European Sustainable Phosphorus Platform

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Plant materials and organic by-products

Challenges of ensuring that organic material recycling routes are not excluded in the new EU Fertilising Products Regulation, that innovation and industrial feasibility are facilitated, and that safety of products from secondary raw materials is ensured (hygiene, non-dissemination of plant pathogens or invasive plant species).

Closing nutrient cycles in organic farming

Summary of the ESPP – IFOAM EU stakeholder meeting on closing nutrient cycles and uptake of recycled fertilisers

Swiss – German phosphorus recycling conference

Update on the new regulatory obligations for phosphorus recovery in Switzerland and in Germany, and on available technologies

European nutrient recycling R&D meeting

25 nutrient recovery research and demonstration projects meet to discuss project coordination and research needs

Dietary phosphorus and health

Major new book assesses nutrition and health aspects of phosphorus in food

Events

IFAT trade fair for sewage - waste – resources
14 - 18 May 2018, Munchen, Germany
https://www.ifat.de/index-2.html
Including: Integrated Nutrient Recovery (Run4Life and ESPP)
http://run4life-project.eu/run4life-ifat/
and "Phosphorus recycling, tighter nutrient elimination requirements and operational costs" (DPP and ESPP)
https://www.phosphorusplatform.eu/scope-in-print/news/1625-ifat-2018-phosphorus-management

Sustainable chemicals for the circular economy
CEN/CENELEC workshop 24 May, Brussels
http://www.cvent.com/d/pgq7vl?lang=en&sms=7&cn=M3zP_uwRDkeGSTGKcFDrJg

ESPC3 – 3rd European Sustainable Phosphorus Conference
11-12 June site visits 13 June), Helsinki
www.phosphorusplatform.eu/espc3

EWWM - 12th European Waste Water Management Conference (Aquenviro)
17-18 July, Manchester UK http://ewwmconference.com/

SPS2018 – 6th world Sustainable Phosphorus Summit
20-22 August, Brasilia
http://www.sps2018.com.br/

European Nutrient Event at ECOMONDO 8-9 November, Rimini, Italy
https://en.ecomondo.com/

The partners of the European Sustainable Phosphorus Platform

Plant materials and organic by-products in the EU Fertilising Products Regulation

The new EU Fertilising Products Regulation, currently under finalization in trilogue (European Parliament, Council, Commission negotiations) will create the possibility for a wide range of products which are currently covered only by disparate national regulations and certifications to be CE-marked (EU-Label): composts, digestates, organic and organo-mineral fertilisers, growing media, biostimulants.

The new EU Fertilising Products Regulation is **highly ambitious in opening single market access for products from secondary raw materials**.

The new Regulation will represent a step-change by giving **effective EU End-of-Waste status** to EU-Label fertilising products.

At a **stakeholder meeting, organised by ESPP and leading concerned industry organisations on 11th April, Brussels**, around 50 experts from different organic material recycling industries, the European Commission, Parliament, Council, agricultural stakeholders, and trade organisations engaged dialogue on a range of technical and legal issues raised by the new regulation, with the objectives of **ensuring that current organic material recycling routes are not excluded**, innovation and industrial feasibility are facilitated, and that safety of products from secondary raw materials is ensured (hygiene, non-dissemination of plant pathogens or invasive plant species).

The meeting organisers were: European Biogas Association (EBA), European Biostimulants Industry Council (EBIC), European Consortium of the Organic-Based Fertilizer-Industry (ECOFI), European Sustainable Phosphorus Platform (ESPP), Growing Media Europe, Working Group on Compost of the North Sea Resources Roundabout, Union des industries de la fertilisation, France (UNIFA).

Chris Thornton, European Sustainable Phosphorus Platform (ESPP) opened the meeting, underlining that the new EU Fertilising Products Regulation will open the market to use the EU-label on products derived from organic materials, but will also open the market for secondary raw materials (inputs for these products) and for **technologies for production and recycling**. This is complex, because the Regulation covers a wide range of different materials, and industries that did not previously dialogue at the European level because they were not covered by the same regulations.

The main industry federations concerned by the new Fertilising Products Regulation worked together for the first time last year, with the **Joint Industry Statement on the EU Fertilising Products Regulation** of 20th November 2017: *https://phosphorusplatform.eu/images/download/Joint-statement-industry-Fert-Regs-finalised-20_11_17.pdf*

One of the key points raised in this Joint Industry Statement, essential for the Circular Economy for all product categories of the new Fertilising Products Regulation is the **question of "by-products"** [point (B) of the Statement]. This concerns both 'industrial' (often inorganic) and organic, crop or plant-based by-products. Progress appears to have been made on inorganic by-products in trilogue, but important issues remain concerning organic materials. See summary of Fertilizers Europe meeting on this question in ESPP *eNews n°21*.

ESPP underlined that one of its key objectives, central to improving phosphorus stewardship, is to facilitate nutrient recycling. The New EU Fertilising Products Regulation is a major opportunity, which will position Europe as a world frontrunner. **Safety and quality are however critical and long-term farmer and consumer confidence must be ensured**. Circular Economy products must offer reliable quality and agronomic benefits to farmers, and must ensure safety: contaminants below risk levels, sanitary safety. For plant-derived materials, this must include preventing dissemination of plant diseases, plant pathogens or invasive plant species.

EU Fertilising Products Regulation terminology

The new EU Fertilising Products Regulation will define criteria for:

- **PFCs (Product Function Categories).** To obtain the EU-Fertiliser label, a product must respect the criteria of a PFC. The PFCs specifically relevant to plant and organic materials are:
  - PFC 1A Organic fertilizers
  - PFC 1B Organo-mineral fertilizers
  - PFC 3A Organic soil improvers
  - PFC 4 Growing Media
  - PFC 6 Plant biostimulants

- **CMCs (Component Material Categories).** To obtain the EU-Label, In addition to the PFC requirements, all materials used in the manufacture of a CE-marked fertilising product must respect CMC criteria (one product can combine several CMCs as inputs to its production process).
- CMCs relevant for plant and organic materials are:
  - CMC2 = Non-processed or mechanically processed plants, plant parts or plant extracts
  - CMC3 = Composts
  - CMC4 and CMC5 = Digestates
  - CMC6 = Food Industry By-Products
  - CMC7 = Micro-organisms
  - CMC8 = Agronomic additives
  - But also
  - CMC1 = any "virgin" material (has never been waste). At present "by-products" are excluded from CMC1 but discussion is underway in trilogue to remedy this.
  - CMC9 = Nutrient Polymers
  - CMC11 = Animal By-Products = currently not defined (an empty box in the proposed Regulation text)
  - Proposed additional CMCs, discussion underway in STRUBIAS = ashes, biochars (from organic materials)

Here is an example of how this will work:

- *Separately collected household organic waste is not itself an eligible CMC (excluded from CMC1 because waste).*
- *But CMCs 3 and 5 (digestate and compost) specify that these can be produced, under specified conditions, from such materials*
- *However, a digestate or compost (produced as specified in CMC3 or 5) can only obtain the EU-Label if it also corresponds to the criteria of one of the PFCs (product categories), probably PFC1A (organic fertiliser, if nutrient levels are high enough) or PFC3A (organic soil improver). These criteria fix contaminant and pathogen limits and material properties such as carbon, nutrient or dry matter content.*
- *In some cases, further processing (such as solid-liquid separation of digestate) may be necessary to achieve the PFC criteria*

Case study: **Germiflor**, Mazamet, France, produces 30 000 t/y of organic fertilisers, organo-mineral fertilisers and soil improvers, based on compost produced from plant materials only and matured for at least six months, selling to 20 countries worldwide. **Traceability is ensured, with labelling of every input material**. Products are adapted to customers' needs, based on soil analysis and field trials have demonstrated effectiveness in improving not only crop productivity, but also better conservation for fruit and vegetables and improved vinification for grapes, as well as improvements to soil including richer micro-flora, water retention and clay-humus properties.

Video (in French) https://www.youtube.com/watch?v=bWeGVyE0OU4

Organic fertilising materials: dynamic, innovative and circular

Florence Nys, General Delegate of UNIFA (French federation of fertiliser industries), explained that UNIFA brings together the various different fertiliser, soil amendment and biostimulants industries in France, including mineral fertilisers, organic fertilisers, organo-mineral fertilisers, liming materials, soil improvers and biostimulants. UNIFA is mandated by the French Government to collect data on mineral fertilisers. UNIFA also compiles data on organic and organo-mineral fertilisers, soil improvers and liming materials.

UNIFA brings together 50 member companies, employing nearly 4 000 people at over 90 production sites. These companies use both mineral fertiliser components and a wide range of secondary materials (see list below). Around 17.5 million tonnes of fertilisers and soil improvers were sold to farmers in France in 2016, of which 2/3 were produced from organic secondary materials. **Taking also into account local use of manure, 27% of nitrogen input to farming in France today comes from recycling, 53% of phosphorus and 73% of potassium**.

It is essential to ensure that the new EU Fertilising Products Regulation enables performance complementarity between mineral and organic components of fertilising products and permits innovation to tap new organic secondary materials or develop new valorisation processes, whilst **ensuring safety and ensuring farmer and consumer confidence**.

UNIFA is thus particularly concerned to **widen and clarify the definitions of CMC2 and CMC6** to ensure that plant-based by-products can be used from industries such as vinasses, animal feed and cosmetics/pharmaceuticals (cakes after extraction oils, feed materials, aromatic or other molecules).

Growing Media Europe (GME) also underlined similar concerns with the proposed EU Fertilising Products Regulation: the need to widen the definition of CMC2 to include current excluded processes using plant materials; ambiguity in the definition of PFC3 "soil improvers" (not clear if mulches are included?) and PFC4 "Growing Medium" (preference would be to use the CEN definition CR 13455); and the importance that labelling and tolerance requirements should take into account that organic materials in fertilising products will evolve over time and not be identical on delivery to conditions on production (e.g. dry matter, form of carbon and nutrients).

These difficulties were illustrated with **examples of materials which are today very widely used in growing media and risk being excluded from the future EU-Label**: plant fibres, which are often treated with heat and pressure, so do not correspond to processes defined in CMC2; tree barks used as mulches and which are "by-products"; coir (coconut husk fibres) which are treated with a buffer solution to replace excess sodium (coconuts grow in saline conditions) by useful potassium, again a process not covered in CMC2.

In discussion, it was strongly underlined the **need to maintain delegation to modify the Regulation annexes** in order to adapt to innovation in organic-based fertilising products, in recycling processes and to mobilisation of new waste or by-product resources.

Case study: **Frayssinet, France**, presented by **Quentin Protsenko**, produces 80 000 t/y of solid organic and organo-mineral fertilisers and 400 000 t/y of liquid fertilisers and biostimulants. Over 60 different organic materials are used as inputs, with many different and varied food industry by-products many of which are not currently included in CMC6. These bring specific benefits, for example vinasse is a key source of potassium, cellulose is important to bring carbon to soil. Traceability of input materials and frequent controls ensure quality and safety. Frayssinet wishes to obtain the EU-Label for its products to ensure their market recognition. However, the company is concerned that many materials used will be excluded from CMC2 as currently defined (and from CMC6 see above), for example plant materials after extraction of oils or other materials by non-mechanical processes. Also, rigid definitions of e.g. CMC2 in the future Regulation could prevent innovation, such as the use of green solvents in extraction processes from plant materials.

Many materials will be excluded under the current FRs proposed text

Chiara Manoli, ILSA SpA Italy and ECOFI Regulatory Committee Co-Chair, presented **ECOFI, the European Consortium of the Organic-Based Fertilizer-Industry**. The EU market for organic-based fertilisers is around 250 million €/year, with mainly SME operators (organic fertilisers, organo-minerals and organic soil improvers).

Ms Manoli presented the **wide range of different organic materials recycled today by the organic-based fertiliser industry**, showing that materials come from many different industry sectors (value chain) sources, are by-products from widely varying extraction or production processes, and concern very many different plants, crops and other types of organic material (see list below).

Many of these will be excluded from use in EU-Label fertilising products, unless the currently proposed Fertilising Products Regulation text is modified, because:

- **CMC1** → excluded because they are (or are derived from) wastes or by-products, or because they are polymers
- **CMC6** (Food Industry By-Products) → initially only a very short list covering certain specified food industry sectors
- **CMC2** (mechanically processed plant materials) → excluded if extraction process does not fit the narrow definition of CMC2 (e.g. cake left after an extraction process using steam, solvent, gas, heat, etc)

Why do organic fertilising products need the future the EU-Label

The European Commission reminded participants that the new EU Fertilising Products Regulation will allow **continuation of existing or development of new national Fertilising Products Regulation**.

Industry participants however underlined that many organic-based fertilisers or soil improvers will wish to obtain the EU-Label. **The new EU-Label is likely to be requested by farmers, or by downstream purchasers**, such as food companies or supermarkets who see it as an easy-to-use quality assurance or purchasing criterion.

Furthermore, **many organic-based products are exported, as is shown by the international markets of the different companies present**. This is because such products respond to specialised user requirements for different soils and crops, and also because readily-available raw materials in one region (which are not easily transportable) can offer product characteristics desirable in another region where such materials are not available.

The range of organic materials used today in fertilising products

Source industry sector	Materials
Agriculture	Crop by-products
Food and beverage	Plant (including seaweed) extracts, hydrolysed proteins, vegetable cakes and meals, natural polymers & starch derivatives, molasses, vinasse, marc, exhausted yeasts, coconut fibre, chaff and husks (e.g. from grains, rice), vegetable tops, seeds & stalks, citrus and other fruit skins and set-asides, pulps & pomaces, fats & oils
Cosmetics	Plant (including seaweed) extracts, vegetable cakes
Pharmaceuticals	Plant (including seaweed) extracts, vegetable cakes
Forestry, wood, paper and packaging	Bark, cellulose, pulp, paper, cardboard, wood fibre, sawdust, wood chips, twigs, recycled plant materials
Environmental management	Water plants and algae from cleaning or dredging waterways or lakes, vegetation cuttings from maintenance of parks, natural habitats, roadsides, etc.
Petroleum	Humic & fulvic acids from lignite & leonardite
Textiles	Flax shives, fibres, vegetable cakes, vegetable stones

One participant questioned why vegetable cakes (plant remains after extracting e.g. edible oils, biofuels, cosmetics extracts …) would be used as soil improvers, whereas such cakes are best used in animal feed. Industry replied that, wherever possible, uses higher in the **waste hierarchy** (human food, animal feed) are preferred, and that this is strongly driven by much higher prices for these uses, but some materials are unsuitable for animal feed and it is these which are used by the organic fertilising products industry.

Wim de Jong, Twence, The Netherlands, explained the difficulties encountered in exporting compost to the UK, despite the actions of the **North Sea Resources Roundabout**. This informal agreement enables coordination between concerned governments and industry to develop country-to-country trade in recycled materials in the region (see *www.phosphorusplatform.eu/scope120*). The Netherlands has a nutrient excess, so little market for compost for farmers, whereas soils in Northern England need both nutrients and carbon which compost can provide. But to sell compost in the UK, UK End-of-Waste status is necessary. UK compost standards are not the same as those in The Netherlands. Additionally, the presence of animal by products (the compost inputs include source separated household organic biowaste) limits transport and storage to specifically licensed companies. Twence therefore underlines that **the new EU Fertilising Products Regulation and the EU-Label will be very important to enable export of compost within the EU**, and will also provide a single, easily understandable (and so marketable) label for export outside Europe.

Making the REACH – Fertiliser Regulation interface workable

Chiara Manoli of ECOFI raised concerns that the **REACH (European Chemicals Regulation) requirements specified in the proposed Fertilising Products Regulation are more demanding than the requirements of REACH itself**, and that this will pose real barriers to innovation and recycling.

These concerns were further detailed by **David Carden, Valagro, Chair of the European Biostimulants Industry Council (EBIC) Regulatory Committee**. REACH exempts from Registration: most non-purified plant-based materials, polymers, substances sold < 1t/year. These exemptions are deliberately not included in the reference to REACH Registration in the draft EU Fertilising Products Regulation, because the European Commission considers that before any substance is used in a fertilising product, the relevant safety assessment should be made and necessary safety data collated. This concerns CMC1 and also CMCs 3-5 (for composting and digestion additives) and CMC6 (food industry by-products). Industry, on the other hand, notes that today such fertilising products are placed on the market under normal REACH requirements without any documented issues for health and safety.

These higher requirements proposed by the Commission would imply a significant additional administrative burden and cost that is disproportionate to the likely improvements. This additional burden could be **disruptive to innovation**, especially since **small test runs would now face the costs of full commercialisation**.

REACH Registration requires chemical regulatory expertise which agro-fertiliser SMEs may not have, and is generally complex and expensive for naturally-derived substances which are not pure chemicals and are naturally variable.

Also, there are various **areas where clarification is needed concerning REACH application**: e.g. for natural polymers and materials derived from them (chelated natural polymers). The polymers are excluded from Registration under REACH. Are they covered by CMC9 (“Nutrient Polymers”) or CMC1 (after a future “by-products” amendment) or neither under the FRs? Is REACH Registration required by the FRs?

It is also noted that compost and biogas are explicitly exempted from REACH, but that digestate is not. EBA, ESPP and others have developed an argumentation in 2014 that **digestate should be considered exempted from REACH**, but an official EU Opinion on this question is still not delivered. See *www.phosphorusplatform.eu/scope101*

In **discussion with participants**, it seems that the challenges are to achieve the objective of **ensuring appropriate safety data and risk assessment of all materials used in fertilising materials**, but to take account that REACH (which is chemical legislation) is not appropriate for assessing plant or organic materials, and to ensure that the information and administrative requirements are not an obstacle to innovation and recycling for SMEs.

One participant commented that **for materials comparable to Plant Protection Products** (e.g. having a biocidal effect) it is precautionary and justified to require a safety assessment and data even if not exempt from REACH.

Ensuring safety of organic materials

Franz Kirchmeyr, Vice-President, EBA (European Biogas Association), explained that digestate is an important source of recycled nutrients, with over 17 000 anaerobic digestion plants operating in Europe today. Feedstock materials include energy crops, agricultural residues, municipal biowastes, food and beverage industry wastes, sewage biosolids.

He presented data showing that **anaerobic digestion effectively kills a range of weed seeds** (e.g. 0% germination after 7 days @ 35°C), and **destroys propagules of Japanese knotweed (invasive plant)** and **kills different plant pathogens** (fungi). Shorter times can be effective in digesters operating at 50°C. Studies also show that application of digestate improves soil properties (lower bulk density, higher water holding capacity).

Concerning the Fertilising Products Regulation project, Mr Kirchmeyr noted that minimum nutrients, carbon and dry matter contents would exclude most digestates, despite the fact that typically applications bring valuable fertilising effects to plants with very low heavy metal loads. This can be addressed by **processing of digestate (solid/liquid separation).** Unprocessed digestate would thus have to be sold locally under national regulations, whereas processed digestate could be eligible for the EU Fertilisers Label, so enabling export. The **confirmation of the exemption of digestate from REACH** is also essential.

Nele Ameloot, Greenyard Horticulture (growing media producer) and President of the Expertise Working Group of **GME (Growing Media Europe)** explained that the growing media industry is proactive in **innovation and in recycling**, with objectives to reduce use of primary raw materials (such as peat) and replace by secondary materials (organic by-products), and also in some cases recycling of used growing media (already operational for mushroom media).

A priority for Growing Media Europe is to allow **self-certification (Module A in Annex IV Conformity Assessment Procedures)** for products containing only CMC2 materials (mechanically processed plant materials). The growing media industry is mostly SMEs who produce thousands of specific, tailor-made growing media for different customers' requirements: registration of each of these with third party certification is not feasible. Experience shows that growing media companies ensure quality and safety responsibly, because it is essential to their customer relation: growing media are a critical input for horticulture, enabling or disabling cultivation, and safety is key for the whole industry. Ensuring safety under self-certification has been successfully implemented throughout the industry for many years, with no problems.

Harry Arijs, DG SANTE, Deputy Head of Unit G1 Plant Health, presented the evolution of the current EU legislation (based on 1977 plant health legislation, now Directive 2000/29/EC) to the **new fully harmonized regime of Regulation (EU)2016/2031**, applicable from 14th December 2019. The objective is to protect the EU's agriculture, horticulture, forestry and the environment from plant pests by monitoring and "horizon scanning" (identifying risks on other continents), early detection at import and eradication. This policy is in conformity with the IPPC (International Plant Protection Convention). It covers all live plant parts (e.g. including cut branches or fruits and seeds) and listed plant products and derived products, including "soil/growing media which contains organic materials or parts of plants". This regulation applies to all professionals selling or producing concerned products, and requires traceability (**European Plant Passport**) for all professional to professional sales and transfers of materials. This new Regulation is not cited in the EU Fertilising Products Regulation draft text, but is considered cited because it extends 2000/29 which is cited in Art. 1.2

Case study: **Laurent Largant**, **AFAIA** (French federation for manufacturers of soil improvers, growing media, organic and organo-mineral fertilizers, mulches and biostimulants). AFAIA represents 72 companies, with 1 700 employees, producing more than 4.2 million tonnes/year of growing media, mulches and organic fertilisers. He explained how the **Pine Wilt Nematode and its vector, a *Monochamus sp.* beetle** has been successfully managed by the growing media industry under current EU plant protection legislation (Directive 2000/29/EC, which is cited in the draft EU Fertilising Products Regulation art. 1.2). Following detection in Portugal in 1999, affected areas were demarcated and EU decisions were taken to limit dissemination, with support from the wood and the growing media industry (which uses bark as mulch and as a growing media component). To date, these actions have been successful and the pest has not spread outside Portugal. This example shows that the EU's Plant Protection legislation is sufficient to prevent plant pathogen dissemination, and other safety requirements in the EU Fertilising Products Regulation (e.g. for CMC2) would not be useful, and could cause confusion.

Conclusions

ESPP thanked the participants for their **constructive input and discussions**, in particular the representatives of the European Commission (DG GROW, DG SANTE, DG AGRI and DG Research and Innovation) who contributed actively to the discussions.

ESPP drew the following conclusions from the meeting:

- **An industry which needs and desires the EU-Fertiliser Label:**
  The organic-based fertiliser and growing media industries, and the biostimulants industry, are dominated by SMEs, but many produce **high-value products with significant export markets and strong product innovation**.
  Access to the EU-Label is seen as very important. Even for organic products which are sold locally, the EU-Label is expected to be demanded by the customer value-chain in purchasing criteria.
- **Bespoke products, innovation, recycling:**
  These industries use a **very wide range of organic secondary raw materials, from many different sources**. Products are often tailor-made for individual customers, or for specific crop / soil / climate combinations, with a high level of innovation and a proactive development of a Circular Economy for nutrients and organic carbon.
- **Self-certification and safety**
  This industry structure and product range means that self-certification is essential to enable SMEs to innovate and **offer bespoke products, corresponding to agricultural user needs**, with feasible cost and time constraints.

  The industry's close links with downstream users and its long experience with existing EU legislation on plant health mean that **traceability and safety are ensured**, as an inherent part of quality.
- **Regulatory coherence and flexibility**
  Core concerns identified by all of the participating organisations, susceptible to prevent their products obtaining the EU-Label, include:
  - widening the list of specified processes in **CMC2** (“**mechanically processed” plant parts**)
  - opening the definition of **CMC6** (“**Food Industry By-Products**”) - which is currently a limitative list of only three materials - to include generic categories of safe materials or source industries
  - ensuring coherence of Fertilising Products Regulation requirements and of **REACH requirements**, to ensure sufficient safety data for substances with possible plant, health or environmental impacts, but avoiding inappropriate and disproportionate application to natural and organic materials where REACH is not adapted
  In order to enable resolution of these and other issues, and adaptation of the Regulation to new recycling opportunities and to innovation, there was a strong feeling across participants of the **importance to maintain the Commission Delegation to modify the Regulation Annexes** (which define the CMCs, PFCs, Conformity Assessment, Labelling)

- **Need for clarification and guidance**

  An overall conclusion is the need for clarification of how the new EU Regulation will function in practice.

  This may require adjustment of wording for a number of CMCs and PFCs (see discussions above). Beyond that, there will be strong need for **some form of official Commission Guidance Documents** (c.f. those existing for REACH) and for explanation by the industry federations at the European and national levels.

  This is particularly critical for the organic-based soil products, which concern many SMEs.

  This Guidance will need to detail **how the new EU Fertilising Products Regulation will operate alongside other regulations** including REACH, Plant Health Policy, invasive plant species (Alien Invasive Species AIS), Animal By-Products, End-of-Waste … The organising industries are willing to support preparation and communication of such Guidance.

A strong positive engagement

The high level of ambition of the new EU Fertilising Products Regulation and the resulting EU-Label raise major challenges, including that the different concerned industries have not previously had a common legal framework at the EU level. This meeting is one of the first times that the different key federations of the organic-based fertilising products have worked together to exchange concerns and proposals, and confirms a **joint industry engagement to forward the Circular Economy, innovation and added value for farmers, crops and soils, whilst ensuring safety.**

This meeting takes forward key issues already identified in the **Joint Industry Statement on the EU Fertilising Products Regulation** signed by fourteen different industry federations (covering mineral and organic products, liming materials, animal by-products, the water industry, animal manures on 20th November 2017) *https://phosphorusplatform.eu/images/download/Joint-statement-industry-Fert-Regs-finalised-20_11_17.pdf*

ESPP and the organising federations intend to **take forward the conclusions of this meeting**, with other organisations and companies of the organic-based soil products industry, and in dialogue with agricultural, food-industry and environmental stakeholders and with other industries concerned by the EU Fertilising Products Regulation (contact: *info@phosphorusplatform.eu*).

In particular, the objective is to develop joint proposals in coming months on:

- **Interaction of Fertilising Products Regulation and REACH** data, documentation, assessment and Registration requirements (substances < 1t/y, (natural based) polymers, natural materials …)
- Clarification for industry of how existing EU regulations on **Plant Health** (see above) and on **Invasive Plant Species** (IAS) can continue to ensure safety when non-sanitised materials (e.g. CMC2, CMC6) obtain the EU-Label, and so can be transported and placed on the market across Europe

Documents

EU Fertiliser Regulation documents

Initial European Commission proposed text, 17.3.2016, COM(2016) 157 final - 2016/0084 (COD)
http://ec.europa.eu/DocsRoom/documents/15949

Amendments proposed by European Parliament
http://data.consilium.europa.eu/doc/document/ST-13610-2017-INIT/en/pdf

Amendments proposed by Council
http://data.consilium.europa.eu/doc/document/ST-14010-2017-REV-1/en/pdf

STRUBIAS first draft report (includes proposed CMC criteria for struvite, ashes and biochars) www.phosphorusplatform.eu/regulatory

Meeting documents: presenters and case study slides:
http://www.phosphorusplatform.eu/plant-and-organic-materials

Meeting organisers website:

UNIFA www.unifa.fr *and*
http://unifa.fr/librairie/publications/rapports-dactivite.html
EBIC www.biostimulants.eu
ECOFI www.ecofi.info
EBA http://european-biogas.eu/
AFAIA www.afaia.fr
GME www.growing-media.eu
ESPP www.phosphorusplatform.eu

Closing nutrient cycles in organic farming

Nearly 100 stakeholders from organic farming organisations, organic and mineral fertiliser companies, compost producers, research and regulators discussed the possible use of recycled nutrient and recycled organic carbon products in organic agriculture.

The meeting was co-organised by **ESPP** (European Sustainable Phosphorus Platform) and **IFOAM EU (International Federation of Organic Agriculture Movements –EU Group).**

The meeting was opened by **Chris Atkinson, IFOAM EU Council Member and UK Soil Association**, who explained why closing nutrient cycles is necessary for organic farming, in particular recycling phosphorus.

The **definition of "organic farming"** adopted by *IFOAM* in 2005 specifies that organic agriculture relies on the health of soils, ecological processes, biodiversity and cycles adapted to local conditions and avoids the use of inputs with adverse effects *www.ifoam.bio/fr/organic-landmarks/definition-organic-agriculture*. This definition refers to the health of soils, ecological processes, biodiversity and cycles adapted to local conditions.

Phosphorus, unlike nitrogen or carbon, cannot be replenished by the plant-soil system, and phosphorus leaving a farm in crops or animal products must be replaced. This was already recognised in the Soil Association (UK organic farming association) *report* "A rock or a hard place" (2011, see SCOPE Newsletter *n°77*).

At present, the use of ground phosphate rock is authorised in organic farming, but this is not an effective fertiliser except in acidic soils, and also poses issues of non-sustainability of supply. Manure, food waste and food industry by-products are today authorised in organic farming, but **do not fulfill phosphorus demand**, because of exclusion of sources from intensive agriculture or relatively low phosphorus content. Sewage sludge was authorised for use in organic farming in the UK by the Soil Association in the 1960's, and similarly in the USA, but is today excluded by EU and US organic standards, because of concerns about contaminants.

For Chris Atkinson, in order to close nutrient cycles in organic farming in the short term, **fertiliser products recovered from sewage sludge and with low contaminant levels should be authorised in organic farming**. In the longer term, separative sewerage systems (eco-sanitation) should offer nutrient sources with lower contaminant levels, and the EU Organic Farming Regulation should be amended to authorise the use of sanitised sewage sludge subject to quality criteria.

Kurt Möller, Universität Hohenheim, Germany, and "Improve-P" *project* (CORE ORGANIC II funded, Improved Phosphorus Resource efficiency in Organic agriculture Via recycling and Enhanced biological mobilization) also underlined the clear need to enable use of recycled phosphorus as input to organic farming.

See Improve-P video tutorial
www.youtube.com/watch?v=LBKmgw5LjLA

Nearly 40% of organic farm soils surveyed in Improve-P were below optimal phosphorus status (in Austria, Swizerland, Germany, Norway, UK, and Denmark), especially in arable organic farming, with mean annual phosphorus balances of -4 kgP/ha (-11 kgP/ha/y for arable).

Fertiliser value of recycled nutrient materials

Dr. Möller presented collated data from a wide range of sources regarding phosphorus crop availability for different recycled nutrient materials (from literature and from *Improve-P* studies). Phosphate rock shows plant availability highly dependent on soil pH, with **near zero fertiliser value of phosphate rock** on most European soils (pH 6 or higher). Struvite shows good phosphorus availability, independent of soil pH, but with variable results suggesting that some materials may not in fact be struvite but mixtures of other phosphate salts. Manures, biological P-removal sewage sludge and compost show phosphorus plant availability comparable to water-soluble mineral fertilisers, whereas digestates and chemical P-removal sewage sludge show lower phosphorus availability.

Else Bünemann-König, FiBL, see below also presented test data showing the near zero fertiliser value of phosphate rock on most soils, and only 40% phosphorus plant availability even on acid soils.

Overall sustainability considerations

Improve-P looked at Life Cycle Analysis of different phosphorus sources, concluding that the most overall sustainable route for sewage nutrients is managed spreading of appropriately treated sludge on farmland. Recovery of nutrients from sewage has an environmental and energy cost, but still has an **LCA generally better than phosphate rock**. The LCA of mineral phosphate fertilisers (which are not authorised in organic farming) is not significantly different from that of phosphate rock.

Improve-P studies on contaminants in sewage sludge and other organic materials (e.g. composts) suggest that risks of accumulation in soil are low at appropriate application rates, whereas the risk of accumulation of cadmium from use of phosphate rock is higher (but still not susceptible to reach risk levels). This confirms the *assessment* in Norway (Erikson et al. *2009* Norway, ISBN 978-82-8082-337-3) concluding a low accumulation risk for most organic contaminants.

Koen Desimpelaere, EIP-AGRI Service Point, presented the conclusions EIP-AGRI *Focus Group* on Recycled Nutrients. The Group's conclusions are published and are summarised in SCOPE Newsletter *n°124*, including recommendations for research needs and for possible Operational Groups under Rural Development funding. Of particular relevance for organic farming are the identified need for research into organic contaminants, societal acceptance and LCA methodologies. Participants are also referred to the conclusions of the *Focus Group* on organic arable farming. See for more information: *https://ec.europa.eu/eip/agriculture/en/focus-groups/nutrient-recycling*
https://ec.europa.eu/eip/agriculture/en/focus-groups/organic-farming-optimising-arable-yields

Organic farmers' acceptance

Else Bünemann-König, Research Institute of Organic Agriculture (FiBL), summarized Improve-P project studies on organic farmer acceptance of recycled fertilisers (see also Loes et al. 2016 in SCOPE Newsletter *n°122* and Loes et al. 2017 *https://doi.org/10.1007/s13165-016-0165-3*). Organic farmers (in seven countries surveyed) were generally positive towards use of recycled nutrient materials, for example nearly 2/3 considering acceptable use of sewage sludge, biowaste or manure from conventional farms. There are however considerable differences between countries in attitudes to reuse of sewage sludge.

Eric Gall (IFOAM EU) confirmed that surveys of organic farmers in the **SUSTAINGAS** project showed their positive acceptance of digestates from wastes and residues, with a preference for using small scale – locally sourced materials.

Discussion of organic farming criteria for recycled nutrients

The EU's "Expert Group for Technical Advice on Organic Production" (EGTOP) gave in *2016* (see ESPP eNews *n°4*) a **positive opinion on the authorisation of sewage-recovered struvite and calcined phosphates as phosphate fertilisers for organic farming in Europe**, subject to their authorisation under the revised EU Fertilisers Regulation. This is therefore dependent on the STRUBIAS process (see ESPP eNews *n°15*).

It was discussed that recycled nutrient products in organic farming **must respect the overall organic principles**, and not copy the development of conventional farming. Dependence on external suppliers poses issues and local recycling loops would be preferable, yet the specialisation of organic farmers is a reality. Farmer to farmer cooperation and management of organic wastes at regional level is a critical issue to be tackled.

Participants underlined the **need for dialogue** to define criteria for what nutrient materials are acceptable in organic farming, taking into account nutrient source/inputs, LCA and sustainability of processing, contaminants.

- To what extent is the use of chemicals in the nutrient recovery process acceptable (e.g. potassium hydroxide)?
- Must recycled nutrients be recovered from 100% organic sources?
- The accent should be on improving sewage quality upstream by avoiding contaminant inputs
- What is the effect on crop nutritional value of the use of organic or recycled nutrient materials? – this is an important purchasing criteria for many organic produce customers.
- Need to involve crop breeding and seed companies: genetics interact with nutrient uptake and use
- Better understand the roles of organic matter and humic acid in recycled nutrient materials (and in soil) in improving nutrient uptake
- Need for long term studies to assess the fate over time of carbon input to soil in materials such as compost or digestate, and how organic farming practices can contribute to long-term carbon retention in soil

Chris Atkinson noted that the definition of organic farming criteria in the USA is a public consultation process, but regrets that it is essentially a "closed" system in the EU. However, the **current revision of the *EU Organic Farming Regulation*** does open opportunities for change.

Else Bünemann-König, FiBL, indicated that this organization is currently working to make a European Organic Farming Input List (*www.betriebsmittelliste.de/en/bml-info/manufacturers.html*) to cover fertiliser materials, composts, etc. This will first be presented at the *BIOFACH* fair in Nuremberg in February 2018. This will list company products which are positively evaluated for use in organic farming by *FiBL*. This list will be further extended to cover struvite and ash-based products, but only after these are added into the EU Organic Farming Regulation (see above).

Organic contaminants and safety of recycled nutrients

Hannah Rigby, Imperial College London, presented studies carried out for the UK Food Standards Agency investigating uptake of organic contaminants present in sewage sludge biosolids and other recycled wastes by grazing animals and by crops. Upper rates of exposure were studied, including mixing biosolids (at 5% dry weight) into feed of lactating cows to simulate ingestion of contaminated foliage or of biosolids from the soil surface by grazing cattle. In this 5% biosolids treatment, organic contaminants were detected in milk at elevated concentrations in comparison to the control, in particular polychlorinated alkanes, and others such as brominated and chlorinated dioxins and furans, brominated flame retardants, and polychlorinated naphthalenes. However, **surface application of biosolids to pasture is rarely practiced, and no-grazing periods and methods of biosolids application minimise ingestion of biosolids from the soil surface by grazing cattle.**

In tests with crop application, **there was no organic contaminant uptake above control levels to wheat grain in a field investigation** after one application of biosolids and other recycled waste materials.

Further studies are needed to provide adequate data for risk assessment of repeated applications of biosolids, but the overall conclusion is that no immediate risk to human health was apparent.

Marissa de Boer, University of Amsterdam and SusPhos presented uptake of pharmaceuticals in nutrient recovery from pharmaceutical-spiked urine and transfer to tomato crops. Nutrient recovery was by struvite precipitation (phosphorus recovery) and by zeolite and biochar (ammonia adsorption). The pharmaceuticals spiked were carbamazepine, diclofenac, ibuprofen, propranolol, sulfamenthoxazole. **Struvite precipitation takes up very low levels of pharmaceuticals**, but the zeolite adsorption processes take up higher levels. Even for these, transfer to the tomatoes was extremely low, with only carbamazepine being detectable – at levels such that it would be necessary to consume **over a tonne of dried tomatoes per day** to pose a health risk. Nonetheless, further work is needed to assess possible impacts of the contaminants on soil ecology.

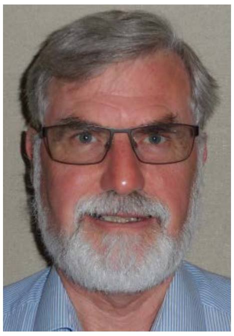
Discussion on contaminants

The following issues were raised by participants concerning contaminants:

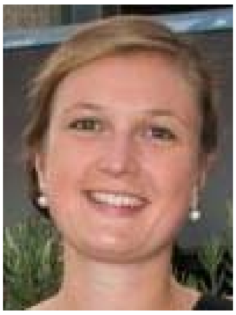
- Risk of accumulation of contaminants with repeated application of recycled nutrient products?
- Possible long term effects of low levels of contaminants, or of combinations of different organic contaminants
- Detection methods for organic contaminants in organic materials?
- Impacts of organic contaminants on soil ecology, soil organism and micro-organism community
- In particular, possible impacts of micro-plastics on soil ecology
- Risk of development of antiobiotic resistant micro-organisms in soil if exposed to pharmaceutical contaminants? Is this a relevant health risk?
- Data can never be complete on organic contaminants (large number of pharmaceuticals and of consumer chemicals, and of their breakdown metabolites), but it is nonetheless important to develop further data to support risk assessment
- The possible risks of organic contaminants must be balanced against the positive LCA of using organic materials (such as treated sewage sludge) on soil compared to incineration
- It should be remembered that most pharmaceuticals are water soluble (mainly not transferred to sewage sludge but to aquatic discharge) and most are adsorbed onto sludge/soil particles and so may be inactivated

Case studies of recycled nutrients in practice

Michel Raaphorst, TIMAC Agro, and also himself an organic farmer, presented the use of **modified struvite as a precision starter fertiliser for maize** in the Netherlands. The product offers added value in phosphorus and/or nitrogen depleted soils, and in organic or low-input crop systems. Specifically developed processing, including dosing of nutrient complements and biostimulants, and delivery as a micro-dose to the root zone at the start of the maize growth period is shown to lead to increase yields. It is identified that this is because **the plant is incited to develop an efficient root structure, also helpful for plant wind resistance and water uptake**. Trials have shown that for maize in the Netherlands, for a range of different genotypes, and also for lettuce and potatoes, precision application of manure is less effective than processed struvite, and that the initial micro-application of struvite phosphorus enables better nitrogen uptake over the maize growth cycle. It is noted that such added value products will often **need to be tailor made for different crops or different climates and soil conditions**. The Netherlands soils generally have sufficient phosphorus for crops, but it is not sufficiently rapidly available for optimal plant development.



Mike Daly, Ostara, explained progress towards regulatory acceptance of sewage-recovered struvite as an organic fertiliser. **Ostara submitted in 2015, via the UK authorities (DEFRA), sewage-recovered struvite to EGTOP for consideration for addition to the EU Organic Farming Regulation** (Annex 1 of EC 889/2008). Following the EGTOP positive opinion in *2016* (see ESPP eNews *n°4*), recovered struvite is expected to be authorised for organic farming once the revised EU Fertilisers Regulation and STRUBIAS are adopted (2019). Ostara struvite has been assessed in the **UK Arable LINK project** (Southampton University, field trials, see SCOPE Newsletter *n°125*) showing that as wheat plants grow so struvite disappears from the soil – the nutrients are released when the plant needs them. The plants develop five times higher root volume than with triple super phosphate application. Further trials are underway in the Nurec4Org project (see below) and with Manitoba University Canada (looking at impacts at soil health and biology).



Viooltje Lebuf, Fertikal, is one of Europe's larger organic (as in carbon containing) fertiliser producers, processing fertilisers and soil improvers from local secondary resources and selling in Europe and to export (see SCOPE Newsletter *n°118*). Today, around 5% of the company's production of pellets is certified for organic farming but none of the company's compost.

Prices for organic farming certified input raw materials can be five times higher, so that certification is a significant economic question.

The company faces a number of **challenges and contradictions in obtaining organic farming certification for its products**:

- Simple solid-liquid separation of pig or cow manure seems to be considered as "processing" which excludes from organic certification
- Chicken manure can be certified if the chickens are "free range" … but then this status is lost if the chickens are enclosed because of bird 'flu or cold weather – whereas Fertikal needs reliable status raw material
- It is not clear which poultry stables are considered "free range" for organic certification, and which are not
- Use of organic farm manures as inputs is not possible, because the organic farmer must demonstrate that their manure production goes to an organic farm (incompatible with commercial processing and distribution)
- Meat and bone meal, on the other hand, is acceptable for organic certification, even if from factory farming
-

Contradictory regulations for recycling nutrients to organic farming

Other participants confirm that currently there is **confusion and incoherence in regulations defining from which materials and how nutrients can be recycled to organic farming:**

- (UK) meat and bone meal ash can be considered as "too processed" to be organic, despite the incineration being obligatory to ensure safety – as well as ensuring elimination of organic contaminants
- (Germany) any trace of catering biowaste excludes from organic, whereas separately collected household biowaste is accepted (despite being generally being of comparable quality to catering biowaste)
- (Germany) the number of animals for the definition of

excluded intensive livestock (manure not acceptable for organic farming) concerns the number of animals covered by the manure contract, not the number actually present on the farm (may be different)

Gerald Dunst, Sonnenerde Austria, presented a local success story (150 farmers) using biochar produced from crop residues as a soil improver. Here, **soil organic matter has increased from 3% to 7%** on average, considered to result in reductions in soil erosion and nutrient losses, lower fertiliser and pesticide use and better soil water retention. He considers that nitrogen is the limiting factor for soil organic carbon, because soil organic material is 10% nitrogen w/w. He underlines the **contradiction that biochar is not authorised as an input for organic farming**, whereas it is authorised on cheese (E153), in animal feed (where it can reduce contaminant toxicity) and is sold in Germany as a fertiliser.

Irmgard Leifert, European Compost Network, indicated that high-quality compost is an important source for nutrients, including phosphorus, and for organic matter recycling in arable organic farming production. Compost from separately collected household food wastes is already authorised for input to organic farming (Annex 1 of EC 889/2008).

A pre-condition for the acceptance of compost and digestate by the organic farming association is that compost and digestate have passed an external control by an acknowledged quality assurance system. **Dr Leifert presented the basic requirements and specific standards given by EU legislation, the Research Institute for Organic Farming (FiBL-Germany) and the national organic farming associations (e.g. Bioland /Naturland, Germany) and the Quality assurance (RAL-Germany, ECN-QAS).** In 2017, around 29% of the RAL - quality certified composting and digestion facilities achieved an FiBl-recognition. About 50.000 tonnes of RAL-quality assured compost produced from biowaste and greenwaste fullfilling the FiBl and Bioland/Naturland criteria were sold to organic farmers in Germany in 2017.

Compost application can fulfil a large part of the nutrient needs for arable crop rotation. For example, with permitted 20 tonnes compost dry matter/ha/3 years, for a compost containing - amongst others – about 0.2 % P (in dry matter), about 40 kgP/ha/3 years (14 kgP/ha/y) are applied. The fertiliser efficiency of phosphorus in compost is relatively high, so 100% can be credited to crop utilisation in the nutrient balance.

Carlotta Hoffmann, Bioland (a German organic farmers' organisation) underlined that **phosphorus deficiency in organic farming can lead to reduced nitrogen fixation**, whereas plant nitrogen fixation is the principal nitrogen supply for organic farming. A first survey in Germany shows that around 40% of organic farmland is today at low phosphorus status. Studies with German organic farmers show general acceptance of the use of recycled nutrients, with key concerns being contaminants and product nutrient efficiency.

Through the Nurec4org (recycled nutrients for organic farming) *project* **dialogue is engaged between producers of recycled nutrient products, organic farmers and consumers**. To date, this confirms the importance of contaminants and nutrient efficiency of products, and also indicates the need to assess the environmental and energy impacts of the recycling chain to ensure respect of organic farming principles. Further actions engaged within Nurec4org will include building consumer – public awareness and pot trials of recycled nutrient products.

Nurec4org organic farmers workshop

A stakeholder workshop of German organic farmers and representatives, organised by the nurec4org project and DBU (German Federal Environment Foundation), 16th November 2017, Frankfurt, identified key criteria for acceptability of recycled phosphate products in organic agriculture:

- **Regulatory authorisation for organic farming**
- **Fertiliser efficiency**: nutrient plant availability, low nutrient losses to the environment
- Low **contaminant** levels and safety
- **Environmental performance** of production process, e.g. energy consumption and greenhouse gas emissions compared to mineral fertiliser production
- **Cost**
- **Transparency**: Life Cycle Analysis, data on production

Discussion and conclusions

Bram Moeskops, IFOAM EU, noted that this meeting helped to put the issue of closing nutrient cycles higher on the agenda of the organic movement. Recycled phosphorus products can be part of the solution to organic farming's phosphorus deficit considering that nutrient cycles should be closed as locally as possible, including at regional level. It is important to avoid economic dependence of farmers on input suppliers.

The meeting showed the **need to identify criteria for acceptance of recycled nutrient products in organic farming**. This discussion is more advanced in some countries than in others, and needs to be taken up at the European level, maybe with appropriate support or recognition by the European Commission.

Ludwig Hermann, ESPP President, summarised the meeting with the following conclusions:

- **Organic farming needs recycled phosphorus.** Specialisation of organic farming results in a phosphorus deficit in non-livestock organic farms. Phosphate rock is not a good phosphorus source: largely not crop-available and posing contaminant and sustainability issues (non renewable resource)
- **Organic farmers are generally positive to acceptance of recycled nutrient products**, but with concerns which need to be addressed (contaminants, nutrient efficiency, overall sustainability, supply dependence …)
- **Organic farming offers potential added value** for producers of recycled nutrient products, and so positive economic value for the nutrient circular economy
- **The current regulatory context is complex, contradictory, incoherent** (between Member States, e.g. on definitions of "processing" or "intensive" sourced manures), for recycled products in organic farming in Europe
- There is a **window of opportunity to integrate recycled nutrient products into organic farming regulation in Europe,** with the revision of the EU Organic Farming Regulation, the new Fertilisers Regulation, STRUBIAS, and an overall positive policy maker approach through the Circular Economy
- **Both societal dialogue and scientific data are needed**. Dialogue should involve organic farmers, organic food companies and supermarkets, consumers, recyclers, agronomists. Data is needed on contaminants and safety, to support risk assessments, and on environmental / LCA aspects.
- **Success stories and positive information already exist**: field tests of products, use by farmers, R&D/implementation projects, positive positions of supermarkets.

Future actions

- **Develop recommendations for outline criteria for acceptance of recycled nutrient products in organic farming**, covering contaminants and product quality, nutrient efficiency, sources of input materials, environmental/LCA aspects, supply/system. This should bring together the organic movement, other stakeholders and science as possible basis for future decisions on candidate products.
- In the short term, incite Member States to **submit further recycled products to EGTOP for consideration,** maybe starting with available sources and products (manure recovered nutrients, STRUBIAS products: biochars, phosphate salts, ashes).
- For this, **identify specific candidate recycled nutrient products available today**, for which data is available and producer(s) ready to put onto the market
- In the longer term, **work on systems approaches**, such as separative sewage (eco-sanitation)

Conference slides, programme, etc.
www.phosphorusplatform.eu/activities/conference/meeting-archive/1602-meeting-eu-organic-agriculture

See also, Möller et al., "Improved Phosphorus Recycling in Organic Farming: Navigating Between Constraints", Advances in Agronomy 2017 https://doi.org/10.1016/bs.agron.2017.10.004

Swiss – German phosphorus recycling conference

This meeting, Basel, 18th October 2017, was organised by FHNW School of Life Sciences, the Phos4You InterReg Nordwest Europa project, BaselArea.swiss and the German Phosphorus Platform (DPP). 160 stakeholders were informed on the status of phosphorus recycling policy in Switzerland and Germany. The launch of the **Swiss Phosphorus Network** (*www.pxch.ch*) was announced.

The positions of Swiss sludge disposal operators were linked to a selection of possible phosphorus recycling technologies available and future developments discussed.

The day was moderated by **Daniel Frank, German Phosphorus Platform** (DPP).

Matthias Nabholz, Canton of Basel-Stadt, underlined that Germany and Switzerland are the first countries in the world to make phosphorus recovery obligatory, opening opportunities to become innovation leaders.

Phosphorus recovery regulatory obligations in Switzerland and Germany

Kaarina Schenk, Swiss Federal Environment Agency (BAFU), explained the **new Swiss category of "Mineral Recycled Fertilisers"** (see ESPP eNews n°*15*) which will accompany implementation of the federal phosphorus recovery obligation, introduced in the Waste Ordinance (see SCOPE Newsletter n°*118*). This fixes limits for heavy metals such that any accumulation in soils does not compromise safety for at least 500 years, whilst remaining technically feasible. NAC (neutral ammonium citrate) and 2% citric acid are considered better indicators of fertiliser value of phosphate than water solubility. The objective is that this new fertiliser category should be implemented from 1st January 2019.

At the same time, **Switzerland is working to implement the Waste Ordinance phosphorus recovery obligation**. This obliges recovery of phosphorus from sewage sludge or sludge incineration ash, and from slaughterhouse wastes. At present, the technical requirements of the phosphorus recovery obligation are not defined (e.g. what % of phosphorus must be recovered, where, under what conditions) and a technical working group will be launched in early 2018 bringing together the Kantons, industry and experts to make proposals. Nonetheless, BAFU underlined that current mono-incineration capacity (incineration of sewage sludge separately not mixed with municipal solid waste or industrial waste) is insufficient to take all Switzerland's sewage sludge.

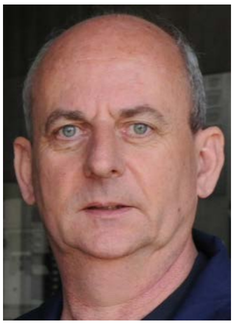
In **discussion**, participants at the meeting noted that until these criteria are fixed, **it is premature to invest in phosphorus recovery in Switzerland**, because technical choices made now may prove to be incompatible or too demanding compared to the final obligations. However, study of phosphorus flows and of logistics, and preparation of a move to separate mono-incineration should already be engaged.

Christian Kabbe, Isle Utilities, presented the status of the German phosphorus recovery legislation, which has been adopted at the same time as a revision of regulations concerning sewage sludge application to land. Although the regulations have now been adopted, **implications of certain aspects remain to be clarified**. To simplify, the new P-recovery legislation will require (within 12 or 15 years, for sewage works > 100 or 50 000 p.e.) recovery of phosphorus if P>2% DM in sludge. The same requirements apply to smaller WWTP if they cannot spread sludge on farmland. (around 24% of German sewage sludge currently goes to agriculture), but this is not clear in the final text. The **sewage sludge use on farmland is acutely limited by the new fertilising regulation** (German Nitrates directive) which limits the nutrient loads applied to land.

Anders Nättorp, FHNW, summarised phosphorus flows in Switzerland, He noted that phosphorus in sewage sludges is around 5 800 tP/y and in animal products around 1 500 tP/y in Switzerland, and that this is currently lost as sewage sludge goes to cement works. This **phosphorus recovery potential is slightly higher than Switzerland's annual consumption in mineral fertilisers**. He summarised different possible routes for phosphorus recovery for which technologies are today available: precipitation from liquid streams; extraction or thermal treatment of sewage sludge; leaching, thermal treatment or acidulation of ash.

Based on P-REX data (see SCOPE Newsletter n°*115*) he estimates that phosphorus recovery could cost 0 – 50 €/t of sludge in addition to current Swiss sludge disposal (incineration) costs of 90 – 140 €/t (tonne of dewatered sludge).

Waste and water companies' positions



Alain Zaessinger, ProRheno (sewage works and sludge management structure) manage some 30 000 t/year of sewage sludge in North West Switzerland, together with **ARA Rhein**. They presented a study of investment options for replacing the ageing sludge incineration ovens in the two locations. The process is defined (**mono-incineration**) and will enable later phosphorus recovery, as required by the new Swiss legislation.

Christoph Egli, AVA Altenrhein (authority with c. 20 sewage works), underlined that we stand at the very beginning and for most Swiss WWTP it's not clear which technology should be applied. Based on the lack of a robust technology readiness **there should not be an overhasty exclusion of promising technologies at this point**.

He points out the essential information which is needed concerning what the phosphorus recovery obligations will be under the new Swiss legislation: Where will this be required/whose duty is it? How much (%) of phosphorus must be recovered? What are the criteria for the recovered product: quality? phosphorus content? This means that it is impossible to decide what process to adopt, or to estimate costs.

The Swiss Water Association (VSA) will organise a workshop in January 2018 to identify the WWTP's requirements. He furthermore presented sludge treatment in Altenrhein, costs of infrastructure and operation, underlining the role of the sludge treatment organisation KIGO in Eastern Switzerland. Furthermore he presented the Pyrophos (pyrolysis) project.

Claudio Bianculli, presented **ZAB (Association for waste recycling Bazenheid)**, which provides sewage sludge treatment for a number of municipalities in East Switzerland (100 000 t sludge/year). Investment in modern incinerators enables cost-effective recovery of energy. **Phosphorus recovery will be tomorrow's challenge**.

Phosphorus recovery processes

Stefan Schlumberger, ZAR, presented the **Phos4Life** process (see ESPP eNews n°*12*) being developed to recover phosphorus from 30 000 t/y of sewage sludge incineration ash from **Kanton Zurich** and other localities in Switzerland. This is currently being pilot tested in Spain. The ash will be dissolved in sulphuric acid, generating phosphoric acid and gypsum. This is similar to the wet acid process used by the phosphate industry to produce most of the world's phosphoric acid. The gypsum, containing aluminium, silicon, calcium and sulphate, and c. 0.5% phosphorus (P), is expected to be compatible for use by the cement industry. The phosphoric acid will then be treated using solvent extraction and hydrochloric acid to remove iron, as iron chloride which can be recycled as coagulant P-removal salt to sewage works. The resulting phosphoric acid will then be purified using solvent extraction (process already used in the technical and food phosphate industries) to remove heavy metals and produce an industrial grade phosphoric acid.

The full scale Phos4Life P-recovery process is **expected to cost 50-70 CHF/tonne of dewatered sludge**, compared to current total costs of sludge treatment (digestion, dewatering, incineration) of c. 300 €/tonne (including costs for digestion, dewatering, transport and mono-incineration). These costs were about 400CHF (2014) before recent investments in the new centralized and more energy efficient incineration installation in the city of Zurich.

Patrick Herr, Remondis Aqua, presented the company's TetraPhos® process (see SCOPE Newsletter n°*123*), which **takes as input mono-incineration ash from fluidized bed combustion of municipal sewage sludge**. The TetraPhos® process treats the ash with phosphoric acid, then, after separation of acid insoluble residue, purifies the resulting leachate with sulphuric acid, ion-exchange and selective nano-filtration **to generate an industrial quality phosphoric acid**. The process also enables recovery of iron and aluminium salts as coagulants, for recycling in sewage works phosphorus removal, gypsum intended for production of building material and a residual ash waste that either is used in the cement industry or if the latter is not possible is landfilled. More than 80% of the ash phosphorus is recovered in the phosphoric acid. Where designed as part of an integrated plant consisting of an incineration facility and a P-Recycling installation, waste heat can be used to concentrate the phosphoric acid product. The rollout of the technology will be implemented as public-private partnership between municipal partners and Remondis. **From 2019, a large scale TetraPhos® plant at the Hamburg Wasser WWTP is planned to treat 20 000 tonnes of ash annually, to recover more than 1 600 tonnes of P**.

Otto Schwarzmann, SUN Nürnberg (sewage works operator), presented experience of operating the **Mephrec** process pilot installation (0.6 t sewage sludge per hour capacity, batch operation). This process operates at >1400°C and generates a "slag" currently containing 2-2.5% phosphorus (P) and with low heavy metal levels. **Operational difficulties encountered include**: the quality of the syngas, generated by the recovery furnace, will not reach economically the standards of fuel-gas to use in electricity generation motors, because of high fly ash particle and coal tar content. Also, the fertiliser value of the slag remains to be proven (see SCOPE Newsletter n°*115*: P-REX results suggest low plant availability). This experience shows that developments and financial assumptions based on lab scale experiments have to be validated at a larger scale. At the moment SUN is negotiating with the project consortia about future collaboration.

Matthias Mann, Küttner GmbH, presented the **Kubota furnace process**. This is also a metallurgical approach technology with a furnace system operating on dried sewage sludge (80% dry matter) with a process temperature at >1300°C. Over 30 furnaces are operated by Kubota in Japan (see SCOPE Newsletter n°*125*), but not today for phosphorus recovery. Most of these are for sludge (mono or shared with household waste) disposal, producing a sage which can be used e.g. as a construction material. Studies are underway into possible phosphorus recovery in furnaces treating only sewage sludge as input. Around 90% of the input phosphorus is transferred to the thermal slag product (this slag represents around 92% of total input mass), whilst most of the contaminants come out in the flue gas from which they can be separated by standard flue gas treatment systems (8% mass). Results presented of **pot trials (soil pH up to 7.2)** show the slag giving similar plant harvests to triple super phosphate for rice, but c. 10% lower for wheat and grass.

Marie-Edith Ploteau, Lippe-verband Germany, summarised four phosphorus recovery processes which will be demonstrated in the Phos4You Interreg NWE project (2016-2020):

- **Sludge bio-acidification (**IRSTEA France) to solubilize phosphorus **combined with struvite precipitation** (**Struvia** process from Veolia) at Lille wwtp (France). The combination of both reactors is expected to significantly increase the P recovery yield from sewage sludge liquor.
- **Chemical acid extraction of phosphorus from partially dried sewage sludge** (Liège University) followed by a reactive-extraction step and fractionated precipitation to remove contaminants and finally a precipitation of calcium-magnesium phosphate that can directly be used as fertiliser ingredient. A mobile demonstration plant that will be used in by-pass at different wwtp throughout Europe will enable to adjust and validate the process in a corresponding simulation tool.
- **Thermochemical two-stage treatment of sewage sludge** (**EuPhoRe-process)** including a reductive step at 650-750 °C and an oxidative one at 900-1000°C in a rotary kiln, as well as a flue gas cleaning. The process produces phosphate-rich ashes very low in contaminants in which phosphorus is expected to be plant available. A 100 kg dry matter input/hour pilot is to be built at Emschergenossenschaft´s installation in Dinslaken, Germany to validate the process and refine parameters. Parallel to Phos4You, the full-scale rotary

sludge incinerator in Oftringen, Switzerland (30 000 tDM/y, manufactured in 1992), will be modified for large-scale implementation of the EuPhoRe process. This should enable the use of the ashes in the fertilizer production chain (instead of current disposal).

- **Acid extraction of phosphorus from sewage sludge incineration ash**, followed by contaminant removal, will be tested at (pre)-industrial scale by the Lippeverband with different ashes from two incinerators of the Emscher-Lippe region, located in Bottrop and Lünen (DE).

Other Phos4You activities include **studying sludge incineration ash quality** from HVC Dortrecht (NL) and SNB Moerdijk (NL). The phosphorus recovery from these ashes is planned at the **Ecophos** full-scale factory in Dunkerque, France (see SCOPE Newsletter n°*120*) Fertiliser value and safety of the different recovered phosphorus products will be assessed. It was underlined that **unrealistically high nutrient inputs (kgP/ha equivalent) as in some previous experiments should be avoided**, and that **soil pH is an important criterion** (test in both slightly acidic and neutral soils).

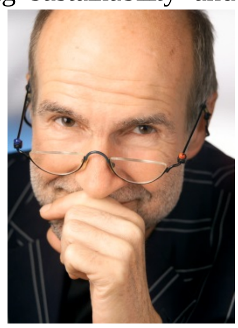
Else Bünemann, FiBL (Research institute for organic agriculture) explained that around 2/3 of phosphorus input to agriculture in Switzerland currently comes from recycling of manure and agricultural byproducts. She presented experimental data on fertiliser value and solubility of recovered phosphate materials, using different extractants, mainly data from pot trials, including sewage sludge incineration ash (low plant availability), meat and bone meal ash (high in acidic soils), struvite (high). For some materials, plant availability and solubility depend on production process or characteristics: for example, one pyrolysis product showed low plant availability, but an alkaline pyrolysis product showed high plant availability. Availability of calcium phosphates depends on the **crystal form**. She concluded by underlining that **water solubility is not a good indicator of plant availability**, that plant availability depends strongly on **soil pH**, and can be modified by **granulation/particle size**.

Maurice Jutz, FHNW, announced the launch of the **Swiss Phosphorus Network** (*www.pxch.ch*). The network will facilitate exchange of information between Swiss actors considering also the different language regions and act as contact point to ESPP and other actors on the European level. Five demonstration projects in Switzerland are currently under way: **Bern, Zofingen, Bazenheid, Zürich and Altenrhein**.

Panel discussion and conclusions

The final panel included **Christoph Egli representing WWTP association Altenrhein and VSA (Swiss WWTP association), Cladio Bianculli, ZAB, mono-incineration operator** and was moderated by **Thomas Wintgens, School of Life Science, FHNW**. It was emphasised by the operators that today it is not clear what is required in terms of phosphorus recovery, nor how much it will cost. **Because this is not fixed by regulation, it is not possible to pass the costs on to water consumers**. The Swiss Federal Environment Agency replied that a study will be engaged in 2018 on conditions and cost, but that a new law would be necessary to allow to pass on costs. The Swiss Federal Office for Agriculture underlined that the price of recovered phosphate fertilisers must be the market price or farmers will not use them, and that recovered fertilisers must respect quality standards to ensure soil protection.

It was concluded that **stakeholders can expect to be invited by Swiss regulators to work on the detail of implementation in early 2018**. These should provide clarity whilst also enabling flexibility. The panel concluded by underlining the **general support for the Swiss phosphorus recovery obligation**, seen as offering important opportunities for improving sustainability and **developing innovation**, and the conviction that technologies under development will enable to achieve the objectives.



Ludwig Hermann, Outotec and **President of the European Sustainable Phosphorus Platform (ESPP)** closed the day and summarised conclusions:

- The new German and Swiss phosphorus recovery obligations are already moving things forward, and will enable these countries to be **innovation leaders**
- Work is needed to define implementation conditions and **how costs can be passed on** to consumers
- A range of **different technologies** are under development, with different approaches and leading to different finished products
- **Agronomic performance** of quality recycled phosphorus products is comparable to mineral fertilisers, despite their not being water soluble

  Quality criteria are important to ensure safety for soil, crops and farmers, and confidence of users and consumers

European nutrient recycling R&D meeting

This second day meeting, Basel, 19th October 2017, was organised by FHNW School of Life Science, the Phos4You InterReg project, the European Sustainable Phosphorus Platform (ESPP), the German Phosphorus Platform (DPP) and BaselArea.swiss. Over 25 EU (Horizon 2020, LIFE, Interreg) and national funded R&D projects, along with participants from industry and policy makers, discussed research orientations, opportunities for project coordination and synergies and needs for future research and demonstration activities.

This is the second such European meeting, following the first EU nutrient recycling projects and policy workshop, Berlin, 2015 (see SCOPE Newsletter n°*111*), organised by ESPP, the European Commission and P-REX. The conclusions are published by the European Commission at *http://bookshop.europa.eu/en/circular-approaches-tophosphorus-pbKI0115204/*

Burkhard Teichgräber, Lippeverband, Lead Partner of the **Phos4You project**, explained that the associated public waterboards Emschergenossenschaft and Lippeverband treat sewage from nearly 4 million people. Recycling of phosphorus is considered an important sustainability objective. But due to industrial discharges into the wastewater, the sewage sludge in the Emschergenossenschaft has been incinerated since 1970's. In rural regions of Lippeverband, sludge has been used in agriculture wherever feasible, in accordance with regulations. However, **concerns about contaminants such as pharmaceuticals or micro-plastics** further push to move to sludge incineration and to look for alternatives to recover nutrients. Around 90% of the sewage sludge incinerated currently goes to mono-incineration. The waterboards are currently looking at an add-on process to recover phosphorus from an existing sludge incineration line, and a new line to process sludge directly to a fertiliser product

Eric Jakob, Swiss State Secretariat for Economic Affairs, explained that Switzerland aims to ensure **economic framework conditions** which enable business development and innovation, including stability and predictability, stakeholder consultation, and a balance between environmental and economic objectives. In this context, the Swiss phosphorus recycling obligation offers opportunities for Switzerland to be an innovation leader.

Chris Thornton, ESPP, summarised EU policies driving nutrient stewardship, from the EU Waste Water Treatment Directive and Nitrates Directive in 1991, through to the circular economy approach today. Important policies are the inclusion of phosphate rock and P_4 on the EU Critical Raw Materials list, the revision of the EU Fertilisers Regulation (and STRUBIAS = criteria for struvite, biochars, ash derived products), R&D funding, standards … He presented a number of examples, showing that companies, farmers' cooperatives and municipalities are **already today successfully recycling thousands of tonnes of nutrients and organic carbon** from manure, animal by products and sewage.

EU R&D funding for actions on nutrients

Stefania Rocca, EASME (Executive Agency for Small and Medium-Sized Enterprises), presented funded projects relevant to nutrient recycling under Horizon 2020 and LIFE over the last two years, and opportunities in 2018-2019.

Relevant Horizon 2020 projects funded in 2016, under the **"Industry 2020 in the Circular Economy"** calls for CIRC-01 and CIRC-02, include large innovation projects such as Systemic, Run4Life, Water2Return (present in Basel). Decision is underway for large demonstration projects under 2017 call.

In 2018 and 2019, new calls under **Horizon 2020 Societal Challenge 5** (Climate action, environment, resource efficiency and raw materials) will address **"Connecting economic and environmental gains – the Circular Economy"**, and including topics on how to remove contaminants from secondary materials (SC5-01) and on water-smart economy and society (SC5-04).

Projects are also possible under Horizon 2020 bottom-up calls such as the SME Instrument and FTI (Fast Track to Innovation), as well as the LIFE programme. LIFE covers two sub-programmes: environment (including nature) and climate action, and supports the focus on circular economy.

Gaëtan Dubois, European Commission, DG Agriculture, presented the Horizon 2020 Societal Challenge Agriculture and Food (SC2) and the actions of **EIP-AGRI (European Innovation Partnership).** EIP-AGRI aims to make links between R&D under H2020 and the European rural development policy.

Under Horizon 2020, several major projects funded in 2016 or pending decision 2017 concern farm recycling and agriculture impacts on water. Calls in 2018-2019 will address **valorisation of urban biowastes, organic agriculture fertilisers from biogas digestate and closing nutrient cycles**.

Another possibility under Horizon 2020 is "**Thematic Networks**" to compile "knowledge ready for practice". Such a network could address synergies between the different current and upcoming R&D activities relevant to nutrients and make links to industry and stakeholders for policy and uptake. However, such networks are only funded for specific duration, so the objective could be to establish a process or structure which could then be self-maintained.

The EIP-AGRI brought together a **"Focus Group" of experts on recycled nutrients** in 2016 (summary of conclusions in SCOPE Newsletter n°*124*). These groups aim to identify research needs and themes for "Operational Groups" (see below).

The Recycled Nutrients Focus Group identified the need for research in the following areas:

- **Organic contaminants**
- **LCA** methodologies/risk assessment
- Assessment of **Nutrient Use Efficiency**
- **Acceptance** of the use of recycled fertilisers by farmers, food industry, public consumers
- Development of **tailor-made recycled nutrient products**
- Use of **remote sensing** for precision farming
- Development of **farm tools** for nutrient content determination and soil carbon balance assessment

These conclusions will input into future EU R&D funding definitions.

EIP-AGRI Operational Groups

Operational Groups (OGs) are local, multi-stakeholder actions, set up to address specific challenges or opportunities, using **Rural Development Funding (RDF)**. Thus, they come from bottom-up local initiatives, funded depending on thematic possibilities in each Region's RDF Programme, with the objective of enabling wider dissemination of results and learning. To date 98/118 Regions include Operational Groups in their Programme, and over 3000 Groups are expected to be launched 2014-2020. Some OGs closely related to nutrients recycling have already started in different regions.

Synergies between R&D projects

The meeting enabled 24 R&D projects relevant to nutrient recovery to rapidly present (1 slide each *www.phosphorusplatform.eu/R&D*), and also a number of PhD students working on phosphorus recovery, enabling all participants to identify each project and make contacts. The **ESPP catalogue of R&D projects**, identifying around 100 R&D projects relating to nutrient management, was circulated at the meeting (*www.phosphorusplatform.eu/R&D*) facilitated this networking. The following projects presented their projects: **AgroCycle, ALGAECAN, ASHES, Biorefine Cluster Europe, BONUS PROMISE, DECISIVE, DOP, ENRICH, IMPROVE-P, INCOVER, Newfert, Nurec4org, Phorwärts, Phos4You, QUB Phosphorus from wastewater, RAVITA, RichWater, Run4Life, SABANA, SMART-Plant, SYSTEMIC, The Resource Container, Water2Return and 3R2020+.**

Several of the projects and technologies are **ESPP members** (**Phos4You, Phos4Life/Zurich Kanton/ ExtraPhos/Budenheim, Ecophos, Systemic, SMART-Plant, ENRICH/Cetaqua, Run4Life** *www.phosphorusplatform.eu/members*) enabling dissemination of their results through ESPP's network and publications, and contacts with ESPP's industry and policy maker membership.

This showed that there are a number of different phosphorus recovery and nutrient recycling **demonstration sites and installations in projects now underway** (and further ones will be launched soon, see above), with important potential for exchange of experience and comparison of results. Industry partners of projects present in Basel show the interest for this work. The projects cover different geographical areas, sectors, type of research, topics and waste/residue flows to be recycled.

Parallel sessions

Five parallel sessions discussed enabled the projects and participants to exchange, with the following conclusions:

Recycled nutrient product qualities and standards. Rapporteur: **Oscar Schoumans, Wageningen Environmental Research**

- Plant nutrient availability assays: provide important information, but should not be regulated. Industry and farmers will identify which products work
- Variability in organic-based recycled materials: farmers are accustomed to managing variability: however measurement standards and real-time measurement systems should be developed
- Organic contaminants are an important issue for recycled product acceptance: regulatory action is needed

Nutrient recovery in the sewage works of the future. Rapporteur **Nicolas Morales Pereira, FCC Aqualia**

- Potential for integration of nutrient recovery into innovative new water treatment systems
- Wide range of technologies and approaches
- New business models are necessary
- Farmer and consumer acceptance of recycled products is a key challenge

Life Cycle -Analysis (LCA) and -Costing (LCC). Rapporteur **Marianne Thomsen, Aarhus University**

- Discussion of LCA 'Functional Unit' and System Boundaries
- Issues with data: often missing, not public, out of date (based on outdated processes), difficulty to move from specific installation data to generic
- Need for work between projects to ensure coherent methodologies

Technology transfer from sewage to/from manures and other streams. Rapporteur: **Emilie Snauwaert, Flemish Coordination Centre for Manure Processing**

- Challenge: downscaling to reliable, small-scale, simple-to-operate recovery technologies for rural areas
- Importance of product standards for recycled fertilisers (expected with EU Fertiliser Regulation)
- Need for funding of:
  - farmer investments
  - demonstration sites, at different scales and different contexts, covering both recovery techniques and the quality of end-products
  - cross border collaboration
  - consumer education about the need to recycle nutrients
- Policy and regulation are key drivers for change

Nutrient recovery: how to move from R&D to implementation. Rapporteur: **Maelenn Poitrenaud, SEDE Environnement (Veolia).**

- Prepare implementation: technical assessment, market analysis, risk assessment, business plan, objectives and planning, milestones
- Need to manage IP (intellectual property)
- Develop strategic partnerships: final users (e.g. farming organisations), investors

Newtrient manure treatment technology evaluation & catalogue

Steven Rowe, Newtrient (representing nearly all of US dairy producers *www.newtrient.com/Catalog/Technology-Catalog*) presented via Skype this organisation's online inventory and evaluation tool for manure processing technologies and process suppliers (see SCOPE Newsletter n°*125*). **Over 220 technologies have been evaluated**, of which over 180 are now in the online catalogue. Evaluations are based on economics, transparency and commercial viability including whether the technology is today operational on-farm, presence of supplier and after-sales, assessment of on-farm operating cases. Around 2/3 of the technologies currently in the catalogue address nutrient recycling. Steve Rowe underlined that **Newtrient is interested to speak with European manure processing technology suppliers** and on-farm case studies.

Conclusions for future actions



A final panel discussed needs for future actions and possible coordination between projects, with **David Scaglione, Gruppo CAP water utility Milan region, Marja-Liisa Tapio-Biström, Finland Ministry of Agriculture and Forestry, Sílvia López Palau, Suez / Cetaqua**, moderated by Chris Thornton, ESPP.

Panelists noted that technology is not today the obstacle to nutrient recovery and recycling but rather:

- **Legal framework**
- Need to engage stakeholders to ensure that recovered products are adapted to **farmers' requirements**
- **Promote acceptance of use of recycled nutrients** by stakeholders such as the food industry, consumers

However, as well as pilot scale demonstration of new technologies, full-scale demonstration of nutrient recovery is important, **integrated into resource and carbon efficient water and waste management**. Cost and technology assessment of these operating systems is important to provide information to industry and policy makers.

Sewage biosolids management is a major operating cost for sewage works: **real data on cost impacts of nutrient recycling** is essential (based on full-scale operations, not pilots or estimates).

Research needs

Proposals for future research needs were put forward:

- Maintaining acceptance and ensuring safety and soil quality in **sewage biosolids use** on crops
- Integrating nutrient recycling and **organic farming**
- **Digital tools** for nutrient management
- Rethinking the **food system** to integrate nutrient stewardship and return of organic carbon to soil
- Assess **emerging contaminants in biosolids and manure**, and how to reduce these upstream or in treatment systems
- Promote an **independent panel** and data base, for evaluation of nutrient recycling technologies, systems, costs
- Development of high-quality recycled nutrient products and their **use in precision farming**
- **Demonstration plants** in different regions, different types of waste / water, different treatment systems
- Developing the sewage works / waste system of tomorrow, designed as a **resource factory** rather than pollution abatement

These objectives require collaboration **between agricultural and environmental** stakeholders and policy makers.

Proposals for joint actions

In order to move forward, proposals included:

- Establish a **Mediterranean network on nutrient recycling**, maybe within ESPP, addressing the specific regional challenges such as water reuse, Mediterranean agricultural systems and crops
- Structure further cooperation between the different nutrient-related R&D projects present, such as **joint dissemination**, **back-to-back events at important industry trade fairs** (water and waste, food industry, bioeconomy …)
- **Organise a further R&D projects meeting**, to follow on from this one, in 2018, to involve the newly funded EU projects (see above), projects not here, etc.

The aim would be to have a **continuous exchange between nutrient R&D projects**: avoid the stop-and-go which has resulted in the past from meetings too far apart (Berlin March 2015, Basel October 2017) and from coordination organised by projects (three year duration).

Conference slides, programme, etc
http://www.nweurope.eu/projects/project-search/phos4you-phosphorus-recovery-from-waste-water-for-your-life/

Dietary phosphorus and health

A new CRC book (24 chapters, 44 authors, 360 pages), presents current knowledge on nutritional aspects of phosphorus (P), body P metabolism, possible health impacts of current levels of phosphorus in Western diets, regulatory aspects, phosphate food additives and phosphorus sustainability questions.

This book (dated 2018) does not bring new information, because it is by nature a collection of review articles, not a comprehensive meta-review. Much of the data referenced is not very recent (5% of articles referenced in the lead chapter 1 more recent than 2013). However, this new book does provide a complete overview and collation of current knowledge. Only a few of the authors are the same as in the Springer Humana 2017 book (see SCOPE Newsletter *n°125*) so this new book provides a parallel review of many of the same question. In particular, the new book's chapters on "regulatory aspects" provide recent information on diet phosphorus intake estimates in the USA and in Europe, on dietary guidelines for phosphorus intake and data (or lack of it) on food additive phosphate consumption.

The Preface, by the book editors **Jaime Uribarri (Icahn School of Medicine, New York) and Mona Calvo (retired from the US Food and Drug Administration),** emphasises the "phosphorus dilemma" underlines that daily average phosphorus (P) intake in North America and Europe are in excess of nutritional needs, suggesting that this may be linked to health risks as well as posing sustainability issues by increasing consumption of non-renewable phosphate reserves and increasing environment impacts of phosphate use. The editors underline that health problems resulting from retention of phosphorus in the body are well known in kidney patients, and that **a number of large epidemiological studies suggest significant associations between raised blood phosphorus levels and risk of cardio vascular disease (CVD).** They note evidence that excess diet phosphorus can lead to disruption of hormone balances (PTH parathyroid hormone, FGF23, vitamin D).

The editors **call for mandatory labelling of phosphorus content of foods** to address these issues, and in particular to facilitate phosphorus intake balance which is critical for kidney patients (26 million people in the USA).

The first part of the book groups a number of review chapters addressing phosphorus and health.

The first book chapter, by **Swati Mehta and Jaime Uribarri**, provides an overview of long-term ("chronic") health risks associated with excess diet phosphorus. The authors indicate that **several cohort studies show correlations between elevated blood phosphorus levels (serum P) and increased risk of cardiovascular disease (CVD), both in kidney patients and in healthy populations**. Furthermore, animal test and in vitro human cell studies show that increased phosphorus concentrations can cause calcification of artery walls, whereas arterial calcification is a known cause of heart failure risk (because it damages the arteries elasticity which physically supports the heart's muscular function). Serum phosphorus may be associated with increased risk of development of kidney disease (one smallish cohort study). This first chapter also looks at possible links between elevated blood phosphorus and inception of kidney disease (one cohort study cited), bone disease, soft tissue calcification, anaemia risk (one large cohort study), prostate cancer (one cohort study cited).

Diet phosphorus levels and health

George Beck discusses in detail **possible relations between phosphorus and cancer inception or development**, based principally on cellular metabolism models, supported by animal studies for some possible mechanisms. Extracellular phosphorus levels around cells certainly modify cell reproduction and metabolism, as do also the hormones related to serum phosphorus (vitamin D, FGF23, Klotho, osteopontin). For humans, two cohort studies cited showed in one case no correlation between blood phosphorus and overall cancer risk but correlations for some specific cancers, and another a possible correlation between dietary inorganic phosphate and prostate cancer. The author shows that there is no data relating diet phosphorus to cancer in humans, and concludes that more research is needed into possible impacts of dietary phosphorus on cancer risks.

Jorge Cannata-Andia et al. discuss the metabolic mechanisms of phosphorus and PTH (parathyroid hormone) effects on bone and on vascular calcification. They note that **evidence of direct effects of elevated phosphorus on bone biology is "scarce"** (one study in humans, one in rats) but that there is significant evidence of a link between bone metabolism and CVD risk (inverse correlation between vascular calcification and bone mineral density and bone loss), and of development of both vascular calcification and bone deterioration in kidney patients (CKD) and with ageing. They call for more research into effects of signaling and transport molecules such as Klotho, NaPi2a, FGF23 and Wnt.

Andrea Galassi et et. discuss possible associations between phosphorus dietary intake and mortality. Of studies concerning non-CKD patients, one shows a positive and one a negative diet phosphorus – mortality correlation. They **call for more research to bridge the gap between metabolic models and epidemiology** (population studies). They underline the need for a holistic approach, considering diet phosphorus alongside other factors including calories, carbohydrates and proteins. They conclude that available evidence does not justify changing current dietary recommendations for phosphorus.

Sven-Jean Tan and Nigel Toussaint discuss possible links between dietary phosphorus intake and heart disease. In this chapter, five cohort studies on non-CKD populations are reviewed, in some cases the same ones as referenced in above chapters. Of these five studies, three show a positive diet phosphorus – mortality or diet phosphorus - heart disease indicator correlation, one a negative correlation, one no correlation. The two other studies show a diet phosphorus – FGF23 correlation. The authors also note that **studies comparing dietary phosphorus intake to serum P levels show "inconsistent results".** Two studies show that low phosphorus intakes reduce serum P, but only one study suggests that high diet P intake leads to increased (baseline) serum P, whereas others show no correlation. The authors conclude that it is not today known whether elevated serum P and FGF23 cause cardiovascular disease (CVD) or are simply correlated biomarkers, and that few population studies link diet phosphorus intake to serum P. They note the difficulties in assessing this latter question resulting from circadian serum P rhythms and from inaccuracies in determining dietary P intake.

Kai Hahn, Markus Ketteler and Eberhard Ritz discuss the same health endpoints from a European perspective. They note that a number of **epidemiological studies show an association between blood phosphorus levels and CVD (cardiovascular disease) risk** but the authors do not present evidence of a diet phosphorus – CVD link. They summarise different uses of phosphates in food additives, food processing, pharmaceuticals and water treatment (see more detailed chapters below) particularly underlining the presence of food phosphates in "fast foods". They call for **further research into possible health impacts of phosphorus levels in diet, in particular to address EFSA food phosphate safety assessment criteria**.

Melissa Melough and Alex Chang discuss the influence of dietary phosphorus on blood pressure. Seven observational human cohort studies, seven animal studies, and the few available human interventional trials addressing this topic are reviewed. Of the few interventional trials cited, two are identified as providing relevant evidence. Overall, the authors conclude that

results are inconsistent, showing negative, positive or no relation, although **a majority of the human observational cohort studies suggest that increased dietary phosphorus is correlated with lower blood pressure**. The authors note that several studies suggest that an increase in protein intake (at the expense of carbohydrate) may modestly reduce blood pressure, although it is not known if this effect can be attributed to dietary phosphorus, or if it is related to other nutritional factors associated with protein intake. Future feeding studies are needed to specifically examine the effect on phosphorus (independent of protein) on blood pressure.

Acidosis hypothesis debunked

Tanis Fenton and David Hanley assess the hypothesis that diet phosphorus intake could be an "acidic anti-nutrient for bone maintenance under the acid-ash hypothesis". Their systematic review identified 13 relevant human dietary randomized intervention studies, and found that contrary to the acid-ash hypothesis, diet phosphorus decreases urinary calcium excretion and increases body calcium balance, modifies urine pH (due to excretion) but does not significantly modify blood pH. **The evidence does not support the acid-ash hypothesis for phosphorus (and does not support suggestions that phosphorus is an acidic anti-nutrient).** The authors updated the often-quoted potential renal acid load food table.

Adriana Dusso et al. discuss the relations between phosphorus and kidney **vitamin D (calcitriol)** production. Phosphorus intake has been shown to reduce serum calcitriol, which can be expected as a homeostasis mechanism, because calcitriol stimulates absorption of phosphorus and calcium from the gut. This is impacted by other factors including frizzled-related protein (FRP4) and matrix extracellular glycoprotein (MEPE). Reduced calcitriol also reduces renal klotho induction, which may have negative effects such as ageing, and bone FGF23 synthesis.

Jaime Uribarri and Man Oh summarise understanding of **body phosphorus homeostasis**. Our bodies contain around 0.7 kg of phosphorus (in a 700g man, that is around 10%P). However, total body phosphorus cannot be measured (alive). Only blood phosphorus concentration (serum P) can be measured, but this represents a very small proportion of total body phosphorus (around 90% of which is in bones, and 10% in cells in soft tissue). Serum P will increase for a few hours after dietary intake, in persons with healthy kidneys. However, **even fasting serum P is a poor short-term indicator, because concentrations may not reflect total body phosphorus** when phosphorus is being released from or fixed into bones, and it may take weeks to find a new equilibrium after changes in intake. There are also significant circadian variations (changes with time of day) of serum P, irrespective of intake, and significant gender differences.

Marta Christov and Harald Jüppner discuss endocrine regulation of phosphorus homeostasis, centered on the roles of FGF23 and PTH (parathyroid hormone) as the primary hormones involved, but also calcitriol (1,25 vitamin D), phosphate cotransporters NPT2, and enzymes – proteins and receptors such as DMP1, Fam20cABCC6, GALNT. They note that **increases of FGF23 with phosphorus imbalance in kidney patients** result in a number of "off target" metabolic effects, posing health problems.

Lili Chan and Jaime Uribarri discuss phosphorus homeostasis in kidney patients (CKD) and end stage kidney patients (ESRD), noting **links between kidney function decline and serum P increase** and again noting the problems of cardiovascular disease, FGF23.

Phosphorus metabolism

The second part of the book discusses diet phosphorus intake and nutritional needs.

Jean-Philippe Bonjour summarises the importance of phosphorus for bone health throughout life. He notes that in some pathologic conditions phosphorus supply can be inadequate. Furthermore, in elderly people calcium phosphate salt supplements taken in combination with vitamin D and adequate protein intake can reduce secondary hyperparathyroidism, bone mass loss and fragility fracture risk.

Alicia Diaz-Thomas and Craig Langman discuss dietary phosphorus requirements in early life and adolescence, concluding that in some cases attention is needed to ensure adequate dietary phosphorus for infants. They suggest that high diet phosphorus in adolescents may cause increases in FGF23 hormones and refer to one study on mice suggesting that FGF23 may lead to cardiovascular disease. The authors also note that increases in obesity in children may significantly impact phosphorus metabolism, by modifying hormones.

Carolyn Macica discusses disturbances in phosphorus homeostasis leading to low phosphorus levels (hypophosphatemia), phosphorus wasting diseases and the use of phosphate salts in therapies. A discussion is included on the adverse effects associated with these therapies and the progressive comorbid conditions that impact mineralizing tissues in phosphorus wasting diseases.

Hans-Göran Tiselius summarises knowledge on metabolic mechanisms of calcium phosphate (HAP) and calcium oxalate precipitation in the kidney, forming kidney stones, subepithelial plaques or intratubular plugs. 85% of kidney stones are calcium based, mostly with a mixture of calcium phosphate and calcium oxalate. Urine pyrophosphates inhibit precipitation. The author concludes that more medical attention and research into phosphate handling and kidney precipitations are needed.

Orlando Gutiérrez addresses impacts of socioeconomic factors on phosphorus balance, suggesting that low socioeconomic status is correlated to diets high in carbohydrates and fats, which are low in nutrients. Studies show contradictory results for protein intake, but do suggest that vegetable protein intake is correlated to socioeconomic status. He notes that **low socioeconomic is correlated to high intake of processed and convenience food, likely to contain phosphate food additives**, in which the phosphorus is highly bioavailable. This high available phosphorus intake may explain economic gradients in markers of bone and mineral metabolism.

Data on food phosphorus availability

Suvi Itkonen et al. **present data on bioavailability (uptake in digestion) of phosphorus in a wide range of foodstuffs, using a new in vitro digestion analysis method**. This shows that only 1/3 – 2/3 of phosphorus in vegetable foodstuffs (bakery products, legumes, seeds) is digestible. The percentage of phosphorus content which is digestible was higher in one bakery product containing phosphate food additives. In meat and fish products, 3/4 to nearly all of phosphorus content was digestible, with and without the presence of phosphate food additives. For dairy products, around half of phosphorus content was generally digestible, but with much higher levels in processed cheeses containing phosphate food additives. The authors note that phosphorus digestibility can vary with processing, such as leavening of bread.

The authors note that **analysis of foodstuffs often shows phosphorus contents significantly different from food composition databases**, so causing inaccuracies in estimates of dietary phosphorus intakes. This is accentuated by the different bioavailability of phosphorus between plant, dairy, meat and food additive sources. There is a **need to develop standardised methods to analyse bioavailable phosphorus content of foods**.

Ranjani Moorthi and Sharon Moe present the difficulties of phosphorus management in **end-stage kidney disease**. They present data from studies with rats and humans showing that phosphorus in vegetarian foods is less bioavailable than that in meat based foods. This is because much of the phosphorus in vegetables, in particular in grains and seeds, is in phytate, which non-ruminants (including humans) cannot digest. Thus if kidney patients take in a significant part of their dietary protein needs as vegetarian protein, rather than meat-based, they will absorb less phosphorus, and so have less issues related to increases in FGF23 and PTH hormones.

Dietary phosphorus recommendations

Mona Calvo and Susan Whiting, in two chapters, discuss dietary guidelines for phosphorus intake, which vary according to age, and are set by the US Institute of Medicine (1997) at 0.58 g P/day (EAR) and 0.7g P/day (RDA) and by EFSA in Europe at 0.55 g P/day (AI) for adults. These levels are compared to data from an number of surveys in the USA and Europe, which show daily intake for adults in the range 1.1-1.3 g P/day for adult women, and 1.3 – 1.8 g P/day for men, that is **around twice the daily requirement**.

The tolerable upper intake levels for phosphorus are also discussed. These are set at 4 g P/day in the USA (Institute of Medicine 1997) whereas in Europe EFSA 2015 (see SCOPE Newsletter n°*112*) considered that an upper limit for phosphorus intake was not useful, underlining the importance however of the phosphorus-calcium balance. Both EFSA in Europe and NHANES in the USA have concluded that increases in diet phosphorus intake have only very small impacts on serum phosphorus concentration in non kidney disease populations; however, most of the studies reviewed focused on fasting serum phosphorus levels which have been established as returning to baseline in morning fasted samples independent of dietary phosphorus levels. This is thought to be related to the well-established intrinsic circadian rhythm of serum phosphorus, an important confounder in studies exploring the links between dietary intake and disease risk. The authors present a very wide range of estimates, from different sources, of the intake of dietary phosphorus coming from phosphate food additives.

They conclude that phosphorus content of foods should be labelled to facilitate intake management for kidney patients and for general population health. They also discuss possible links between phosphorus intake and cardiovascular disease, cancer and FGF23 hormone resistance (see discussion of these above).

They further conclude that **more research is needed** into: biomarkers of health effects (other than serum phosphorus which is considered by EFSA to be not a good marker), hormone mechanisms of phosphorus homeostasis and their links to health endpoints, clarification of possible relations between diet phosphorus and health risks, more accurate measurement of diet phosphorus intake.

Phosphate food additives

Ray Winger presents in detail the **different phosphate compounds which might be used in over 100 different types of food and beverage**, including phosphates used in food processing as well as food additives. He notes that European (and other countries) regulation requires that the presence of food additives be indicated on foods, but that this does not provide any information about the quantities present. He notes that EU assessments have found that food phosphate intake is below the ADI (Acceptable Daily Intake) for all age groups, but that questions remain because some phosphorus containing food additives do not have an ADI (these are organic compounds with phosphorus added, such as modified starches or lecithins, not inorganic phosphate food additives).

Phosphorus sustainability

In the final two chapters of the book, **James Elser** et al., and **Charles Ferro** address **phosphorus sustainability** (already discussed in K. Hahn et al. chapter). The supply of phosphorus (non renewable, limited resource) and the fate of phosphorus (crop use and farming losses, manure, food waste, human sewage, eutrophication impacts) are summarised, and a range of solutions discussed: reduce demand, improvement of crops and fertiliser practices, optimising livestock production, reducing food waste, phosphorus recycling and reducing crop-based biofuels.

"Dietary Phosphorus: Health, Nutrition, and Regulatory Aspects", ed. J. Uribarri & M. Calvo, CRC Press 2018, ISBN 13: 978-1-4987-0696-4, 370 pages http://www.crcpress.com

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HELSINKI 11-13 June 2018 ESPC3 European Sustainable Phosphorus Conference

The ***3rd European Sustainable Phosphorus Conference 2018*** (**ESPC3**), 11-13 June 2018, Helsinki, is the unique event bringing together companies, stakeholders, regional and national authorities, innovation and researchers, to discuss phosphorus and nutrients sustainability actions and policies. This third conference (ESPC3) follows from the first two such European conferences in *2013* and *2015*. In particular, the conference will present and **assess integration** of phosphorus and other nutrients into EU policies since the publication of the EU Consultative Communication on Sustainable Use of Phosphorus (*2013*), **enable dialogue** with industry and stakeholders concerning future policies and see success stories from companies and environmental management.

Objectives of the conference are: **make links** with soil organic carbon sequestration and climate change, **showcase** research and innovation, business success stories from across Europe and global scientists call for phosphorus sustainability (Our Phosphorus Future project).

ESPC3 is jointly **organised by** the *European Sustainable Phosphorus Platform* (ESPP) and the *Baltic Sea Action Group* (BSAG), and supported by the *Finnish Ministry of the Environment* and the *Finnish Ministry of Agriculture and Forestry*, and *EasyMining*, *Kemira* and *Yara*. More information, the programme and registration can be found at ***www.phosphorusplatform.eu/ESPC3***

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