broader national and international initiatives. Additionally, Emilia-Romagna's focus on sustainable development creates a supportive environment for biotech implementation. Here is a breakdown:

- National Research Funding: Italy's national research programs channel funding towards agricultural biotechnology projects that can benefit Emilia-Romagna's food production.
- Regional Focus on Sustainable Development: "2030 Agenda for Sustainable Development" Strategy: This regional strategy aligns with the UN's 2030 Agenda for Sustainable Development, which includes goals related to sustainable food production. Biotech advancements can contribute to achieving these goals.
- European Regional Development Fund (ERDF): the Emilia-Romagna programming document (POR FESR 2021-2027) defines the strategy and interventions for the use of the resources assigned to the Region by the ERDF, within the framework of the Cohesion Policy. Through ERDF, the region works to strengthen the economic, social and territorial cohesion of the European Union and reduce the development gaps, with 5 strategic objectives for 2021-2027: a smarter, greener, more connected, more social, closer to citizens. The Region's Program is defined in strict coherence with the main European and national strategies which identify the ecological and digital transition as the two pillars of the economic and social development of the territories, strengthening their cohesion. It also follows a strategic and unitary vision of the programming of European, national and regional funds, which has taken the Green Deal and the 2030 Agenda as priorities. The Program is structured into 4 priorities, corresponding to different lines of intervention, each of which provides specific objectives and actions, as follows:
  - Research, innovation and competitiveness
  - Sustainability, decarbonisation, biodiversity and resilience
  - Sustainable mobility and air quality
  - Attractiveness, cohesion and territorial development

Other Initiatives:

- Farmer Training Programs: selected programs help equip farmers with the knowledge and skills to adopt new biotech practices, potentially offered through agricultural extension services or industry associations.

Overall, while there is at the moment no region-specific strategy solely for biotech in food, Emilia-Romagna's participation in national and international initiatives, along with its commitment to sustainable development, creates a supportive environment for future exploration and implementation of these technologies.

4.4.1.5. Regional brainstorm report

General Information	
Region	Emilia-Romagna
Responsible Cluster	Clust-ER
Workshop Date	23/05/2024
Number of Participants	29
Workshop Method	A two-stage event with a first part dedicated to presentations by innovative SMEs of their business models and innovation in two sessions, each one dedicated to a macro argument: 1/ Biotech for food: new trends and non-conventional food; 2/ The opportunities of lignocellulose for food. This was then followed by the brainstorm part. During session 1, five innovative SMEs presented their innovation and business model around biotechnologies for food; as can be seen on the screenshot below. 

REPORT

Description of Item	Analysis – Major Points of Discussion
The most important challenges	• Overcoming public reluctance and fears (first barrier) through better "Claims" for products deriving from waste - There was discussion about the need to search for claims for products deriving from waste, which may also have a higher cost (second barrier). • Harmonization of regulation is needed, at EU and Member State level; in Italy "what falls to the ground" cannot be considered a by-product. In the Nordic countries on the other hand, they rightly foresee a product and co-product logic; it would be necessary to replace "by-product" with "secondary raw material".

Interregional cooperation & strategies	• **Inter-industry collaboration** also at interregional levels (in the same country or within bordering countries) - greater collaboration between the biotech industry and other industries (mechanical, chemical, etc.) is a desirable path to improve products. • **Waste management** - the need to elect a local point that can manage waste - also coming from other regions was highlighted; with the need to identify intermediaries to act as local management point for waste - need for an intermediate figure between those who produce and those who reuse waste, capable of stabilizing waste. • But first and foremost to collaborate we need to be informed -partnerships like I4CE are essential to help our local ecosystems understand **what happens in other ecosystems**
Measurements & actions	Should focus on: • Skills and innovation capacity - There has been discussion as to whether there are sufficient skills and how these should be channelled and directed to increase innovation capacity. Specifically, the need to implement a specialist course on biotechnology-enzymology has been discussed; generally, the scientific ecosystem (Regional authorities with higher education) must act on the educational offer of the new generations and encourage multidisciplinarity. • Consumers - It was reiterated that the main attention must be paid to the consumer, so working with associations for example is crucial • Support for small/micro businesses through tax relief and incentives for companies that innovate for example. • Tell sector actors where by-products are – for example, a database on by-products is needed, which is important not only to understand the quantities, but also what problems exist (presence of insects, impurities, stones, seasonality). • Tell the sector where the experimental facilities are; a mapping of these is urgently needed. • Support transfer of knowledge and innovation to avoid “selfishness” – an option could be to use the clusters to do so?

Cooperation research and industry	• Food innovations should stem from the need for greater sustainability revealed by research, following a top-down dynamic. Research and industry should work on this together as industry has the pulse of society, request for more sustainability and research knows how to increase sustainability

REGION SPECIFIC ISSUES (Optional)

Description of Item	Analysis – Major Points of Discussion
Create a network of actors in Biotech for food	Participants called for the following actions to be put in place: • Continue organizing meetings between small and large companies (first of them was the B4F Parma workshop); • Connect those on the market with small research companies; • Create moments of BtoB awareness, to make people understand how advantageous it is to collaborate with small innovative companies and introduce such innovations or support them (idea to organise an event at Biosphere to showcase their facilities and continue discussions with the working group created in Parma)

4.5. Greece

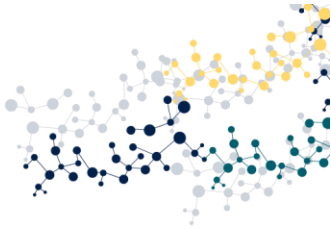
4.5.1. Central Macedonia

4.5.1.1. Food industry

The Region of Central Macedonia (RCM) generates 26% of the Greek GDP, up to 25% of the national primary agricultural production and accounts for 24,7% of Greece's total exports (of which 32,1% are from the food sector).

This sector is particularly known for its resilience during economic downturns, clear leadership in export, substantial contributions to the development of the economy, participation in research projects and synergies with value chains of other economic sectors.

The sector is directly linked to research, innovation and new and/or digital technologies, while its "maturity" in RSM incorporates many different approaches in relation to its course over time, technological and research developments, trends and perspectives and the dynamics occurring in the research, academic, and business ecosystem of the region.



Following an examination of the sector in the context of the update of the Smart Specialization Strategy for the RCM, for the programming period 2021-2027, the following valuable financial data emerged:

- The food and beverage industry accounts for 21%, (2019 data) of the total number of employees in the Food and Beverage industry in Greece, with a turnover of 3.06 billion euros and 2,719 legal units, maintaining the second place at the level of the Greek territory.
- The increase in international food sales by 8.5% (2016 vs 2020) makes the region the leader in food exports in Greece, with a share in the total export turnover of 35.8%, reaching €1.87 billion.
- The submission of 435 proposals for research projects with a total budget of €178.3 million in the flagship program RESEARCH-CREATE-INNOVATE (national), and 82 budget proposals of €22.97 million in Horizon 2020, highlight the dynamics of the sector in R&D.
- The continuous development of entrepreneurship in the food industry with an average of approximately 80 new businesses established yearly in the period 2014-2021 .

The Following agricultural products make RCM a leader in the field of Agri-Food at the national level: Shellfish, Rice, Milk, Eggs, Honey, Cereals, Industrial plants, Fresh fruit, Cattle breeding, Poultry breeding, Olives, Wine.

In RCM, after a thorough investigation within the ecosystem of the region, the Agri-Food Sector proves to be one of the 3 “champions” of the Smart Specialization Strategy (RIS3).. Nevertheless, it has to adopt a strong plan for digitalization and integration of new methods and technologies in primary production and food processing industries, in order to both highlight the positive synergies with other sectors such as ICT, Supply Chain, Cosmetics, Health and Tourism and reduce the effects on Transport, Energy and Environment.

4.5.1.2. Biotechnology application suppliers

Biotechnology and genetic applications are playing are getting more attention in the agri-food sector in Central Macedonia. Indicative technological trends include:

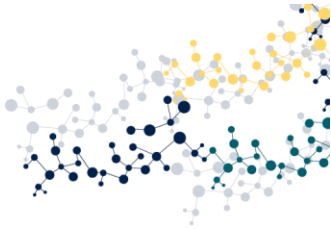
- **Molecular breeding techniques and advanced integrated genomics** are technologies that use genetic information to improve breeding programs and enhance the quality of crops and livestock. Genetic characterization and structure of Greek breeds has so far been limited to single or few nuclear markers, mostly in form of microsatellite markers.
- **Genetically engineered crops and animals** are another area of biotechnology that is being used to enhance food production systems. According to the recent data bases the endemic plant species and animals in Greece, while they appear to be more resistant to climate change, are not as productive as commercial ones. The challenge of the biotechnological sector is to increase indigenous species efficiency with natural

reproduction. By leveraging these cutting-edge biotechnological and genomic approaches, researchers can discover and harness the genetic diversity present in crops and animals to develop or to protect the already existing varieties that are resilient and can thrive in challenging environments, ultimately contributing to sustainable food production systems in Greece and beyond.

4.5.1.3. RTO's

Universities

- **AUTH: Aristotelion University of Thessaloniki/ Faculty of Chemistry/ Laboratory of Chemistry and Food Technology**. Research themes:
  - Technofunctional properties of biopolymers in food systems
  - Encapsulation of flavour compounds
  - Exploitation of novel protein sources (algae, snails, edible insects, industrial hemp) as in the development of food products
  - Milk analogues
  - Edible films & coatings
  - Exploitation of industrial by products for the preparation of novel value-added products and additives
  - Phenolic and aromatic potential of grapes and wines and Wine sensory analysis
  - Biotechnological production of natural food ingredients (pigments, bioactive lipids, flavor active compounds, organic acids, hydrolytic enzymes) with microorganisms in different culture systems
- **AUTH: Aristotelion University of Thessaloniki/ Faculty of Agriculture/ Laboratory of Food Science & Technology**. Research themes:
  - Chemistry and physical chemistry of polymeric food carbohydrates (isolation and structural characterization of starch, plant cell wall and microbial polysaccharides; rheology of polysaccharide solutions and gels; interactions with solutes in low moisture food products, starch crystallization in model systems and bakery products).
  - Thermal analysis of food constituents (state and phase transition behavior of food carbohydrates, fats, proteins by thermal analysis and relation to end-product quality and stability).
  - Mechanical, thermal and gas diffusion properties of water- and polyol-plasticized polysaccharide blends.
  - Edible films and coatings – Nanocomposites of food biopolymers (physicochemical aspects and applications).
  - Low-fat dairy products (processing aspects, rheological and sensory evaluation).
  - Processing and storage effects on stability of food products and their constituents.
  - Functional foods – Nutraceuticals (product design and stability of bioactives).
- **IHU: International Hellenic University/ Faculty of Geotechnical Sciences/ Laboratory of Food Science & Technology**. Research themes:
  - Active Biodegradable Starch-Based Food Packaging



- Research and development of anti-inflammatory functional foods, of high nutritional value, enriched with ω-3 fatty acids, utilizing by-products of Greek fishing and aquaculture
- Photosynthetic microalgae cultures for the sustainable production of high-quality nutritional value products for humans, fish and animals

Research centres:

- ***CERTH/INAB***

  The Institute of Applied Biosciences at the Centre for Research and Technology Hellas (INAB|CERTH) conducts research in the Life Sciences that extends from microbes to plants, animals and humans.

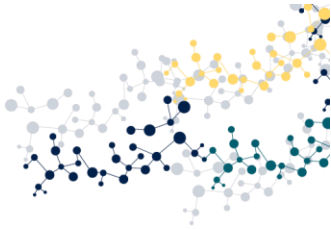
  In this context, INAB conducts Biomedical research and deals with the development and evaluation of digital health interventions and personalized medicine, while also holding a leading position in Agri-biotechnology, utilizing modern high-performance methodologies, molecular biotechnology and 'breeding by design' approaches, with the aim of developing high quality and value products.

  Research themes:

  - INAB has a leading position in the Agri-Food sector, emphasizing on omics applications, molecular biotechnology and ‘breeding by design’ approaches to achieve high quality agri-food and non-food products.
  - Identify, characterize and utilize novel enzymes of plant and microbial origin
  - Develop microbial cell factories for the production of high added value products
  - Exploit & valorize Greek biodiversity for the development of high added value products
  - Understand basic molecular mechanisms of plants using omics data
  - Employ metabolic engineering for reconstituting natural product biosynthesis

  Within this overall frame, main focus areas and objectives of INAB | CERTH include:

  - to exploit of Greek biodiversity: identification of valuable genes useful in plant breeding, enhancing their yield and the nutrient content
  - to identify, characterize and utilize novel enzymes of plant and microbial origin participating in natural product biosynthesis
  - to employ metabolic engineering of yeast for reconstituting natural product biosynthesis and achieving high yields in an economic and environmentally friendly manner
  - to apply plant breeding for increased yield, quality and production of food products, production of high value products and the development of tolerant plants to biotic and abiotic stresses using genetic and omics technologies
  - to assist in the genetic improvement of local autochthonous animal breeds
  - to isolate and characterize microorganisms for industrial uses and forced evolution to tailor to specific applications
  - to assess the nutrient content of local food products
  - to undertake morphogenesis, physiological, phenotypic and quality characterization of crop plants and bioenergy crops
  - to deploy microorganisms and microbial communities in the biodegradation and valorization of byproducts of the Agri-Food sector



- to perform genomics and metabolomics studies of marine macroalgae for novel applications in the Food and Health sector
- Biomedical Research at INAB|CERTH revolves around the dissection of disease pathogenesis and the development and validation of innovative methodologies, products and services of medical interest in order to facilitate the transition "from bench to bedside", in line with the concept of precision medicine for maximizing benefits while at the same time minimizing unnecessary costs and toxicities.

- ***CERTH/iBO***

  The Institute for Bio-Economy and Agri-Technology (iBO), is one of the five Institutes of the Centre for Research and Technology – Hellas (CERTH), a legal entity governed by private law with non-profit status, supervised by the General Secretariat for Research and Technology (GSRT) of the Greek Ministry of Development and Investments.
  iBO focuses on the scientific field of agri-technology and the broader scientific area of bio-systems engineering under the integration of multi-disciplinary and inter-disciplinary specializations and research units. At the same time, iBO's research priorities include rational environmental management and sustainability assessment of bio-production activities, and the optimisation of human interactions within these activities, all in the direction of adopting the principles of the circular economy.
  Research themes:
  - Environmental impact assessment in Bioproduction: Industrial ecology approaches to the design of bio-production, industrial, and urban systems with reduced ecological footprint in order to foster the cyclical economy.
  - Waste Management in Bioproduction: development of alternative agro-waste management. The use of different bio-industrial wastes is an important component of sustainable agriculture in order to close nutrient cycles on a global, regional, and local scale (e.g. organic fertilizers).
  - Bioenergy and energy crops: assessment of availability and energy content of biomass, such as energy crops, perennial crops, forest and agricultural residues and livestock farms waste within the Bio-Economy concept.
  - Energy production systems from biomass of different kinds, using different energy carriers:
  - solid biomass (wood logs, chips or pellets)
  - gaseous biofuels (biogas, biomethane and syngas)
  - liquid biofuels (refined vegetable oils, biodiesel, bioethanol)

- ***CERTH/CREPI***

  Chemical Process Engineering Research Institute, a non-profit research and technological development (RTD) organization was founded in 1985 in Thessaloniki, Greece. From 1987 to March 2000, CREPI was a member of the Foundation for Research and Technology-Hellas (FORTH), headquartered in the island of Crete. In March 2000, CREPI became a founding member of a new research center, the Center for Research and Technology-Hellas (CERTH), established in Thessaloniki.
  Research themes:
  - Membrane materials development with applications including but not limited to fuel production, energy-related processes and bioengineering, biotechnology pre-and

post-treatment processes, advanced oxidation processes, targeting to increase sustainability and promote circular economy concepts in bio-based production of fuels and materials.

- Development of biomaterials with application in the health sector.
- Circular economy concepts.

4.5.1.4. Regional strategies & initiatives

- **Regional S3 strategies at RCM**

  One of the champion sectors of RIS3 of the Region of Central Macedonia (RCM) is Agri-food. In this perspective, RCM decided to support collaboration between businesses and researchers along EU food value networks for engaging consumers in the Agri-Food system and promote bio-based economy.

  Specifically, RCM is actively involved in three existing platforms and working hard to create a new one about. These three platforms are: High tech farming, Nutritional ingredients, and Traceability and big Data and the one the region is developing focuses on Personalized Nutrition. Moreover, RCM is an active member at the European Region for Innovation in Agriculture, Food and Forestry (ERIAFF).

  Trying to utilize of new knowledge in the food industry and bio-based sectors in general, RCM aim to: catalyze food entrepreneurship and innovation; foster at interregional collaboration at all stages between a diversity of partners; strengthen competitiveness of industries in order to respond better to specific consumer demands emerging from the market.

  The *Regional Operational Program (ROP) of Central Macedonia* is about 900 million euro (Table 3.9), in terms of commitments to date, figure that includes EU funding and national co-funding (public expenditure). More than half of these funds address environmental (22.9%) and transport (27.2%) projects or actions, while even a higher share of resources is devoted to human resources development and protection (33.3%). A relatively smaller amount is available for actions in support of entrepreneurship (10.9%) and for research and technology (3.6%)

- **RCM's regional funding programs for R&D addressed to companies.**

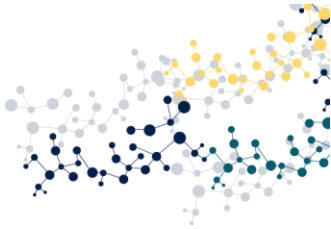
  The most important development opportunities in the region are the production of high-quality products, the development of a strong science base and the development of new start-ups in ICT, bio-food and agro-tech, as well the development of clusters and value chains of local export-oriented firms.

  Innovation Vouchers for SMEs of the Region of Central Macedonia

  The Action aims to strengthen micro, small and medium enterprises, through the purchase of innovative consulting and support services for the transfer of know-how from institutionally recognized Innovation Bodies, for:

  - the development of innovative products / services,
  - the development of innovative production or operation processes and
  - improving the quality of products / services produced.

  Research – Innovate



This action is a Strategic Significance Project under the Competitiveness Program (NSRF 2021-2027) and the grant percentage can reach up to 80% of the total budget.

Funding applications pertain to research and innovation projects, concerning the 8 sectors of the National Smart Specialization Strategy 2021-2027 (S3 – No3: Agrifood Chain). The projects could be in a) Research and Development by Businesses, b) Partnerships of Businesses with Research Organizations, c) Utilization of Research Results and d) Secure financing for Businesses having received the Horizon: Seal of Excellence.

Collaborative formations (Clusters) to promote innovation in local entrepreneurship.

- Supporting the capacity of SMEs to develop in regional, national and international markets, and to participate in innovation processes.
- Increasing the productivity and extroverted orientation of SMEs.
- Strengthening cooperative formations (Clusters) promoting Entrepreneurship, Competitiveness, Extraversion

- **RCM's regional funding programs for hiring R&D personnel and/or support doctoral thesis at universities.**

  National Strategic Reference Framework (NSRF)

  Regional Operating Program

  Both programs support hiring R&D personnel and/or support doctoral thesis at universities in collaboration with SMEs.

- **Tax benefits supporting R&D (national level).**

  Offered to companies through central government and applied throughout regions based on their level of development (EU Definition: Developed Regions, Regions in Transition, Less Developed Regions).

Finally, an agrifood hub (ThessInnoFood) is under creation at Thessaloniki, at an area where more than 100 university, agrifood related, institutes and labs are already established, to further support the collaboration of private sector and universities in the field of agrifood and a more efficient use of biotechnology. It is going to incorporate labs related to the development of the use of biotechnology into food by creating new ingredients and innovating manufacturing. An incubator for start-ups in food, biotechnology and biomanufacturing will be established as well as premises for the attraction of the R&D departments of large food companies. The project has just received the first round of financing.

4.5.1.5. Regional brainstorm report

General Information	
Region	***Central Macedonia, Greece***
Responsible Cluster	ATECluster
Workshop Date	03-06-2024

Number of Participants	226
Workshop Method	In person. In group discussions.

REPORT

Description of Item	Analysis – Major Points of Discussion
Most Important Challenges	***Research*** • Research stands relatively high in producing results (both basic and applied research) and being involved in innovative projects. • Unfortunately, the number of startups coming out of universities is very low due to a lack of entrepreneurial skills and access to finding. • Stronger on-going collaboration between RTOs and industries is required, beyond standalone projects. It needs to be facilitated both by research, university and regional authorities. • Large scale pilot plants are missing thus forcing both research and industry to abandon innovative projects as they cannot scale up laboratory results. ***Industry*** • Industry is relatively reluctant to adopt biotechnology improvements to products mainly due to additional higher investments and technical expertise required. • Improvement of production processes is required to adopt for biotechnology. • Market penetration of biotechnology involved products is low and difficult to achieve. ***Innovation*** • Create/ organize a strong ecosystem that favors startup creation in the food industry. • More interesting sectors to further look at the RCM level such as Plant based foods/ Use of alternative proteins (fruit, vegetables, fish, algae), Fermentation/ Enzymes/ Precision fermentation (milk, olives, wine), Probiotics (functional foods), Emulsifiers (baked goods). • Financial barriers (high investments costs). ***Other***

	• Consumers' perception (not trained to understand food biotechnology related issues such as safety, ethics, etc). • Regulatory issues at EU level. • Health and safety concerns. • Concerns about the use of biotechnology (GMOs) for food applications without adequate safety studies or without proper information of the consumers. In the context of circular economy and the reuse of bio-products ensure the qualitative characteristics of the fermentation feedstocks so as not to introduce harmful/toxic compounds (e.g. heavy metals, antibiotics etc.) in the food chain.
Interregional Cooperation	Difficult to establish as there is no mapping at EU Regions level. Lack of wide visibility of biotechnology companies (in Eu and regionally). Industry has only ad hoc cooperations (individual) without formal marketing/ sales channels.
Regional Measures	Create regional policy on biotechnology. Map the regional biotechnology ecosystem. Provide regional grants and/ or tax incentives for both the use of biotechnology for the improvement of existing products and/ or processes and the creation of biotechnology providers/ technology solutions. Create pilot facilities for new/ improved products testing.
Cooperation Research - Industry	Missing an actor to orchestrate the collaboration between universities and RTOs. Missing an actor to facilitate/ engage the cooperation between industry and universities/ RTOs.

REGION SPECIFIC ISSUES

Existing value chains	Microalgae, Fermented Foods, Alternative Proteins

Thematic priorities for future interregional cooperation	• Plant based foods • Use of alternative proteins (fruit, vegetables, fish, algae) • Fermentation/ Enzymes/ Precision fermentation (milk, olives, wine) • Probiotics (functional foods) • Emulsifiers (baked goods)
Local startup environment	Food: in primitive stage, very few startups exist Food-related: in a more advanced stage, larger number of startups exist (AI, safety, block chain, traceability, etc)

5. STRENGTHS, WEAKNESSES, OPPORTUNITIES AND CHALLENGES WITHIN THE ECOSYSTEM OF BIOTECHNOLOGY IN THE FOOD INDUSTRY

5.1. SWOT Food industry

Strengths for the food industry
What are the advantages of using biotechnology in the food industry? Which biotechnology applications are already implemented the most?
• Biotechnology can have a positive effect on nutritional composition. It can be used to enrich foods with vitamins, minerals and other essential nutrients. • It can be used for production of foods with improved characteristics. Through biotechnology applications like the use of fermentation or enzymes, it is possible to modify the organoleptic proeperties of foods such as, taste, color and texture. These applications can be interesting in the production of alternative proteins and products made with them or the valorization of sidestreams. For example, enzymes offer the possibility of using milder processing conditions for protein extraction and hydrolysis compared to physicochemical methods, thus preserving the integrity and nutritional value of the protein fraction. Knowing the exact molecular composition of a food and its behaviour during simulated gastrointestinal digestion is of fundamental importance to determine the changes which can occur with processing and possible interactions with human metabolic processes • Biotechnology applications can enhance shelf life. This results in a reduction of food waste. For example fermentation can be used to lower the pH which can result in an increased shelf life. • The use of biotechnology applications in the food industry can have an improved impact on sustainability. For example microbial protein can be produced with less land use and wáter use compared to traditional proteins. Biotechnology can contribute to the sustainability of the primary production by developing crops that require less water or are suitable for growing in less fertile soil conditions, thus conserving natural resources. • Biotechnology applications in the food industry can also improve the production efficiency and in some cases the cost effectiveness. • Biotechnological applications are already deeply integrated into various sectors of the agrifood industry especially traditional fermentation processes: long-standing practices in brewing, wine-making, baking, sausage production, and dairy processing. Enzymatic technologies for carbohydrates and fibre hydrolysis and extraction as well as microbial biomass production (probiotic, starter cultures) are also used in the agrifood sector today

Weaknesses for the food industry
Where do you see weaknesses in the application of biotechnology in the food industry? Is there enough knowledge about the use of biotechnology applications and the possibilities? Is there enough willingness?
• The food industry is quite traditional and it is not always easy to implement new technologies • The implementation of a new technology/product requires investments to adapt or build new installations, especially for smaller companies this is difficult. Technical complexity: biotechnological processes demand specialized expertise as well as precise control over various parameters such as temperature, pH, substrate, etc. Competence is essential to ensure proper transformation, master substrate complexity, and mitigate contamination risks. • Elevated product pricing: the end products usually involve higher production cost in the beginning, especially when production is done on a lower scale and therefore higher market price, which is not competitive with products obtained by more conventional technologies. There is a need to develop economically viable models to ensure accessibility for consumers.
Opportunities for the food industry
Where do you see opportunities for the companies to implement biotechnology applications? Which sectors in the food industry are the most interesting to further look into the possibilities? Which biotechnology applications look the most promising?
The integration of biotechnology applications presents numerous opportunities for companies within the food industry. Interesting biotechnologies include: • Enzyme technologies: the application of enzymes for the extraction of fibers, proteins, and bioactive compounds holds great potential for enhancing the nutritional profile and functional properties of food products. By leveraging enzyme technologies, companies can innovate and differentiate their offerings while addressing consumer demand for healthier and more sustainable options. • Precision fermentation: they open new possibilities for creating high-value food products with precise attributes, particularly micro-organisms secondary metabolites and enzymes. • Traditional fermentation: it remains a big application of biotechnologies applied to agri-food. • Process engineering: when working with biotechnologies, it is important to consider them not as isolated steps, but as part of an entire process, with upstream and downstream process

They can be a great opportunity for the following food applications:

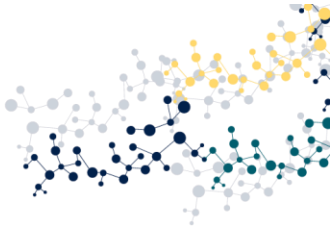
- Utilization of variable and sidestream materials: biotechnologies provide the flexibility to utilize a wide range of raw materials and by-products as substrates for food production. This presents a significant opportunity towards more circular value chains. Despite being underutilized in current industrial practices, many research projects are focused the valorisation of food by-products.
- Plant-based food sector and protein alternatives: biotechnologies offer exciting opportunities in the rapidly growing plant-based food sector and the development of alternative protein sources. Through biotechnological interventions, companies can create plant-based products with improved taste, texture, and nutritional value, catering to the rising demand for sustainable and ethical food options.
- Alternative fats and sugars: biotechnology is not only interesting for proteins but also to make other alternative ingredients with an improved nutritional profile or a more sustainable production process.
- Probiotics production : probiotics offer potential health benefits and can be incorporated into various food and beverage products, including dairy, fermented foods, and functional beverages.
- Production of bio-surfactants and emulsifiers for their applications in baked goods (bread), meat products, sauces, etc.

Threats for the food industry

What are the risks of implementing biotechnology applications in the food industry?

What are the hurdles and barriers to implement biotechnology? (legislation, investment needs, ...)

- The current legislation (Novel food application) for the use new biotechnology applications is seen as one of the largest barriers for implementation. It also imposes a risk that the knowledge build in Europe will be valorised outside of Europe.
- For the biotechnology implementation it requires a large investment to build production facilities with enough capacity. At this point it is also difficult to find already existing production facilities where you can do your first scale-up.
- Consumer acceptance and market acceptance: although traditional fermentation are often well perceived by consumers, overcoming scepticism and fostering trust in biotechnological innovations remains a critical challenge for new applications.
- Intellectual Property Issues: Patent disputes and intellectual property rights can create barriers to innovation and access to technology.
- Market Competition: Traditional agricultural practices and organic farming methods may compete with biotech approaches, affecting market share.
- Health and safety concerns: while biotechnological processes are generally safe, concerns regarding contamination, allergens, growth of unwanted pathogens may impact consumer acceptance and regulatory approval.



- Unintended Consequences: Potential unintended environmental impacts or health risks associated with biotech crops can lead to public backlash and regulatory crackdowns.

5.2. SWOT Biotechnology applications suppliers

Strengths for the biotechnology applications suppliers
What are the advantages of using biotechnology in the food industry? Why would they focus on the food industry? Which biotechnology applications are already implemented the most?
Biotechnology offers numerous advantages in the food industry, as listed above, making it an attractive focus area for suppliers. Biotechnology suppliers for the food industry are often very closely linked to the companies of the food industry and sometimes a food company themselves. The main strengths are • Versatility and innovation: biotechnologies enable the development of innovative solutions to enhance food products, address consumer preferences, and meet sustainability goals. In the context of food transition, biotechnologies play an important role in moving towards a more sustainable and resilient system. • Diverse applications: apart from traditional fermentation, biomass production is now widely implemented in the food industry, primarily to produce food supplements like probiotics and starter cultures. Precision fermentation also contributes significantly to the food industry, facilitating the synthesis of various metabolites such as bioactive compounds, enzymes, and biosurfactants. Additionally, enzymatic technologies for carbohydrate and fiber hydrolysis and extraction play a crucial role in the agrifood sector, enhancing nutritional profiles and functional properties of food products. There are so many micro-organisms that could be used in food production, the possibilities are rather endless
Weaknesses for the biotechnology applications suppliers
Where do you see weaknesses in the application of biotechnology in the food industry? What are weaknesses of the biotechnology applications itself? Do they have enough knowledge about the food industry?
Despite their advantages, biotechnology applications in the food industry face several challenges: • Substrate variability: working with organic products and by-products as raw material imply substrate variability, requiring the development of robust and adaptable biotechnological solutions to maintain consistent performance.

- Technical and technological complexity: biotechnological processes may encounter technical hurdles and require ongoing research and development to optimize efficiency and effectiveness.
- High investment costs, especially for upscaling
- The margins in the food industry are smaller compared to other sectors where biotechnology can play a role, e.g pharmaceuticals

Opportunities for the biotechnology applications suppliers
What are the opportunities for them to focus on food industry? Which sectors? Which biotechnology applications look the most promising?
Although the food industry in general is quite traditional. A lot of companies are looking into the possibilities of biotechnology at this point and the early adopters have already implemented new technologies. The food industry is also a big industry worldwide and will always be necessary guaranteeing a good and large sales market. The biotechnology applications listed in the SWOT for the food industry above are off course those that offer the most opportunities for the biotechnology application suppliers as well.
Threats for the food biotechnology applications suppliers
What are the hurdles to implement biotechnology in food industry? Biotechnology is less associated with food, why?

Several hurdles and threats may impede the implementation of biotechnology in the food industry and are related to those listed in the SWOT above:

- Regulatory challenges: in some case the use of biotechnologies implies the development of novel foods (eg. single cell protein), wich is often a bottleneck for their industrial implementation. Every new process, or same process with other micro-organisms needs a new novel food application. The lack of centralized regulations and harmonization across European regions also poses challenges for biotechnology suppliers.
- Association with pharmaceuticals: biotechnologies are primarily associated with the pharmaceutical sector today, which may divert attention and resources away from the food industry. This is partially caused by higher added values of pharmaceutical products. Big pharmaceutical compagnies (GSK, Buyers, Pfizer, Catalant, etc) offer a lot of well-paid jobs, and are therefore more attractive, at the expense of the agro and agri-food sectors.
- Competition with other sectors: biotechnology applications face competition from sectors with lower regulatory barriers and implementation costs, such as environmental uses, energy production, detergents, and bioplastics.
- Economic and financial challenges
- Competition with non-EU countries: the EU's decision to avoid genetically modified organisms (GMOs) may risk losing a competitive edge in the international market. Non-EU countries with fewer regulatory restrictions on GMOs may gain an advantage, potentially displacing EU-based biotechnology suppliers in global markets.

5.3. SWOT RTO's (research centres, pilot facilities)

Strengths for RTO's
What do RTO's in the regions offer for the food industry? What makes them "unique"? (compared to other facilities)
RTOs in the region/country play a crucial role in supporting the food industry by offering a range of specialized services and capabilities. Their uniqueness lies in their accessibility, expertise, and innovative approach compared to other facilities. • Accessibility to industrials: RTOs are accessible to industrial partners, facilitating collaboration and knowledge exchange. They serve as valuable resources for companies seeking innovative solutions to address challenges in the food industry. • Well-equipped facilities: RTOs are equipped with state-of-the-art laboratories, equipment, and facilities necessary for conducting advanced research and development activities. These infrastructures enables them to perform a wide range of analyses, experiments, and pilot-scale trials to support the food industry's needs. • Expertise in biotechnologies: RTO's possess expertise in various biotechnological fields, enabling them to offer specialized services tailored to the needs of the food industry. Although biotechnology is not implemented to a large extent in all the regions of B4F, there are RTO's active on this topic in every region. • Innovation and development of new products: RTOs contribute to the development of innovative products for the food industry, including protein alternatives and other functional ingredients. Their focus on fundamental research helps understand the mechanisms of microorganisms and harness their potential to meet industrial and consumer needs. • Prestation services: RTOs provide prestation services such as microorganism screening, aromatic profile analyses, product characterization and research for further scale-up.
Weaknesses for RTO's
Are the needs of food companies served in the RTO's? Are provided services "specific" enough? Are the food companies sufficiently involved in the development of the pilot facilities' offer?
RTOs face several weaknesses that may hinder their ability to fully meet the needs of food companies and effectively support industry innovation: • Underutilized research outcomes: funding programs are often aimed towards research project, at the expense of projects for industrial development and implementation. A lot of the research end up with patent filled, with no real industrial applications because of regulation hurdles and investment costs. • The translation of lab/pilot scale to industrial scale is not always easy to do

- Lack of pilot scale facilities accessible for punctual industrial needs especially for transversal steps (upstream and downstream), especially for drying.
- Lack of facilities for accessible clinical studies: there is an increasing demand for clinical studies, especially in areas such as pro-biotics.
- RTO's need to find qualified personnel

Opportunities for RTO's
Are the RTO's in the regions linked to other? (Cooperation) What new services can be an "added value"?

RTOs have several opportunities to leverage their capabilities and enhance their impact:

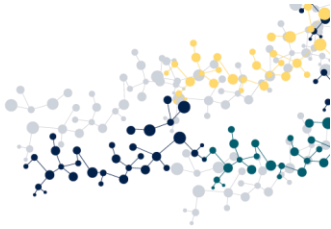
- Financing opportunities: RTOs have access to various funding sources, including European projects and regional financing initiatives.
- Collaboration and partnerships between RTOs and with industrial companies regional and European): these partnerships facilitate knowledge exchange, resource sharing, and collaborative research initiatives. A lot of these collaborations happen through projects.
- Innovation offerings to industrial: RTOs play a vital role in offering innovative solutions to industry challenges. Working with the complexity of living life, this leaves countless opportunities and potential to provide added value to industrial partners, driving competitiveness and sustainability in the marketplace.
- The interest in biotechnology applications in the food industry is growing but this also comes with a lot of research questions from food companies towards those RTO's

Threats for RTO's
Are there enough financial resources? Are they always 'state-of the art? Do they have enough equipment, capacity and human resources?

RTOs face several challenges and threats that may impact their ability to effectively support the food industry

- Gap between research and industrial needs: there is often a disconnect between research innovations and industrial requirements. RTOs to often focus on fundamental research and pilot scale scaling up, without industrial feasibility analysis mass balances, energy cost , economic profitability and market relevance studies.
- Applicability at industrial scale and technological challenges: one of the key challenges for RTOs is ensuring that their innovations and solutions are applicable and scalable at an industrial level. There may be uncertainties about whether technologies developed in RTOs' laboratories can be effectively implemented and integrated into industrial processes to achieve desired outcomes and meet market demands.
- Although there is enough capacity for pilot tests at RTO's across Europe, companies might have difficulties to find funding for these tests, especially when the RTO is not located in their own region.

- Technologies change really fast and machinery is improved. It is not always easy to stay up to date with all the ongoing trends.



6. CONCLUSIONS & ACTION POINTS

6.1. Conclusions

Initially, by analysing the data presented at the previous sections, it is safe to state that across all the regions presented in the Biotech4Food Project:

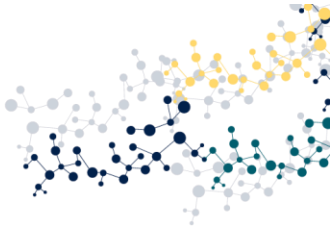
- the food sector is an S3 priority,
- the food sector is very important, both in terms of employment and revenue created,
- the use of biotechnology and biomanufacturing varies considerably from the most advanced region (Flanders) to the less one (Central Macedonia),
- the use of biotechnology and biomanufacturing represents the pathway to innovate by improving products, developing new ingredients, guaranteeing safety and sustain food production.

By reviewing the state of biotechnology worldwide (including Europe) and the data collected through the on-line questionnaires, the interviews and the regional brainstorming workshops several, common to all regions, conclusions could be drawn:

1. The most important ***challenges facing the food industry***:
    - Non yet consistent biotech ecosystems, neither interconnected or structured
    - Regulatory barriers and differences in legislation between EU member states
    - High cost of investment for incorporating biotechnology into products
    - Access to funding for investments in research, innovation and production
    - Consumer perception and acceptance of bioproducts
    - Lack of adequate infrastructure for the development of biotechnology and difficulties in industrial scaling
    - Logistics issues (value chain, valorisation of side streams, etc)
    - Loose cooperation between academia and industry, neither structured transfer of technology to the market or building up technological knowhow
    - Shortage of skills and specialized staff
    - Market competition
    - Intellectual property rights

More specifically, concerning the ***food companies***, we noticed the following:

1. The food companies are quite traditional, and it is not always easy to implement new technologies.
2. There are certain domains (winemaking, brewing, baking, dairy processing, sausage production) where biotechnology is being deeply integrated mostly in the form of traditional fermentation.
3. The deployment of biotech is currently hindered by a lack of access to finance regardless of the size of the company. Early stage and small companies such as spin-offs, start-ups



and SMEs, face particular problems with the high costs for patenting inventions, the challenges associated with a lack of harmonised intellectual property (IP) legislation across the EU, and accessing finance for scaling-up biotech projects in Europe.

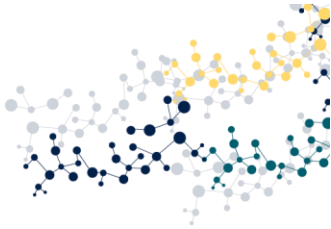
4. Large multinationals also suffer from a lack of public R&D funding for demonstration and commercial plants in Europe compared to other regions of the world, and as a result, some have decided to invest outside of Europe, despite having developed their technologies in Europe.
5. Companies are facing a lack of a workforce understanding biotech equipped with the necessary skills (biotech, AI, ICT, analytics, etc).
6. However, even if a competitive route to market can be established, biotech products face a long journey to commercialisation due to regulatory constraints before they reach end users and consumers.
7. Consumer awareness of biotech products is poor. Their advantages and functionalities are not clear enough.
8. The issue of the wide diversity of legislation, laws and regulations regarding the safety and labeling of biotechnological foods from one European country to the other and the lack of a clear positioning on some biotech related issues makes it extremely difficult for companies to navigate the regulatory landscape and obtain necessary approvals to develop new products and scale up.

More specifically, concerning the ***biotech suppliers***, we noticed the following:

1. Biotech suppliers for the food industry are often very closely linked to the respective food companies and sometimes they are a food company themselves.
2. Biotech suppliers face several challenges:
    - Substrate variability: working with organic products and by-products as raw material imply substrate variability, requiring the development of robust and adaptable biotechnological solutions to maintain consistent performance.
    - Technical and technological complexity: biotechnological processes may encounter technical hurdles and require ongoing research and development to optimize efficiency and effectiveness.
    - High investment costs, especially for upscaling.
    - The margins in the food industry are smaller compared to other sectors where biotechnology can play a role (e.g pharmaceuticals).

More specifically, concerning the ***RTOs***, we noticed the following:

1. RTOs play a crucial role in supporting the food industry by offering a range of specialized services and capabilities. Their uniqueness lies in their easy accessibility to industry, better equipped facilities, research expertise and innovative approach compared to companies' R&D facilities.



2. Nevertheless, RTOs also face several weaknesses that may hinder their ability to fully meet the needs of food companies and effectively support industry innovation such as:
    - underutilized research outcomes
    - not always easy transition from lab/ pilot scale results to industrial scale
    - lack of qualified personnel.
3. RTOs face a disconnect between research innovations and rapidly changing industrial requirements.

6.2. Action points

Each region, based on the degree of usage of biotechnology within its local food ecosystem, requires undertaking a different and more specific approach relative to its needs. This is going to be further elaborated within the context of the Biotech4Food Project at a regional level. On the section below is presented a "roadmap" of action points that could be undertaken by each region and further elaborated/ adapted to the regional needs.

Thus, based on the data collected throughout the on-line questionnaires, the interviews and the brainstorming workshops, as well as the experience of the Project's Partners with biotechnology and biomanufacturing, for the continuation of this report we are not going to present region-specific action points, but rather propose a series of more general actions/ requirements/ needs the need to be adapted by the food industry in Europe within the horizon of the next 10 – 15 years.

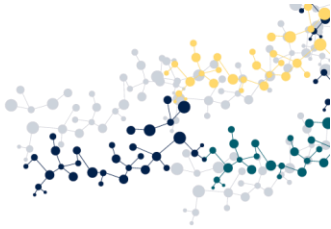
By taking into account the current societal, demographic and environmental challenges, reinforcing the bioeconomy's industrial dimension and its links to biotechnology and biomanufacturing contribute to a stronger EU economy.

Through the proposed action points it is important to unlock the full benefits of biotechnology and biomanufacturing, which are crucial for the competitiveness and modernization of EU industry and offer high growth and productivity potential.

The following is a non-exhaustive list of actions/ requirements/ needs aiming at a higher level of adaptation and usage of biotechnology in everyday life (the action points address the challenges stated in the previous section).

The following are action points that can be addressed within the scope of the Biotech4Food project or with the I4CE partnership.

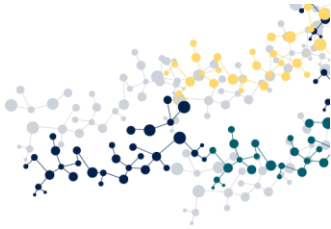
1. ***Legislation & Regulation***
    - Provide information about the current legislation and support in how to set up a novel food application and to find other partners who can support companies in this.



2. ***Funding/ Investments***
    - Improve the visibility and alignment of different EU funding schemes and demonstrate how they can be integrated. Inform stakeholders about the possibilities for European/regional funding.
    - Inform and educate companies on finding funding and set up matchmaking sessions with investors
3. ***Stimulate innovation***
    - Put success stories and good practices more in the spotlight to inspire other companies
    - Stimulate national and/or regional cluster organisations to be involved in interregional public-private partnerships, elaborating projects (like Biotech4Food) that promote biotech use and innovation.
    - Investigate the scope for using novel biomass. An assessment of sustainable waste flows is needed. Technologies need to be developed to deal with the inherent variability of waste and residue products.
    - Inform and educate companies about the new technologies or new possibilities with existing technologies
4. ***Consumer perception & acceptance***
    - Provide correct evidence-based information about the use of biotechnology in food products and showcase different products, such as products made with more traditional biotechnology like traditional fermentation to show that these newer products can also be safe and healthy.
5. ***Infrastructure/ Logistics***
    - Promote funding support for trials at dedicated pilot plant facilities.
    - Provide information on possible sale-up facilities for companies and outsourcing of production.
6. ***Academia/ Industry cooperation***
    - Stimulate collaboration between industry and public institutes. Sharing the possibilities that RTO's have to offer with industry (part of this document). Set up matchmaking events and invite experts of RTO's at training sessions.

There are also action points on a higher level where the Biotech4Food project and the I4CE partnership can only have an indirect effect via lobbying, writing policy recommendations and setting a good example.

1. ***Legislation & Regulation***
    - Simplify regulatory framework for both faster access to market and keeping up with the pace of change in science and technology.



- Develop process, product, and data standards that enable iterative improvement and integration and competition with traditional manufacturing processes.

2. ***Funding/ Investments***
    - Introduce a series of measures, such as financial incentives or tax reductions (national/ regional), that could be used to help foster investments, whilst public procurement for industrial biotechnology-derived products could help create markets.
    - Industry and venture capital alone likely cannot effectively move the needle in advancing the biotech without government support and public–private partnerships.
    - Setup a distinct EU Biotech Investment Fund that could help pool resources from different financing mechanisms such as those available through the European Investment Bank and private funds and help leverage Commission contributions.
    - Increase EU grants awareness and stimulate cooperation, attract foreign investments, de-risk investments.
3. ***Stimulate innovation***
    - Stimulate innovation across disciplines (AI, ICT, etc) by accelerating their uptake in biotechnology together with academia and industry.
    - Provide financial and tax incentives to companies investing into biotech innovative research.
4. ***Consumer perception & acceptance***
    - Targeted information campaigns to customers and end-users can help develop the market, but also to ensure maximum impact (should first ascertain peoples' understanding to identify the gaps to address).
    - Define a coherent strategy to promote the development of biotech products in the EU and one which recognises the benefits that these products can bring without which, biotech products face a challenging route to market.
    - Develop an EU wide campaign to improve public awareness and perception of biotech and biotech-derived products (special purpose website, information desk, promotional films, educational material and tools). Identify, leverage and build upon EU capabilities for pilot and demonstration facilities.
    - Communicate to consumers (public) about the benefits of biomanufacturing, including for health, the economy, the environment, and security and build trust around practices and products.
    - Engage with non-traditional voices, not within the boundaries of industry, to represent biotech could help demystify the industry. Use public figures, actors, etc to undertake the actions.

5. ***Infrastructure/ Logistics***
    - Set up fundings for companies to invest in infrastructure at pilot and demonstration scale to bring innovative European ideas to market. The I3 calls are a first example but there are other forms of funding possible and necessary for investments in scale-up.
    - Try to set up a network between the different RTO's to set up centres of excellence. These centres of excellence could help to enable reproducibility through standardization and best practices for quality control, scaling, and analytics.
    - Promote funding support for trials at dedicated pilot plant facilities.
6. ***Workforce***
    - Develop a workforce which can maintain Europe's competitiveness in biotechnology in close collaboration with excelling academia.
    - Ensure the biotech workforce is trained in critical skills, including data science and analytics, process engineering, quality management, technoeconomic analysis, life cycle assessment.
    - Provide support funds to help develop biotech-specific teaching programs.
7. ***Academia/ Industry cooperation***
    - Industry, academia, and regulatory agencies could be proactive and more effective at sharing data and lessons learned, including for both successes and failures.
    - A central portal for sharing resources, successes, and failures could improve communication across industry, academia, government, and the public.
    - Creation of living labs focused on biotech.

ANNEX A: METHODOLOGY

To develop the Biotech4Food activities, including support to SMEs and crafting the implementation roadmap and strategy, the state of play in the food sector and the state of the art regarding the implementation of biotechnology, in the involved regions, were inventoried and analysed.

To obtain the relevant information, a survey was conducted using a multi-stakeholder approach, engaging all relevant stakeholders including food companies, biotechnology application suppliers, RTO's and regional authorities. The questionnaire was set up, then distributed among all project partners for further dissemination through their networks via email, newsletter, articles and other relevant communication channels. The questionnaire consisted of three parts with specific questions aimed at the food industry, biotechnology suppliers, and RTOs. The focus was on regional initiatives as well as on the opportunities and challenges faced by these organisations.

Approximately 100 organisations and experts, either responded to the survey or were interviewed.

In addition to the survey, more in-depth interviews with experts in the field were conducted in each region. Additional sources of information for the ecosystem and SWOT analysis included other projects, general reports and the regional multi-stakeholder brainstorms.

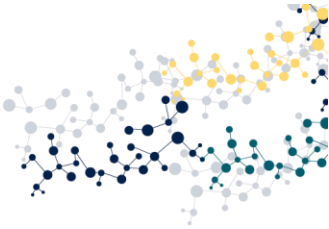
The main goal of the workshops was to go more into detail on the challenges related to implementing biotechnology in the food industry and to discuss potential measures To address these challenges.

The second goal was to identify themes for which interregional cooperation could be advantageous.

The third goal of the workshops was to ensure no data was missing in the regional analyses (identification of stakeholders, regional strategies & projects, local start-up environment, SWOT analysis, ...).

During the workshop, the following questions were addressed:

1. Do you agree with the listed challenges and risks that are stated in the regional analysis (from survey/interviews) and that these are the most important ones. Are there any important challenges/risks missing?
2. On which biotechnology applications do you think interregional cooperation can create the most advantages? How can the region explore innovative strategies to strengthen the use of biotech in food systems, develop affordable and healthy foods with new potential ingredients such as plant-based proteins, algae, etc? How can we create bridges between European actors to support the creation of new interregional value chains? What do you think is necessary on a European level to enhance the implementation of biotechnology in the agrifood industry and to stimulate interregional innovations?



3. What other care is necessary in the region on a local level to improve the implementation of biotechnology in the food industry?
4. How can research and industry facilitate their interaction to strengthen the use of biotechnology in food systems?