Online stakeholder dialogue webinar:

Friday 27th November: Nutrients in the EU Farm-to-Fork and Horizon Europe

Within the new **Green Deal**, the EU's **'Farm-to-Fork'** policy poses ambitious objectives for agriculture – food system sustainability, including to reduce nutrient losses by 50% and fertiliser use by 20% before 2030, to improve nutrient stewardship (revised **Circular Economy Action Plan** and **European Integrated Nutrient Management Action Plan**) and to address diet, including via consumer food product nutrition labelling. Horizon Europe also underlines circularity in the food system, and proposes to develop a "comprehensive EU policy to balance nutrient cycles".

The objective of this webinar is to understand challenges and opportunities for nutrient management in 'Farm-to-Fork' policy implementation and enable dialogue between policy makers, NGOs, industry and professional organisations, scientists and regions/cities.

Friday 27th November, in three parts:

- **9h00 - 10h30 CET:** dialogue and questions/discussion with experts
  Nutrients in EU Green Deal policies: from objectives to actions
- **11h30 -12h30 CET**: preparation of a contribution document for the European Commission
  Input to the EU's Integrated Nutrient Management Action Plan
- 14h-15h30 CET: ESPP Annual General Assembly - members only.

Registrants to the 'Farm-to-Fork' webinar are invited to **prepare before 23 November 2020 a contribution which be made available to all webinar registrants**. ESPP will put online and circulate to all registrants one indexed pdf document containing all contributions received by this date as follows:

- please send to info@phosphorusplatform.eu by 23rd November: maximum one page (but a well-spaced half page is more likely to be read); MUST be in WORD or RTF (NOT in pdf); can include hyperlinks to other documents, websites, etc; should include your contact email(s). Submissions which are too long or not in WORD/RTF will NOT be used.

Registrants are advised to also **prepare a short statement which you can yourself post to the online 'Chat'** at an appropriate point during the meeting, to link to this submission document and/or your website and/or to other publications. Registrants can also prepare in advance 'Chat' questions to submit online during the meeting to the webinar speakers and panellists

Webinar "Nutrients in the EU Farm-to-Fork and Horizon Europe", Friday 27th November. 2020.

Registration: https://www.eventbrite.co.uk/e/nutrients-in-eu-farm-to-fork-policy-tickets-127743595533

Full programme and speaker updates here:
https://www.phosphorusplatform.eu/events

Consultations & calls

Call for input: which recycled nutrient products for Organic Farming

ESPP is planning a webinar with Organic Farming associations across Europe to discuss which types of recycled nutrient products may be acceptable in Organic Farming, in order to then submit dossiers proposing their authorisation in the EU Organic Farming Regulation. Various organic or secondary materials (e.g. certain composts and digestates, plant biochar, certain animal by-products, wood ash) are already included in the Organic Farming Regulation (Annex I of EC 889/2008 as authorised fertilisers). Also, struvite recovered from sewage and calcined phosphates from sewage sludge incineration ash are currently expected to be added (EGTOP Opinion 2 February 2016 here). This webinar will be based on short presentations of various recycled nutrient products "candidates" for Organic Farming, based on discussion of Fact Sheets for candidate recycled nutrient products. **If you wish to propose your recycled nutrient product to the Organic Farming movement, and present at this webinar, then you should prepare a Fact Sheet using the template** here **by 15th December 2020 (to** send to ESPP as indicated on the template).

More information here

EU consultation on Soil Strategy

Open to 10th December. Consultation on an EU Soil Strategy "Healthy soil for a healthy life" (Roadmap), as part of the EU Biodiversity Strategy. Objectives fixed in the Biodiversity Strategy include to stop land degradation by 2030, with action to promote soil fertility, reduce erosion, increase soil organic matter, as well as addressing loss of wetlands and peatland and net land take and sealing. Problems cited include "Diffuse soil contamination by … antibiotics, excess fertilisers, microplastics, sewage sludge …". Proposed actions include promoting sustainable soil management and improving soil quality monitoring.

Roadmap consultation HERE.

EU consultation on Zero Pollution Ambition

Open to 10 February 2021. Public consultation on the EU Zero Pollution Action Plan for air, water and soil, to be adopted in 2021. The Commission's 'Roadmap' outlines as key orientations to: strengthen implementation and enforcement, improve the regulatory "acquis" on health and environment (including water, waste and wastewater), address soil pollution, improve governance and drive societal change / sustainable consumption. The public consultation questionnaire asks for input on questions such as to what extent pollution is felt to be negative, which populations are most exposed, which EU policies are known, which types and sources of pollution should be priorities, possible types of action (regulatory, financial, education, …), significance of digitalisation. "Excess nutrients (nitrogen and phosphorus)" are proposed as one of the possible priority pollutants.

"EU Action Plan Towards a Zero Pollution Ambition for air, water and soil" HERE

EU consultation on environmental product claims

Open to 3rd December 2020. Consultation on product environmental claims & PEFs (Product Environmental Footprints) HERE

Horizon2020 R&D calls: Circular Economy, Farm-to-Fork

Calls for R&D proposals are **open to 26 January 2021** on eight themes for the EU Green Deal (total one billion €). The themes include Farm-to-Fork, territorial Circular Economy, climate, biodiversity/ecosystems and zero pollution/toxic free environments.

The call on "Systematic innovations in support of the Farm-to-Fork Strategy" CL-GD-6-1-2020 specifically cites nutrient cycles, antimicrobial resistance and food waste as challenges. Proposals should address one of six proposed objectives including farm carbon sequestration, reducing fertiliser nutrient losses and fertiliser use, shifting to sustainable healthy diets.

The call on "Systemic solutions for the territorial deployment of the circular economy" LC-GD-3-2-2020 should be led by "circular territorial clusters", bringing together companies, administrations and stakeholders for a "circular systemic solution". Key product value chains cited are those of the EU Circular Economy Action Plan, including food, water and nutrients.

"European Green Deal Call is open - €1 billion investment in green and digital transition", proposal submission deadline 26 January 2021 HERE.

Call for presentations – Green Deal water & raw materials

Organised by ESPP member MonGos, the first International Conference on Strategies toward Green Deal Implementation - Water and Raw Materials (ICGreenDeal2020) will take place online 14-16 December 2020. Proposals are invited to 30 November 2020 deadline for presentations or posters are invited on environmental engineering and management related to water or raw materials.

ICGreenDeal2020

Call for papers – Bio-based fertilisers

The journal "Agronomy" (Soil and Plant Nutrition) is calling for papers on "Integrated Nutrient Recovery from Organic Waste and Bio-Based Fertilizers" for a special issue. Submission deadline: 15th December 2020.

EU call for NGO Green Deal actions

The EU has pre-announced a call (to be published mid December) for NGO projects at the Members States' level to mobilise and strengthen civil society participation and contribution to the implementation of the European Green Deal (under DG ENVI LIFE) EU budget 12 million €, maximum contribution 300 000 € per project.

Invitation for input on LCA guidelines for growing media

Growing Media Europe has published, for comment, proposed Life Cycle Analysis methodology guidelines (in accordance with the EU's PEFCR Product Environmental Footprint Category Rules). Input is invited from stakeholders, industry, LCA experts, e.g. on document structure, methodology, applicability.

"GME draft Guidelines for LCA calculations open consultation", deadline 14th December 2020 here.
www.growing-media.eu/

Policy

Meat and bone meal possibly excluded from Organic Farming

It is ESPP's understanding that all MBM (meat meal, bone meal) may be excluded from use in Organic Farming in a proposed update of EU Regulation 889/2008. The EU Committee for Organic Production, 28-29 October 2020, discussed modifications to the Annex II (authorised fertilisers) of this Regulation to limit animal by-products to only Cat.3, thus excluding* meat meal and bone meal, which are Cat.2, despite they continue to appear in the list of authorised products. This would deprive Organic Farming of a significant source of recycled phosphorus (and potassium). If this is of concern to you, we suggest that you contact your national Organic Farming organisations, and your national Agriculture Ministry. ESPP would be interested in any feedback or information.

** Exact wording added: "animal by-products (including by-products of wild animals) of category 3 and digestive tract content of category 2 (categories as defined in Regulation (EC) No 1069/2009)"*

ESPP input on EU pollutant register

ESPP submitted input to the EU consultation on the E PRTR (European Pollutant Release and Transfer Register), October 2020, supporting the European Commission proposal to improve the register's contribution to Circular Economy objectives, and suggesting to include data on resource recycling. ESPP also suggested that large cattle production units should be included in the register (which already includes large poultry and pig units). ESPP also supported the proposal to widen the E PRTR to 'emerging' pollutants, such as PFAS/PFOS (perfluoroalkyl chemicals) and microplastics.

ESPP input to E PRTR consultation, October 2020 HERE.

German Phosphorus Platform 'Policy Memorandum'

DPP (the German Phosphorus Platform) has published a ten page 'Policy Memorandum', taking position on key policy and regulatory questions relevant to phosphorus recycling. The document provides information on the current policy status, and makes proposals for policy changes or actions, with the aim of stimulating dialogue and gathering support of stakeholders and decision makers.

The DPP Memorandum notes that major challenges remain to enact German legislation which makes phosphorus recovery obligatory from larger sewage works in Germany (ordinance passed three years ago with implementation deadlines of 2029 / 2032), and that support is needed from politicians and administrations. Sewage sludge could replace around 10% of mineral phosphate fertiliser use in Germany. The German Platform underlines that leadership should be provided to municipalities by Federal and Land governments, including financial support for implementation, funding of R&D and development of Life Cycle Analysis studies and definition of a German nutrient strategy, based on knowledge of nutrient resources and flows (for at least P, N and K). It is noted that, in some cases, regional P-recovery installations are likely to be preferable, in order to reduce costs and optimise costs and improve logistics of recycled phosphorus use, and financial support is needed for construction of large-scale installations.

To facilitate market uptake of recycled phosphorus products, the German Platform considers that economic and market incentives should be implemented by the German government, e.g. by including environmental externalities in prices, quotas for recycled P use (for farmers, distributors and/or the fertiliser industry), subsidies, taxes, bans or use obligations, regulation fixing the same cadmium limits for all fertilisers. It is underlined that better information is needed on recycled nutrient products for farmers, and requested that appropriate recycled phosphorus products be authorised for use in Organic Farming. The German Platform also recommends to remove the current requirements of the national Fertiliser Ordinance (DüMV) on P-solubility and on specification of the origin of input materials, in order to evaluate all products neutrally on the basis of their quality. The German Platform proposes that plant phosphorus availability testing for fertilisers should be standardised and German regulation modified accordingly.

"Politikmemorandum der Deutschen Phosphor-Plattform DPP e.V. 2020 Positionen zur Umwelt- und Landwirtschaftspolitik" (Policy memorandum of the German Phosphorus Platform DPP e.V. 2020 Positions on environmental and agricultural policy), in German, 23 October 2020 www.deutsche-phosphor-plattform.de

EU to (nearly) ban all PFAS chemicals

The European Commission has published its new "Chemicals Strategy towards a toxic-free environment", with an accompanying document specifically addressing PFAS (per- and polyfluoralkyl substances). The European Commission's press release announces the objective to phase out of PFAS in consumer products "*unless their use is proven for society*", and this is specified in the Action Plan annex to the Chemicals Strategy by "*restrict PFAS under REACH for all non-essential uses*", but also by adding PFAS (as a group) the annexes of the Environmental Quality Standards Directive and of the Groundwater Directive and by "*address the emissions of PFAS …through the revision of the legislation on sewage sludge*" The document on PFAS states that it would be beneficial that regulation address PFAS as a group, in that regulation of one type of PFAS leads to regrettable substitution by another type. This document also indicates that the revision of the EU Sewage Sludge Directive1986/278 "*could provide the opportunity to introduce limits for organic contaminants such as PFAS … including the possibility to have a limit for total PFAS*".

COM document on PFAS (per- and polyfluoralkyl substances) SWD(2020)249
EU Chemicals Strategy, 14 October 2020 COM(2020)667 and annex Action Plan COM(2020)225

Nutrient recycling

Lystek sewage sludge thermal hydrolysis

In North America, in 2020, Lystek will transform over 1.2 million tonnes of sewage sludge (c. 180 000 t DM) into a "concentrated" liquid fertiliser (15% DM) for agriculture, that is over 3 000 tonnes of phosphorus/year. Dewatered sewage sludge and/or food waste, is thermally hydrolysed (steam injection at 75°C, with alkali addition and physical shearing) for around 30 minutes, sufficient for sanitisation. The resulting liquid can be used as a fertiliser, and/or partly returned to the anaerobic digester (enhancing methane production by up to +25%). The liquid fertiliser is authorised for use in agriculture, depending on State or local regulations in the USA, either as Class A Biosolids or as an agricultural fertiliser product. Depending on the input material (e.g. sewage sludge anaerobically digested or not), the liquid fertiliser has 20 – 40 %/DM organic carbon and typically around 5-2-4 N-P-K. Recent installations by Lystek include St. Thomas - Ontario, Innisfil – Ontario, St. Cloud – Minnesota, Fairfield-Suisun – California, Goleta – California (food waste). www.lystek.com

Upcycling manure to activated carbon adsorbent

Earthcare, LLC (USA) is rolling out installations to dry and gasify (at 760 – 1000 °C) organic wastes on an industrial scale, producing a sterile Ecochar® (biochar), which can be used as an activated carbon adsorbent tertiary treatment to remove contaminants such as heavy metals and organic compounds in wastewaters.

The company has seven plants operating to date, each producing c. 4,000 t/y of biochar (Netherlands, USAx4, Russia x 2), and processing pig, cattle or poultry manure, food, fibre or bioethanol plant wastes, and/or animal by-products. An eighth plant with four adjacent gasifiers is underway in Ha'il, Saudi Arabia to process ~60,000 tons broiler chicken litter per year, producing ~17,200 t/y of biochar. Research shows that manure-derived and sewage-derived biochar is highly effective for contaminant removal, probably because of the fixed phosphorus it contains, see Kolodynska 2017.

The heat energy generated by combustion of the syngases has been shown in full scale systems to be sufficient to dry and process sewage sludge dewatered to 20% DM or more.

All of the input phosphorus and 15-20% of input nitrogen is bound into the biochar. The remaining nitrogen is converted to atmospheric N_2 (the syngas combustion generates very low NO_x) and emissions are filtered by both a chemical scrubber and a bio-bed.

The system is recognised as an agricultural Best Management Practice (BMP) by the US EPA / Chesapeake Bay Program for eliminating the runoff of nitrogen and phosphorus. When the biochar is used to remove organic contaminants from wastewater, it can be decontaminated and reused by thermally destroying the organic contaminants in the triple-pass rotary drum dryer. When the biochar is used to bind heavy metals on contaminated land or in wetlands, it can remain in place, but biochar adsorbing heavy metals at wastewater treatment plants would need to be disposed to approved landfill.

Website https://www.earthcarellc.com/
Contact: Peter Thomas pthomas@manuregy.com

Correction

N2 Applied LCA results

We reported – incorrectly - in our last eNews results of a Life Cycle Analysis (LCA) of application of N2 Applied's technology to transform nitrogen from the air with manure or digestate into an organic and mineral fertiliser. The LCA in fact showed that, compared to current practice (as defined by the Arla Foods Farm Tool), N2 Applied technology can reduce greenhouse gas emissions from dairy farming by -36%: anaerobic digestion of manure to produce biogas -16%, N2 Applied alone (treating manure) -27%; biogas + N2 Applied (treating digestate) -36%.

Further information including graphs showing LCA results HERE.

Webinars

European Commission webinar on P-recovery from municipal sewage

As part of the 18th European week of Regions and Cities, the European Commission organised a webinar on phosphorus recycling from municipal sewage works. 20th October 2020, introduced by Johanna Bernsel and Fleur Van Ooststroom-Brummel.

Chris Thornton, ESPP, summarised different routes for recycling nutrients from sewage, from application of composted or digested sewage biosolids in agriculture, through to "upcycling" where high quality chemicals or fertilisers are recovered and contaminants are removed. Slides here

In discussion, it was indicated that different routes are adapted for different contexts, depending on sewage works size, regional agronomic needs, etc.

Paula Lindell, Helsinki Region Environmental Services Authority (HSY), Finland, explained that the region's first option for policy is to not incinerate sewage sludge, in order to return the carbon content to soil. Upstream actions to reduce at source contaminants from industrial discharges and form households are important to improve sewage sludge quality. Because iron or aluminium coagulants are used to achieve very low phosphorus discharge concentrations, no existing process is suitable for phosphorus recovery. HSY is therefore developing its own processes for P- and N-recovery (RAVITA™) and is testing pyrolysis (biochar production from sewage sludge).

Lukas Egle, City of Vienna, Austria, explained the city's overall policy to improve sewage sludge valorisation: development of sludge anaerobic digestion to produce biogas and stabilise sewage sludge, then drying and mono-incineration. Actions underway with the aim of achieving energy-positive incineration and to facilitate phosphorus recovery from the ash include seeking authorisation to incinerate Cat.1 animal by-products (MBM meat and bone meal, which has both high energy content and high phosphorus content), reducing sand (filters) and substituting iron precipitants. Testing is at an advanced stage for use

of the sewage sludge (mono)incineration ash in the fertilizer industry to partially replace phosphate rock in fertiliser production. However, intake of ash into this process is limited by sand (silica) and the iron present in the ash.

Challenges posed by the waste status of sewage sludge were discussed. Some progress has been made with the allocation of a specific waste number for sewage sludge incineration ash, which is thus recognised to be Non Hazardous. It may also be possible to have End-of-Waste status by self-declaration if the ash is used "to substitute a raw material".

Caroline Attard, European Commission DG Environment, indicated that a prospective study on recycling and waste status is underway in the context of the evaluation of the Sewage Sludge Directive.

Robert Van Spingelen, Ostara, indicated that the Ostara has 22 Pearl struvite P-recovery reactors operating worldwide in sewage works. In all cases, the water company has an offtake contract with Ostara who ensure distribution and marketing of the Crystal Green® branded struvite fertiliser product.

He underlined the environmental benefits of struvite recovery in sewage works: lower greenhouse emissions (see struvite recovery "emergy" in ESPP eNews n°35), contribution to reductions of P and N discharges from sewage works, lower in-field nutrient losses. Agronomic research by Ostara shows that because the struvite pellets do not burn plant roots and only release nutrients as required by the plant, higher yields and lower nutrient losses can be achieved. In photos of trials, roots are shown to grow to cover the struvite granules. Tests show that organic acids are released by plant roots and solubilise the nutrients in struvite. The phosphorus is thus only released when the plant needs it and will take it up.

EU 18th European Week of Regions and Cities webinar "Recovered phosphorus from municipal wastewater" 20th October 2020: online here and link to replay video

Biofertilisers and biostimulants from algae

The **EABA (European Algae Biomass Association)** online workshop, 7th October 2020, opened by **Jean-Paul Cadoret, Algama Foods and EBEA**, enabled discussion and networking between 90 participants around the different value contributions of macro- and micro-algae to agriculture and the food chain. Algae can be applied to soils as harvested (e.g. dried) or after cell-lysis, or can be processed to extract specific substances, so as fertilisers, soil improvers or biostimulants.

Vince Ördög, Széchenyi István University, Hungary, presented review data showing that microalgae can increase soil nutrient content by nitrogen fixation, enhance growth of beneficial PGPR (Plant Growth Promoting Rhizobacteria) and release antimicrobial compounds against soil-born plant pathogens. Algae have been shown to produce many different plant hormones. Auxins and polysaccharides produced by microalgae have beneficial effects including plant growth stimulation, increased chlorophyll content, photosynthesis and ROS (Reactive Oxygen Species) scavenging; and improved plant tolerance against salt and drought stress.

Pi Nyvall Cohen, Olmix Group, presented **industry experience processing red and green seaweed to products with fertiliser (nutrient content), soil improver and biostimulant effects**. Field tests show that after several years' application, soil carbon increases, crop root volume is improved, soil microbial biomass increases by up to +40% and mineral fertiliser application can be reduced by 5-10% for nitrogen, -40 kgP/ha, -80 kgK/ha and -50 kgMg/ha. Trials are underway in Brittany testing zero chemical intrant / zero mineral fertiliser production of wheat fertilised with the algal products. Regulatory challenges include acceptance for Organic Farming, and the fact that seaweed collected from deposits on beaches is considered a "waste", but not the same seaweed collected in shallow water near the beach.

Theodora Nikolakopoulou, European Commission DG GROW, outlined the new EU Fertilising Products Regulation, and its significance in providing a European regulatory status for products such as biostimulants and soil improvers, and in providing "End-of-Waste" status for secondary materials when processed into an EU fertilising product (i.e. in a labelled and conformity assessed product). **Maris Stulgis, European Commission, DG MARE**, indicated that algae have significant industrial potential and DG MARE is there to help untap the potential of algae for various applications. **Kristen Sukalac, Prospero and Partners**, outlined the regulatory challenges facing the use of algae and derived components in biostimulants and organic fertilisers under the new EU Fertilising Products Regulation.

Questions in discussion of the EU Fertilising Products Regulation included the need to widen the list of micro-organisms for biostimulants (CMC7, currently limited to four species), the question of why cyanobacteria are excluded (CMC2), whether cell lysis of microalgae is acceptable processing (CMC3) and whether substances extracted from microalgae grown on wastewaters can be eligible for CMC1 (or are they excluded as being waste-derived)?

Gabriel Acien, University of Almeria, Spain, presented a marketing study for algae production (SABANA project 2016-2020 Horizon 2020). Algae production raceways are a proven technology, with commercially operating installations of 5 000 m^2 and more. The cost of algae production is higher than their nutrient value for fertiliser, but the economics are different where algae production is used for wastewater treatment. Extraction of substances for biostimulants can provide a higher added value.

Companies participating included:

- **Cécile Le Guillard, Agro Innovation International, Centre Mondial de l'Innovation Roullier, France,** is producing algal extracts from seaweed and microalgae containing different kinds of bioactive molecules. CMI Roullier develops innovative solutions for agriculture, including plant biostimulants as well as products for plant nutrition and stimulation of plant defences.
- **José Maria Goméz, BIOMASA PENINSULAR,** using microalgae grown on biofilm for nutrient removal as tertiary sewage treatment, then lyophilisation and formulation with other secondary materials to produce recovered and bio-based fertilisers
- **Robert Stenekes, ICL Group, The Netherlands**, investigating new sustainable inputs to agriculture
- **Christophe Vasseur, INALVE**, cultivates and refines marine microalgae-biofilm into sustainable ingredients for aquafeed formulators: a microalgae-based protein to substitute fishmeal, a lipid fraction as a replacement for fish oil and a polysaccharides fraction to boost animal health.
- **Frédérique Ferey, LafargeHolcim**, looking into production of algae to take up CO2 emissions from cement production
- **Franck Hennequart, Algaia, France,** are producing a range of different products from seaweed in Brittany, including for food applications, cosmetics, pharmaceuticals, and also including plant biostimulants. Seaweeds bring nutrients to plants (e.g. N, K, Ca, Mg, Cu) and also amino-acids and sugars, and contain alginate, a chelating agent which facilitates crop access to minerals in soils.
- **Luis Lombana, Ficosterra, Spain,** processing algae and seaweed to produce biostimulants and organic soil improvers

Research presented included:

- **Yagut Allahverdiyeva-Rinne, University of Turku, Finland,** presented the NordAqua research consortium which is investigating improvements to algae production, including for wastewater treatment, and use of algae as a biofertiliser or biostimulant.
- **Rok Mihelič, University of Ljubljana, Slovenia**, processing algae grown in food waste digestate to produce biostimulants and algae grown in slaughterhouse waste to produce fertilisers in the Water2Return project (Horizon 2020, 2017-2020)
- **Hans Reith, Wageningen UR, The Netherlands**, Magnificent-Algae project (BBI 2017-2021), processing microalgae as nutritional ingredients, human food or animal feed or cosmetics
- **Jesus Martin Marroquin, CARTIF**, Algaecan project (LIFE 2017-2020), using microalgae to treat fruit and vegetable processing wastewater. The microalgae could be used as biofertilisers or animal feed
- **Enrica Uggetti, Universitat Politècninca de Catalunya BarcelonaTech**, projects on using algae for wastewater treatment then recycling the algae as biofertilisers: INCOVER project (Horizon 2020, 2016-2019) and looking at producing biofertilisers from microalgae: Al4Bio project (Spanish Ministry of Science, Innovation and Universities (MCIU), Research National Agency (AEI), and European Regional Development Fund (FEDER), 2019-2021) and PAVITR project (Horizon 2020, 2019-2023)

EABA "Algae Biofertilizers and Biostimulants" technical webinar workshop, 7th October 2020 https://algaeworkshops.org/algae-biofertilizer-and-biostimulants/

IFS webinar presents nutrient recycling projects

As the IFS webinar of 10th November (70 participants, part of the IFS agronomy webinar series), two R&D projects into nutrient recycling were presented.

Romke Postma, Nutrient Management Institute, The Netherlands, presented the ReNu2Farm project (Interreg) which is looking at potentials for nutrient transfer between regions with livestock production towards crop growing regions. Desk study data compared the nutrient surpluses in some regions with crop needs in others, for N, P and K, and for organic matter, taking into account regional climate, soil and differing crop needs. Conclusions are that even in high manure regions, there is a need for concentrated nitrogen fertilisers to top-up manure nutrient inputs, and additionally for potassium for root crops. In low manure regions, there is a need for N, P and K, and additionally for organic matter for root crops. This should be taken into account when producing tailor-made fertilisers from recycled materials.

Results were presented of a **survey of 1225 famers concerning attitudes to use of secondary nutrients** (in Belgium, France, Germany, Ireland, UK, Luxemburg and The Netherlands, 2018-2019, carried out by which was performed by CIT, Cork, Ireland). Contaminants were the biggest concern for farmers (heavy metals, plastics, other pollutants, pathogens). Farmers currently using secondary materials underlined the importance of the nutrient ratio, organic matter and price; whereas non-users underlined price, ease of application and certification. Over all respondents, known nutrient content and nutrient ratios corresponding to crop needs were identified as key qualities to enable possible substitution of mineral fertilisers.

Martin Blackwell and Tegan Darch, Rothamsted Research, UK, presented the Thallo / Elemental Digest System process proposed for recycling of abattoir and other wastes, as presented in the PlosONE 2019 paper here. Bones and other Cat. 2 organic abattoir wastes are milled to a fine slurry, then combined with sulphuric acid and a metal catalyst, then pressure sterilised (20 mins. @ 133°C, 3 bars DEFRA method 1), before drying and granulation to produce a slow-release organo-mineral fertiliser (see patent WO2014202986, 2014). It is indicated that other wastes can be added, e.g. calcium phosphate from baby food production, biomass combustion ash or waste from fire extinguisher refilling (the silicones in fire extinguisher material is broken down by the high-pressure sulphuric acid treatment). It is suggested that proposed process offers advantages compared to current recycling routes for Cat. 2 abattoir by products (see EU industry data in "Understanding Animal by-products and phosphorus recycling in SCOPE Newsletter n°122), because on-site processing at the abattoir reduces waste, enables recovery of some materials for the human food-chain in an initial sorting stage, and can be adjusted to produce bespoke fertiliser formulations (including different micronutrients) adapted to local soil/crop needs.

The Thallo product typically contains 6.5% N, 3.1% "acid soluble" P, 3% K, 9% S, 9% Ca and up to 30% organic matter, and also many other elements including e.g. zinc (430 ppm), iron (115 ppm). Results from pot trials (16 weeks, with grass and wheat) were presented, comparing the Thallo product to standard NPK mineral fertiliser and slow-lease N fertiliser. Mostly, plant yields were very similar for the three different fertilisers. The Thallo product showed better yields in sand, presumably because of its organic matter content. Analysis of micro-nutrients in the grown plants showed complexity of results, suggesting interactions between different nutrients and micronutrients present.

International Fertiliser Society (IFS) webinar series: programme, registration, access to recordings of past webinars (free for IFS members) Here

Research and publications

Nearly half of the world's cropland is phosphorus limited

A meta-analysis of 652 phosphorus addition experiments in the field, from 285 publications 1955 – 2017, suggests that 49% of croplands and 45% of natural terrestrial ecosystems are phosphorus limited. Phosphorus inputs increased aboveground plant production by an average of 14% in croplands (compared to no P addition controls), which are often already fertilised, and 35% in natural systems (compared to no P addition controls). The data set covered all continents except Antarctica and wide ranges of precipitation. Soil phosphorus limitation was not restricted to tropical soils, with data showing P limitation in natural systems across Europe and in cropland in Northern Europe.

"Global meta-analysis shows pervasive phosphorus limitation of aboveground plant production in natural terrestrial ecosystems", E. Hou et al., Nature Communications (2020) 11:637 DOI

Organic farms show P and K deficits

A study of farm gate nutrient balances and soil nutrient status in twenty Organic farms I Germany shows wide variability, but a mean phosphorus deficit of -3 kgP/ha (SD = standard deviation ±6). Nutrient budgets were calculated as all inputs (fertilising products, manures, animal feed, seeds, plus estimated BNF = biological nitrogen fixation per crop) minus estimated offtakes in crops and by-products. Losses in leaching/runoff were not considered in the calculation. Mean farm balances for nutrients assessed, other than P, were all positive with wider variation: N = +19 (±26), K = +5 (±28), Mg = +7 (±10), S = +12 (±33). Levels of (extractable) nutrients in soils were not correlated to the nutrient balance for N, K, Mg, S, but were correlated for P. Some 14% of soils across the 20 farms showed extractable soil P below optimal levels (KTBL 2015, VDUFA 2018, groups A or B), 27% optimal soil P (group C) and 50% above optimal (D or E). The authors note that farms with a prolonged past of Organic Farming showed higher risk of P depletion in soils and that reliance on biological nitrogen fixation was linked to soil depletion of both P and K. The authors further conclude that "P and K scarcity (are) a major challenge for Organic farms with high reliance on BNF in the long term".

"Reliance on Biological Nitrogen Fixation Depletes Soil Phosphorus and Potassium Reserves", M. Reimer, Nutr Cycl Agroecosyst 2020, DOI.

LCA of struvite recovery

A life cycle assessment (LCA) was carried out of the Nine Springs municipal wastewater treatment plant (WWTP) in Madison, Wisconsin (38,000 p.e. biological P-removal, biosolids used in agriculture) - with and without struvite recovery. In 2017, the WWTP implemented additional phosphorus release from the secondary (bio-P) sludge before gravity thickening and installed the Ostara Pearl struvite recovery system which operates on the sludge thickening liquor (filtrate). Although there was an increase in influent nutrient concentrations after 2017, resulting in a slightly increased discharge concentrations, the authors note that struvite recovery would generally improve effluent quality by reducing nutrient returns to the WWTP in the dewatering liquors. Taking into account the balance of increased chemical and energy consumption versus the recovery of phosphorus and nitrogen (modelled as an LCA offset for fertiliser value), the environmental impacts generally decreased with struvite recovery implementation. In this case, the net greenhouse impact of adding struvite recovery was a reduction in total emissions for the WWTP of around 1% or approximately 4 gCO_2-equ./m^3 wastewater treated.

"Environmental impacts of phosphorus recovery through struvite precipitation in wastewater treatment", M. Sena et al., J. Cleaner Production 280 (2021) 124222 DOI

Manure in the Baltic Region

A report by the SuMaNu project summarises manure management in the Baltic region. Examples of Finland, Sweden, Germany and Poland, with maps, show the uneven distribution of livestock production (and so manure). An overview of different manure processing technologies is provided covering, with estimated investment and operating costs for some: solid-liquid separation, slurry acidification, composting, anaerobic digestion (AD), drying, vacuum evaporation, combustion, pyrolysis, gasification, ammonia stripping, membrane separation, struvite precipitation. For some technologies (AD, thermal drying of poultry manure, pelletisation, combustion, gasification vacuum evaporation) case examples are presented. The report concludes that manure processing is needed to enable storage and transport of manure from livestock intensive regions in the Baltic to crop-growing areas, where fertilisers are needed and nutrients can be used efficiently, but that to date manure processing is too expensive for farmers. It is emphasised that the final product must correspond to farmers needs (e.g. spreading equipment) and that reliable information for farmers on the product's nutrient content and nutrient plant availability must be available.

See also reports on manure processing technology: Wageningen The Netherlands ESPP eNews n°45, NIBIO Norway 2020 ESPP eNews n°41, Washington State University USA 2018 ESPP eNews n°31, the detailed online data base (costs, farmer assessments …) operated by Newtrient in the USA and the specifications in the EUBAT document for intensive rearing of pigs and poultry (updated 2017)
"Manure processing as a pathway to enhanced nutrient recycling", report of SuMaNu platform, S. Luostarinen et al., 2020, ISBN 978-952-380-037-3 access.

Northern Ireland increasing phosphorus surplus

The phosphorus stock and flow analysis for Northern Ireland (NI) carried out within the RePhOKUs project shows that the agricultural P surplus has increased by nearly +50% since 2008 (8.7 kgP/ha in 2008, 12.3 kgP/ha in 2017). This results from a c. +25% increase in P imported in animal feed (+3.4 kgP/ha increase) and a nearly +50% increase in mineral P fertiliser use (+1.4 kgP/ha). Over the same period, average river SRP (soluble reactive phosphorus) increased by around one third (62% of P-total inputs to waterbodies in NI are estimated to be from agriculture). Considering all inflows and outflows of P to NI, the regional P balance (2017) was +5.5 kgP/person (compared to around 0.6 kgP/person P intake in diet: only c. 10% of the net NI P import – export is actually being eaten). The NI food system "phosphorus use efficiency" is calculated by the authors to be 38% (P in agricultural food products / P inputs to the agricultural system). This low P use efficiency (PUE) is considered to be linked to livestock production. Manure produced in NI contains 20% more P than the region's total P input needs, whereas only c. 10% of poultry manure is processed (2% of P in all NI manures).

"Phosphorus Stocks and Flows in an Intensive Livestock Dominated Food System" S.A. Rothwell et al., Resources, Conservation and Recycling, online here. A technical summary of the work and results from a subsequent stakeholder workshop can be found here.

Nano calcium phosphate for cancer tumour treatment

Researchers have developed a possible treatment route for cancer tumours using calcium phosphate nanoparticles (c. 100 µm diameter, mesoporous), which can be loaded with antitumour drugs (doxorubicin = DOX was tested) and coated with arginylglycylaspartic acid = RGD (a common peptide responsible for cell adhesion). Multidrug resistance of tumours is the primary cause of chemotherapy failure. The prepared nano calcium phosphate composite (called TCaNG) showed good tumour targeting. Once taken into the tumour cell, as well as delivering the drug DOX, the TCaNG releases calcium which suppresses cellular respiration, so reducing production in the cell of glycoproteins which remove cancer drugs. Glycoprotein production is reduced both by direct inhibition (due to calcium accumulation in mitochondria) and by blocking cellular ATP production (adenosine tri phosphate, necessary for energy cycling) so reducing the effectiveness of the glycoproteins. The TCaNG reduced the proliferation of drug-resistant tumours in mice by a factor of c. 13.

"Nanoenabled Intracellular Calcium Bursting for Safe and Efficient Reversal of Drug Resistance in Tumor Cells", J. Liu, Nano Lett. 2020, DOI.

Unsupported claim that P fertilisers impact biodiversity

The title of a paper in 'Nature Ecology & Evolution' suggests that it shows phosphorus fertilisation to "eradicate" threatened plants in northern Europe. The paper is based on data from 16 sites in a few widely separated zones: seven in the band Netherlands – Belgium – Switzerland, five in Eastern Poland / Belarus, one in Sweden, one in Northern Scotland and two in Siberia. The paper shows, for these sites, correlations suggesting that both "availability" of phosphorus to plants and ratio of "available" P/N are more correlated to plant biodiversity and to threatened plant species than N or K. "Availability" is not here based on soil data, but is estimated from above-ground plant biomass nutrient ratios. As authors indicate, this sensitivity to P is to be expected as P is generally the "limiting nutrient" in nature. The authors then suggest that "An EU Phosphate Directive" is needed, based on speculation that reducing P-fertiliser application would reduce P availability in land relevant to threatened biodiversity. ESPP does not see evidence in the paper to support this: it seems likely that reduced P-fertilisation of a field might reduce P levels in land nearby, but it is not clear how reduced P fertilisation would significantly lower P availability in more remote areas (e.g. the Northern Scotland or Siberia sites in the study). Atmospheric phosphorus deposition is never mentioned in the paper, despite N deposition being discussed. Other sources suggest global phosphorus deposition may be quantitatively nearly 1/5th of P annually mined in phosphate rock, but that most atmospheric P deposition comes from natural sources (e.g. dust from deserts, pollen and other biogenic materials), see ESPP eNews n°43.

"Phosphorus fertilization is eradicating the niche of northern Eurasia's threatened plant species", M. Wassen et al., Nature Ecology & Evolution 2020 DOI.

Taiwan: diet phosphorus acceptable but calcium too low
Iran: diet phosphorus and calcium too low, sodium too high

Based on data from 7580 respondents in a national eating and drinking study, and analysis of 876 representative food product samples (purchased in supermarkets), it is concluded that average adult phosphorus intake in diet is around 1.2 gP/day, higher in toddlers, and with a small increasing trend with age from children through to the elderly. The phosphate intakes were higher than the AI (Adequate Intake) and lower than the UL (tolerable Upper intake Level), so "no significant risk" to health. The main dietary sources of phosphorus were grains (including rice), fresh meat and poultry and milk products. The authors note that none of these contain phosphate food additives. Calcium intake in adults is around 0.5gCa/day, compared to an AI of 1 gCa/day for adults, so are considerably too low.

In a separate study in the city of Shiraz, Iran, based on a dietary survey of 438 persons and analysis of 580 food samples from shops and markets, phosphorus intake is estimated at only 0.21 gP/day, considerably lower than the EAR (estimated average requirement) of 0.58 gP/day. Calcium intake was 0.24 gCa/day, again much lower than the EAR of 0.8 gCa/day. For both phosphorus and calcium, around 90% of the population had intakes below the EAR. Whereas sodium intake was 1.47 gNa/day compared to an EAR of 1.5 gNa/day. 70% of the population had sodium intakes higher than the UL of 2 gNa/day.

"Risk Assessment of the Dietary Phosphate Exposure in Taiwan Population Using a Total Diet Study", M-P. Ling et al., Foods 2020, 9, 1574, DOI.
"Dietary Intakes of Zinc, Copper, Magnesium, Calcium, Phosphorus, and Sodium by the General Adult Population Aged 20–50 Years in Shiraz, Iran: A Total Diet Study Approach", E. Babaali et al., Nutrients 2020, 12, 3370, DOI.

New book "Phosphorus: Past and Future"

By Jim Elser and Phil Haygarth, this new book, 250 pages, presents phosphorus' roles in biology, human health and nutrition, ecosystems and in environmental sustainability. The importance of mined phosphate rock to global food production is explained, and the environmental problems generated by phosphorus losses to surface waters. Phosphorus sustainability efforts are presented, with solutions and possible future scenarios.

"Phosphorus: Past and Future, J. Elser & P. Haygarth, publication 1st January 2021, ISBN 978-0199916917

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