FERTIMANURE

FERTIMANURE POSITION PAPER ON INCREASING THE SCOPE OF BIO-BASED FERTILISERS FOR ORGANIC FARMING

1. Introduction and context

Organic agriculture is a farming system that sustains the health of soils, plants, animals, ecosystems and people whilst contributing to long-term food security and protect climate. Organic farming accounted for 9.2% of the EU's total 'utilised agricultural area' in 2020. However, the EU Green Deal, through the Farm to Fork Strategy, has established the ambitious target of reaching the 25% of agricultural area under organic farming and a significant increase in organic aquaculture by 2030.

Organic agriculture aims to be more environmentally friendly than conventional agriculture, being able to address sustainable development goals (economic, social, and ecological benefits). In that sense, organic agriculture has shared goals with the bioeconomy such as sustainability of food production, minimum environmental impacts with a closed farming system that effectively is recycling nutrients and designated inputs (EC/2021/1165 annex II).

The maintenance of soil fertility is paramount for organic agriculture: as no highly soluble mineral fertilisers are authorised; organic farmers aim to work in closed nutrient cycles as much as possible. In that sense, external inputs, accepted to be used in organic farming, are selected based on a strict set of criteria, with the aim to exclude any inputs that may cause harm to humans, animals, the environment, and climate, or may be in contradiction to the traditions of the sector and/or expectations by organic farmers and consumers. As a result, a limited number of fertilising products are allowed in organic production systems. In fact, nitrogen source in organic farming comes mainly from certain agricultural practices (use of leguminous crops, intercropping, etc.) and dried, composted, or digested farmyard manure and liquid excrements (Regulation 2021/1165, Annex II) rather than from effective mineral nitrogen fertilisers and other mineral nitrogen sources, which are strictly forbidden (Regulation 2018/848 annex II, 1.9.8). However, phosphorus, potassium and micronutrients sources are authorised for organic farming and can come from finite mineral sources (soft ground rock phosphate, aluminium-calcium phosphate, crude potassium salt, potassium sulphate, magnesium salts, etc.) (Regulation 2021/1165 annex II). In general terms, manure-based fertilisers, soil conditioners and nutrients from factory farming origin are strictly prohibited in organic farming. However, this last limitation does not apply to blood, bone, meat, fur or hair-based products.

To achieve the ambitious target of 25% of agricultural area under organic farming by 2030, it is necessary to provide the organic sector with options that will create the conditions that can trigger the change in EU agriculture towards the high-quality standards that EU consumers value. One major limitation of organic farming is the nutrient availability at early growth stages, since easily available mineral fertilisers cannot be applied.

FERTIMANURE project (H2020, Grant Agreement No. 862849) is proposing new circular economy strategies aiming to be aligned with current European initiatives (Circular Economy

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Action Plan, Farm-to-Fork Strategy, New Common Agricultural Policy, etc) producing high quality and safe fertilising products (bio-based fertilisers, BBFs) from animal manure, which is one of the most important secondary sources of nutrients that, we highly believe, can be crucial to ensure a sustainable agriculture and the future food security.

The EU has the world's largest livestock sector. Meat, milk and eggs make up 40% of the EU's agricultural value and it accounts for 48% of total EU agricultural activity, with an estimated €130bn output value annually and employment for almost 30 million people. Moreover, the trends in food demand are not expected to change during the following years. EU meat production is expected to reach 47.5 million tonnes by 2030, and global meat consumption is estimated to increase by an average of 1% per year between 2017 and 2030. In this context, it is important to note that 72.2% of all EU livestock is produced by very large intensive livestock farms.

The FERTIMANURE project will contribute to the organic sector by providing synthesized technical guidance for an adequate fertiliser supply. FERTIMANURE aims to provide relevant key information to change the paradigm about bio-based fertilising products recovered from animal manure in organic farming, demonstrating that FERTIMANURE BBFs can offer the quality and safety requirements as well as efficiently perform in agronomic and sustainability terms, bringing also benefits over the agronomic use of unprocessed manure. This will benefit both, the required increase in organic farming as well as circular economy. Nevertheless, FERTIMANURE fertilising products are mainly recovered from the manure generated in factory farming, as extensive farming does not have significant problems with manure management. Thus, considering Regulation 2018/848, nowadays it may seem complicated to integrate FERTIMANURE products in organic production systems. It is true that it would also be needed to see how the factory farming sector can be improved to guarantee relevant aspects such as animal welfare; however, FERTIMANURE project is out of this scope.

In this regard, a thoroughgoing discussion involving different key actors (organic farmers, policy makers, regulation authorities, food industry, consumers, scientific advisory bodies, etc.) is needed to reach a shared approach on the authorised use of the recovered BBFs. Considering the possibility to use nutrients recovered from animal manure (even though from factory origin) for organic farming would help to integrate recycled nutrients into organic food production closing nutrient cycles, improve nutrient uptake at early growth stages and lowering the dependency upon non-renewable and less sustainable nutrient sources.

2. FERTIMANURE bio-based fertilising products

FERTIMANURE project has installed and is operating 5 different on-farm pilots to recover a total of 18 bio-based fertilisers (BBF) from animal manure (pig, cattle, and poultry).

The definition of BBF in FERTIMANURE is the following: *Bio-based Fertilisers (BBFs) are fertilising products or a component to be used in the production of (Tailor-Made) Fertilisers that are derived from biomass-related resources. The BBFs of FERTIMANURE are "obtained through a physical, thermal/thermo-chemical, chemical, and/or biological processes for the treatment of manure or digestate that result into a change in composition due to a change in concentration of nutrients and their ratios compared to the input*

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material(s) in order to get better marketable products providing farmers with nutrients of sufficient quality".

Within FERTIMANURE products, 2 types of products could show potential for being used in organic farming:

a. Organic amendments: biochar from manure, soil conditioners from manure
b. Biostimulants

Currently, the factory farm origin is the main limitation of FERTIMANURE products to be accepted in organic farming. Apart from that, there is also a barrier related to every thermal process-derived products (biochar, P-rich ashes), as organic farming does not support this kind of technology applied to nitrogen rich manure due to loses in exhaust gases. Apart from these limitations, Table 1 presents other reasons why the FERTIMANURE BBFs would not be currently accepted in organic farming.

Table 1. Categorisation of FERTIMANURE BBFs and why they are not authorised in organic farming

Product	**CMC category identified in FPR**	**Why would not be authorised as established in (Regulation 2021/1165, Annex II)(*)**
Organic amendments: biochar from manure	CMC14	Not produced "*from plant materials*"
Organic amendments: soil conditioner from digestate	CMC5	Anaerobic digestion process requirements according to Regulation (EU) No 142/2011 (pasteurisation/ sanitisation step)
Algae derived products (biostimulants)	CMC1	Algae not "*from organic or collected in a sustainable way in accordance with point 2.4 of Part III of Annex II to Regulation (EU) 2018/848*".

(*) This is additionally to the factory farming origin limitation

In terms of product quality and safety, quality parameters of FERTIMANURE products are checked according to EU Regulation 2019/1009. Main composition of the products mentioned are given in Table 2 while safety related parameters analysed so far in different products are given in Table 3. Analysis of FERTIMANURE products have consistently been performed for more than one year on a monthly basis.

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Table 2. Main composition of FERTIMANURE BBFs obtained through different technological configurations

Description	Type	Origin (feedstock)	Technology applied (Country)	DM (g kg^{-1})	TN (g kg^{-1})	NH_4-N (g kg^{-1})	TP (g kg^{-1})	TK (g kg^{-1})	TS (g kg^{-1})
Soil conditioner	Soil amendment; solid	Cattle slurry	Anaerobic digestion (mesophilic) (NL)	285	7.4	2.9	2.8	5.2	1.8
Biochar	Soil amendment; solid	Cattle manure	Thermo Catalytic Reforming (DE)*	980	16	0.7	28	127	4.1

*Although derived from thermal process, the TCR system includes the MAP reactor to treat exhaust gases and recycle nitrogen from it

Table 3. Safety parameters on FERTIMANURE BBFs obtained through different technological configurations

Description	Type	Origin (feedstock)	Technology applied	Zn (mg kg^{-1}DM)	Cu (mg kg^{-1}DM)	Ni (mg kg^{-1}DM)	Pb (mg kg^{-1}DM)	Cr (mg kg^{-1}DM)	Cr VI(mg kg^{-1}DM)	Hg (mg kg^{-1}DM)	As (mg kg^{-1}DM)	Cd (mg kg^{-1}DM)
Soil conditioner	Soil amendment; solid	Cattle slurry	Anaerobic digestion (mesophilic) (NL)	315.75	50.48	4.15	2.61	6.96	-	0.03	0.72	0.21
Biochar	Soil amendment; solid	Cattle manure	Termo Catalytic Reforming (DE)*	367.50	50.15	7.99	2.12	12.90	-	0.03	1.01	0.10

*Although derived from thermal process, the TCR system includes the MAP reactor to treat exhaust gases and recycle nitrogen from it

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3. Policy-relevant information that FERTIMANURE can provide

Organic farming is defined by a set of principles and goals. The FERTIMANURE project is aligned with many of them and can thus provide valuable contributions to boost organic farming. In that sense, the following table aims to present how the work done in this project could potentially help the organic farming sector in being more competitive, sustainable and aligned with EU initiatives.

Table 4. How FERTIMANURE contributes to specific objectives and principles of organic farming

	Objectives and general principles of organic farming	**How FERTIMANURE contributes to the objective**
Objectives	Contributing to protection of the environment and the climate	FERTIMANURE BBFs are produced from **secondary nutrient resources**, and they are assessed in different terms such as agronomic (including mineralisation tests to assess the **efficient use of nutrients and potential nutrient losses**) and expected **environmental performances** (including the **whole life cycle of products**). Tailor Made Fertilisers (TMFs) are formulated to be efficient nutrient sources for specific crops, avoiding nutrient losses.
	Maintaining the long-term fertility of soils	Within FERTIMANURE different BBFs are produced aiming for different agricultural purposes: (i) mineral fertilisation by recovered ammonium and phosphorus products, (ii) organic soil conditioners able to improve physical structure and microbial soil functions and (iii) products specifically aimed to enhance microbial activity and soil health (biostimulants and TMF-enriched with microorganisms). By combining different FERTIMANURE BBFs, **nutrient and carbon cycles can be closed** by returning them to agricultural soils and ultimately, **soils' health can be restored,** and their **fertility improved** at long-term.
	Substantially contributing to a non-toxic environment	As detailed in section 2, **quality and safety parameters** of FERTIMANURE BBFs are aimed to be guaranteed by thoroughly assessing the analytical parameters considered in the **European Fertilising Product Regulation 2019/1009** identified as reference in terms of quality parameters for products and substances authorised to be used in organic farming (Regulation (EU) 2021/116). Additionally, **monitoring of potential antibiotic resistance genes** are being carried out within FERTIMANURE BBF production and application steps. Besides, from agronomic point of view, BBFs are expected, in general terms, to show **lower pollution risk** compared to mineral fertilisers.
	Encouraging short distribution channels and	FERTIMANURE aims to obtain high quality BBFs by applying biorefinery processes **directly on farm** where

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	local production in the various areas of the Union	they can be efficiently used or sold to fertilising industry as ingredient for their formulations. Therefore, FERTIMANURE aims to contribute towards shortening of supply and distribution chains.
General principles	The responsible use of energy and natural resources, such as water, soil, organic matter and air	FERTIMANURE aims to implement innovative integrated treatment schemes on-farm by the implementation of 5 different and complementary biorefineries. Different technologies are assessed for 3 different manures and **use of material and energy resources are being monitored and optimised** during each biorefining process to meet this principle. **Environmental sustainability assessment** is carried out for each BBF obtained considering its **whole life cycle**, including its processing and application.
	The production of a wide variety of high-quality food and other agricultural and aquaculture products that respond to consumers' demand for goods that are produced via processes that do not harm the environment, human health, plant health or animal health and welfare	The **agronomic performance** of FERTIMANURE BBFs is assessed through agricultural trials performed at different scales. Fertilisation of experimental crops is done considering the characteristics of BBFs, soil characteristics and the nutrient requirements of crops avoiding nutrient loses. To achieve this tailored fertilisation plan, the **FERTIMANURE TMF nutrition tool** was developed which will be publicly available. FERTIMANURE Nutrition tool, thus, aims to supply the required amount and form of nutrients to agricultural crops. Among parameters evaluated within agricultural trials, **volume, quality and health of the crop** produced is assessed. Besides, as mentioned, environmental sustainability of the whole life cycle of FERTIMANURE BBFs is being assessed.
	The restricted use of external inputs; external inputs shall be limited to: natural or naturally-derived substances among others;	**Main feedstock** used to produce FERTIMANURE BBFs is **manure**, in different forms and origins. Manure is a **natural and renewable resource** and the recycling of its carbon and nutrients contributes significantly to close carbon and nutrient cycles, reducing the dependency upon non-renewable nutrient sources.
	The adaptation of the production process, where necessary and within the framework of this Regulation, to take account of the sanitary status, regional differences in the ecological balance, climatic and local conditions, stages of development and specific husbandry practices	Within FERTIMANURE, estimation of nutrient imbalances among livestock intensive farming regions in Europe has been performed. Additionally, FERTIMANURE is developing a **logistics tool** aimed to **appropriately manage the recycled nutrients** from those regions with surplus to those with deficit. As stated, agricultural trials are performed following the fertilisation plan given in the nutrition tool considering the status and characteristics of soils which contribute to minimise nutrient loses.

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In the framework of FERTIMANURE, the following relevant data will be obtained to provide policy-relevant information to demonstrate that some of the fertilising products obtained in the project can fulfil the quality requirements needed for organic farming:

- Quality and safety check of the FERTIMANURE BBFs in line with the new Fertilising Product Regulation 2019/1009. The *Regulation EC/2021/1165 "Authorising certain products and substances for use in organic production"*, states that fertilising products authorised to be used in organic farming should be compliant with Regulation (EU) 2019/1009.
- Thorough evaluation of antibiotic resistance genes and their dynamics when the BBFs are applied.
- FERTIMANURE products will be compared in field tests with raw manure and with other commercial fertilising products.
- Sustainability assessment (LCA, LCC, sLCA) of the production processes and products to demonstrate how these can contribute to a more circular approach.

Due to the severity of land degradation and climate change, organic farming appears to be an attractive and feasible option for farmers in the future. In addition, the growing concern for long-term soil productivity and sustainability has highlighted the need to employ techniques that reduce the negative impacts of agricultural activities on soil quality. For this reason, new strategies and appropriate policies need to be put together in order to develop sustainable food production, which is also one of the key objectives of EU strategies and policies.

Manure-derived products represent an effective management strategy to improve biological and chemical properties of soils. Therefore, applying the FERTIMANURE fertilising products can benefit the organic sector's environmental performance.

The application of FERTIMANURE`s products will both, increase crop production and improve soil fertility and quality. In addition, the adoption of good management practices is needed to boost the amount of carbon stored as soil organic matter by soil carbon sequestration. In this regard, FERTIMANURE`s soil amendments will contribute to maintain or even increase the amount of organic carbon stored in the soil. This fact significantly influences soil physicochemical and biological properties. Also, increasing SOC can help to achieve ambitious global policy initiatives such as the "4 per 1000 Initiative", launched by the French agricultural sector in 2015. This policy aims to demonstrate that agricultural activities, and in particular increasing soil organic carbon sequestration, can play a crucial role in climate change mitigation while simultaneously improving food security.

Modern agriculture involves the overuse of synthetic or mineral fertilisers that have a considerable negative impact on soil, water, and air quality. In this context, phosphorous (P) rich products are highly relevant because of their origin from secondary sources compared with mineral P, which is scarce and comes from detrimental mining activities outside the EU. Hence, obtaining phosphorus from biological and renewable resources could contribute towards the independence of a finite resource.

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Biostimulant products are an effective complement to crop nutrition and crop protection in organic farming, as well as being an important valorisation strategy for several types of organic wastes and by-products. Some of the organic biostimulants that are currently used in organic farming include: plant hormones, humic acids, protein hydrolysates, sea kelp, fish emulsion and others.

The use of natural biostimulants address some of the most important global agricultural challenges including those of organic farming:

- Feeding a growing population that requires yield increases and enhanced crop quality.
- Increasing plant tolerance to biotic and abiotic stresses, such as (re-)emerging diseases and pests, extreme temperatures, irregular rainfall and other stressful growing conditions related to climate change.
- Promoting quality attributes of crops, which can mean higher incomes for farmers, better storage and more nutritious food for consumers.
- Facilitating nutrient assimilation, translocation and use by the crops can prevent these nutrients from leaching or running off into neighbouring ecosystems, leading to a better use of natural resources and higher return on investment for farmers.
- Helping protect and improve soil health by fostering the development of beneficial soil microorganisms, which can lead to improved nutrient and water uptake, stress resistance and a higher resistance to erosion.

With the information provided in this position paper, FERTIMANURE project is willing to start discussing and contributing on how the Regulation 2018/848 could be adapted to acknowledge certain BBFs recovered from animal manure as authorised fertilising products for organic farming. We highly believe that this is a crucial step to move towards a more sustainable agricultural sector and contribute to future food security.

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