Summit of the Organic Fertilisers Industry in Europe

Brussels & hybrid, 17-18 January 2023

Already 120 participants are registered for this second organic and organo-mineral fertiliser industry conference. Speakers and registrants to date include the European Commission (DG AGRI, DG GROW, JRC), Copa-Cogeca, S&P Ferticon, iFoam, Notified Bodies, Registered participants to date include : Fertira, Koppert, Deleplanque, LBST Denmark, Omya, SEDE Veolia, Agrobiogel, Teagasc, Mills Nutrients, Tessenderlo, Adas, Honkajoki Oy, Protix, WEW, Benefert, Agrana, DCM, Evergreen, Ferm O Feed, Boicompig, Tervalis ….

The 1st SOFIE meeting, 2019, brought together, for the first time ever, the European carbon-based fertiliser sector, and attracted participants, from industry (two thirds of participants), as well as regulators, stakeholders and R&D, from 14 European countries and worldwide (summary in SCOPE Newsletter n°130).

SOFIE2 is co-organised by ESPP, ECOFI, Eurofema and Fertilizers Europe, with support of the International Fertiliser Society.
SOFIE2 - 2nd Summit of the Organic and organo-mineral Fertilisers Industries in Europe,
Brussels & hybrid, 17-18 January 2023 *www.phosphorusplatform.eu/SOFIE2023*

Workshop on Nitrogen Recovery

Brussels & hybrid, 19 January 2023

www.phosphorusplatform.eu/NRecovery

This workshop is open, for physical participation in Brussels, to invited participants only whereas online access is open to the public. This is necessary to enable an operational working meeting in Brussels. Online participants will be able to actively participate through the Chat and the dedicated networking space on Swapcard.
Information and registration online (hybrid) www.phosphorusplatform.eu/NRecovery
Participation in Brussels: contact Olivier Bastin, ESPP

ESPP General Assembly and New Year 2023

ESPP wishes all the best for 2023 to all of our eNews readers. We hope that the year will bring an end to Russia's war against the Ukraine and peace to nations and populations across the world, and we look forward to actions on nutrient sustainability, coherent with actions on climate change, in Europe and worldwide.

ESPP's General Assembly, hosted in Brussels (by Fertilisers Europe) and online, 28th November 2022, saw participation at the meeting of just over half of ESPP's 52 Members and Partners, and formal email vote of over 90% of ESPP's legal Members.

The General Assembly validated, with the necessary quorums, the 2021 accounts, 2022 and 2023 budgets (keeping membership fees at the same level as previous years).

The assembly also validated (with the specific necessary quorum and voting conditions) the **modification of ESPP's statutes to widen the association's objectives and actions to cover "recycling of other nutrients".** ESPP will now take forward actions on recovery and recycling of nitrogen and of other nutrients, but will not engage in questions such as crop nitrogen use efficiency, nitrogen losses, nitrogen and climate change (except where these are relevant to ESPP's core objective of phosphorus sustainability). The assembly underlined that ESPP's core competence remains phosphorus, and that action on recycling of nitrogen or other nutrients must be financed by new member fees or other new funding.

The ESPP N-Recovery Workshop (Brussels and online, 19th January 2023) aims to identify companies and stakeholders interested to establish a Nitrogen Recovery Group within ESPP.

Developments towards phosphorus recycling in 2022

The ESPP General Assembly noted a number of successes over the past year, with progress towards P-recycling in Europe with significant regulatory developments including:

- Regulatory proposal for Urban Wastewater Treatment Directive
  → framework to set minimum reuse & recycling rates for N and P
- EU Fertilising Products Regulation entered into force July 2022
  → composts, digestates, precipitated phosphates, ashes, biochars
- Recovered precipitated phosphates in Organic Certified Production
  → Public Consultation closed 21/11/22
- EU Communication on fertilisers (9th November 2022) – promotes nutrient recycling
- Legal obligation to recover P from sewage notified to EU by Austria, not yet legally ratified in Austria but expected
  → 3rd European country, after Switzerland, Germany www.phopshorusplatform.eu/eNews070

ESPP continues to develop communications to enable networking between stakeholders, companies and researchers interested in nutrient sustainability and to promote phosphorus recycling:

- 4th European Sustainable Phosphorus Conference, June 2022, with active engagement of Vienna City and of Borealis, and more than 300 participants www.phosphorusplatform.eu/Scope143
- Social media: LinkedIn over 800 followers and Twitter nearly 2500 followers
- ESPP website: c. 60 000 users/year - up from c. 40 000 in 2021
- ESPP emailing list (eNews): 93 000 recipients, most recent eNews n°71 = 12 000 clicks

ESPP projects and actions for 2023

ESPP expects to take forward the following dossiers in 2023 (to be confirmed):

- INMAP (EU Integrated Nutrient Management Action Plan)
- EU water policy: Urban Waste Water Treatment Directive (see eNews 71), Sewage Sludge Directive
- Critical Raw Materials: re-evaluation underway of 'Phosphate Rock' and 'Phosphorus' (P_4) ; and Potash (?) ; MSA for 'Phosphate Rock' ; link between CRM - energy - food security policies
- EU Fertilising Products Regulation: JRC study on possible additional CRMs, implementation …
- Cat. 1 ABP ash: ESPP legal Opinion, safety data survey 2022, EFSA evaluation 2023 ?
- Recovered nutrients in Organic Farming: submission of dossiers by companies via Member States
- End-of-Waste / animal feed regulation / algae
- Nitrates Directive and recycled manure nutrients www.phosphorusplatform.eu/eNews047
- EU "Taxonomy" ?
- ESPP – DPP – NNP Recycling Technology Catalogue http://www.phosphorusplatform.eu/techcatalogue
- Events: SOFIE2, N-Recovery, Organic Certified Farming (PROPRE), P_4 chemistry and uses, iron-phosphorus interactions, adsorbents for P-removal and recovery, Phosphorus Research in Europe Meeting (PERM6), event in Italy with the Italian Phosphorus Platform …

Policy

European Commission Communication on availability and affordability of fertilisers

The Commission recognises the EU's dependency on imports for fertilisers, impacting farmers' costs and food insecurity, and the strategic need for organic fertilisers, green ammonia and nutrient recycling, alongside sustainable and precision farming, to improve nutrient use efficiency and reduce losses.

Actions announced include:

- Use **CAP (Common Agriculture Policy) Member State Strategic Plans** to support efficient and sustainable fertiliser use whilst preventing nutrient losses, including rollout of the **FaST tool** (Farm Sustainability Tool for Nutrients): "*CAP Strategic Plans support partial replacements of mineral fertilisers by organic fertilisers like manure, sewage sludge and biowaste, from methanisation processes or biological and thermal treatments, while ensuring that this does not result in higher nutrient losses*"
- **Organic and recycled fertilisers**: "*Better access to organic fertilisers and nutrients from recycled waste-streams, especially in regions with a low usage of organic fertilisers*"
- Support for **Green Ammonia** (from renewable energies, not from natural gas)

ESPP welcomes the **recognition of the importance of organic and recycled fertilisers,** as well as improving fertiliser use and calls for strong EU action to support these be included in the Integrated Nutrient Management Action Plan under preparation for 2023. ESPP underlines that the nitrogen, phosphorus and potassium present in organic waste streams (manure, sewage biosolids, food wastes, animal by-products) are in total significantly greater that used in mineral fertilisers, and potential for increasing recycling is considerable.

The European fertilisers industry (Fertilizers Europe, 9th November 2022) has underlined the need to optimise nutrient use, in particular with the EU FaST tool and precision fertiliser practices, and called for "*measures to support the transition to a low-carbon fertilizer industry*".

ESPP welcomes the possibility to require nutrient recycling in the proposed **revision of the EU Urban Waste Water Treatment Directive** (published 26th October 2022) and calls for this requirement to be rapidly implemented. This should also be included in the Sewage Sludge Directive revision underway. Germany and Switzerland already have regulatory phosphorus recycling obligations; and now also Austria.

ESPP notes the recognition in the Communication of the importance of the EU Fertilising Products Regulation 2019/1009 to open the market for recovered fertilisers and for "*Specialty EU fertilising products such as inhibited fertilisers, controlled release fertilisers and plant biostimulants".* ESPP calls to **accelerate removal of legal obstacles to recycling of nutrients from animal by-products (ABP), where these are confirmed to be safe, such as Cat.1 ABP incineration ash.** We call on the Commission to mandate rapidly EFSA (European Food Safety Agency) to assess the safety of these materials.

ESPP welcomes the announced aim of improving fertiliser use of manure and processed manure **in compliance with the Nitrates Directive**. ESPP notes the Commission's clarification that proposed JRC "RENURE" processed manure materials (see ESPP eNews n°47) with potential ammonia emissions should continue to be subject to strict Nitrates Directive application requirements. ESPP underlines that it should be recognised that **mineral fertilisers recovered from manure** do not have ammonia emission or leaching risks different from fossil-derived mineral fertilisers, and should not be considered as "processed manure" (similarly for biomass grown using manure as a substrate), see ESPP eNews n°71.

The Nutrient Circular Economy, increasing nutrient recycling and organic fertilisers, alongside Nutrient Use Efficiency and green ammonia, are the only way out of EU import dependency for fertilisers, and so are critical to ensure food security, farmer livelihoods and to limit food inflation.

ESPP calls for clear regulatory actions and fiscal or market incentives to support nutrient recycling in the upcoming Integrated Nutrient Management Action Plan.

2nd European Summit of the Organic Fertilisers Industry in Europe (SOFIE), 17-18 January 2023, Brussels and online www.phosphorusplatform.eu/SOFIE2023

European Commission Communication "Ensuring availability and affordability of fertilisers", COM(2022) 590, 9th November 2022 here and press release / Q&A / summary here.

ESPP input on Critical Raw Materials (CRM), food security and energy policies

ESPP calls for EU policy to combine nutrient CRMs, food security and energy. EU consultations on CRM policy excluded agricultural products and energy, whereas NPK are critical for food production and gas for N-fertiliser (see ESPP eNews n°71). ESPP's input underlined that "Phosphate Rock" (in effect, phosphorus in any form) is on the EU Critical Raw Materials list, because it is non-substitutable for fertiliser, animal feed and food and the EU is highly import dependent. Natural gas supply and price challenges have strongly impacted N-fertiliser production in Europe, threatening farmers' access to fertilisers, and so EU food security. ESPP also underlined the synergies between nutrient recycling and environmental objectives: reducing nutrient losses to waste and eutrophication, reducing nitrogen losses to air (greenhouse nitrogen gases, ammonia). ESPP welcomes that the Commission's proposed CRM policy Roadmap emphasises recycling and improving "level

playing field. ESPP suggests that such policies should be implemented for nutrients and proposes a number of policy actions to incite and facilitate phosphorus recycling.

ESPP input submitted to EU public consultations on Critical Raw Materials (CRM) policy, 25th November 2022
www.phosphorusplatform.eu/regulatory

ESPP input on Polluter Pays Principle (PPP)

ESPP welcomed the launch of EU work to better implement PPP, underlining the social costs of nutrient losses and eutrophication, and the need to implement PPP for emerging contaminants which are an obstacle to nutrient recycling, in particular by implementing PPP into the Common Agricultural Policy and by obliging full cross-compliance between CAP funding and local River Basin Management Plans under the Water Framework Directive. The Commission's draft Roadmap refers to the European Court of Auditors report (2021) which emphasises that polluters do not bear the full costs of water pollution. ESPP provided references to several studies illustrating the societal costs of eutrophication. ESPP calls for the "Extended producer responsibility" proposed for pharmaceuticals and cosmetics in the draft revision of the Urban Waste Water Treatment Directive (October 2022) to be extended to cover industrial chemicals, plastic additives, micro-plastics and agrochemicals. ESPP notes the call from different organisations to fully implement ban on PFAS proposed under the Green Deal (SWD(2020)249). ESPP also calls for dialogue with the EU food industry, supermarkets and consumer organisations on contaminant safety in nutrient recycling.

EU consultation on the Polluter Pays Principle closed 11/12/2022 and ESPP input.

NGOs "Manifesto" for PFAS ban

Call signed by around 100 organisations calls on the EU to implement the ban on PFAS as a "group" (announced in the Chemicals Strategy eNews n°49), by banning PFAS in all consumer products by 2025 and completely by 2030. PFAS (per- and polyfluorinated substances) are considered a problematic contaminant in sewage sludge (see e.g. Sweden Water position in eNews n°66) and EU Commission workshop 2021 (eNews n°55). The Arcadis report on contaminants in fertilising products (for DG Environment, 2021) recommended to "remove PFAS as completely as possible from fertilising materials" (eNews n°61). The 'Manifesto', signed by EEB (European Environmental Bureau), CHEMTRUST, Friends of the Earth, Greenpeace and others, specifically refers to the problem of PFAS in sewage sludge (referring to the EFSA 2020 Opinion) and one of the ten call points is "to urge the EU authorities to adopt waste legislation ensuring the classification of PFAS-containing waste as Hazardous and/or POPs waste. That is to avoid PFAS-containing waste being circulated back into the economy and the environment via recycling and other routes such as sewage sludge spreading." The Cefic (European Chemistry Industry Council) position is that "grouping" of chemical substances should be supported by robust evidence and coherence, whereas PFAS (considered as a group of chemicals with a stable carbon-fluoride bond) covers some 4700 very varied chemicals (Cefic May 2021, EFCTC 2020).

NGO "Manifesto for an urgent ban of 'forever chemicals' PFAS" https://www.banpfasmanifesto.org/en/

EU fertilisers policies

ESPP input on recycled nutrients in certified Organic Farming

ESPP welcomed the proposal to authorise recovered precipitated phosphates in Organic Farming, as this will help address the P-deficit in Organic Farming and is coherent with the principle of recycling (see ESPP eNews n°71). ESPP welcomed that is widened beyond only struvite, and to include recovery not only from municipal wastewater. ESPP suggested that clarification is needed as to whether EU Fertilising Product Regulation (FPR) conformity assessment is required, and what is the definition of "not from factory farming". ESPP suggested that further recycled nutrient materials should be assessed for inclusion into the EU Organic Farming Regulation: Renewable calcined phosphates (cf. positive EGTOP Opinion 2016 ("Final Report on Fertilisers II") and other phosphorus fertilisers recovered from ashes as defined in FPR CMC 13, Potassium fertilisers recovered from municipal waste incineration ashes, Recovered elemental sulphur, Bio-sourced adsorbents used to treat wastewaters, Phosphorus-rich pyrolysis and gasification materials (inc. biochars), Algae and algae products grown to treat wastewater, Vivianite, Recovered nitrogen from off-gases. ESPP included wording proposals for inclusion of these materials into the Organic Farming Regulation 2021/1126 Annex II.

ESPP has previously exchanged with the European Commission concerning inclusion of recycled nutrient materials into the Organic Farming Regulation. The conclusion is that for this to progress, companies and operators need to obtain that Member States submit dossiers to the European Commission. ESPP can provide relevant information and possibly coordinate submission of dossiers for similar substances by different companies to different Member States. We are also interested by proposals of other recycled nutrient materials (in addition to those listed above) of potential interest for Organic Farming.

ESPP input to EU public consultation "Organic production – authorised products & substances (updated list)", 21st November 2022
www.phosphorusplatform.eu/regulatory

Industry summary of regulatory tasks for recycled fertilisers

Experts from Yara outline the different regulations and safety concerns a company must address to place on the market a fertiliser based on secondary materials. Presented at the International Fertiliser Society Conference, December 2022 (IFS Proceedings 867), the 23-page paper summarises the new EU Fertilising Products Regulation and its implementation (in particular Conformity Assessment), but also the other regulations relevant to recycled fertilisers. This covers waste-related regulations (Waste Framework Directive, Animal By-Products Regulation, water and sewage sludge regulations) but also other legislation which is applicable to all fertilisers, but may be more complex to apply for organic-based or waste-derived fertilisers: chemical legislation (REACH, CLP), transport regulation, Explosive Precursors (important because ammonium nitrate can be dangerous if mixed with organic materials), Occupational Health and Safety (e.g. health hazard bio-agents, respirable dust, APEX = explosive atmospheres), environmental permitting of operating sites (to handle waste or secondary materials). It is reminded that apparently 'harmless' biological materials require careful management in the workplace: grain flour can be allergenic (protein), wood dust can be carcinogenic, any organic dust can be explosive (e.g. flour). These possible workplace risks require risk assessment and are generally outside the experience of mineral fertiliser operators. Practical approaches for companies envisaging use of secondary materials in fertiliser production are proposed, including management quality systems, initial testing on national market before moving to CE-Mark, early engagement with a Notified Body to prepare Conformity Assessment.

"Professionalising the recycling of recovered nutrients into fertilisers", W. Franke, R. Mulatto, N. Hammer, Yara International, IFS (International Fertiliser Society) Proceedings n°867 https://fertiliser-society.org/product-category/proceedings/

Animal By-Products (ABPs) in CE-mark fertilisers

Parallel to the consultation on DG SANTE proposals to authorise certain Animal By-Products in EU, DG GROW has started elaboration of necessary amendments to the EU Fertilising Products Regulation annexes (see also eNews n°71). ESPP input requested clarification that ABPs can continue to be used, as is already today the case, in National Fertilisers (with traceability) or in EU-fertilisers (under certain conditions, without traceability), can be used in EU-fertilisers either directly (under CMC10) or as inputs to other CMCs (depending on processing conditions: composts, digestates, precipitated phosphates, ashes, biochars). Other stakeholders raised the very valid question that ABPs under CMC10, in particular "processed manure", should be subject to the same quality conditions as manure-derived composts or digestates, e.g. contaminant limits, macro-plastics …

DG GROW proposals here and ESPP input www.phosphorusplatform.eu/regulatory

German steel slag industry legal action against FPR "By-Products" CMC12 criteria

The steel slag industry suggests in particular that the limits for chromium and vanadium fixed in CMC11 are not relevant for "safety" and are not justified by the "latest scientific evidence". The legal submissions states that these heavy metal limits will "exclude lime-containing fertilising products from the steel industry". ESPP cannot take position on a legal case underway. We note however that the limits fixed for chromium and vanadium in CMC11 were discussed at the EU Fertilisers Expert Group, with participation of Member States, NGOs and industry organisations, and they were proposed in the European Commission (JRC) document "Technical proposals for by-products and high purity materials as component materials for EU Fertilising Products" (§19.2.7 page 124-126) which references some 15 scientific publications dating from 2000 to 2016.

Fachverband Eisenhüttenschlacken v Commission, European Court of Justice, Case T-560/22, 2 September 2022 here.
"Technical proposals for by-products and high purity materials as component materials for EU Fertilising Products" JRC128459, EUR 31035 EN, ISBN 978-92-76-50116-9, 2022

Nitrogen recycling technology mapping

ESPP operator mapping and literature search on N recycling and recovery

ESPP has published a literature review of recent publications (science papers, reports, …) on nitrogen recovery technologies, identifying technologies, operators and keynote publications. The assignment resulted in two tables (Europe, rest of world) classifying all identified stakeholders with a description of their technology (substrate, technology type and readiness level, final product and industrial use). This did not include direct application of manure or sludge to the ground, nitrogen stabilisation in manure and recovery routes such as biomass production. The information was updated with existing contacts within the industry and research community. Although non exhaustive and subject to improvement along the way, it has been used as a source of information for ESPP's actions on nitrogen reuse and recovery.

The results demonstrate that **active research in under way** on the topic, along with different demonstration projects. Without surprise, N-rich streams such as manure or digestate are targeted in priority and the main recovery route is fertilising. Several commercial technology providers are active in the field, at different scales. Some European countries display more technology providers than others, reflecting in some cases local agricultural environment.

Due to the chemistry of nitrogen and the type of N-rich substrate applicable (often in liquid/slurry phase), N recovery technologies are often **applied locally** (i.e. as close as possible to the source), contrary to other nutrients such as P that might be processed in centralised plants. An extreme example is pure urine processing, that is not widely applied. A second challenge is often the relatively **low concentration** of recovered ammonia, often as a water solution.

Concentration of a nitrogen-containing stream such as digestate (often after prior treatment) to a liquid fraction recovered as fertiliser is applied at industrial scale. The main technology in that case is membrane filtration (reverse osmosis or nanofiltration).

Currently, the main nitrogen recovery technology, supplied by different engineering companies, is **ammonia stripping** (often air stripping followed by acid/water scrubbing). Stripping has been applied for decades in industry as well as to remove N from wastewater, leachate and digestate and improve treatment performance. The process is variable depending on the supplier and the substrate (e.g.with or without caustic dosing),and developments such as vacuum stripping and membrane contactors are still underway or start being applied industrially.

A European company has also developed a technology to **separate** ammonium from liquid streams and recover it as ammonium sulphate, with industrial pilot plants are currently running. Another works with BiPolar Membrane Electro Dialysis.

A large amount of **pilot or laboratory**-scale technologies are currently under development or proof of concept, with various degrees of readiness (forward osmosis, ion exchange using resins or zeolites, etc.), or a mixture of different technologies (for example to extract N from ion exchange regeneration solution).

Mapping report and literature search on nitrogen recovery, Akinson Tumbure and Olivier Bastin for ESPP, December 2022 available here

The mapping report will be presented and discussed at the ESPP workshop on Nitrogen Recovery, Brussels & hybrid, 19 January 2023 www.phosphorusplatform.eu/NRecovery

Nutrient recycling

The OCP Group, Morocco and world food security

Independent expert article considers that OCP and Morocco hold the keys to future world fertiliser and food supply security, underlining OCP's contribution to Africa's food production, and the importance of "green ammonia". Michaël Tanchum, Middle East Institute*, starts by reminding that Morocco holds over 70% of known world phosphate rock reserves. He explains the significance of these reserves by underlining the importance of P as an essential nutrient for plants, essential to feed the world's growing population. He suggests that P fertilisers were critical in enabling the world's population to increase from <2 to 8 billion over the last century. Morocco-based OCP Group (an ESPP member) has been transformed over recent decades to become a global leader in the phosphate and fertiliser industries.

Over the last 15 years, through a fundamental transformation of its industrial strategy, OCP's phosphate production has doubled, and its fertiliser production tripled, reaching 24,5 MT and 10,9 MT respectively. By 2020, OCP had earned global market share leadership positions in multiple phosphate-based categories: phosphate rock 33%; phosphoric acid 54%; and fertiliser 26%. As the largest private sector employer in Morocco, OCP employs some 18,000 people and reported total revenues of more than US$9 billion in 2021.

OCP already uses 87% renewable energy to power its operations (as it evolves to 100% clean energy by 2030) and is reducing water use by 15% by 2024.

Operating in a water-scarce region, OCP is committed to not drawing Morocco's precious freshwater. The Group already meets nearly 1/3 of its water use from sewage works reclaimed water (Khouribga, Benguerir, Youssoufia) and desalination and ultimately targets 100% of its water needs met through non-traditional sources by 2026.

A challenge to increasing fertiliser production to help feed the growing global population sustainably, is access to and price of natural gas (ammonia is today produced from natural gas). This is accentuated by Russia's attack on Ukraine.

OCP has signed a partnership agreement in Nigeria, whereby the company will provide Nigerian farmers with locally-produced customised fertilisers and strengthen the partnership between the Group and the Nigerian natural gas industry. OCP is also developing fertiliser production in other African countries (Ghana, Ethiopia …).

Mr Tanchum's article notes that Morocco is investing in large scale solar electricity production which could in the future power green ammonia and hydrogen.

The article underlines the importance of OCP's "Agribooster" programme in Africa which has already helped more than 700 000 farmers in Africa increase productivity by one third or more by addressing fertiliser access (including credit) and adapting fertiliser products to crop needs.

In response to the turmoil in global food and commodity markets in 2022, OCP launched an emergency response by donating and discounting 550KT of fertiliser for the continent. In the longer term, the company will reserve 4 million tonnes of fertiliser for the continent in 2023 irrespective of global demand and higher market pricing in other regions.

"Morocco's New Challenges as a Gatekeeper of the World's Food Supply: The Geopolitics, Economics, and Sustainability of OCP's Global Fertilizer Exports", M. Tanchum, January 2022 (9 pages) HERE.
Michaël Tanchum is with the Middle East Institute and European universities and institutes. The Middle East Institute (MEI) is an independent, not-for-profit educational organisation. Its funders are transparently listed here and Morocco and OCP are not significant funders.

RENOWAGRO: 800 participants in Zaragoza

The first RENOWAGRO conference, on sustainable use of organic secondary resources organized by Térvalis Group - Fertinagro Biotech, 14-15 November 2022, brought together over 800 participants, mainly from the agri-food sector. The event was opened by Sergio Atarés, Tervalis, Luis Planas, Spanish Minister of Agriculture and Javier Lambán, President of Aragon Region.

Luis Planas recalled that nutrients for agriculture can be recovered from manure slurries and sewage sludge and that companies are already active because "there is no sustainability without profitability … a healthy and more productive soil at a lower cost is essential". He underlined that these secondary materials should be used appropriately, advocating innovation.

The president of Aragon announced that the Region's objective is to replace all use of mineral fertiliser with organic products from the treatment of slurry, building on the experience and R&D of the Teruel-based group Térvalis.

Speakers underlined the importance of agricultural and industrial innovation, balanced and effective bio-based fertilisers from manure and digestate, soil health as pillars of an agricultural transition to circular, sustainable and biodiversity enhancing practices. The differences between conditions and requirements of Spanish soils compared to those of central and northern European countries was discussed, emphasising the need to increase organic carbon in Spanish soils.

Speakers included: Laia Llenas, Beta Technological Centre at the University of VIC (and Fertimanure), Ángel Ruíz, Spanish National Research Council CSIC, Luis Lassaletta, Politecnical University of Madrid, José Antonio Mayoral, University of Zaragoza, Javier Ponce, Spanish Technology Fund CDTI, Keiji Jindo, Wageningen University, Fernando Miranda, Spanish Ministry for Agriculture, Grazia Masciandaro, Italian Research Council CNR, Pisa, Carlos García, CEBAS – CSIC, Rodolfo Canet, Instituto Valenciano de Agricultura – IVIA, Nicola Frison, Università degli studi di Verona, Ana Robles, Gent University and Ludwig Hermann, Proman and ESPP.

RENOWAGRO – international meeting on organic resources for sustainability of the agri-food sector, Zaragoza, 14-15 November 2022
www.renowagro.com

Potential ammonia emissions from secondary nutrient products

Lab study assesses potential ammonia emissions from soil after use of 39 different organic-carbon secondary nutrient products. The products tested are mostly dried and pelletised and sold under national fertiliser regulations. Raw materials for the products tested included digestates, poultry manure, plant residues, food processing residues, and animal by-products. Total N content of the products was 0.4 – 17 % fresh weight. Ammonia losses were evaluated after surface application or incorporation of the materials to either pure sand or four different soils, at equivalent to 400 kgN/ha (high fertilisation level) and incubation for six weeks at 15°C. Ammonia losses varied considerably between the different materials, from 0% for composted olive oil residues to more than 2/3 losses of total N for digestates, but were mitigated considerably when the products were incorporated into the soil. Significant correlation was found between initial ammonia losses from the different products and their pH and ammonium content. Soil incorporation reduced ammonia losses by 37 – 96 % compared to surface application. This is already well known for liquid slurries and digestates with high proportion of ammonium-N, and is EU agricultural BEMP (Best Environmental Management Practice for agriculture EU 2018/813) and the study shows that this can also be true for pelletised products containing mainly nitrogen in an organic form.

NOTE: Information on the classification of the products under the EU Fertilising Products Regulation 2019/1009 (into CMCs and PFCs, Table 1) is indicative only, because many of these products are not (today) eligible for use in EU-fertilisers : e.g. none of the cited animal by-product derived materials can be used in EU-fertilisers until possible future regulatory amendments are made; compost of biochar, seaweed or digestate recovered minerals are all excluded from CMC6.

"Potential ammonia volatilization from 39 different novel biobased fertilizers on the European market – A laboratory study using European soils", L. Wester-Larsen et al., J. Environmental Management 323 (2022) 116249 DOI. Work funded under the Lex4Bio project.

Potassium recovery from alkaline battery processing

Hazenite (a potassium – sodium – magnesium phosphate, similar to struvite: $KNaMg_2(PO_4)_2 \cdot 4H_2O$,) was precipitated from alkaline battery black mass processing water. Alkaline batteries use potassium hydroxide as electrolyte, but are generally contaminated with zinc carbon batteries (containing ammonium chlorides). Depending on the battery treatment process, potassium needs to be removed from process wastewaters containing ammonium or from the process itself (to allow recovery of zinc and manganese sulphates). The process waters are alkaline which facilitates Hazenite precipitation by adding phosphate, magnesium and further adjusting pH, followed by filtration (0.45 µm). In 1.6 litre laboratory tests, 50% - 60% removal of K was achieved after one hour reaction at 1:1:1 K:P:Mg ratio, increasing to c. 80% removal at 1:1.5:1.5 K:Mg:P, with in all cases over 80% P removal and over 90% Mg removal. Ammonium in the wash water did not inhibit Hazenite precipitation. The authors conclude that precipitation was rapid and purity of the Hazenite high, with operation at room temperature without consumption of excess chemicals, making this a potentially feasible route for potassium removal and recovery from alkaline battery processing. Recent studies (Watson 2020 see SCOPE Newsletter n°138, Raniro 2022) suggest that Hazenite is an effective fertiliser.

"Precipitation of potassium as hazenite from washing water of spent alkaline batteries", S. Lapinkangas et al., Chemical Engineering Journal Advances 12 (2022) 100426, DOI.

Lithium Iron Phosphate battery cathode recycling

Lab-scale testing of acid leaching and ion exchange to recover lithium salts and phosphate minerals from lithium iron phosphate battery cathodes. This study tested the concept using virgin $LiFePO_4$ cathodes at laboratory scale. Sulphuric, citric and oxalic acid were tested for leaching of cathode material, which contains lithium iron phosphate and additives, including c. 1.4% carbon (coating). Oxalic acid (0.5M) was selected as optimal achieving >95% lithium and phosphate leaching, whilst leaving 95% of the iron in the solid largely as ferrous oxalate. The lithium was then separated from the solution onto an ion exchange resin (iron would interfere with this and would fix to the iron exchange resin instead of lithium), releasing potassium ions from the resin. Potassium chloride was used to release the lithium from the ion exchange resin (releasing lithium chloride solution, for lithium recycling) and restore the potassium ion exchange resin. The leaching solution thus becomes a potassium phosphate solution, potentially useable for mineral fertiliser production.

"Proof-of-Concept study of ion-exchange method for the recycling of $LiFePO_4$ cathode", X. Zhang et al., Waste Management 157 (2023) 1–7, DOI.

Elevated atmospheric CO_2 (eCO_2) and crop nutrient levels

A review of 160 publications concludes that eCO_2 reduces concentrations of most nutrients (N, P, K, S, Fe, Mg, Zn) by up to 5 – 25% in plant tissue, potentially limiting increased photosynthesis and reducing crop nutritional value. The biological mechanisms reducing plant N content under eCO_2 are analysed, but little information is provided on mechanisms for other nutrients (including phosphorus). Papers reviewed in ESPP's SCOPE Newsletter n°137 concluded that eCO_2 will increase plant nutrient requirements, resulting in increased root development; that eCO_2 will generally increase soil P mineralisation (by soil microbes), possibly increasing P-availability for crops but also leading to increased risk of soil P losses; and that plant P-uptake could be limited by N availability. This new review paper reinforces this third point, concluding that a number of studies show lower N content of plant tissues under eCO_2. Reduced plant uptake of N and of other nutrients under eCO_2 may result from lower soil available nutrients, nutrient limitation and a "dilution" effect with increased growth and carbon uptake, reduced transpiration (so reduced nutrient transport with water uptake). However, these effects cannot explain differences in tissue concentration reductions between different nutrients, nor the reductions observed. There is increasing consensus that, beyond these effects, eCO_2 leads to reduced plant Nutrient Use Efficiency. Total nutrient uptake increases, but less than increases carbon fixation. For nitrogen this seems to relate mainly to reduced nitrate-N uptake (with less impact on ammonia-N or organic-N uptake), possibly related to impacts on genes and proteins involved in nitrate transport, or on nitrate or nitrite metabolising enzymes.

"The decline of plant mineral nutrition under rising CO_2: physiological and molecular aspects of a bad deal", A. Gojon et al., Trends in Plant Science, Month 2022, https://doi.org/10.1016/j.tplants.2022.09.002

Digestibility of recovered calcium phosphates

Review paper concludes that phosphorus in bone-derived DCP and TCP are better available for poultry than in the same calcium phosphates from phosphate rock. Digestibility in rock-derived calcium phosphates is MCP > DCP > TCP, that is the higher the P:Ca ratio, the more available the phosphorus. The number of studies comparing uptake by non-ruminant livestock of P from bone derived calcium phosphates versus rock-derived calcium phosphates is limited (around ten studies identified). The authors conclude that digestibility for poultry of bone-derived DCP and TCP was better than for rock-derived, but that data is lacking for comparisons for MCP for poultry and for all three calcium phosphates for pigs. Overall differences seem to be relatively small, and lower than variations in results between different studies or between different rock-derived calcium phosphates. The authors conclude that further research is needed into digestibility of bone-derived MCP for poultry and bone-derived calcium phosphates for pigs. ESPP notes that researchers nearly always conclude that further research is needed, and that in this case the existing studies tend to suggest that digestibility of calcium phosphates is variable, and can result in significant variations in livestock growth (if diet phosphorus is given only to recommended values, with no margin of security) but seems to be related not to the material from which the calcium phosphates are derived, but maybe to chemical and physical form.

"Calcium and phosphorus digestibility in rock- and bone-derived calcium phosphates for pigs and poultry: A review", A. Woyengo et al., Animal Feed Science and Technology, (2022) https://doi.org/10.1016/j.anifeedsci.2022.115509

Phosphorus recycling potential in Eastern Europe

The 3rd PhosV4 Project Workshop, Brno (Czech Republic) & hybrid, 15/11/2022, discussed potential secondary phosphorus resources and recycling routes in the V4 countries (Czech Republic, Hungary, Poland and Slovakia).

Julia Tanzer, Proman Management, summarised **phosphorus management perspectives in Austria**: despite significant decreases in agricultural P-balances, over 10% of river monitoring sites continue to exceed thresholds for orthophosphate, especially in agricultural areas. Specific indicators are needed for P management (import dependency and mineral fertiliser use, emissions to water bodies, soil accumulation, waste P losses) but these are not comparable to other substances and do not provide an overall indicator. Management scenarios for Austria suggest that mineral P fertiliser imports could be reduced by higher recovery from waste, and by reducing losses to water and soil accumulation, with economic benefits for farmers and co-benefits of lower mineral N fertiliser use and reduced N losses.

Jiri Jaromir Klemes, Brno University of Technology, and Marzena Smol, Polish Academy of Sciences, Poland explained that **nearly all of the sewage sludge produced in the V4 countries is currently used as fertiliser on land**, often after composting, but that a small amount (<10%) still goes to landfill. This route should be banned because it wastes the nutrients and organic carbon in the sludge, and risks contributing to landfill methane losses.

Zoltan Toth, Hungarian University of Agriculture and Life Sciences, summarised the range of available technologies for phosphorus recovery from sewage and presented initial results of the Lex4Bio project showing that crop response to P-fertiliser can be optimised by a combination of soluble mineral P fertiliser and slowly available P (e.g. struvite, manure).

Sebastian Hreus, Technical University of Kosice, indicated that rocks used for silicate aggregate extraction for the construction industry, at several quarries in Slovakia, contain up to 0.03 – 0.08% P. Such mining by-product could theoretically be a source of secondary phosphorus, but the P concentrations are two orders of magnitude lower than low-grade commercial rock, so that extraction is unlikely to be feasible. P-concentrations up to 7-8 % P have been found in some localised deposits of sandstones, resulting from geological lake P sedimentation, but to date no economically sized deposit is known.

Several R&D projects addressing phosphorus recovery and recycling were presented: Lex4Bio, PhosForce, InPhos, CEPhosPOL, PolFerAsh, CEPhosPOL.

The first two PhosV4 workshops included presentations by **Damien Cazalet, Veolia Wasser Deutschland GmbH** and **Yariv Cohen, EasyMining**, on routes for phosphorus recovery from sewage, respectively by bio-acidification to solubilise P in sludge followed by phosphate precipitation, and recovery of quality calcium phosphate products from sewage sludge incineration ash.

PhosV4 project "How to stay alive in V4? Phosphorus Friends Club builds V4's resilience" https://www.phosv4.eu/

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