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Workshops and meetings

SOFIE3: call for presentations – open to 15th October

3rd Summit of Organic and organo-mineral Fertiliser Industries in Europe. 16-17 January 2024, Brussels Plaza & hybrid

SOFIE is the only industry meeting place for organic-carbon-based fertiliser producers, distributors, advisory, technology suppliers. The [first SOFIE](#) (2019) attracted 125 participants, with 230 for [SOFIE2](#) (January 2023, *photo below*).



SOFIE3 will cover:

- policy and market
- agronomic benefits, in particular field trials and case studies
- processing from diverse input materials to consistent products for farmers
- application best practices, e.g. co-application with mineral fertilisers, biostimulants
- environment, carbon benefits, LCA, Circular Economy
- business models and product success stories

Short proposals for presentations, company showcases or posters by 15th October to info@phosphorusplatform.eu : see details [HERE](#).

SOFIE3 is co-organised by [ESPP](#), [Eurofema](#) and [Fertilizers Europe](#), with support of the [International Fertiliser Society](#)
www.phosphorusplatform.eu/SOFIE2024

NERM Nutrients in Europe Research Meeting - call for abstracts to 15th November

6th PERM becomes NERM – 16-17 April 2024 – Brussels & online – plus research students meeting & site visits.

NERM (Nutrients in Europe Research Meeting) is organised by ESPP, FERTIMANURE, LEX4BIO, RUSTICA, SEA2LAND, WALNUT and Biorefine Cluster Europe.

Towards closing nutrient cycles for a sustainable future, from R&D to implementation.

- key outcomes of recent nutrient recycling R&D projects
- roadmap for future nutrient recycling R&D needs
- nutrient recovery technologies and recycled fertiliser production
- quality, application and use, stakeholder acceptance of secondary fertilisers
- from nutrient recovery to market



Plus PhD / research students event 15th April and site visits (on-farm and sewage treatment nutrient recovery sites).

Call for abstracts, open to 15th November 2023, and outline programme are published <https://phosphorusplatform.eu/nerm>

Policy

EU Soil Health Directive proposal

Public consultation **open to 3rd November 2023**. Possibility to input plain text comments (max. 4 000 characters) plus document. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13350-Soil-health-protecting-sustainably-managing-and-restoring-EU-soils_en

EU proposed food waste reduction targets and actions

Amendments to the EU Waste Framework Directive, as proposed by the European Commission, would fix targets to reduce food waste by 2030: **-10% for food manufacture and processing, -30% for households**. Member States must define Food Waste reduction programmes, including the following actions: behavioural change campaigns, actions to address supply chain inefficiencies, food donation systems, skills training, funding for SMEs and social economy actors. The proposed amendments to the Directive are currently open to public consultation and will go to European Parliament and Council for decision.

“Revision of EU Waste Framework”, **public consultation open to 22nd November 2023**. Possibility to input plain text comments (max. 4 000 characters) plus document. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13225-Environmental-impact-of-waste-management-revision-of-EU-waste-framework_en

What is the nutrient recycling potential of food waste?

Phosphorus and nitrogen in food waste could supply around 10% of nutrients needed for crop production. Analysis for Seattle, USA, suggests that if all food waste were collected and nutrients recycled (compared to only 10% - 50% current collection rates) this would supply 0.6 kgN and 0.1 kgP (per person, per year). The estimates are based on [Zhang 2007](#), who analysed food waste in San Francisco, finding average contents (% dry matter) of 3% N, 0.5% P and 0.9% K. These estimates of nutrients in food waste compare to an estimated 6.6 kgN and 1.1 kgP considered necessary input to grow non animal feed crops. ESPP notes that average dietary intake of phosphorus is around 0.5 kgP/person/year (c. 1.3 gP/person/day, see [SCOPE Newsletter n°103](#)). Estimates of food waste production and collection vary considerably: US EPA 2009 = 109 kg/person/year, Seattle 123 kg in 2009 reduced to 65 kg in 2021 in single-family homes, but only 56 kg down to 30 kg in multi-family homes (apartments). The conclusions are that nutrient recycling potential from food waste is limited (compared to municipal wastewater and manure) but is nonetheless significant, and that the priority must be to reduce food waste.

“Connections: How Much N And P Are In Urban Residuals?”, S. Brown, *BioCycle*, [7th August 2023](#).

Proposed criteria for “Processed Manure” in EU fertilising products

Public consultation is **open to 30th October** on proposals a Delegated Regulation to include “Processed Manure” (as defined in the Animal By-Products Regulations) in the EU Fertilising Products Regulation FPR (CMC10). ESPP’s proposed input is [HERE](#) for comment. The proposed criteria are based on a [draft JRC report](#) circulated for comment to the Fertilisers Expert Group late September. The proposed Delegated Regulation would add processed manure to CMC10 to the EU Fertilising Products Regulation, under certain specified conditions. This concerns only “Processed Manure” which has reached an End Point as defined in EU Animal By-Products (ABP) Regulation 1069/2009, that is fulfilling the criteria specified in the ABP daughter Regulation 142/2011 – Annex XI – Chapter I – Section 2, which specifies (inter alia) heat treatment of at least 70°C for 1 hour in a registered ABP processing plant

It is noted that manure which has undergone composting or anaerobic digestion according to both the criteria in the ABP Regulations and the criteria in CMCs 3 or 5 of the EU Fertilising Products Regulation (FPR) are already authorised under the

FPR* (It is ESPP's understanding that this also applies to combustion ashes and pyrolysis materials / biochars subject to the criteria of CMCs 13 and 14*).

The proposed criteria for "Processed Manure" in CMC10 specify that the material shall have a limited oxygen uptake (intended to ensure stability), sets limits for PAH (poly aromatic carbons) and indirectly for certain herbicide residues, and specifies that the material can be post-processed by a specified and limited list of processes including solid-liquid separation, drying, pH adjustment, P or N recovery and that additives necessary for such processes can be used (with limits and conditions). The proposed criteria also require storage to be protected from sunlight and precipitation, intended to avoid ammonia losses to air, odours or leaching. ESPP suggests that such loss mitigation should also cover transport, that it be clarified whether this refers to before ABPR processing, between ABPR processing and FPR certification or after FPR certification (placing on the market). ESPP also suggests that this criterion should be made clearer by specifically referring to limiting air pollution, leaching and accidental spillages. ESPP notes, and welcomes, that limiting ammonia losses during use should be addressed in labelling (Annex II of the FPR).

ESPP thanks the European Commission for the rapid production of these proposed criteria and draft Delegated Regulation for "Processed Manure" in CMC10, and notes that these take into account comments input by stakeholders, in particular concerning post-processing.

European Commission public consultation "EU fertilising products – Processed manure as a component material in EU fertilising products", **open to 30th October 2023** (4 000 characters plus possibility to upload a document) [HERE](#)

ESPP's proposed input is [HERE](#) for comment.

European Commission JRC DRAFT circulated for comment (not yet adopted or endorsed by the European Commission) "Technical proposals for processed manure as a component material for EU Fertilising Products" [LINK](#).

* These points remain to be clarified.

EU workshop on standards and NACE codes for bio-based materials

100+ participants in Brussels and online discussed standards needs to support the bio-economy concluding that clear definitions are needed to support Public Procurement policies and for transparency for companies in the market at a workshop organised by the European Commission on 29th September 2023. Presentations included DG GROW, CEN/TC 411 / WG 4 'Sustainability criteria, life cycle analysis and related issues', ISO/TC 276 'Biotechnology' and Eurostat. The workshop emphasised that standards are considered important by companies to enable market access, improve quality and reduce risks. One study suggests that standardisation contributes 30 – 40% of GDP growth and of labour productivity ([Menon, Nordic Economies, 2018](#)). Participants noted that the US is actively developing bio-based standards to promote national production in line with the Inflation Reduction Act objectives. Much work is ongoing on standards for forestry and paper products, and on aspects such as Life Cycle Assessment or general circularity approaches (e.g. [ISO/TC 323](#) - Circular economy). There is wide demand from many different industry sectors for standard development for various bio-based products and processes.

NACE codes were discussed. These are important because used in EU statistics and often also in policy criteria. However, NACE codes are based on companies' economic activity (often reflecting the production process and output products) and are not adapted to identifying inputs or processes used (a company's NACE code will say it produces textiles, not whether or not it uses IA to control its machines). Participants noted that use of NACE codes in e.g. the EU "Taxonomy" criteria is ineffective in identifying bio-based inputs.

ESPP indicated that there is a need for a standard for defining "bio-based" nutrient content of fertilisers (or of e.g. phosphorus in technical chemicals) in that the CEN methodology for quantifying bio-based content of products ([CEN/TR 16721](#)) uses radio-dating which is not applicable to P, K or N (see [ESPP eNews n°73](#)). This is also relevant for interpretation of the wording "nutrients of solely biological origin" in the EU Fertilising Products Regulation (PFC definitions of Organic Fertiliser, Organo-Mineral Fertiliser, Organic Soil Improver). ESPP's draft position Paper on the definitions of "Bio-Based Fertiliser" or "Bio-Based Nutrient" is available [here](#) and is open for comment. ESPP notes that development of many standards is underway to support implementation of the EU Fertilising Products Regulation and STRUBIAS.

The European Commission concluded that the workshop demonstrated the importance of standards to industry, and confirmed the need to further work on standards relevant to bio-based materials, and also to look at how standards and NACE codes are used in EU policy criteria.

DG GROW is also working on market tools to promote uptake of bio-based products, and announced a second workshop on this theme 11th December 2023. See ESPP's input to the first such workshop (10th May 2023) [here](#).

Written input to DG GROW is open to 15th October GROW-F2@ec.europa.eu

European Commission DG GROW Bio-Based Products [page](#).

NGOs and water industry call for publication of EU nutrient action plan

Fourteen organisations have signed a joint letter to the European Commission asking for rapid publication and high ambitious of the EU's INMAP (Integrated Nutrient Management Action Plan), announced in 2020 in the Green Deal. They underline that INMAP is urgent and necessary to achieve the Farm-to-Fork, Biodiversity and Zero Pollution Action Plan targets to reduce nutrient losses by 50% by 2030. The letter states that "bold action and clear directions are needed" and urges the European

Commission “to hold to its promise to deliver the INMAP and to listen to scientific expertise for setting the path until 2030 and beyond ... the EU could achieve genuine strategic autonomy in nutrients management and ultimately food production”.

Open letter to the: European Commission “Completing the European Green Deal: The Commission’s initiative for an Integrated Nutrients Management Action Plan”, European Environmental Bureau (EEB), Eureau, AquaPublica and others, 13th September 2023 on [EEB website](#).

Phasing out synthetic fertilisers ?

ESPP questions the statement in the letter cited above that “phasing out synthetic fertilisers use in the EU is realistic as part of a transition to agroecological farming, accompanied by a cut in food waste and a shift to sustainable diets”. It is not ESPP’s competence to discuss this statement for nitrogen. For phosphorus, we note that both of the two studies referenced ([Poux IDDR 2018](#), [Billen 2021](#)) explicitly state that they do not address phosphorus. ESPP also notes that phosphorus inputs are considered to have been a determinant allowing global population expansion beyond one billion after the 19th century ([Smit et al. 2009](#)). Phosphorus cannot be biologically fixed from air. Medieval agriculture was phosphorus efficient so phasing out inputs from mined phosphate rock might mean returning to both a medieval population level and a medieval average diet. However, dietary shifts have less impact on net P use than they do on N or CO₂, because P is conservative: what goes into one end of the cow comes out the other end (some is lost in growing fodder to feed animals). ESPP has often presented slides in conferences (publicly available [here](#)) indicating that “Without mineral phosphate fertilisers we could feed maybe 1/5th of the current world population (adapted from [Dawson et al., Food Policy 2011](#))”. ESPP does not suggest that this is accurate but to date nobody has indicated to us that it is completely wrong, and (as we have done when presenting these slides) we call on scientists to carry out such an assessment for phosphorus.

Any comments on this discussion are welcome and may be published in our next eNews. Send to info@phosphorusplatform.eu

EU report on phosphorus and nitrogen R&D projects

75-page DG Research summary of 72 Horizon 2020 projects on nutrients (total 370 M€ EU funding) proposed as a contribution to INMAP (the announced EU Integrated Nutrient Management Action Plan). The report, prepared by the European Commission DG Research and Innovation, analyses 72 Horizon 2020 research projects, completed or underway and with project budgets > 1 M€, addressing phosphorus and/or nitrogen cycles, nutrient pollution reduction techniques, fertiliser production, nutrient use in agriculture or governance. The projects are considered to have policy impact if e.g. policy recommendations were elaborated within the project, and to have technological impact if e.g. a pilot plant was built. It is not however analysed whether policy recommendations made by the project have been considered by policy makers or implemented into regulation, nor whether the pilot plant led to industrial scale up and uptake to market. The projects led to a total of forty-two pilot plants, four patents and nearly 100 scientific publications or conference proceedings. Policy outcomes cited include that the Urban Waste Water Treatment Directive should be revised (underway), that the Sewage Sludge Directive should be revised (expected) and the establishment of EU End-of-Waste criteria for products recovered from wastewaters (rejected for the moment, European Commission 5th April 2022, see [ESPP eNews n°65](#)) and financial incentives for circular water technologies (not yet anticipated). Conclusions include the need to enable permanent access to project outcomes after projects end (project websites tend to disappear when project funding terminates), centring dissemination efforts at the end of the project (when there are results and outcomes to present, rather than presenting what the project hopes to do) and including policy recommendations relevant to EU legislation in technical projects.

“Systematic approach preventing pollution from nitrogen and phosphorus. A contribution to the Integrated Nutrients Management Plan from the Research & Innovation perspective”, European Commission DG Research & Innovation, August 2023 [DOI](#).

Nutrient recycling

Unilever adopts N2 Applied’s nitrogen valorisation technology

Four N2 Applied plasma slurry nitrogen upgrade installations, supplied in partnership with food industry technology leader GEA, will be installed at dairy farms in the Netherlands to improve supply chain sustainability for Unilever. The N2 Applied system increases nitrogen fertiliser value of slurry and stabilises nitrogen present in the slurry, so reducing losses to water and losses of methane, ammonia and greenhouse gases to air. The N2 Applied technology is provided by GEA as a “manure enricher solution” as part of the GEA “Next Generation Farming” approach. The four installations in the Netherlands will provide data for a year to enable Unilever to assess benefits for milk supply chain sustainability and potential for scale-up. GEA state that the system can reduce dairy farms’ total carbon footprint by up to 30%, and that reducing nitrogen losses allows more efficient nutrient use and so economic benefits for the farmer.

“N2 Applied’s technology will be used by food industry giant”, [N2 Applied News](#), September 2023.

“GEA partners with Unilever to improve sustainability on dairy farms”, [31st August 2023](#).

UK water companies' recycling working group

Led by Thames Water, UK "Resource Recovery Technical Working Group" aims to bring together stakeholders and collate information on technologies and regulation. Members to date include several English water companies, Scottish Water, Irish Water, consultancy experts, researchers and government representatives. A first online meeting, with around forty participants, 28th September, discussed developments in EU and UK regulations (EU Waste Water Treatment Directive revision, EU Fertilising Products Regulation and UK fertilisers regulations, REACH and UK REACH, End-of-Waste) and how to develop an economic market for recycled nutrients and other recovered materials (e.g. polymers). Future meetings will look at resource recovery and nutrient recycling technologies, end-use needs, building markets for recovered materials, operating parameters and scalability, economics and technology evaluation, contaminants and safety.

UK "Resource Recovery Technical Working Group". This working group is open.

To participate contact: Robert Naylor Robert.Naylor@thameswater.co.uk

ESPP slides from RAMIRAN September 2023, update on EU policy and regulations for organics recycling [HERE](#).

Seminar on circularity in the water sector

The Aqua Publica Europea event, in Verona and online 29th June, saw 120 participants discuss the legislative framework, sludge management approaches, and measures to increase the circularity of the wastewater sector.

Milo Fiasconaro, Aqua Publica Europea, Bernard Van Nuffel, Vivaqua, and Roberto Mantovanelli, Viveracqua, welcomed participants and introduced the main objectives of the seminar: to explore the approaches to circularity in the water sector across Europe and to promote a dialogue with experts and institutions about how to address common challenges in the context of the ongoing revision of the Urban Wastewater Treatment Directive and the publication of the evaluation of the Sewage Sludge Directive by the European Commission.

Nele-Frederike Rosenstock, European Commission, DG ENV, summarised the main novelties of the revision of the Urban Wastewater Treatment Directive (UWWTD, see also [ESPP's summary](#)), now under co-decision in the Parliament and Council, and its relevance to sludge management. Articles 14 and 20 are especially important for circularity and sludge, as they address the tracking of non-domestic pollution and its reduction at source (art. 14), which should result in cleaner sludges, and the use of sludge according to the waste hierarchy (art. 20), as well as the introduction of recycling rates for P and N. She also reported on the recently published [evaluation of the Sewage Sludge Directive](#), which finds that the Directive is effective and relevant and supported by stakeholders, although more can be done to adapt it to Green Deal targets and currently available technologies. At the moment, it is yet to be decided politically whether or not the text will be revised, but this would seem appropriate as it dates from 1986.

Jon Rathjen, Scottish Government: Scottish Water's has moved from dumping sludge into the ocean as a waste until 2000, into making it a resource, with the Scotland's wastewater sector now producing 3% of the nation's energy needs as biogas from sludge digestion, with the sludge digestate mostly valorised in agriculture, and other sources as wind and solar.

Gudrun Winkler, Hamburg Wasser: the public operator manages Germany's biggest wastewater treatment plant (150 million m³/y) operating sludge digestion and incineration. The plant is energy neutral since 2011, thanks to the VERA incineration plant processing 100 000 m³ of dried sludge/y, producing 89 GWh/y of electricity and 80 GWh/y of heat (before accounting the energy used to dry the sludge). Around 1 700 tP/y of phosphorus will be recovered as phosphoric acid from the sewage sludge incineration ash by the Remondis TetraPhos (now in production). The TetraPhos process also recovers iron/aluminium salts for recycling of phosphate precipitants to wastewater treatment.

Paolo Giandon, Veneto Region: Veneto has seen a reduction in the direct use of sewage sludge in agriculture observed since 2017 due to regulatory uncertainties and farmers' mistrust. A waste management plan was therefore proposed by the Veneto region in 2022 to prioritise the reuse in agriculture, describing different sludge disposal routes (direct reuse in agriculture, composting, energy production) depending on sludge quality. Mr Giandon also mentioned challenges posed by the recast of the UWWTD, related to high cost and time needed for implementing the required measures.

Bertrand Vallet, European Commission, DG RTD, outlined the Commission's research agenda on circularity. Circular economy was a key topic for the Horizon 2020 funding framework and was mainly focussed on resource recovery from wastewater and prevention of pollution. The current funding programme, Horizon Europe, is providing 655.5 million € for water in the 2021-2024 period, and is particularly focussed on harnessing the innovation potential and market uptake of successful circular economy examples, and on the implementation of large-scale circular systems for the reuse of water and sludge.

Two projects currently ongoing by APE members were then presented. The first one, presented by **Enrico Pezzoli, Como Acqua,** intends to build an anaerobic digestion plant in the Como area, co-financed under the Recovery Fund, treating sewage sludge, agri-food wastes, green wastes and the organic fraction of municipal solid waste. The Fanghi Project, presented by **Marco Blazina, Metropolitana Milanese,** and concluded in 2022, built a HTC pilot plant and a mono-incineration plant for sludge thermal valorisation and phosphorus recovery.

The seminar concluded with a panel discussion addressing the framework conditions to step up circularity. **Veronica Santoro, ESPP,** emphasised that a plurality of effective approaches to circularity already exist and presented concrete examples of phosphorus recovery in the wastewater sector. She also stressed the importance of communication and stakeholder engagement

to ensure adequate societal support to circularity. **David Bolzonella, University of Verona**, agreed that there is a plurality of approaches available, and there is no silver bullet to solve the issue of sludge management. He also argued that society is moving away from an 'end-of-pipe' approach to wastewater and that treatment plants are being transformed into 'bio-refineries' capable of recovering precious substances. Despite this, end markets for these substances are not yet stable. In this regards, **Bertrand Vallet** highlighted the lack of a 'critical mass' or critical quantity of recovered materials that can underpin investments in supply chains. All panellists agreed that there is not a one-size-fits-all solution to circularity, approaches can be combined according to contextual conditions, and political choices on the appropriate mix must be made at national and local level to bolster circularity.

"Circular ways: promoting circular approaches in wastewater treatment", organised by Aqua Publica Europea with Viveracqua and Acque Veronesi, [29th June 2023](#)

Urban Wastewater Treatment Directive [Recast \(26/10/2022\)](#); Sewage Sludge Directive [evaluation \(22/05/2023\)](#)

Research

US STEPS 25-in-25 Phosphorus Sustainability Roadmap

US Academy of Science funded (since 2021) phosphorus sustainability Center STEPS has published a 70-page Roadmap proposing a 25% reduction in dependence on mined phosphate and a 25% reduction in P losses within 25 years. The Roadmap outlines the phosphorus Problem, a Vision for phosphorus Sustainability and nine Opportunities for action. It underlines the challenges of rising global food demand, phosphate rock as a finite resource, inefficient phosphorus processing and use, legacy P trapped in soils and eutrophication leading to algal blooms. Action on phosphorus is situated in the global agendas of innovation and sustainability, emphasising the need to improve P monitoring, process animal and farm wastes, improve agricultural P efficiency, reduce phosphate rock mining waste and develop valuable products from P-recycling. The nine proposed actions are: improving agricultural P-use efficiency, processing farm wastes and particularly manure to fertilisers, recovering P to valuable products, reducing and recovering phosphate mining wastes, reducing food supply chain and food wastes, improving P-monitoring, developing markets for P-management solutions, engaging stakeholders to accelerate technology adoption, increasing public awareness. These nine actions are each detailed into short-term, medium and long-term sub-actions, The 33 sub-actions are organised by "stakeholder": advocacy, academia and NGO, farmers, finance, food chain industry, regulators, waste & water industries, mining, media. An Appendix identifies over 90 "aggregated impact opportunities" proposed in other reports including Our Phosphorus Future (see [ESPP eNews n°67](#)), RePhoKUS, [OCP Sustainability Report 2021](#), [Water Research Foundation Holistic Approach to Nutrient Management 2022](#) ...

STEPS "25-in-25: A Roadmap Toward U.S. Phosphorus Sustainability" Roadmap, May 2023 [DOI](#).

Long-term P fertilisation reduces carbon sink function of a peatland

The C sink function weakened after P fertilisation due to increased ecosystem respiration, resulting from changes in vegetation composition and litter quality, increased enzyme activity, microbe metabolism and peat decomposition. The study was conducted in a peatland in northeastern China, where a 12-year experiment (2007-2019) mimicked environmental changes by adding different levels of P (5 and 10 kg ha⁻¹ y⁻¹) to the soil, to assess the impact of P fertilisation on CO₂ emissions. The following were monitored for five months (May to September 2019) after the 12 years of P fertilisation: CO₂ fluxes, soil total C, N and P, vegetation and plant cover, dissolved organic C in peat pore water, and activity potential of extracellular hydrolytic enzymes. Long-term P addition altered vegetation structure by inhibiting the growth of *Sphagnum* mosses and facilitating that of vascular plants, without significantly changing gross primary production relative to the controls. The shift in vegetation led to more high-quality litter and easily accessible C sources for microbes. This increased ecosystem respiration and boosted phenol oxidase enzyme activity, likely due to higher phenolic content in the plant litter. Consequently, the concentration of dissolved organic C in pore water increased, accelerating peat decomposition. Nitrogen metabolism enzyme activity increased, whereas phosphorus and carbon metabolism enzymes were unchanged. Additionally, fungal abundance increased in P-fertilised plots, potentially accelerating the breakdown of soil organic C and increasing CO₂ emissions. As a result of these processes, the peatland's capacity to absorb CO₂ was significantly reduced with P fertilisation. The average net CO₂ uptake during the growing season was in fact only 0.002 at high level of P, compared to 0.063 mg/m²/s in the control plots.

"Long-Term Phosphorus Addition Strongly Weakens the Carbon Sink Function of a Temperate Peatland" F. Lu et al., *Ecosystems* (2022) [DOI](#).

LCA impacts of wastewater-derived P products

Life Cycle Analysis suggests that partial substitution of rock-based P fertilisers with wastewater-derived P products reduces global warming, eutrophication, ecotoxicity, and acidification potential of crop production. The study assessed the life cycle environmental impacts, for a functional unit of producing 1 kg of crop, of replacing half of the conventional rock-based P fertilisers in maize, rice, and wheat production with P products derived from wastewaters from six different recovery routes. The considered wastewater treatment plant included activated sludge treatment and anaerobic sludge. The P recovery routes considered were: precipitation from digester supernatant (struvite or tricalcium phosphate) and P-recovery from sewage sludge

mono-incineration ash (Rhenania phosphate or single superphosphate). The pathways and scenarios were evaluated based on literature data and inventories, databases, and modelling of P recovery integration into a wastewater treatment plant. Results indicate that wastewater-derived struvite, tricalcium phosphate, and Rhenania phosphate-like product can reduce environmental impacts in most scenarios, with the extent of change varying by crop. Eutrophication potential decreased in nearly all pathways and scenarios, because the LCA calculation assumed reduced P content in the wastewater treatment plant effluents. Conversely, processes involving thermo-chemical treatment and chemical extraction increased global warming potential and ecotoxicity in all scenarios, outweighing the benefits of avoiding conventional fertilisers due to additional chemical inputs and heating energy.

"Life Cycle Environmental Impacts of Wastewater-Derived Phosphorus Products: An Agricultural End-User Perspective" K. A. Lam et al., *Environ. Sci. Technol.* (2022) [DOI](#).

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