B-Ferst

From waste to growth: sustainable agriculture with B-Ferst

Advanced Technology Brochure

July 2024

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Introduction

The agricultural sector: challenges and next steps

> ***"We must work together with the men and women in EU farming to secure our food supply for the future. Our farmers face mounting challenges: that is why we want to launch a strategic dialogue on the future of EU agriculture. I am convinced that agriculture and protection of the natural world can go hand in hand. We need both"***

Ursula von der Leyen,
President of the European Commission, State of the Union, 2023

The EC's focus on research in agriculture is undeniable through strategies such as the European Green Deal (GD) and the Farm to Fork (F2F) strategy that envisage a total investment of €10 billion on R&I under mainly Horizon Europe[1]. As part of the F2F strategy, the EU plans to **reduce nutrient losses by 50% while ensuring that there is no deterioration in soil fertility**. As part of the GD, the Commission also commits to help prevent excessive use of fertilisers while fostering the recycling of nutrients from different kinds of organic waste. In addition, the **Circular Economy policy aims to move to mineral/ inorganic to organic nutrient providers from recycled and biowaste sources**.

Such consistent investment and policy action play an important role in supporting the agricultural sector as it faces many challenges which require wider collaboration across the value chain.

On the one hand, the European Union depends largely on non-renewable external raw materials and uses natural gas as the main energy source in the manufacture of fertilisers. On the other hand, certain nutrients applied in fertilization can be lost in the environment for various reasons such as their management in the field, soil characteristics or environmental conditions.

It is now more than ever necessary to develop creative ideas to help:

- → Promote the circular economy.
- → Protect nutrients and improve their efficiency.
- → Extend the use of low-carbon fertilisers.
- → Implement cultivation and manage techniques.

The overall aim of this is to achieve the **ambitious sustainability objectives that we have set for ourselves**.

[1] Data taken from https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf

B-Ferst role

In view of these challenges, B-Ferst has an important role. This project aims not only to produce innovative fertilisers, ensuring the reuse of biowaste and agrifood waste, but it is also committed to releasing onto the market a product that improves soil quality and reduces environmental impact.

B-Ferst's proposition is therefore based on the reuse of biowaste to replace non-renewable, non-domestic and energy intensive raw materials (nutrients, additives, and polymers). This entails the creation of new circular bio-based value chains which, in turn, entails greater collaboration amongst the agricultural sector and the stakeholders involved in the production of fertilisers.

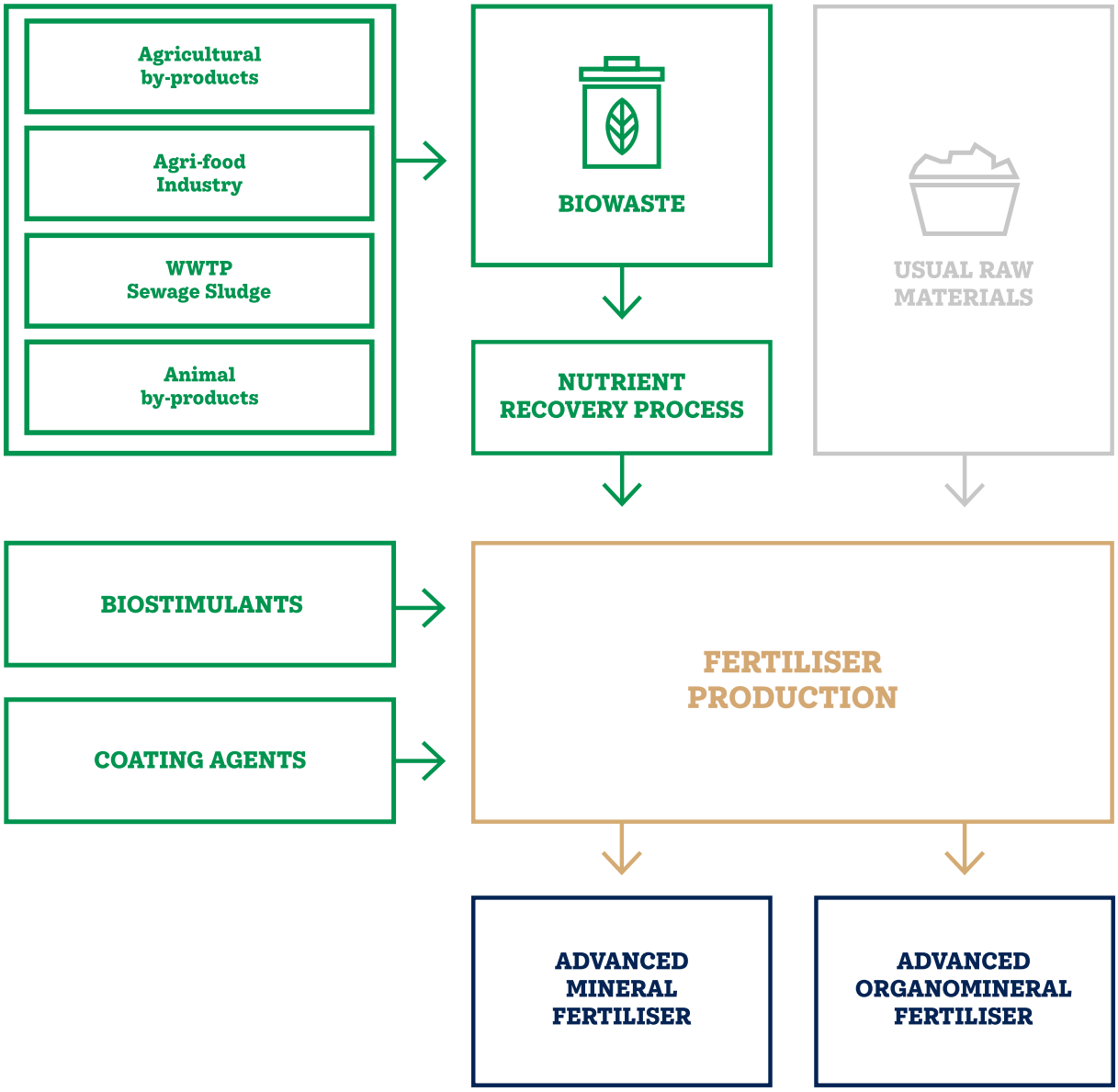


Figure 1. Cicle of production of BFerst fertiliser

Innovating agriculture with B-Ferst

The new eight fertilisers developed within B-Ferst

B-Ferst's main objective has been to integrate the valorisation of bio-wastes in agriculture management plans to **create new circular and bio-based value chains from bio-waste**, municipal waste management, agrifood industries, considering an interaction between farming and fertiliser sectors. In order to incorporate these new materials, it is important to consider **several factors** such as quality, safety, industrial process, logistics, economic viability, regulation, and life cycle.

Keeping these factors in mind, **eight specialised fertilisers** have been developed within B-Ferst:

1. Bio-based mineral fertiliser.

2. Bio-based mineral fertiliser enhanced with microbial plant biostimulants[2] (MPBs).

3. Bio-based mineral fertiliser enhanced with non-microbial plant biostimulants (NMPBs)[3].

4. Organo-mineral fertiliser enhanced with MPB.

5. Organo-mineral fertiliser with NMPB.

6. Bio-based organo mineral fertiliser enhanced with MPB.

7. Bio-based organo mineral fertiliser enhanced with NMPB.

8. NMPB based on bio-waste by-products from dry industrial oil crops or compost.

[2] Certain microorganisms that stimulate natural plant nutrition processes, improving plant nutrient use efficiency, tolerance to abiotic stress, quality characteristics or increasing the availability of nutrients confined in the soil or rhizosphere. They act as a complement to fertilisers, with the aim of optimizing their efficiency and reducing nutrient application doses..

[3] These rely on chemical or biological compounds that do not involve live microorganisms

The specialised nutrient mixes are required for a **more sustainable management of resources** by tailor-made nutrient dosing adapted to farmer systems.

By **associating bio-based nutrients with plant biostimulants**, B-Ferst aims to develop and place onto the market sustainable agricultural products.

→ **Product #1** contains a certain proportion of biobased nutrients that are able to replace the conventional raw materials partially. These nutrients come from ashes, recovered phosphates (i.e. input from P-recovery stage developed within B-Ferst Project), among other selected biowastes.

→ **Product #2 and #3** are based on the Product #1 enhancement by adding new biobased biostimulants (MPB or NMPB) and biodegradable coatings. All have been developed using biowastes from different sectors, which means that even the specialised additives come from biobased sources. They are able to improve the agronomic efficiency of the recovered nutrients.

→ **Products #4, #5, #6, and #7** contain specifically selected organic matter (vegetable biomass) from different origins. Moreover, #P4 and #P5 are coated with the developed biostimulants and coatings that increase the efficiency of the formulated organomineral fertiliser.

Similarly to #P2 and #P3, Products #6 and #7 also include a certain proportion of biobased nutrients, biostimulants and biodegradable coatings that, together with the high quality organic carbon, constitute a new family of enhanced biobased fertilisers.

→ **Product #8** as NMPB based on biowaste from industrial oil crops is based on the enzymatic process on seeds from dry oleaginous that is able to obtain proteins hydrolysates with bio-stimulant effects.

Table 1 summarises and quantifies the range of composition and biobased nutrients replacement within the B-Ferst products.

B-Ferst Product	BB Material	Organic Carbon	Recovered Nutrients
#1 M-BBx-0	10-25%	0	4 - 25.4 %
#2 M-BBx-MPBx	10-25 %	0.6 - 2.1 %	5.2 - 30.5 %
#3 M-BBx-NMPBx	10-25%	0.1 - 0.3 %	4.7 - 26.2 %
#4 OM-0-MPBx	35%	8.1 - 9.6 %	15.3 - 24.7 %
#5 OM-0-NMPBx	35%	7.5 %	14.8 - 20.6 %
#6 OM-BBx-MPBx	45%	7.5 %	18.7 - 32.3 %
#7 OM-BBx-NMPBx	45%	7.5 %	21.2 - 35.7 %
#8 0-0-NMPBx	> 95%	> 15 %	0.15 %

Table 1. B-Ferst products description

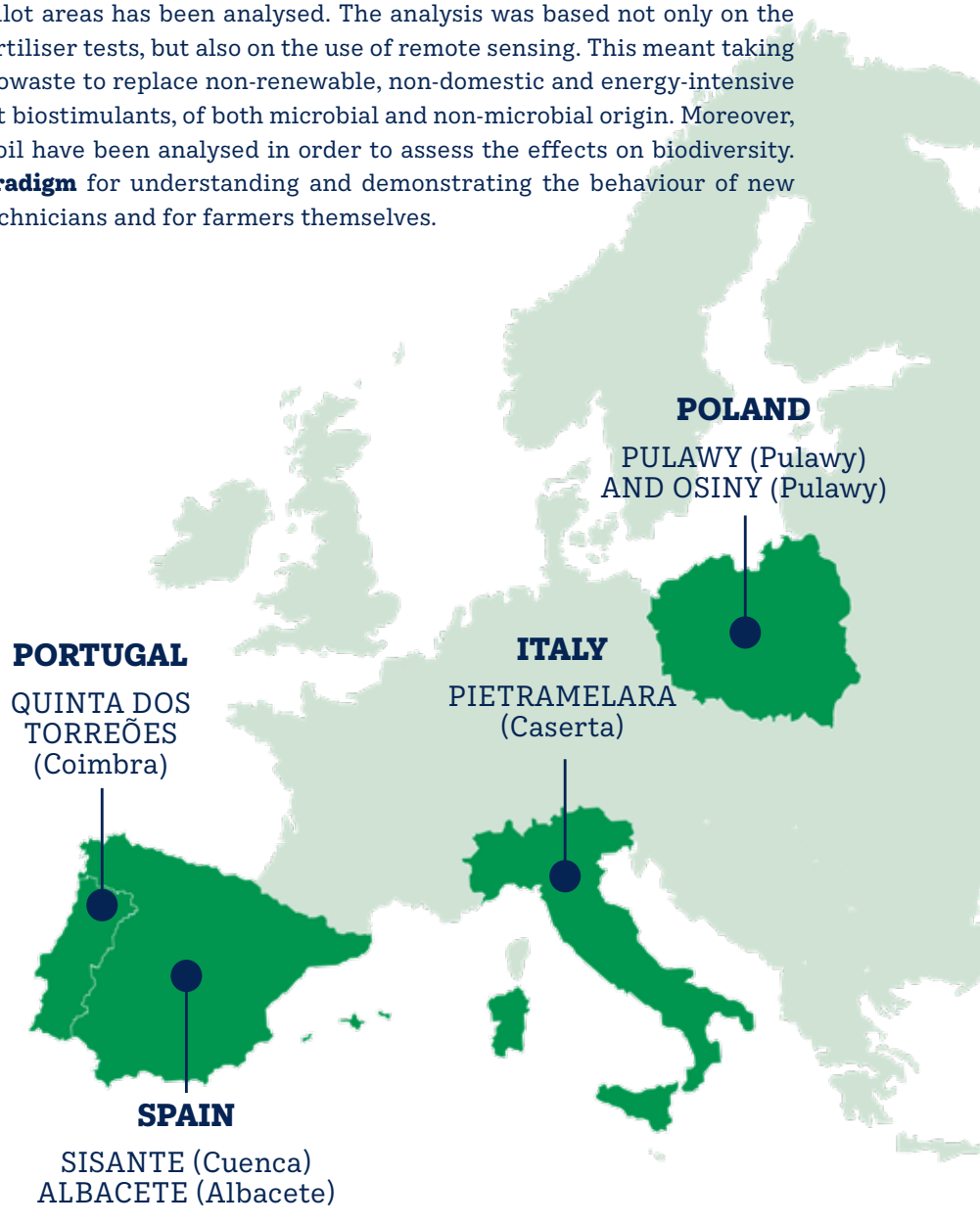
Demonstrating sustainable value chains

The field trials and the demo plants

In order to test the fertilisers, B-Ferst held field trials in pilot areas located in different climatic areas.

The trials aimed to **demonstrate the behaviour and performance** of the new fertiliser products on a representative range of commercial plots. A comprehensive performance evaluation was carried out on commercial plots during three campaigns, on various crops (some under irrigation and others rainfed) and in four countries (Italy, Portugal, Spain, and Poland), selected for their fertiliser consumption and their different agroclimatic zones.

The data collected from all the pilot areas has been analysed. The analysis was based not only on the standard parameters of typical fertiliser tests, but also on the use of remote sensing. This meant taking into consideration the reuse of biowaste to replace non-renewable, non-domestic and energy-intensive raw materials, and the use of plant biostimulants, of both microbial and non-microbial origin. Moreover, the biological properties of the soil have been analysed in order to assess the effects on biodiversity. These trials represent a **new paradigm** for understanding and demonstrating the behaviour of new fertilisers, both for specialised technicians and for farmers themselves.



The eight innovative fertilisers were formulated and optimised at Fertiberia facilities in Seville and Huelva, where **two demo plants** (nutrient recovery and biobased coatings) have been built.

One demo plant was developed to solubilise nutrients from biobased waste. In particular, it was designed to recover phosphate from biowaste such as ashes from sewage sludge, agrifood, oil crops and livestock waste. **This first-of-its-kind demo plant is based on a novel acid leaching technology**.

The other demo plant was developed for **adding bio-based coatings with a wide range of properties** (physical, chemical and biological). This process entails adding biostimulants (MPB or NMPB) to improve soil nutrients. Biodegradable coatings based on biopolymers will be used to guarantee the performance of certain biostimulants.

These two innovative processes of nutrient recovery and coating were introduced as part of B-Ferst in order to make the manufacturing process more sustainable and have an improved and more sustainable final product thanks to the reuse of biowaste.

How to encourage farmers to adopt biofertilisers

A primary market and customer analysis was conducted to understand **the potential of the adoption of bio-based fertilisers**. The research was designed to detect the key factors that make farmers switch from conventional to bio-based fertilisers. To develop the survey questionnaire, a literature review was conducted, which identified two potential research questions:

→ The key fertiliser attributes driving farmers' decisions to switch from conventional to bio-based alternatives.

→ Psychological predictors of pro-environmental behaviour.

Credits: Terre dei Lombari and AgriSat

Based on the identified research questions, a questionnaire was given to agricultural experts from European countries who have good knowledge of farmers' behaviour as a result of their direct cooperation with the farmers and long-time experience in the sector (e.g., agricultural advisors; researchers with experience in working with farmers or commercialists who have many loyal customers/farmers).

The survey showed that **nitrogen certainty influenced decision-making about fertilisers use the most, followed by financial factors**. Other factors were less important (such as form of the fertiliser, volumes of fertiliser, organic content, pests and diseases attributes, the rate of nutrient release).

Furthermore, when it comes to the **psychological predictors**, the conclusion was that there is a potential among farmers to switch to biobased fertilisers, which is based on the characteristics of the farmers that the surveyed experts reported. These characteristics include:

- → Awareness of the climate change and its consequences.
- → Positive farmers' attitude toward environmentally friendly practices.
- → Expectation of higher financial pay-offs associated with low-emission agricultural practices.
- → Regular investment in business/farming development and new technologies.
- → Strong attachment of farmers to their land and property.

Despite the promising potential for adoption, there are also some barriers that must be addressed. One of these is the perception among experts that farmers' primary concern is to achieve high crop yields, regardless of the specific technology or method used. This attitude might be a challenge to the adoption of bio-based fertilisers if these products are not perceived as directly contributing to yield improvement. Furthermore, most experts think that a lack of appropriate education is a serious issue in agriculture. They emphasise the need for comprehensive education and training initiatives related to the new bio-based fertiliser products that target farmers specifically. Finally, the monetary aspect, identified as one of the most important product attributes, can represent a serious barrier if the product is not priced competitively with the conventional fertiliser and if it does not provide the profitability expected in the implementation of sustainable practices.

It is therefore essential to emphasize how bio-based fertilisers directly contribute to yield improvement. This can involve **conducting and disseminating research that can demonstrate the efficacy of bio-based fertilisers in enhancing crop yields**. Furthermore, **education and training** should focus helping farmers to understand the benefits and proper use of bio-based fertiliser products. This can involve workshops, extension programmes, and educational materials that address the specific barriers and opportunities for change in each context. Also, **collaboration** among researchers, decision-makers and stakeholders should be encouraged to promote bio-based fertilisers that meet the farmers' needs while also increasing environmental objectives. Finally, bio-based fertiliser products must be **competitive** with conventional fertilisers in terms of both performance and price if they are to become viable alternatives for farmers. In addition, financial incentives can further encourage the adoption of bio-based fertilisers and improve farmers' economic viability.

Towards a greener future

Benefits of bio-based B-Ferst products

To assess the efficacy of the new fertilisers, B-Ferst considered three criteria: the agronomic, the environmental and the economic benefits.

The **agronomic evaluation** criteria focused on the efficiencies of nutrients, water, and energy, which ultimately translate into economic benefits. The **environmental evaluation** looked at the conditions for and degrees of reducing soil, water, and air contamination, increasing or preserving soil fertility, and reducing fossil fuel consumption and GHG emissions.

After the assessment based on these criteria, B-Ferst fertilisers presents several of the **benefits** of bio-based fertilisers, designed to promote sustainability and environmentally friendly agricultural practices:

→ Soil enrichment

Biobased organomineral and organic fertilisers play a crucial role in transforming and enriching the soil structure through the addition of organic matter, creating an environment that fosters optimal plant growth. In particular, they contain high quality organic carbon from selected origins and an array of beneficial microorganisms such as bacteria and fungi. This infusion of organic matter acts as a natural binding agent, fostering the formation of aggregates and enhancing soil porosity and aeration.

Credits: Terre dei Lombari and AgriSat

➔ Microbial activity and biodiversity

In general, there is a lack of information on the effect of biobased fertilisers on plant growth and soil microbiomes. Therefore, B-Ferst compared those parameters with the conventional mineral fertiliser, in particular the effects of biobased mineral and organomineral fertilisers on the soil bacterial community[4]. It was demonstrated that soil background conditions determine the ultimate effect of treatments on soil diversity. However, the new fertiliser with biostimulants generally has no effect on soil biodiversity or even a positive effect, especially with the biobased fertilisers without NMPB or MPB that seems to attract to the rhizosphere beneficial bacteria general (PGPR):

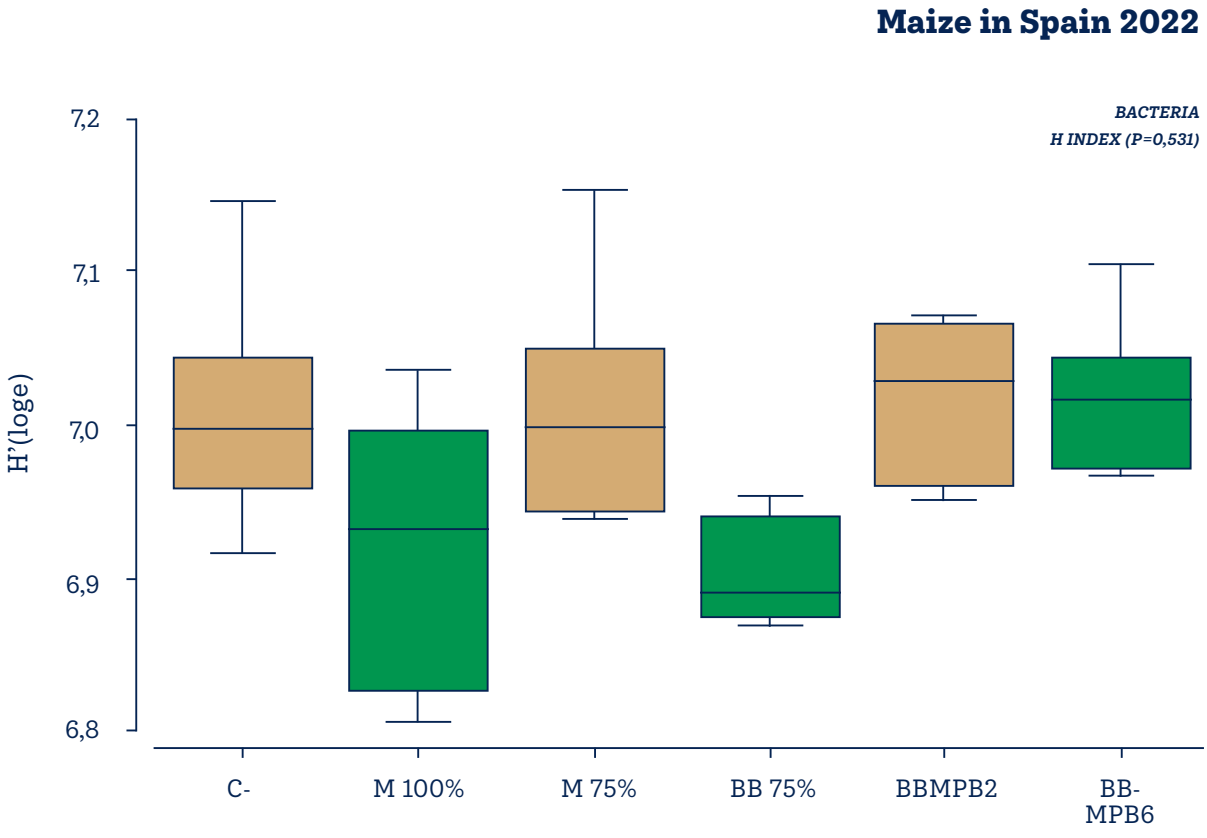


Figure 2. Graph representing the results from the analysis of bacteria on the tested fertilisers. Image provided by University of Leòn

[4] Barquero, Marcia & Cazador, Cinta & Ortiz, Noemí & Zotti, Maurizio & Brañas, Javier & González-Andrés, Fernando. (2024). Fertilising Maize with Bio-Based Mineral Fertilisers Gives Similar Growth to Conventional Fertilisers and Does Not Alter Soil Microbiome. Agronomy. 14. 10.3390/agronomy14050916.

➔ Slow release of nutrients and enhanced nutrient use efficiency

Differently than mineral fertilisers, many bio-based fertilisers release nutrients slowly over time, providing a sustained supply to plants. Biobased products contain specialised coatings that decrease solubility kinetics, enabling nutrients inner solubility characteristics.

This slow-release mechanism not only maximises nutrient uptake by plants but also promotes soil health and stability, even in extreme weather conditions. The slow-release nature of many bio-based fertilisers, coupled with improved microbial activity, can lead to better nutrient use efficiency.

➔ Reduced environmental impact

The environmental sustainability of the newly developed B-Ferst fertilisers was assessed over their entire life cycle: from production until application on the field. The basis for comparison, the functional unit, was defined as 'the fertiliser needed to produce 1 tonne dry substance of crop'. A reduction of the environmental impact was observed in the cases where the crop yield obtained with the B-Ferst fertiliser is higher than with a conventional (non-biobased) fertiliser. For example, for fertiliser #2 M-BB-MPB7 which contains ashes with available nutrients as the bio-based input, a carbon footprint reduction of more than 10% was observed. For this fertiliser, impact reductions between 10% and 18% were observed for the 8 other environmental impact categories as well.

Credits: Terre dei Lombari and AgriSat

The EU policy on bio-based products

Biobased products can make the economy more sustainable and lower its dependence on fossil fuels. Therefore, the EU has declared the biobased products sector to be a priority area with high potential for future growth, reindustrialisation, and which addresses societal challenges. An assessment done by the EC has indicated that biobased products and biofuels represent approximately €57 billion in annual revenue and involve 300,000 jobs.

EU policies linked to bio-based products have been developed and include the following:

→ The EU's industrial policy which aims to raise industry's contribution to EU GDP.

→ The Commission's bioeconomy strategy and action plan aims at shifting the European economy towards a greater and more sustainable use of renewable resources. The second pillar of the strategy focuses on the development of markets and competitiveness in bioeconomy sectors (such as the biobased product sector) by sustainably increasing primary production, conversion of waste streams into value-added products (biorefineries), and mutual learning mechanisms for improved production and resource efficiency.

→ The flagship initiative for a resource-efficient Europe under the Europe 2020 strategy supports the shift towards a resource-efficient low-carbon economy to achieve sustainable growth.

→ The Circular Economy Package was created to help European businesses and consumers make the transition to a stronger and more circular. The proposed actions contribute to 'closing the loop' of product lifecycles through greater recycling and reuse and bring benefits for both the environment and the economy. This transition will be supported financially by ESIF funding, €650 million from Horizon 2020 (the EU funding programme for research and innovation), €5.5 billion from structural funds for waste management, and investments in the circular economy at national level.

→ The European Innovation Partnerships (EIP) were launched under the Commission's Innovation Union flagship programme to accelerate the market take-up of innovations which address key challenges for Europe.

Specifically:

- The EIP for Agricultural Productivity and Sustainability (EIP-AGRI) aims to promote competitive and sustainable agriculture and forestry that "achieves more from less". It contributes to ensuring a steady supply of food, feed, and biomaterials.
- The EIP on Raw Materials aims to achieve the transition to a circular economy by providing valuable lessons on how to boost recycling and the re-use of materials.

Until recently most recycling-derived fertilisers (RDFs) were not able to be classified as EC fertilisers within the scope of Regulation (EC) No 2003/2003 which only dealt with inorganic fertilisers. 'Inorganic fertiliser' is defined as a fertiliser in which the declared nutrients are in the form of minerals obtained by extraction or by physical and/or chemical industrial processes. To overcome this issue, as part of the circular economy initiatives, the **Commission adopted the new Regulation (EU) 2019/1009 on Fertilising products in July 2019**, aiming to simplify the existing legislation, to improve the way the EU's fertiliser market works and to extend the rules to non-harmonised products, in effect those fertilisers governed by EU countries' national laws. Regulation (EC) No 2003/2003 was withdrawn in effect on 15 July 2022

and Regulation (EU) No 2019/1009 has been in force since 16 July 2022, giving producers three years to prepare for the requirements of the new regulation.

Regulation (EU) No 2019/1009 aims at 'facilitating the recognition of organic and waste-based fertilisers in the single market and thus encourage the recycling of bio-nutrients as fertilising products in the circular economy'. When strict rules for the safe recovery of nutrients into secondary raw materials are fulfilled, those raw materials may be used as a component of CE-marked fertilising products. This means that RDFs can become an EU fertilising product, provided that they meet the criteria i.e. for raw materials, production, agronomic efficacy, and contaminants.

This regulation will definitely help the **spread of more sustainable products such as those produced within B-Ferst project**. In turn, this will accelerate the transition to a more circular economy.

Watch the Project Video

https://youtu.be/Wv2jY7LcpY8

B-Ferst for a better and more sustainable future of agriculture

The use of biobased fertilisers supports sustainable agriculture by:

- → Using renewable resources.
- → Reducing environmental impact.
- → Promoting nutrient recycling.
- → Enhancing soil health.
- → Fostering microbial activity.
- → Providing slow-release nutrients.
- → Contributing to carbon sequestration.
- → Building resilience to climate variability.

Biobased fertilisers, like the ones produced within B-Ferst project, prove that it is indeed possible to produce a fertiliser that improves the crop yield, protect the biodiversity of the soil and reduce the carbon footprint.

The use of bio-based fertilisers marks a pivotal advancement in sustainable agriculture. As B-Ferst explored, these **innovative products offer many benefits** while mitigating environmental impact. However, it's essential to recognise that **their effectiveness is intricately tied to various factors** such as soil characteristics, agro-environmental conditions, and crop requirements and management.

In response to these complexities, integrated nutrient management strategies have emerged as a beacon of agricultural innovation. By seamlessly combining biobased fertilisers with traditional mineral counterparts, we harness the strengths and address the limitations of both approaches, ensuring optimal nutrient delivery tailored to the dynamic needs of crops. This integrated approach, exemplified by the innovative solutions developed by B-Ferst, not only maximises crop productivity but also fosters resilience in the face of environmental challenges.

As we look ahead, it is clear that the integration of advanced technologies and sustainable farming practices, such as those dealt within B-Ferst project, are essential for a **more sustainable crop production**. By embracing these cutting-edge solutions, we pave the way for a **greener, more efficient and resilient agricultural industry**, where innovation and sustainability go hand in hand.

Visit B-Ferst website to join the fertiliser revolution

https://bferst.eu/

B-Ferst

Farmers and industry together
for a sustainable agriculture

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