I3-4-BIOFERTILIZERS

SOWING INNOVATION
HARVESTING SUSTAINABLE YIELD

Interregional innovation investments for biofertilizers and circular bioeconomy solutions for a sustainable agriculture

Call: I3-2023-INV1

Action: I3-PJG

Grant Agreement No. 101161143

Deliverable 2.4

Specifications and KPIs for the industrial process of each investment case

[April – 2025]

[Version 1.3]

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Project ID	101161143
Project title	I3-4-BIOFERTILIZERS: Interregional innovation investments for biofertilizers and circular bioeconomy solutions for a sustainable agriculture
Deliverable title	Specifications and KPIs for the industrial process of each investment case
Deliverable number	2.4
Deliverable version	1
Date of delivery	30/04/2025
Reviewed by WP leader	UVIC-UCC
Dissemination level	PU
Partner(s) responsible	UVIC-UCC

Version	Date	Contributors	Description
1.1	13/02/2024	Laura Mejias and Jordi Llimós (UVIC-UCC)	First draft
1.2	11/04/2024	Investment case partners	Second draft
1.3	28/04/2024	Laura Mejias and Jordi Llimós (UVIC-UCC)	Final version

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Table of Contents

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

List of Figures

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

List of tables

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

List of acronyms

ACM	Composted Mixed Conditioner
AD	Anaerobic Digestion
CAGR	Compound Annual Growth Rate
CAP	Common Agricultural Policy
CE	European Conformity
DSSs	Decision Support Systems
EEA	European Economic Area
EM	Effective Microorganisms
EU	European Union
GIS	Geographic Information System
HTC	Hydrothermal Carbonization
IC	Investment Case
ITC	Information and Communication Technology
KPIs	Key Performance Indicators
NEIA	New European Innovation Agenda
NPK	Nitrogen, Phosphorous and Potassium
O_2	Oxygen
OFMSW	Organic Fraction of Municipal Solid Waste
OUR	Oxygen Uptake Rate
PAH	Polycyclic Aromatic Hydrocarbons
PFC	Product Function Categories
PGPR	Plant Growth-Promoting Rhizobacteria
RIVs	Regional Innovation Valleys
SME	Small Medium Enterprise
SSF	Solid State Fermentation
TRL	Technology Readiness Level
USD	United States Dollar

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

1. Summary

Biofertilizers are emerging as a sustainable alternative to conventional fertilizers, combating soil degradation, water pollution, and greenhouse gas emissions. Their use aligns with the growing global demand for environmentally friendly agricultural practices that maintain productivity while minimizing ecological harm. In the European Union, although the term "biofertilizer" is not explicitly defined, Regulation 2019/1009 on Fertilising Products provides a framework for their commercialization under the categories of organic fertilizers and plant biostimulants, depending on their function. These products are consistent with the objectives of the EU's Farm to Fork strategy, which seeks to reduce nutrient losses by 50% and preserve soil fertility by 2030. This report focuses on two main areas: the industrial process specifications and performance indicators of the eight investment cases, and a comprehensive market analysis based on regional customer needs.

2. Introduction

The increasing global demand for sustainable agricultural practices has driven significant interest in biofertilizers as an alternative to conventional fertilizers. Traditional fertilizers, while essential for maintaining soil fertility and ensuring crop productivity, contribute to environmental issues such as soil degradation, water contamination, and greenhouse gas emissions. In response, biofertilizers have emerged as a promising solution, offering a more sustainable approach to soil health and crop nutrition by harnessing natural microbial processes to enhance nutrient availability.

Within the European Union, regulatory frameworks such as the EU Fertilising Products Regulation (Regulation 2019/1009) provide guidelines for the commercialization of organic and waste-based fertilisers, soil improvers, and plant biostimulants. Although the regulation does not explicitly define the term "biofertilizer," these products are categorized under organic fertilisers and plant biostimulants based on their functionality. Biofertilizers, which contain living microorganisms that enhance nutrient uptake and improve plant resilience, align with the EU's Farm to Fork strategy, which aims to reduce nutrient losses by 50% while maintaining soil fertility by 2030.

This report focuses on two key aspects: the industrial process specifications and key performance indicators (KPIs) for each investment case, and an in-depth market-oriented customer-needs analysis of the regions where these investment cases are implemented. By evaluating both technical and market-driven factors, this study provides a comprehensive understanding of the viability, scalability, and impact of biofertilizer solutions in different regional contexts. The findings will contribute to optimizing production processes, ensuring compliance with regulatory standards, and addressing the specific needs of agricultural stakeholders across various European regions.

3. Specifications and KPIs for the industrial process

3.1. Investment case #1: UNIOVO

Objective of the Investment Case:

UNIOVO, a medium-sized company with 50 employees, specializes in the production and sale of laying hens' shell eggs. As part of its strategy to create added value from its by-products, the company aims to develop an industrial-scale composting system to transform poultry manure into a high-quality organic fertilizer.

European agriculture produces huge quantities of high-quality food, but also massive amounts of waste deriving from farm animals, including about 1.4 billion tonnes of manure each year. Currently, UNIOVO produces 7,000 tons of poultry manure annually, which contains valuable nutrients such as nitrogen, phosphorus, and potassium. However, its direct use presents environmental and logistical

challenges, including the presence of harmful bacteria, strong odours, and ammonia emissions. To overcome these issues, investment case objective is to implement a controlled aerobic composting process that ensures compliance with EU Regulation 142/2011 and 2019/1009. This solution aligns with circular economy principles by converting waste into a valuable soil amendment, reducing dependence on chemical fertilizers, and supporting sustainable agricultural practices.

Current Design/Production Scheme:

UNIOVO has been experimenting with composting using open trench methods; however, this approach has failed to consistently achieve the required temperature and retention times. To improve the process, the company has installed a plug-flow composting reactor at its industrial facility. This reactor operates in a closed system, consists of three processing stages, and has a daily treatment capacity of three tons of poultry manure. The reactor is equipped with a control system currently undergoing testing to optimize its performance.

New Developments/Changes to Demonstrate in the Investment Case:

The key technical challenge for UNIOVO is achieving consistent control over temperature and retention time to comply with EU standards. The project will focus on enhancing the control system to monitor and regulate temperature and airflow within the reactor and assessing different process conditions (mixture composition, moisture, free air space, the volume of the reactor, heat exchange System, etc..) to optimize composting time and product quality. Also, to further validate and optimize the composting process, laboratory-scale evaluations will be conducted with the University of Coimbra, exploring additional organic residues that could enhance compost quality when co-composted with poultry manure and validating the end-product as a marketable organic fertilizer, ensuring compliance with agricultural standards and farmer needs.

The investment case will also explore potential end-users and commercial opportunities, leveraging the growing regional demand for organic soil amendments. Proper stabilization of the product will facilitate storage, transport, and application, creating a viable business model that integrates waste management and sustainable agriculture, while producing a marketable fertilizer product.

Industrial Requirements of the Investment Case:

To achieve full-scale implementation, the following industrial steps will be undertaken:

- Optimizing reactor design and operation, ensuring a stable composting process. The purchase of a new reactor will be assessed depending on the necessity of the optimization.
- Developing robust process monitoring and automation, ensuring continuous compliance with temperature and retention time requirements.
- Conducting agronomic validation trials to assess the fertilizer's effectiveness in improving soil health and plant growth.
- Ensuring compliance with regulatory and market standards to facilitate product certification and commercialization.

Expected Specifications of the New Product:

The new compost product will be developed to fully comply with EU regulatory requirements, ensuring it is a high-quality organic fertilizer suitable for agricultural use. Key features include adherence to EU Regulation 142/2011 and 2019/1009, guaranteeing both safety and effectiveness. The compost will be pathogen-free, achieved through a controlled exposure to 70°C for at least 60 minutes. It will have optimized nutrient content, benefiting from poultry manure's natural richness in nitrogen,

phosphorus, and potassium. The product will also enhance soil health, boosting organic matter, improving moisture retention, and reducing the need for chemical fertilizers. Additionally, it will be easy to handle and store, offering a practical and sustainable fertilization option for farmers.

Target KPIs (Key Performance Indicators):

Table 1: Key Performance Indicators of the investment case #1: UNIOVO

Key performance indicator	Target
Total poultry manure treated in the reactor	10 t/day
Compost production	4 t/day
Moisture of the produced compost	40-65%
Product compliance with EU standards	Achieved
Successful agronomic validation trials conducted	1
Stability of the product (OUR)	<25 mmol O_2/kg organic matter/h
Pathogen in product (*Escherichia coli* or *Enterococcaceae* and *Salmonella spp.*)	0
Concentration of PAH in the product	< 6 mg/kg dry matter
Macroscopic impurities (>2 mm) in the product	< 3 g/kg dry matter
Environmental and techno-economic analysis	1

3.2. Investment case #2: FERTIEBRO

Objective of the investment case:

FERTILIZANTES DEL VALLE DEL EBRO S.L., (FERTIEBRO) is located in Soses, a town in the Ebro valley. It is in the epicenter of one of the largest irrigation areas. Its main activities are manufacture and distribution of liquid and solid fertilizers as well as correctors. FERTIEBRO also carries out continuous care of farmers with its commercial team and its own laboratory.

The objective of this investment case is to develop and produce an innovative concentrated gel biofertilizer that features high calcium content while being entirely free of nitrogen. This product aims to address the needs of agricultural sectors requiring targeted calcium supplementation without the risk of excessive nitrogen input, which can impact plant growth balance and soil health. By leveraging advanced formulation techniques, the biofertilizer will ensure optimal nutrient availability, ease of application, and enhanced absorption by crops. Additionally, its gel-based composition will provide improved stability, controlled release, and compatibility with sustainable farming practices, contributing to soil regeneration and long-term agricultural productivity.

Current design/production scheme:

The process has been developed but remains at a low Technology Readiness Level (TRL), presenting challenges in scaling up for industrial production. Previous developments in gel formulations with similar products provide a strong foundation for further innovation.

Currently, the market normally offers solid formulations, as liquid alternatives are limited to some applications, making handling easier. Additionally, the production process integrates the use of by-products as raw materials, aligning with ongoing formulations of other products using these sustainable inputs. This approach enhances resource efficiency and supports circular economy principles.

New developments/Changes to demonstrate in the investment case:

The project focuses on developing a high-performance gel biofertilizer by incorporating liquid by-products, as raw materials. This approach enhances sustainability by repurposing industrial by-products, reducing waste, and contributing to the circular economy. The use of acetic acid may also help stabilize the gel matrix and improve nutrient availability for crops.

To scale up production from laboratory to industrial levels, an efficient reactor system will be designed and constructed. The reactor will feature a plate heat exchanger, a scrubber and special discs for the gels that mix and shear the material, ensuring excellent mass transfer and eliminating dead volumes, which are crucial for maintaining product homogeneity and stability.

Ensuring the long-term stability of the biofertilizer is essential, requiring an iterative study to assess whether the product retains its key physical and chemical properties, such as viscosity, nutrient content, and homogeneity. Factors like temperature, storage conditions, and interactions with packaging materials will be examined to ensure reliability. The gel formulation represents a breakthrough by enabling the creation of supersaturated liquid solutions, allowing for twice the number of active units per package compared to traditional liquid products. This leads to reduced packaging needs, optimized logistics, lower export costs, and a minimized environmental impact. Selecting the right packaging is equally important, as it must provide adequate protection, facilitate handling, and minimize environmental impact. Various packaging materials and designs will be tested to optimize product preservation, logistics, and sustainability.

To validate the biofertilizer's effectiveness, comprehensive agronomic trials will be conducted. These studies will evaluate its impact on crop growth, nutrient uptake, and soil health, comparing its performance with existing fertilizers. Key indicators such as yield improvement, nutrient efficiency, and plant health will confirm the product's agronomic benefits and ensure it meets market demands. This structured approach will enable the successful scale-up, production, and commercialization of a sustainable, high-performance gel biofertilizer.

Industrial requirements of the investment case:

The project includes several key technical improvements and validation steps to ensure the successful production and application of the gel biofertilizer.

A crucial aspect of the development is the revamping of the reactor/mixing tank, which involves replacing the mixing disc and motor to enhance efficiency and ensure optimal mixing performance. Alternative solutions will be identified in case additional modifications or adjustments are required during implementation. These upgrades aim to improve the homogenization of the gel, optimize material transfer, and increase production reliability at an industrial scale.

In parallel, the product packaging system will be redesigned to adapt the existing filling and packaging infrastructure to the new gel formulation. This adjustment will ensure seamless integration into the current production line while maintaining efficiency, product stability, and ease of handling for end-users. The redesigned system will also focus on minimizing environmental impact by optimizing packaging materials and reducing logistics costs.

To further support product validation, pot test in a greenhouse facility is planned. This controlled environment would allow for more precise testing of the biofertilizer under different conditions, helping to fine-tune application methods and assess its performance across various crops before large-scale field trials.

The final validation phase will involve field trials and controlled tests. In real-field conditions, the biofertilizer will be applied to apple orchards to evaluate its impact on fruit development, nutrient uptake, and overall plant health. Additionally, pot tests with horticultural crops will be conducted to assess its effects on soil properties, root development, and growth performance under controlled

conditions. These trials will provide essential agronomic data, ensuring the biofertilizer meets quality standards and effectively enhances crop productivity.

By implementing these technical upgrades and validation steps, the project aims to optimize production, ensure product stability, and demonstrate its agronomic benefits before commercial deployment.

Expected specification of the new products:

The new gel will contain a calcium concentration between 16 and 18 fertilizer units, ensuring an effective and balanced nutrient supply for crops that require calcium supplementation without additional nitrogen.

The product will be designed to fully comply with EU regulations, guaranteeing its safety, efficacy, and environmental sustainability. As part of this compliance, it will obtain the CE mark, which certifies that it meets the high safety, health, and environmental protection requirements necessary for commercialization within the European Economic Area (EEA).

In addition to regulatory compliance, the formulation will prioritize stability, controlled release, and ease of application, ensuring optimal calcium availability for plants while maintaining compatibility with existing agricultural practices. The biofertilizer will also integrate sustainable production principles, using by-products from the agri-food industry to support circular economy goals.

By meeting these expected specifications, the new gel biofertilizer will offer a high-performance, eco-friendly solution tailored to modern agricultural needs.

Target KPIs (key performance indicator):

Table 2: Key Performance Indicators of the investment case #2: FERTIEBRO

Key performance indicator	Target
Biofertilizer production volume	≥10 tons/year
Raw materials assessed	≥2
Number of products	≥2
Number of field trials	1
Number of crops validated	2
Calcium concentration in the product	16-18 fertilizer units

3.3. Investment case #3: AGRIENERGIA

Objective of the investment case:

AGRIENERGIA is a private company specialized in the treatment of the organic matrix, mainly deriving from the separate collection of urban waste, through a process of energy and material recovery. It produces biogas, converted into energy (electricity and heat) and compost.

The objectives of this investment case are the following:

- Develop at least three different types of compost-based biofertilizers and/or organo-mineral fertilizers in a demonstrative plant.
- Incorporate biochar into the anaerobic digestion (AD) process to achieve at least 10-15% increase in biogas production and mitigate nitrogen emissions during composting, using 5% biochar in each cell.
- Integrate effective microorganisms into the composting process to enhance its efficiency and quality.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Current design/production scheme:

AGRIENERGIA currently manages the organic fraction of municipal solid waste (OFMSW) through a combination of anaerobic digestion (AD) and composting processes, maximizing resource recovery and energy generation.

The anaerobic digestion process employs dry batch technology, utilizing five anaerobic cells to facilitate the breakdown of organic matter under controlled conditions. This method enhances the stability and efficiency of the digestion process, leading to the production of biogas, a renewable energy source primarily composed of methane (CH_4) and carbon dioxide (CO_2).

The generated biogas is used for electricity and heat production, contributing to energy self-sufficiency and reducing reliance on fossil fuels. Meanwhile, the solid digestate undergoes a composting phase, where it is further stabilized and transformed into a composted mixed conditioner. This high-quality organic amendment is suitable for use in agriculture, including organic farming, providing essential nutrients and improving soil structure.

Through this integrated approach, AGRIENERGIA supports circular economy principles, reducing waste disposal, lowering greenhouse gas emissions, and promoting sustainable agricultural practices.

New developments/Changes to demonstrate in the investment case:

The innovative solution stands in the process of converting compost, a soil conditioner into an organic fertilizer, biostimulants and pit moss substitute to increase the circular economy of the organic waste value chain and to cope with organic matter in soil. The model starts by improving the fertiliser produced by mixing compost and biochar (TRL 8) to study and test different variations by adding effective microorganisms (EM), or other ingredients to increase the value to retain nitrogen, water and other elements. The model aims to study the production of three types of fertilizers with different shapes (raw, pellet, liquid):

- A substitute for pit moss (the extraction of natural pit moss will be banned soon in all EU)
- A bio-stimulant using EM, compost and other ingredients prepared under anaerobic conditions.
- An organic fertiliser made from compost and biochar and enriched to increase the NPK in different percentages to fit with the main Mediterranean cash crops needs.

Industrial requirements of the investment case:

The industrial requirements for the investment case involve several key components. First, a blending or mixture machine will be necessary for combining materials efficiently. A metal separator will be required to remove any metal contaminants from the process, ensuring the purity of the final product. Lastly, a shredder will be needed to process materials into smaller, more manageable pieces for further use.

Expected specification of the new products:

The expected specifications for the new products include full compliance with European Regulation 2019/1009, ensuring they meet safety and quality standards. The products will also carry the CE mark, signifying their conformity with EU regulations. These products will be classified as biostimulants, organic fertilizers, or organo-mineral fertilizers, depending on their formulation and use. Additionally, they will fall under the PFC 7 category (Fertilising product blend) indicating their role in enhancing plant growth and soil health.

Target KPIs (key performance indicator):

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Table 3: Key Performance Indicators of the investment case #3: AGRIENERGIA

Key performance indicator	Target
Biomass processed	4000 tons/year
Biofertilizer produced	2000 tons/year
Number of products	≥3
Number of field trials per fertilizer	2
Number of regions tested in different countries	2
Number of techno-economic reports and business cases	3
Increase in biogas production	10-15%

3.4. Investment case #4: DESARROLLOS AGROQUÍMICOS S.A.

Objective of the investment case:

Desarrollos agroquímicos S.A. (DASA) is a Spanish fertilizer and biostimulant manufacturer that has been in the fertilizing business since 1941. DASA designs, manufactures and markets its products in more than 15 countries and started its international expansion in the 1980s. DASA offers farmers tools to face the new climatic conditions that agriculture is facing nowadays, with a wide range of tailored products and the most appropriate strategies for each growing condition. DASA's exclusive production processes are designed to create plant extracts, and their in-house technical multidisciplinary team develops a wide range of plant extracts for crop nutrition and soil health products.

The main objective of this investment case is to develop a circular-economy-oriented project for production of natural biostimulants consisting of a range of high-efficiency products based on organic sources of Nitrogen, Phosphorous and Potassium.

Current design/production scheme:

DASA aims to develop innovative biostimulant products derived from various organic plant sources rich in nitrogen, phosphorus, and potassium. These plant-based biostimulants will be produced using DASA's laboratory facilities and pilot production plant, employing extraction processes tailored to optimize bioactive compound retention. The primary raw materials for these extracts will be sourced from plants cultivated in the surroundings of the DASA factory, ensuring sustainable and regionally sourced inputs. This approach integrates local agricultural compounds into high efficiency biostimulant formulations, leveraging advanced extraction techniques and circular economy principles to support both crop yield and soil health.

New developments/Changes to demonstrate in the investment case:

The investment case involves developing concentrated solid biostimulants—specialized formulations that promote plant growth and health by activating new mechanisms of action. Unlike conventional biostimulants, these are designed to stimulate unique physiological or biochemical pathways within plants, potentially leading to improved resilience, nutrient uptake, or growth efficiency. As a physicochemical treatment the semi-carbonization will be studied and applied to one raw material.

The investment case also includes plans for scaling up the production of these biostimulants from lab or pilot-scale to full-scale manufacturing, as well as commercializing the products, making them available for broader use in agriculture. This phase would involve refining the production process, ensuring quality control, and developing distribution strategies to bring these innovative products to market.

Industrial requirements of the investment case:

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

The industrial requirements for the investment case include the acquisition of a drying machine and the establishment of a greenhouse for conducting essential tests. The drying machine will be used to reduce water content in materials, thus minimizing the costs and challenges associated with water transportation. This will increase the efficiency of the production process, making it more cost-effective and environmentally friendly.

Additionally, a greenhouse will be set up to perform soil and plant incubation tests. These tests will be crucial for assessing the biostimulant effect of the developed product, allowing for the evaluation of its potential benefits for plant growth, soil health, and overall agricultural productivity. The greenhouse will provide a controlled environment where the impact on soil and plant development can be closely monitored and studied, helping to optimize the use of the product in various agricultural settings.

Expected specification of the new products:

The objective is to develop a solid product with a dark colour and a granule size that will be determined based on further testing and production requirements. As a biostimulant, the product will focus on enhancing plant tolerance to abiotic stresses, such as drought or extreme temperatures, helping improve resilience under challenging environmental conditions.

As a fertilizer, the product will be designed with carefully controlled NPK concentrations to ensure efficient nutrient delivery for optimal plant growth. The new products will fully comply with EU Regulation 2019/1009, ensuring they meet the required safety, quality, and environmental standards for agricultural use within the European Union. In this sense, this will boost the market outlets for the bioproducts. In 2024, 78% of the product was exported, with only 3.6% exported to Europe. However, the percentage of exports to Europe is expected to increase in 2025 with the incorporation of new European clients.

Target KPIs (key performance indicator):

Table 4: Key Performance Indicators of the investment case #4: DESARROLLOS AGROQUÍMICOS S.A.

Key performance indicator	Target
Number of formulated products	≥2
Number of pot test campaigns	≥3
Number of field trials	1
Number of regions tested in different countries	1
Number of crops tested	3

3.5. Investment case #5: N-FIX

Objective of the investment case:

N-Fix NV is an AgTech startup that was founded in July 2022. N-Fix is dedicated to supporting crop farmers, by providing cost- effective access to high-quality microbials (biofertilizers, biostimulants, and biopesticides). By upgrading agricultural and food industry residues, N-Fix aims to create a sustainable and geographically independent supply chain that reduces reliance on chemical fertilizers and facilitates the transition to sustainable, regenerative agriculture.

Investment Case #5 aims to produce high-quality microbials from agricultural biomass residues. The main objective is to demonstrate and scale up (TRL-8) a cost-effective solid-state fermentation process (up to 4.000 Ton/year) for microbial production avoiding single use of plastics and food ingredients. Other objectives are also to improve the formulation process for maximizing microbial shelf life and to evaluate and demonstrate the agricultural performance.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

Current design/production scheme:

Currently, microbials are produced by fermentation utilizing the submerged precision fermentation technology which relies on expensive growth media using food or feed. After fermentation, the final product is obtained once the fermentation broth is dried.

New developments/Changes to demonstrate in the investment case:

N-Fix has developed an innovative manufacturing process that enhances agricultural sustainability by transforming residual biomass streams, such as manure, into high-value organic fertilization products. The microbial manufacturing platform integrates hydrothermal carbonization (HTC), solid-state fermentation, and formulation to enable the cost-effective and sustainable production of microbial biofertilizers, biostimulants, and biocontrol agents.

The process begins with HTC, which converts biomass into a slurry containing hydrochar and process water while removing ammonia. After cooling to an optimal temperature, beneficial microorganisms are introduced and cultivated, allowing them to colonize the hydrochar by utilizing nutrients present in the process water, such as nitrogen (N), phosphorus (P), and dissolved carbon (C). The resulting mixture is then pelletized using specialized equipment, producing a uniform, easy-to-handle product suited for storage and field application. Pellet size and shape can be customized to match specific agricultural needs, optimizing application rates and ensuring compatibility with various row crops.

The task aims to optimize and scale-up the SSF development process at 1 m^3 scale. Optimization is done by monitoring process parameters such as pH, oxygen concentration, temperature, additional nutrients etc.

Industrial requirements of the investment case:

The industrial requirements for the investment case include the need for biomass residues as raw material, ensuring a steady supply from agricultural operations. It also requires specialized, off-the-shelf bioreactors and equipment for microbial production and fermentation. Additionally, the project must comply with EU environmental and quality standards for both biomass processing and microbial production.

Expected specification of the new products:

The final product will contain a high concentration of active microorganisms to enhance soil health and nutrient uptake. It will be compatible with a wide range of crops and various application methods, including foliar spraying, soil incorporation, and fertigation. The product will effectively promote plant and soil health, improving nutrient absorption, soil structure, and resistance to diseases, resulting in healthier crops and better yields. Additionally, it will meet EU standards for biofertilizers, ensuring safety and quality in line with Regulation 2019/1009, making it a reliable solution for sustainable agriculture.

Target KPIs (key performance indicator):

Table 5: Key Performance Indicators of the investment case #5: N-FIX

Key performance indicator	Target
Product purity	≥98%
Number of field trials	1
Product compliance with EU standards	Achieved
Product application form	3
Product shelf life	1 year
Product registration on national-level	Achieved

3.6. Investment case #6: VERAGROW

Objective of the investment case:

VERAGROW is a French SME based in Normandy, whose activity is the recovery of organic waste from agriculture, livestock or the food industry, into 100% natural fertilizers with exceptional qualities, obtained by vermicomposting. VERAGROW offers alternative and effective biological solutions to chemical fertilizers that respect the fauna and flora with revitalizing properties for the soil.

The objective of the investment case is to produce biostimulants ready-to-use derived from vermicompost, inspired by oxygenated compost tea. Additionally, the goal is to validate their agronomic performance in France and another EU country.

Current design/production scheme:

The production of vermicompost involve the use of tanks, a grinder, a homogenizer, and a manual packing machine, with a production capacity of 1,000 Liters per day. This vermicompost is the raw material that will be used as the main input to produce our different biostimulants

To date VERAGROW has developed 3 biostimulants: VERALEAF®, VERASPIDA® and VERATERRA® respectively dedicated to foliar application, seed coating and soil preparation before sowing.

New developments/Changes to demonstrate in the investment case:

Extract and concentrate all active principles and key elements from the vermicompost into a liquid format. This will require higher capacity equipment and a redefined production routine to optimize the process.

Industrial requirements of the investment case:

The industrial requirements for the investment case include modifications to the mixing tank, an upgrade to the sieving machine, and a transition from a manual to an automatic packing machine. Additionally, there will be a need to increase electricity capacity and accommodate higher water consumption.

Expected specification of the new products:

It is expected to maintain the same properties/characteristics of the current product. Additionally, it will meet EU standards for biofertilizers, ensuring safety and quality in line with Regulation 2019/1009, making it a reliable solution for sustainable agriculture.

Target KPIs (key performance indicator):

Table 6: Key Performance Indicators of the investment case #6: VERAGROW

Key performance indicator	Target
Daily production	6000 L/day in two batches
Number of field trials	2
Number of products	3
Number of regions tested in different countries	≥2
Number of homologations	≥2

3.7. Investment case #7: CYBELE

Objective of the investment case:

CYBELE AGROCARE provides sustainable agricultural solutions by producing soil-derived bacteria to enhance soil health and reduce reliance on mineral fertilizers. The company focuses on promoting soil biodiversity and cutting greenhouse gas emissions in European agriculture. CYBELE has successfully screened, selected, and industrialized phytobeneficial bacteria with biofertilization and biostimulation properties, addressing crop nutrition, climate resilience, and soil carbon storage. Collaborating with major cooperatives and seed producers in France and across Europe, CYBELE is the second-largest developer of Plant Growth-Promoting Rhizobacteria (PGPR) in France by market authorizations.

The objective of the investment case is to optimize and scale up the production, formulation, and field testing of PGPR-based biostimulants, particularly with *Azospirillum brasilense*. The goal is to improve the product's performance to replace mineral nitrogen fertilizers and promote sustainable agricultural practices across Europe. Additionally, the effectiveness of the current product will be enhanced.

Current design/production scheme:

The current design and production scheme includes the successful completion of the first phase of industrial-scale production of *Azospirillum brasilense*, with the product now available on the market at a Technology Readiness Level (TRL) of 7. Market authorization has been obtained in France and Germany, allowing the product to be sold in these countries. Additionally, the product has been tested under controlled conditions in a greenhouse to assess its performance.

New developments/Changes to demonstrate in the investment case:

The investment case will focus on several key developments and improvements. Industrial production will be optimized to maximize bacterial concentration, yield, and overall process robustness, ensuring the viability and stability of the final product. Innovative formulations will be developed to enhance strain activation, implantation, and phytobeneficial effects, improving the product's effectiveness in agricultural applications. Additionally, agronomic testing will be conducted to validate the product's efficacy and performance under real-field conditions.

Industrial requirements of the investment case:

The investment case requires the establishment of an optimized and scalable industrial production process to ensure efficiency, quality control, and regulatory compliance. Additionally, activators must be tested and validated to enhance bacterial strain performance, ensuring their compatibility with large-scale production and storage. To confirm the solution's applicability, multi-year agronomical trials must be conducted under diverse conditions, assessing crop performance, soil health, and economic benefits. Meeting these requirements will support the development of a validated, scalable, and market-ready solution.

Expected specification of the new products:

The new products will be formulated as PGPR-based biofertilizers specifically optimized for field crops. They will be designed to be fully compatible with conventional farming practices, ensuring easy integration into existing agricultural systems. Additionally, these biofertilizers will contribute to sustainability by reducing the CO_2 equivalent footprint compared to traditional farming methods that rely on mineral nitrogen fertilizers.

Target KPIs (key performance indicator):

Table 7: Key Performance Indicators of the investment case #7: CYBELE

Key performance indicator	Target
Number of products	1
Number of crops tested	3

Number of validations	3
Minimum number of regions tested	1

3.8. Investment case #8: AGENSO

Objective of the investment case:

AGENSO is an innovative SME based in Athens, Greece, specializing in ICT solutions for smart agriculture, environmental management, water management, and smart cities. The company develops IoT hardware, software, and Decision Support Systems (DSSs) to address climate change, food production challenges, waste prevention, and energy efficiency, promoting sustainability and a circular economy. Its team of 20 experts in software engineering, electronic engineering, and agriculture drives innovation in these fields.

The objective of the investment case is to development on an innovative tool that will assist end-users to optimize fertilizers application.

Current design/production scheme:

AGENSO has developed a GIS application that is able to host different layers and features of data display. This tool will be used as a basis to present data from soil sampling, drone images and satellite imagery and support end-user.

New developments/Changes to demonstrate in the investment case:

Such a tool does not exist, leaving farmers and farming advisors with no tools to cover the needs of fertilizing. The tool will provide interpolation maps to display the current conditions and prescription maps to guide fertilizer application.

Industrial requirements of the investment case:

There are no specific industrial needs for this phase of the project. The software is being developed by AGENSO, focusing on creating an advanced algorithm and user-friendly display. Additionally, validations will be conducted using selected sensors, along with the development of an information-gathering system to enhance data collection and analysis.

Expected specification of the new products:

A web-based digital tool is being developed to enhance agricultural monitoring and decision-making. This tool will allow users to input field points of interest with specific measurements for spatial monitoring. It will integrate data from drone-captured images and satellite imagery to provide a comprehensive analysis. The processed information will be visualized in an intuitive format, assisting end-users in making informed decisions.

Target KPIs (key performance indicator):

Table 8: Key Performance Indicators of the investment case #8: AGENSO

Key performance indicator	Target
Number of final integrated system developed and ready to enter market	1
Validation under real scenario	Achieved
Number of validation sites	3
Number of input information type in the tool	3

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

4. In-depth market-oriented customer needs analysis

The analysis has been based partially on information collected within the tasks of the project and reported on the deliverables D2.2 (Report on market trend analysis and ecosystem mapping) and D2.3 (Report on the state-of-the-art in the fertilizing industry).

4.1. Biofertilizers Industry & Market Overview

The biofertilizer industry is experiencing significant growth, driven by the increasing demand for sustainable agricultural practices and heightened awareness of the environmental impacts associated with chemical fertilizers.

4.1.1. Market Size and Growth

In 2024, the global biofertilizer market was valued at approximately USD 2.53 billion. Projections suggest that the market will grow from USD 2.83 billion in 2025 to USD 6.34 billion by 2032, exhibiting a compound annual growth rate (CAGR) of 12.21% during the forecast period. North America held the largest market share of 30.83% in 2024, with the U.S. market expected to reach USD 1.28 billion by 2032 [1]. In Europe, the biofertilizer market size is estimated at USD 1.14 billion in 2025 and is expected to reach USD 1.77 billion by 2030, growing at a CAGR of 9.3%[2]. This growth is largely attributed to the rapid expansion of the organic farming sector and the increasing regulatory focus on sustainability. The European Union saw a notable 10.8% increase in organic producers in 2022, with Italy leading the way, with more than 80.000 organic producers. During the last years, France was the largest market for biofertilizer in Europe, followed by Spain. This surge in organic farming has directly boosted the adoption of biofertilizers, as they are essential for maintaining soil health and meeting the demands of organic certification standards[3].

4.1.2. Key Trends, Drivers, and Challenges in the Biofertilizer Market

The biofertilizer market is influenced by a combination of key trends, drivers, and challenges. A primary trend is the increasing demand for sustainable crop production inputs, as both farmers and consumers increasingly embrace organic farming practices. This growing interest is driving the need for biofertilizers, which offer an eco-friendly alternative to chemical fertilizers. The European Union has played a significant role in promoting biofertilizers, actively encouraging farmers to transition to more sustainable options through the Common Agricultural Policy (CAP). This initiative supports organic farming and biobased products, including direct green payments to farmers who adopt sustainable practices. These policy efforts are a significant driver of the rising market demand for biofertilizers in the region[4,5].

Advances in microbial technologies also contribute to the market's expansion. Innovations in microbial strains and production methods have made biofertilizers more efficient and stable, leading to greater acceptance among farmers. These technological advancements are making biofertilizers a reliable and effective choice for sustainable farming.

However, despite these positive trends, several challenges hinder the widespread adoption of biofertilizers. Limited awareness of their benefits and potential, particularly among farmers accustomed to chemical fertilizers, remains a major barrier. Additionally, regulatory hurdles across regions complicate the market entry and expansion for biofertilizer producers. Supply chain limitations, particularly in remote areas, further restrict the accessibility of biofertilizers.

Despite these challenges, the ongoing environmental concerns surrounding chemical fertilizers and the economic advantages of biofertilizers—such as improved soil fertility and enhanced crop yields—are expected to drive continued market growth. Government support through policies, incentives, and subsidies will remain critical in encouraging the adoption of biofertilizers, solidifying their role in the sustainable agriculture movement.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

4.2. Customer Segmentation

A detailed analysis of the biofertilizer market requires an understanding of the different customer segments, their characteristics, and specific needs. The market for biofertilizers consists of a diverse group of farmers, ranging from smallholders to large-scale agribusinesses, with varying levels of awareness, financial capacity, and agronomic practices. Identifying these segments and their respective profiles enables a more targeted approach to promoting biofertilizer adoption and overcoming barriers to market penetration.

4.2.1. Customer Segments

The biofertilizer market can be broadly divided into three primary customer segments based on farm size, fertilization practices, and level of engagement with sustainable agricultural solutions.

The smallholder farmers segment includes those managing relatively small plots of land and operating within strict financial constraints. These farmers generally have limited access to technical knowledge and rely heavily on external advisory services. Although some smallholders recognize the potential benefits of biofertilizers, adoption remains low due to budget limitations, skepticism about product performance, and a lack of readily available supply channels. Cost-sensitive by nature, smallholder farmers require affordable and easy-to-use biofertilizer solutions with clear agronomic benefits.

The medium-scale farmers segment consists of producers who have some level of financial flexibility and access to technical expertise. They are more likely to experiment with biofertilizers but remain cautious due to concerns about inconsistent performance and return on investment. Medium-scale farmers often adopt a hybrid approach, combining conventional fertilizers (such as NPK, used by 52.38% of respondents) with biofertilizers to assess their impact on yield and soil health. Many in this segment express interest in sustainable practices but require further education and financial incentives to increase biofertilizer use.

The large-scale agribusinesses segment includes highly mechanized and commercially driven operations that prioritize efficiency, yield optimization, and long-term soil health. These businesses have access to expert agronomic advice and are more likely to integrate innovative fertilization strategies if they prove cost-effective and scalable. However, despite their financial capacity, large agribusinesses remain cautious about adopting biofertilizers due to concerns about product consistency, scalability, and regulatory uncertainty. Some rely on organic fertilizers, such as manure and compost, but on-farm production remains limited, with only 28.6% of farmers producing their own organic inputs.

4.2.2. Customer Profiles

Based on the segmentation analysis, distinct customer profiles can be identified, each with unique motivations, barriers, and decision-making processes regarding biofertilizer adoption.

The Traditional Farmer represents those who predominantly rely on conventional fertilizers and are reluctant to transition to alternative solutions. This group prioritizes cost and immediate yield impact over sustainability. Their main barriers to biofertilizer adoption include limited awareness, skepticism about performance, and resistance to changing long-established farming practices.

The Pragmatic Adopter includes farmers who recognize the benefits of biofertilizers but require clear evidence of their effectiveness before fully integrating them into their fertilization routines. These farmers often start with small-scale trials, applying biofertilizers at moderate rates (10–50 kg/ha annually) while maintaining conventional fertilizers as a safety net. Their purchasing decisions are influenced by agronomist recommendations, government incentives, and product reliability.

The Sustainability-Oriented Farmer is committed to regenerative agriculture and seeks to reduce chemical inputs while improving soil health. This group actively looks for bio-based solutions and may already be using compost, manure, or biostimulants such as humic acids and seaweed extracts. However, these farmers face challenges related to high costs, limited product availability, and insufficient institutional support, with 73.68% believing that EU policies do not provide adequate assistance for fertilizer alternatives.

The Tech-Savvy Agribusiness consists of large-scale commercial farms that adopt data-driven decision-making and integrate new technologies when they provide measurable benefits. These businesses require standardized, high-performance biofertilizer products that fit into precision agriculture models. While interested in biofertilizers, they demand scientifically backed results, competitive pricing, and a reliable supply chain to ensure consistency at scale.

4.2.3. Implications for Market Strategy

The diversity of customer segments and profiles necessitates a differentiated market strategy to effectively promote biofertilizer adoption. Smallholders require cost-effective solutions and stronger advisory support, including localized demonstration projects to showcase real-world benefits. Medium-scale farmers benefit from targeted incentive programs and tailored educational resources to build confidence in biofertilizer performance. Large agribusinesses need assurances regarding product reliability, standardization, and compatibility with existing fertilization regimes.

To address the market needs of these diverse segments, product development efforts should focus on improving performance consistency, offering scalable formulations, and enhancing distribution networks to increase accessibility. Policy interventions, including financial incentives and regulatory support for biofertilizer adoption, would further facilitate market growth by addressing cost concerns and supply chain limitations.

A well-structured approach to market segmentation and customer profiling provides valuable insights for designing targeted outreach programs, optimizing product offerings, and ultimately accelerating the transition toward more sustainable fertilization practices in European agriculture.

4.3. Customer Needs

A comprehensive understanding of farmers' needs and challenges is essential for facilitating the adoption of biofertilizers. Although 57.14% of farmers report familiarity with biofertilizers, none consider themselves "extremely familiar," indicating a substantial knowledge gap that may hinder effective adoption. Additionally, factors such as cost, product performance, and accessibility remain critical barriers to widespread implementation.

4.3.1. Factors Influencing Purchase Decisions

Farmers evaluate several factors when considering the adoption of biofertilizers, with cost-effectiveness being a primary concern. Most farmers allocate less than €80 per hectare annually for fertilization, which makes biofertilizers relatively expensive compared to conventional fertilizers. While expectations regarding yield improvements vary, many farmers anticipate modest increases of 1–10%. However, 25% of respondents report no perceived improvement, likely due to inconsistent product performance or mismatches between biofertilizers and specific soil or crop conditions.

Beyond economic considerations, soil health and environmental benefits are recognized advantages of biofertilizers. Many farmers acknowledge their potential for improving long-term soil fertility and sustainability. However, these benefits do not always translate into immediate financial returns, limiting their influence on purchasing decisions. Additionally, ease of use and compatibility with existing fertilization practices are significant factors. Conventional fertilizers continue to dominate, with 52.38% of farmers applying NPK formulations as their primary nutrient source. Transitioning to

biofertilizers requires changes in application methods, which can be perceived as an operational challenge.

4.3.2. Key Barriers to Adoption

Despite growing interest in biofertilizers, several challenges continue to hinder their broader adoption. Limited technical knowledge and inadequate advisory support remain significant obstacles. While over half of farmers are familiar with biofertilizers, many lack a detailed understanding of proper application methods, product compatibility, and expected agronomic outcomes. Agronomists and agricultural advisors play a critical role in guiding farmers, highlighting the need for enhanced technical training and extension services.

Cost remains a major deterrent, as farmers operate within strict financial constraints. The perceived high cost of biofertilizers, combined with concerns about inconsistent efficacy, discourages adoption. Biostimulants, which could complement biofertilizers, are also underutilized, with 57.1% of farmers not incorporating them into their fertilization strategies. Even among users, expenditure remains low, typically below €50 per hectare annually.

Variability in product performance further complicates adoption. While some farmers report moderate yield improvements, others experience no noticeable benefits, leading to skepticism regarding product reliability. This inconsistency may result from variations in soil conditions, inadequate application methods, or the selection of inappropriate biofertilizer products. Addressing these concerns through improved formulations and precise recommendations tailored to specific crops and soil types is crucial.

Supply chain limitations also present a challenge, as 81.0% of farmers rely on external suppliers for biofertilizers, reflecting limited on-farm production capacity. This dependency increases costs and raises concerns about product availability, particularly in regions with underdeveloped distribution networks. Expanding access to locally produced biofertilizers could enhance affordability and reduce logistical constraints.

A lack of policy and institutional support further exacerbates these challenges. A significant majority of farmers (73.68%) believe that EU support for fertilizers, including biofertilizers, is insufficient. Stronger policy incentives, such as subsidies, tax reductions, and research funding, could enhance adoption rates by making biofertilizers more economically viable. Additionally, aligning regulatory frameworks with circular bioeconomy principles could facilitate the integration of organic waste into biofertilizer production, further promoting sustainability.

4.3.3. Untapped Opportunities & Potential Solutions

To overcome the existing challenges, several opportunities arise to accelerate the adoption of biofertilizers through targeted interventions. First, expanding education and training programs for farmers, supported by agronomists and advisory services, would help close the knowledge gap and improve application practices. Digital advisory tools, workshops, and technical support networks could further facilitate knowledge transfer.

Also, cost reduction strategies, including targeted subsidies, tax incentives, and cooperative purchasing schemes, could alleviate financial constraints and make biofertilizers more accessible. Encouraging bulk purchasing agreements among farmer cooperatives could also help lower costs.

Improving product performance through the development of more stable, efficient, and crop-specific biofertilizer formulations is essential for increasing farmer confidence. Research and development efforts should focus on enhancing the consistency and effectiveness of biofertilizers under different agronomic conditions.

Strengthening supply chains by promoting local biofertilizer production and improving distribution networks could enhance accessibility and affordability. Encouraging on-farm production of organic fertilizers, such as compost and manure-based biofertilizers, could reduce dependence on external suppliers. Currently, only 28.6% of farmers produce organic fertilizers on-farm, indicating significant potential for expansion. Additionally, livestock waste integration could be further promoted, as manure already constitutes over 50% of fertilization inputs for those who engage in on-farm fertilizer production.

Finally, enhancing policy support through increased EU funding for biofertilizer adoption, research grants, and incentive programs would further facilitate market growth. Aligning biofertilizer policies with broader sustainability and circular bioeconomy strategies could also drive innovation and adoption.

4.4. Europe Competitive Landscape

The biofertilizer market is highly competitive, with several leading companies offering innovative products and solutions. These companies cater to the growing demand for sustainable and eco-friendly agricultural inputs, leveraging advanced microbial technologies and natural resources to improve soil health and enhance crop yields.

The biofertilizer market in Europe is rapidly evolving, driven by the increasing demand for sustainable agricultural practices and eco-friendly solutions. Companies across the continent are focusing on enhancing soil fertility, improving plant growth, and promoting environmental sustainability through innovative biofertilizers and biostimulants. These companies, spread across various European countries, offer a diverse range of products, each contributing to the advancement of organic and sustainable agriculture.

In the United Kingdom, Bionema Group Ltda. stands out with its BioNFix biofertilizers and a wide array of biostimulants, including Rootvita, Groprim, and Floretocare. These products focus on enhancing nitrogen fixation and optimizing nutrient absorption, leveraging microbial strains like *Paenibacillus azotofixans* and *Azospirillum lipoferum*. Another key player, Seafields, is making significant strides in addressing environmental challenges by utilizing Sargassum biomass for atmospheric CO2 capture, which is then transformed into bioplastics, biofertilizers, and biofuels, thus contributing to both agriculture and sustainability.

In Spain, companies like Corteva Agrisciences, Chlydro, and Rovensa Next are at the forefront of biofertilizer innovation. Corteva's Vitasoil and biostimulants such as TrichoSym Bio and Mycoup aim to enhance plant nutrition and resilience to abiotic stress, improving the overall health of crops. Chlydro focuses on microalgae biomass to capture CO_2 from wastewater, producing biofertilizers with added ecological benefits. Rovensa Next offers a range of products based on *Bacillus subtilis*, such as Wiibio and Brotaverd, that enhance soil microbiota, boost plant development, and regenerate soils for more sustainable agricultural practices.

France is home to numerous influential companies specializing in biostimulants and biofertilizers. Elephant Vert provides 100% natural organic fertilizers like Fertinova and Novastim, while Terrial focuses on the conversion of organic waste into fertilization solutions, further promoting sustainability. Agrauxine by Lesaffre, a division dedicated to biosolutions, utilizes microorganisms for biocontrol, biostimulants, and bionutrition. Other noteworthy French companies include Veragrow, Gaiago, Mycea, Penn-Ar-Bed, Laboratoire Biodevas, Invers, and Mycophyto, each offering unique approaches to sustainable plant growth, such as utilizing earthworm science, mycorrhizal fungi, and marine resources.

Italy also plays a significant role in the European biofertilizer market, with companies such as Italpollina, SCAM, Agronutrion, and Fertileva offering a range of biofertilizers and biostimulants

aimed at improving soil health and fostering sustainable farming practices. Italpollina's products, including Guanito and Italpollina 4-4-4, focus on natural soil fertility enhancement, while SCAM's biofertilizers like Algae Fitostim promote healthy crop growth. Agronutrion and Fertileva offer liquid fertilizers and organic solutions that help optimize plant nutrition and support the natural vitality of soils.

Other key Italian companies, including Agribios, Agricola Internazionale, Novafert, Compo Expert, LEA, Brenntag, UNIMER, Germina, A.G.M. Srl, Organazoto, FCP Cerea, and ILSA, further expand the range of biofertilizer and biostimulant products available to European farmers. These companies specialize in various types of fertilizers, ranging from organic to organo-mineral, as well as products designed to optimize nutrient absorption, promote soil health, and reduce the environmental impact of conventional farming.

On the international stage, YARA is a significant player, providing a wide array of nitrogen-based and compound fertilizers designed for precision farming and sustainable agricultural practices.

Overall, the European biofertilizer market is characterized by its diversity, with a growing emphasis on eco-friendly, organic solutions that cater to the increasing demand for sustainable agriculture. As companies innovate and expand their product portfolios, they contribute to the transition towards a more sustainable and productive agricultural system, one that reduces dependence on synthetic chemicals while improving soil health and enhancing crop yields. This competitive landscape reflects the broader trend toward sustainability in agriculture, making biofertilizers and biostimulants essential components in the future of European farming

4.5 Regional market of the investment cases

The Regional Innovation Valleys (RIVs) initiative is one of 25 actions under the New European Innovation Agenda (NEIA). Its goal is to unlock Europe's full innovation potential by linking highly innovative regions with those that are less developed, fostering collaboration to tackle societal challenges through advanced technology.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

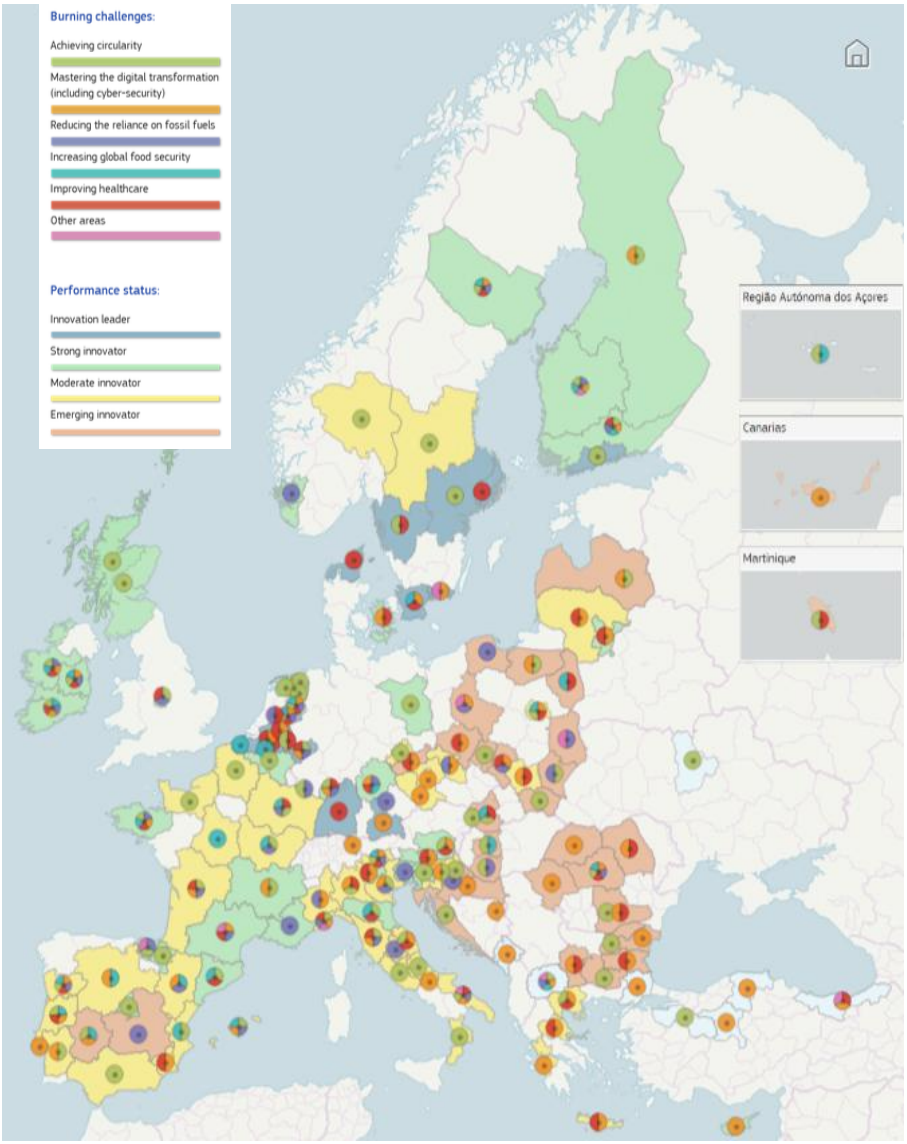

Figure 1. Interactive map of the Regional Innovation Valleys

Across 146 participating regions, competitive advantages are identified and leveraged to close the innovation gap, strengthening Research & Innovation ecosystems through complementary expertise[6].

The regions hosting the investment cases can be classified regarding the performance (innovation leader, strong innovator, moderate innovator and emerging innovator) and the cohesion view (more developed region, transition region and less developed region).

From a performance perspective, the region of IC-5, Oost-Vlaanderen (Belgium), is classified as an innovation leader. The regions of IC-2 and IC-4, Catalonia (Spain), along with IC-3, Emilia-Romagna (Italy), are considered strong innovators. Meanwhile, IC-1, Coimbra (Portugal), IC-6, Basse-Normandie (France), IC-7, Île-de-France (France), and IC-8, Attiki (Greece), fall into the category of moderate innovators.

From a cohesion perspective, IC-2, IC-3, IC-4, and IC-5 are classified as more developed regions, whereas IC-6 and IC-7 are categorized as transition regions. Finally, IC-1 and IC-8 are classified as less developed regions.

These differences in classification across the investment cases highlight the regional disparities in innovation capacity, which in turn influence trends, needs, and regulatory frameworks in the biofertilizers market. Next, a more specific analysis of the regional markets for each investment case will be presented.

4.5.1. Spain (Catalonia)

Catalonia is one of Spain's most advanced regions in terms of sustainable agriculture and innovation in agri-food systems. The regional government strongly supports organic farming and the use of bio-based products through its Agri-Food Strategic Plan, aligned with EU initiatives such as the Farm to Fork Strategy and the Green Deal. Catalonia also plays a leading role in implementing the Spanish Circular Economy Strategy, promoting the use of organic waste for the production of biofertilizers.

The region has a well-developed agricultural sector, particularly in high-value crops such as fruits, vegetables, vineyards, and olive groves—sectors that are more likely to adopt biofertilizers due to their sensitivity to soil health and environmental impact. Catalonia also benefits from a robust research and innovation ecosystem, with public and private entities engaged in developing biostimulants, microbial inoculants, and compost-based fertilizers. Furthermore, local policies incentivize organic production, reduce chemical inputs, and support precision agriculture, fostering a favourable environment for the uptake of biofertilizers.

4.5.2. Italy (Emilia-romagna)

Emilia-Romagna is a major agricultural hub in northern Italy, known for its high-quality food production and innovation in sustainable farming practices. The regional government has implemented policies under the Piano di Sviluppo Rurale (Rural Development Plan) to promote organic and low-input agriculture. These include financial incentives for farmers adopting biofertilizers and for companies investing in bio-based product innovation.

The region hosts several agricultural research institutes, universities, and technology parks focused on biotechnology and bioeconomy, which actively collaborate with the private sector to develop and commercialize biofertilizers. Emilia-Romagna's agri-food sector—ranging from vineyards and horticulture to cereals and industrial crops—presents multiple opportunities for biofertilizer application. The increasing concern for soil degradation, nitrate pollution, and climate resilience further accelerates the demand for sustainable fertilization solutions.

4.5.3. France (Normandie/Île de France)

France has taken a proactive role in integrating biofertilizers into its agricultural strategy through its Plan Écophyto and the National Bioeconomy Strategy. While the term "biofertilizer" is not always explicitly used in regulations, the promotion of organic amendments, composts, and biostimulants falls under various policy frameworks aimed at reducing synthetic inputs.

In Île-de-France, the biofertilizer sector is supported by its proximity to major R&D centers, universities, and startups specializing in agritech and circular bioeconomy. The region's intensive horticulture, greenhouse production, and urban agriculture create a strong market for advanced fertilization solutions, including microbial and organic-based products.

In Normandy, a more rural region with a strong presence of cereal crops and livestock farming, biofertilizer adoption is emerging, particularly in response to nutrient management regulations and EU nitrate directives. Local pilot projects and regional development programs are beginning to support the transition toward circular fertilization practices using manure, compost, and digestate as raw materials.

Organic matter is abundant in Normandy, particularly from livestock farming. In addition, Normandy is the largest equestrian area in France, which generates large quantities of manure. Covering 70% of its territory, agriculture is a major part of Normandy's economic landscape. It is also, through its practices and diversity, an activity that shapes the Normandy landscape.

4.5.4 Portugal (Coimbra)

In Portugal, the national Strategic Plan for the Common Agricultural Policy (PEPAC) encourages the use of organic and circular fertilization practices to improve soil health and reduce dependency on imported synthetic fertilizers. Coimbra, located in the central region of Portugal, is characterized by diversified agriculture, including vineyards, olive groves, and horticultural crops, which are suitable for the use of biofertilizers.

The region is also involved in research initiatives under EU-funded projects that promote the development of microbial biofertilizers, and composted organic materials derived from agricultural and agro-industrial waste. Public policy at both national and regional levels supports the valorisation of biowaste and the production of organic fertilizers as a strategy to enhance soil fertility, close nutrient loops, and mitigate environmental impacts.

4.5.5. Belgium (Oost-Vlaanderen)

Belgium, particularly the region of Oost-Vlaanderen, has a highly technological agricultural sector, with a strong presence of horticulture and intensive crop production underpinned by high-tech farming practices and innovative research collaborations. The adoption of biofertilizers is driven by European regulations and green ambitions, alongside a growing demand for more sustainable agricultural products in international markets.

Agricultural biotechnology in the region is dynamic and rapidly evolving sector, supported by significant collaborations between research institutions, universities, and industry players. Flanders is home to leading research centres such as the Ghent Centre for Plant Systems Biology, as well as Flemish Institute of Biotechnology (VIB) which are internationally recognised centres of excellences. These institutions, amongst others based in Flanders, have been instrumental in bridging scientific research and agricultural applications, contributing to the development and validation of innovative biofertilizers[7].

Flanders, and especially the region of Ghent in Oost-Vlaanderen, has become a hub for plant biotechnology, and research and development activities. Major agribusiness companies such as BASF, Syngenta and Inari operate within this innovation ecosystem[8].

Since the late 1990's, VIB has established a strong track record in spinning off successful agricultural biotech companies, contributing significantly to the regional bioeconomy. Notable spin-offs include Devgen, CropDesign, Biotalys, Aphea.bio and Protealis. Between the spin offs and the VIB research centre, they form one of the world's major biotechnology research and development clusters, employing over 1,000 people dedicated to plant biotechnology[9].

Devgen, VIB's first spin off began with a Nematode/RNAi screening platform and evolved into a seed technology company before being acquired by Syngenta in 2012. Biotalys develops protein-based biocontrol products originally derived from research at VIB and Vrije Universiteit Brussel (VUB), aimed at replacing chemical pesticides. Aphea.bio produces biofertilisers and biostimulants using natural microbial consortia, targeting staple crops like wheat and maize. Finally, Protealis born from a strategic alliance between VIB and ILVO, focuses on breeding legumes and enhancing their performance through innovative seed coatings[10].

4.5.6. Greece (Attiki)

Attiki, encompassing the capital region of Athens, has a mixed agricultural profile with olive groves, vineyards, and peri-urban farming. While Greece as a whole faces challenges in terms of fertilizer import dependency and soil degradation, there is growing recognition of the role of biofertilizers in supporting sustainable agriculture. National policies, guided by the Greek Strategic CAP Plan, are beginning to emphasize the importance of soil health and the reduction of chemical inputs.

In Attiki, innovation hubs and agritech startups are emerging, contributing to the early-stage development of the biofertilizer market. The region also benefits from pilot initiatives and EU-funded projects aiming to demonstrate the viability of microbial inoculants and compost-based fertilizers. Nevertheless, awareness among farmers and access to reliable products remain key challenges, requiring further policy support and knowledge transfer.

5. Conclusions

This deliverable brings together the key findings from eight innovative investment cases focused on scaling up sustainable biofertilizer and biostimulant solutions across Europe. The cases reflect a wide range of technologies, from composting and solid-state fermentation to gel and microbial formulations, many of which make use of agricultural and industrial by-products, reinforcing the principles of circular economy.

Each case responds to specific regional needs and market conditions, showing the diversity of Europe's agricultural landscapes and levels of innovation. For each initiative, clear technical goals and Key Performance Indicators have been defined to measure progress in production, product quality, regulatory alignment, and agronomic validation. These KPIs are aligned with the EU Fertilising Products Regulation (2019/1009) and broader EU goals, such as those in the Farm to Fork Strategy, which aims to reduce nutrient losses and strengthen soil health.

The market analysis section highlights several challenges slowing the adoption of biofertilizers, including low awareness among farmers, concerns about product consistency, high production costs, and regulatory complexity. At the same time, it identifies strong opportunities for growth, thanks to rising demand for sustainable farming solutions, emerging policy support, and advances in microbial and digital agriculture technologies.

Moving forward, there is a clear need to support education and technical outreach for farmers, improve the performance and affordability of products, strengthen local supply chains, and encourage closer collaboration between companies, researchers, and policymakers. Equally important is the role of clear, supportive regulation and targeted financial incentives to boost adoption and help these innovations reach the market.

Overall, this deliverable provides a solid foundation for shaping industrial strategies, market approaches, and policy recommendations to advance biofertilizers as a cornerstone of Europe's transition to a more sustainable, resilient agricultural system.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

6. References

1. Fortune Business Insights. (2024). *Biofertilizers Market Report*. Retrieved from https://www.fortunebusinessinsights.com/industry-reports/biofertilizers-market-100413
2. Mordor Intelligence. (2024). *Europe Biofertilizers Market Report*. Retrieved from https://www.mordorintelligence.com/industry-reports/europe-biofertilizers-market
3. Yadav, A., & Yadav, K. (2024). Challenges and Opportunities in Biofertilizer Commercialization. *SVOA Microbiology*, *5*(1), 01-14.
4. Ibáñez, A., Garrido-Chamorro, S., Vasco-Cárdenas, M. F., & Barreiro, C. (2023). From lab to field: Biofertilizers in the 21st century. *Horticulturae*, *9*(12), 1306.
5. European Commission: European Innovation Council and SMEs Executive Agency, *A new european innovation agenda – Connected innovation ecosystems*, Publications Office of the European Union, 2025, https://data.europa.eu/doi/10.2826/4674992
6. European Commission. (2025). *Selected regional innovation valleys*. Retrieved from https://projects.research-and-innovation.ec.europa.eu/en/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda/new-european-innovation-agenda-roadmap/selected-regional-innovation-valleys
7. Segers, Jean-Pierre. (2017). Green Biotechnology in Belgium: The Ghent Innovation District. SSRN Electronic Journal - Biotechnology eJournal. 1. 2. 10.2139/ssrn.2986113.
8. *Ghent R&D Hub*. (2017). VIB Meets Agricultural Biotechnology. https://agribiotech.sites.vib.be/en/ghent-rd-hub
9. *Agribiotech cluster in Ghent*. (2025). VIB.BE. https://vib.be/en/business/our-success-stories/agribiotech-cluster-ghent
10. *VIB spin-offs*. (2021). VIB Meets Agricultural Biotechnology. https://agribiotech.sites.vib.be/en/vib-spin-offs