

European

Sustainable

Phosphorus

Conference

LEIDA

2024

8 - 10 October

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ESPP actions

Registration is now open for the 5th European Sustainable Phosphorus Conference

8-10 October 2024, Lleida, Spain. 120 abstracts received. With three European Commission services, United Nations, industry & experts from Europe and worldwide. Site visits to industrial nutrient recycling, digestate processing (Fertilizantes del Ebro, biogas installations). ESPC5 follows on from ESPC4 Vienna, 2022 which, with 320 participants onsite and 80 online, was the biggest conference on phosphorus ever worldwide. Join us for this unique networking, industry, policy and science event.

Updated programme, registration, site visit details: <u>https://www.phosphorusplatform.eu/espc5</u>

Webinar: including Animal By-Products in the EU Fertilising Products Regulation (FPR)

17th September, 14h – 16h (CEST, Brussels time). Recycling animal by-products to fertilisers: nutrient circularity, food chain safety and consumer confidence. Jointly organised by ECOFI, Eurofema, ESPP. With participation of the European Commission (DG SANTE, DG GROW Fertilisers). This webinar will address several key questions: Which Animal By-Product (ABP) materials can currently be used in EU fertilising products? Under what processing conditions? How do the EU ABP Regulations and the Fertilising Products Regulation (FPR) fit together? What other materials could be considered? What logic and procedures should be followed to consider additional materials?

Secondary materials and fertiliser industry operators are invited to submit examples of ABPs with significant recycling potential as fertilisers. These should be safe, higher uses in the waste hierarchy (food, animal feed) should not be feasible, and they should currently not be authorised under the EU FPR.

This first webinar will present the current regulatory context, discuss several examples of potentially valuable ABPs that are currently excluded from the FPR, and propose ways to advance the inclusion of different types of ABP materials.

Registration open (free) <u>https://us02web.zoom.us/meeting/register/tZUrce6sqz0qGdD1o9cwY3u7GaJ4oo1gn5cA#/registration</u> Please send industry examples of ABP materials for consideration: short text indicating origin of material (from which industries, type of byproduct), processing, agronomic value, potential (tonnes/year EU), health and environmental safety, industry contacts (emails) – to <u>info@phosphorusplatform.eu</u>

EFSA call for input on P-recycling from Cat.1 Animal By-Product ash: deadline 5th July

The European Food Safety Agency (EFSA) is calling for input by Friday 5th July on use of Cat.1 Animal By-Product ash in fertilisers, considering prion risk (TSE/BSE) and other possible biological or chemical risks (see <u>ESPP eNews n°87</u>, EU EFSA <u>Mandate M-2023-00166</u>, EFSA-Q-2024-00278). Draft SAFOSO risk appraisal report <u>here</u> – for comment to 4th July. If you are aware of data, publications or evidence relevant to the health or environmental safety or to agronomic value of ABP Cat.1 ash, please submit to EFSA (with copy for information copy to <u>ESPP</u>) or send to <u>ESPP</u> and we will submit for you.

ESPP has submitted a number of reports and studies which we have collected to date, and also a specific and new analysis of prion (BSE/TSE) risk estimation for use of Cat.1 ash for fertiliser, prepared for ESPP by <u>SAFOSO</u>. A "final draft" of this analysis



has been submitted to EFSA and can be consulted <u>here</u>. Your comments and additions to this document are invited to <u>ESPP</u>. We will submit to EFSA, in August, a finalised version taking into account additional information which you send us.

Input to EFSA **MUST** be made via the specific web portal Portalino, by Friday 5th July, and must refer to question number EFSA-Q-2024-00278. To do this, you must first contact EFSA <u>by email</u> and request opening of a Portalino account. Alternatively, send your input to <u>ESPP</u> and we will submit.

Draft SAFOSO risk study of Cat.1 ash, for ESPP here - for comment and input by end July please.

"Processed Manure" now authorised in EU fertilising products

Manure can now be used as an input for CE-mark fertilising products, under specific conditions, as such after ABP Regulation sterilisation under CMC10, or also as input to composts, digestates, biochars (CMCs 3, 5, 14). European Commission <u>Delegated Regulation 2024/1682</u> (4th March 2024), completing DG SANTE <u>Delegated Regulation 2023/1605</u> (see <u>ESPP eNews n°86</u>), enables, as of now and under specified conditions, the use of "Processed Manure" as a component material under the EU Fertilising Products Regulation (FPR) CMC10. This concerns 'Processed Manure' as defined in the EU Animal By-Products Regulation ABP <u>1069/2009</u> and Annex XI, §2, ch. I of <u>142/2011</u>.

Manure can already today also be used as an input to EU FPR composts and digestates (CMC3, CMC5) if the composting / anaerobic digestion process achieves the ABP sterilisation requirements (ABP Annex XI, §2, ch. I of <u>142/2011</u>) or as an input to EU FPR pyrolysis and gasification materials (CMC14) if the pyrolysis/gasification process achieves the ABP "Processed Manure" sterilisation requirements (as above).

The new Delegated Regulation 2024/1682 sets specific conditions for use of "Processed Manure" in EU FPR CMC10 including:

- processing must be as specified for "Processed Manure" in the EU Animal By-Product Regulations (temperature, time, registered installation ...),
- this also means that the requirements of the ABP 'End-Point' for fertilisers, fixed by <u>Delegated Regulation 2023/1605</u> must be respected: size or packaging, mixing with other materials, labelling,
- particle size,
- pressure granulation, pelletisation, drying,
- stability,
- PAH₆ limit.

Note that this new <u>Delegated Regulation 2024/1682</u> covers only 'Processed Manure' in FPR CMC10. The conditions for inclusion into CMC10 of other Cat.2 and Cat.3 materials (as listed in <u>Delegated Regulation 2023/1605</u>) are still under study. Cat.2 and Cat. 3 materials can already be used as inputs to FPR composts and digestates (CMCs 3, 5) if the composting/anaerobic digestion process achieves the ABP sterilisation requirements (ABP Annex XI, §2, ch. I of 142/2011.

European Commission Delegated Regulation (EU) 2024/1682 "amending Regulation (EU) 2019/1009 of the European Parliament and of the Council as regards adding processed manure as a component material in EU fertilising products", 4th March 2024 <u>https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401682</u>

Positions and prizes

IFS 10th Brian Chambers crop nutrition research prize

The International Fertiliser Society prize (UK£ 1000 plus 2 x UK£ 500) rewards completed or advanced research (PhD / MSc level) susceptible to make a practical contribution to improving crop nutrition. Application form (one page) and information on previous prize winners is <u>here</u>

Submission deadline: 30th September. IFS Brian Chambers International Award for Early Career Researchers in Crop Nutrition. HERE.

PhD positions open on nutrient recycling and fertilisers

Timac Agro and the University of Bari, Italy, have opened for candidatures five PhD positions:

- Innovative Strategies for the Application of Plasma-Activated Means for Plant Nutrition
- Exploring a circular model for natural polymers production for microencapsulation in agriculture
- Valorising olive paste on a circular model for agricultural soil health
- Enhanced Design and Evaluation of Porous Materials for Nutrient Recovery and Their Potential as Fertilisers
- Ash recovery: Development of strategies for nutrient recovery from waste streams for contributing to the fertiliser industry's sustainability

The PhDs will be with University of Bari (Università degli Studi di Bari Aldo Moro), Department of Earth and Geoenvironmental Sciences. They are three year PhDs, with 6-12 months at another international research institute. They are funded by Italian National Recovery and Resilience Plan (NRRP) – Next Generation EU (NGEU) and TIMAC AGRO Italia S.p.A.

Applications should be submitted within 1-2 months. Deadlines and further information: <u>https://www.dindistegeo.it/</u> or Daniela Pinto <u>daniela.pinto@uniba.it</u> and Daniel El Chami <u>Daniel.elchami@roullier.com</u>.



Job offer - Morocco

The Global Phosphorus Institute (GPI), Benguérir, Morocco, is recruiting a Research and Operation Analyst. Application deadline 15th August. Role is to review information (regulatory, company, scientific) to support decision making and to plan and organise activities.

Information: <u>https://www.tgpi.org/en/home</u> -> "Opportunities" Information on GPI, see <u>ESPP eNews n°56</u>.

Nutrient recycling

ISO Circular Economy standard integrates nutrient recycling

Newly published ISO 59004, vocabulary and principles for the circular economy, includes definitions related to nutrient cycles and cites nutrient recycling as an example of circular economy actions. This new ISO standard, defining vocabulary and principles, joins four others in the ISO 59000 family, which aim to harmonise understanding of the circular economy and support its implementation and measurement, with ISO 59010 (circular economy business models), ISO 59020 (measuring and assessing circular economy performance), ISO 59040 (product circularity data sheet) and ISO 59014 (principles of recovery of secondary materials).

ISO 59004 provides terms and definitions, sets a vision and principles for a circular economy, and offers practical guidance for actions to implement in any organisation. Key points include:

- definitions: 3.1.21 "Biological cycle" is defined as biological nutrient cycling, and refers to composting (definition 3.1.17), anaerobic digestion (3.1.18) and "extraction of bio-chemicals" (not defined).
- anaerobic digestion is noted to produce "normally, nutrient-rich digestate" and nutrient recovery from composting or anaerobic digestion is cited under value creation in "Cascading of biological resources" (6.4.3.3)
- energy recovery should if possible be coupled with resource recovery, with nutrient capture cited (6.4.7)
- nutrient cycling is cited as a critical ecosystem service (6.5)
- cited examples of actions towards value recovery include: recovery and recycling of biowaste; processes for extraction
 of biobased products and feedstocks from biowaste, residual biomass, wastewater and sludge; R&D to extract
 nutrients as fertilisers from wastewater (B.4) and safe return of nutrients and carbon to soils from biodegradable
 materials (C.4.5).

ISO 59004 (May 2024), 51 pages, c. 200€, "Circular Economy – Vocabulary, principles and guidance for implementation" <u>https://www.iso.org/standard/80648.html</u>

Updated position paper on sewage sludge biochar

European Biochar Industry (EBI) Consortium document presents evidence that pyrolysis can largely eliminate organic contaminants, discusses phosphorus plant availability, and calls for inclusion of sewage sludge biochar into the FPR (EU Fertilising Products Regulation). The document has been input to the currently ongoing NMI study (for the European Commission) into additions and extensions to the FPR Component Material Categories (Annex II CMCs). It updates a previous position paper of January 2023 (ESPP eNews n°73). It aims to present new scientific evidence published since the JRC STRUBIAS report 2019. This report concluded that sewage sludge should be excluded from authorised inputs to FPR biochars (CMC14) but noted that this "could possibly be revised once robust and extensive techno-scientific evidence underpins the safe use of (specific) pyrolysis & gasification materials derived from sewage sludge".

Arguments and evidence are provided on contaminant elimination in pyrolysis processes. It is explained why the technology is adapted for implementation in municipal sewage works (deployable and scalable). Agronomic, environmental and carbon benefits of biochar are presented, including contribution to carbon sinks and greenhouse gas emissions reduction. It is noted that sewage sludge biochar is authorised under national regulations in the Czech Republic, Denmark, Finland and Sweden.

PFAS elimination

The 20-page paper brings together arguments and references showing that pyrolysis at 600°C or higher can eliminate nearly 100%% of PFAS (several studies) with data from one installation suggesting that PFAS are not transferred to flue gas. This is confirmed (at pyrolysis temperatures from 400°C) in the 2024 study by Husek et al. (<u>ESPP eNews n°85</u>), not cited in the EBIC document.

Concerning PFAS, ESPP notes that the cited study by <u>Sørmo et al. 2023</u> (ref. 13 in the document) analysed PFAS in 8 different input materials (of which 4 sewage sludges, wood chips, garden waste ...), in resulting biochar and in flue gas, for a Biogreen 2-10 kg/hour pyrolysis unit (ETIA Technologies, now part of VOW ASA), operated at temperatures 500 – 800°C. PFAS in the biochars ranged from non-detectable to 3.4 ppb, with removal of 99.6% or higher in all cases. Sørmo et al. found PFAS in flue



gas, after combustion of the condensed pyrolysis oil, at all pyrolysis temperatures tested and for all of the feedstocks. Mean flue gas PFAS concentration was c. 70 ng/m². This also confirms similar results in flue gas in the Thoma study. <u>Thoma et al. 2022</u> report analysis of PFAS in biochar produced from bio-dried sewage sludge and in offgas from a commercial Pyreg pyrolysis system (c. 3 500 t dried sewage sludge/year). The pyrolysis operated with reactor inner wall temperatures 650°C front end and 590°C rear end (residence time c. 19 minutes). PFAS in offgas was analysed after post-combustion at 1020°C. 21 of 41 PFAS compounds were detected in the input sewage sludge, but none in the biochar (the authors note that non-analysed PFAS compound could be present). Only two of the analysed PFAS compounds were found in the post-combustion offgas (analysis in scrubber water). <u>Kundu et al. 2021</u> report results from lab scale pyrolysis (250 g/h, semi-continuous, 5 h residence time) at 600 – 700 °C of anaerobically digested, solar dried sewage sludge. The authors report suggest 50% - 96% destruction of 6 of the 12 analysed PFAS compounds and net formation or low destruction of the others. For several of the PFAS compounds, most of the final PFAS output was estimated to be in the post-combustion offgas (analysed in scrubber water).

Evidence of elimination of pharmaceuticals, microplastics and other organic pollutants is provided. Heavy metals are largely not removed in pyrolysis but the paper argues that their concentration ratio to phosphorus is the same as in sewage sludge and that they are less mobile.

Phosphorus plant availability and processing conditions

The EBI paper concludes that phosphorus in sewage sludge biochar is plant available. ESPP suggests that further evidence is would be useful on this: only one relevant published study is cited, ref. 47, <u>Fristak et al. 2018</u>, laboratory pyrolysis at 430°C for two hours, compared to 2 seconds currently required in the EU FPR CMC14). ESPP notes that a second study cited (ref. 21, Chen et al. 2022), suggests that at 600°C or higher pyrolysis will result in mainly mineral forms of phosphorus, in particular apatite (the principal mineral of phosphate rock, which is poorly plant available) and it can be guessed probably also iron/aluminium phosphates in sewage sludge biochar (also mostly poorly plant available).

For ESPP, further evidence should be developed to show that sewage sludge pyrolysis carried out at a high enough temperature to ensure elimination of PFAS and other organic contaminants, resulting in a material with immobilised heavy metals and immobile carbon (justifying carbon credits), can achieve the phosphorus availability criteria of the EU FPR (80% NAC solubility), so justifying the claim to be phosphorus "reuse & recycling" (new Urban Waste Water Treatment Directive vocabulary).

The EBI paper proposes that specific conditions be included into the FPR CMC14 for input of sewage sludge: minimum operating temperature 550°C - 600°C for a non-specified minimum time ("duration that ensures full carbonisation"). ESPP regrets that more precise temperature and time proposals are not put forward by industry, taking into account factors such as particle size and other process parameters, or other specific analysis criteria to demonstrate full carbonisation. A wording needs to be developed which could be proposed for inclusion into the FPR CMC14 and which would be implementable by CE-mark certification organisations (Notified Bodies).

Position paper "Sewage sludge as feedstock for pyrolysis and gasification materials (CMC14) EU Fertilising Products (EU) Regulation 2019/1009", European Biochar Industry Consortium, April 2024 <u>HERE</u>.

3rd PRO-FEM Conference, Catalunya: Bio-based Fertilisers and nutrient recovery

200 participants discussed nutrient recovery technologies, definitions of bio-based fertilisers, paths to market, underlining the need for a multi-actor approach covering all the value chain to find successful business cases.

The Catalan Government explained the potential for nutrient recovery in the Catalan region, in particular from animal manure, because Catalonia is a reference region in livestock production. The Catalan biogas plan includes a plan for digestate valorisation to produce bio-based fertilisers. Laura Van Schol, NMI explained the European regulatory framework for fertilisers. The Spanish National Entity of Accreditation (ENAC) talked about the procedures to be followed for certifying fertilising products in Spain. The Spanish Ministry of Agriculture, Fisheries and Food and the Spanish Ministry of Ecological Transition and Demographic Challenge emphasised alignment of Spanish regulations with Europe.

Challenges for nutrient recovery were discussed and successful case studies presented, including digestate valorisation, compost production, insect-based organic amendments, bio-stimulants from slaughterhouse subproducts. Discussions noted the biorefinery process approach to reach zero-waste and the need to balance reducing operational costs with final quality of recovered products, noting that the market price of bio-based fertilisers is limited by the price of nutrients in mineral fertilisers.

Regulatory barriers were the main concern during the whole conference, especially the End-of-Waste status of input materials, and in particular sewage and agro-industrial sludges. The EU FPR excludes sewage sludge from use as an input material, except for precipitated phosphates and after incineration (sewage sludge ash derivates) and the <u>new Spanish waste regulations</u> align with this, so excluding from End-of-Waste status all sewage or agro-industry sludge derived materials. This impacts a number of fertilising product manufacturers in Catalonia who are today using sewage sludge or other sludges as input materials, in combination with other materials, to produce organic and organo-mineral fertilisers or commercial composts.



Examples of company success stories present at PRO-FEM

Fertiebro (Fertilizantes del Ebro) produces liquid fertilisers, deficiency correctors and solid fertiliser blends. The company operates one of the largest blending facilities in Spain, using raw materials of circular origin. Its R&D laboratory specialises in optimising industrial processes to manufacture from different raw materials, including secondary nutrient sources, and in analysis to offer tailor-made and a high-quality final products for customers. At PRO-FEM, Fertiebro discussed their experience and the importance of using secondary nutrient sources in their production.

Almenar Bioenergy (Bioenergia de Almenar) operates anaerobic digestion to convert organic matter (manure, waste from agrifood industry, agro-industrial sludges ...) into green energy, with biogas that is valorised for different energy applications. The company produces from the digestate a solid fertiliser, clean water and a liquid concentrate with high nutrient content. At PRO-FEM, Bioenergia de Almenar shared their positive business model and the future challenges that they are facing concerning regulatory barriers affecting their activities.

At <u>ESPC5, Ledia, 8-10 October 2024</u>, site visits will enable you to meet Fertiebro and Almenar Bioenergy installations and visit their installations processing secondary nutrient streams into fertiliser products.

Next PRO-FEM conference edition will address soil health and will take place in Lleida (Spain) in 2025.

PRO-FEM Bio-based Fertilisers and nutrient recovery, 16-17 May 2024, Vic, Spain, Office of fertilisation and valorisation of livestock manure of the Catalan Department of Agriculture (Catalan Government), with the BETA Technological Center and the and the Horizon Europe projects Fertimanure and Novafert: <u>website</u>.

Microplastics

Microplastics and phosphorus in soils

High microplastic levels in soil, such as from plastic mulch films, can reduce phosphorus availability, likely due to adsorption onto the microplastic surfaces and possibly by increasing phosphorus mineralisation. However, this effect can be mitigated by phosphate fertiliser. Studies indicate that microplastics have more variable impacts on soil nitrogen availability.

Impacts are complex because they result not only from physico-chemical actions, but also from modifications to soil microbial communities and so to microbial activity (e.g. phosphatase enzymes). See for example, H. Ya et al. 2022 <u>DOI</u> who showed the formation of specific microbial communities on microplastics surfaces.

A recent paper suggesting that microplastics can release phosphorus into the soil from phosphorus flame retardants seems to be pure speculation*. J. Zhou et al. 2024 DOI, based on meta-analysis of 73 publications, suggest that microplastics in soil are correlated to increased soil phosphorus, soil available P and P leaching. They suggest that phosphorus flame retardants in microplastics might leach into the soil. To illustrate, consider a comparison: if churches and pubs appear together on a map, it might seem that most drinkers are churchgoers. However, both are simply located in village centres, not in open fields or lakes. The authors don't evaluate whether their suggestion is realistic. For soil phosphorus to increase by 5 ppm, assuming microplastics contain 5% phosphorus and release it over ten years, a 0.1% concentration of such microplastics in soil would be needed. This is a high level, considering most microplastics come from textiles, tyres, and non-flame-retardant plastics like mulch films. Therefore, it's unlikely that phosphorus in soil comes from flame-retardant plastics unless near a site processing waste electronics without dust filters. It's more probable that Zhou et al.'s correlation between microplastics and soil phosphorus is due to both being linked to agricultural activities, especially plastic mulch films. The two studies cited by Zhou et al. to support possible phosphorus input to soil from flame retardants seem irrelevant. They focus on the effects of non-flame-retardant microplastics on soil microbe phosphatase enzymes (ref. 70, S-S. Liu et al. DOI) or phthalates, not flame retardants (ref. 29, J. Wang et al. 2016 DOI). This aligns with the conclusions of F. Corradini et al. (2021) DOI in Chile, who found no evidence of microplastic pollution in natural grasslands and rangelands, but did find it in croplands and cultivated pastures. They noted that microplastic levels were not related to proximity to roads, mining, or urban areas. They concluded that microplastics are not ubiquitous in the environment and that their presence in soil is mainly related to agricultural activities, although the exact source was not identified.

R. Wang et al. (2024) <u>DOI</u> tested the effects of adding microplastics to soil on phosphorus availability in the lab. They used pure polymer microplastics (polyethylene PE, PVC, bio-based biodegradable PLA) without additives, at 5% dry weight and sizes ranging from 25 to 1080 µm. This high level of microplastics could occur exceptionally in fields with repeated use of mulch films. After applying phosphate fertiliser, they found that PE and PVC microplastics reduced Olsen-P by 10-40%, while PLA reduced it by 40-75%, compared to the control (no microplastics). Smaller microplastics caused greater decreases in Olsen-P. Adding fulvic acid reduced the microplastics' effect on Olsen-P. The authors concluded that microplastics reduce phosphorus availability by adsorbing it onto the polymers.



L. Wan et al. 2023 <u>DOI</u> meta-analysed 114 experimental studies, comparing microplastics addition to soil to control (not microplastics added), concluding that microplastic addition reduces total soil P, soil available P and total soil N.

F. Yu et al. 2023 <u>DOI</u>, using $0.5 - 1 \mu m$ polyethylene microplastics at 0.5 - 1% also showed that the microplastics led to considerable decreases in soil total and available phosphorus (reductions of up to -50%).

Q.L. Zhang et al. 2024 <u>DOI</u> tested, in pot experiments, the effects of adding 1% LDPE (low density polyethylene) microplastics to soil, showing that adding phosphate fertiliser mitigated impacts of the microplastics on bacterial communities (including impacts on microbes with phosphatase genes) on soil nitrate and on rice growth.

X. Li et al. (2022) <u>DOI</u> tested the addition of 1% polyethylene and polypropylene microplastics to soil in incubation tests, using pure polymers ground to 1-5 mm diameter. They tested these in the presence of organic or mineral fertilisers. The results showed that the microplastics consistently decreased soil available phosphorus, but had varied effects on soil nitrate and ammonia. The authors suggest that the varying results on soil nitrogen might be because these effects are more related to impacts on microbial communities (and thus nitrogen mineralisation) rather than physico-chemical impacts.

X. Wang et al. 2022 <u>DOI</u> provide a detailed review of effects of microplastics on elements cycling in the environment, with a concise chapter summarising knowledge on impacts on the phosphorus cycle. They note that "many studies" show that microplastics addition decreases soil total and available phosphorus, suggesting that this may be because microplastics lead to increased phosphatase activity, leading to P losses, or in fields because high use of plastic mulch films leads to reduced soil organic matter, again leading to P losses.

Z. Zhuang et al. 2023 <u>DOI</u> incubation tested addition of microplastics (polyethylene, polypropylene, butylene adipate terephthalate, ploy lactic acid = PLA) at 0.1 – 1% to paddy field soil. The microplastics (except for in some cases the biodegradable PLA) reduced soil P availability, inhibited soil alkaline phosphatase and reduced genes involved in organic P mineralisation and inorganic P solubilisation.

M. Yi et al. 2020 <u>DOI</u> also showed in soil incubation tests that microplastics of different forms (film, fibre, microsphere) of polyethylene and polypropylene impacted phosphatase and urease (P and N cycling enzymes) and soil bacteria communities.

M. Yin et al. 2023 <u>DOI</u> showed that PVC, polypropylene and poly lactic acid (PLA) microplastics significantly impacted microbial communities and N and P cycling in incubation tests with river sediments, suggesting that they could increase release of ammonia nitrogen and soluble phosphorus from sediments.

Full references of papers cited: click on the DOI link.

* Disclosure: the author of the above for ESPP also works for the Phosphorus, Inorganic & Nitrogen Flame Retardants association (pinfa).

Soil impacts of microplastics in sewage sludge and household organic waste composts

Studies suggest that microplastics in sewage sludge used in agriculture will not negatively impact soil ecosystems. J. Liengaard Johansen et al. (2024) reviewed available data on microplastics in sewage sludge and composted organic household waste. They concluded that, when applied within legal limits, these materials result in soil microplastic levels below those considered harmful to ecosystems. This is supported by the CRUCIAL field trials in Denmark, which show no negative effects and even increased abundance of earthworms and other soil organisms after 100 years of sewage sludge application (see SCOPE Newsletters <u>149</u> and <u>123</u>).

Microplastic levels have been reported at 10⁵–10⁸ particles per kg of dry matter, with differences likely due to varying measurement methods and particle size limits. Microplastics smaller than 500 µm could make up around 0.7% of the dry matter in sewage sludge. These microplastics mainly come from abrasion of textile fibres during laundry, washing sponges, car tyres, and paints. Microplastics in household organic waste are generally larger (rarely below 1 mm) and might be lower in content than in sewage sludge. However, when both are applied according to crop phosphorus requirements, household waste could result in a higher soil plastic content by weight.

Based on 30 studies, the maximum levels of microplastics in agricultural soils are around 0.02% of dry matter. There is little evidence to suggest that microplastics impact soil organisms or plants at these concentrations. Studies showing impacts on microbial communities and nutrient cycling are usually at much higher concentrations (often around 1%).

The authors conclude that applying sewage sludge at agronomically appropriate or legal limits poses "limited risks" to agricultural ecosystems. However, they note a significant lack of data, particularly on comparable microplastic levels in sewage sludges, composts, and soils, the long-term fate of microplastics in soils, and ecosystem impacts considering various factors like microplastic type, soil type, climate, and other pollutants.

Reference: "Extent and effects of microplastic pollution in soil with focus on recycling of sewage sludge and composted household waste and experiences from the long-term field experiment CRUCIAL," J. Liengaard Johansen et al., Trends in Analytical Chemistry 171 (2024) 117474 <u>DOI</u>.



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