Sous le haut patronage

France conference on phosphorus recycling in agriculture

-Summary-

First ever national meeting on recycled phosphorus in agriculture discusses recycled nutrient products quality, policy, legislation and circular economy.

A first French national meeting on recycled phosphorus in agriculture, supported by the Agriculture Ministry, with participation of the French Environment and Finance Ministries, identified national expertise in organics recycling and secondary materials standards, and a need for policy leadership and regulatory developments.

The one-day conference on "Recycled phosphorus in agriculture: secondary resources, products, quality, regulation", co-organised by COMIFER (French national committee on rational fertilisation) and ESPP, with the patronage of the Ministry for Agriculture Food and Forestry, took place on 11th April 2017, at the prestigious agricultural training centre *AgroParisTech*, with over 150 participants from farming organisations, regulators and policy makers, fertiliser industry and distributors, science and agronomy, stakeholders and media.

The meeting was opened by **Christine Le Souder, Arvalis (French arable crops R&D institute)** and **President of COMIFER**, with the objectives of day: to identify questions and opportunities for recycled phosphorus use in agriculture, as a key component of the circular economy.

Chris Thornton, ESPP (European Sustainable Phosphorus Platform), explained why phosphorus stewardship is important. Phosphate rock is a non-substitutable, limited resource, for which Europe is largely dependent on imports. Prices are linked to global food prices and supplies are geographically concentrated, leading to potential instability. At the same time, phosphorus and nitrogen are identified as key factors exceeding "Planetary Boundaries" (see SCOPE Newsletter n°*103*) and phosphorus is the most frequent (non morphological) reason why rivers and lakes are failing to achieve EU Water Framework Directive quality objectives. This has led to recent developments in EU policies, in particular inclusion of phosphate rock on the EU list of 20 Critical Raw Materials (see SCOPE Newsletter n°*104*) and inclusion of nutrients in the EU's Circular Economy policies. The proposed new EU Fertilisers Regulation (currently in the final decision process) will take this forward, by opening the EU market for recycled nutrient products and thus also for nutrient recycling technologies. ESPP showed a selection of success stories where companies are already recycling nutrients, including from manure, sewage, slaughterhouse wastes. He noted that France has in the past been condemned for failure to implement EU legislation on nutrients (Nitrates Directive, Urban Waste Water Treatment Directive) but that the Circular Economy now offers positive opportunities for synergies between environmental improvement, farmers' income, rural jobs and new technology business.

<u>Fertilising residual materials (MAFOR)</u>

Patrick Dabert, IRSTEA, presented the conclusions of the French collective expertise (ESCo) on the use of organic fertilising residual materials (MAFOR) in agriculture and forestry, produced jointly by INRA, CNRS and IRSTEA for the Ministries for Agriculture and for the Environment in 2014 (see SCOPE Newsletter n°*109*). France produces nearly 400 Mt/year (wet mass) organic wastes (livestock, households, industry, not including on-farm crop by-products). Around 300 Mt are livestock manures/slurries, of which 250 Mt bovine and 50 Mt other livestock. Around half of the manure produced falls directly onto fields, the remaining half is mostly applied to farmland. Overall, nearly 95% of the collected organic wastes are recycled in animal feed or composting or other agricultural land application routes. representing nearly 210 ktP/y (480 kt P_2O_5), compared to around 230 ktP/y (530 kt P_2O_5) applied in commercialised

organic and mineral fertilisers. He identified as obstacles to effective recycling of organic wastes: geographic concentration of sources, physical parameters making transport difficult (in particular water content), reaction with other elements rendering phosphorus poorly crop available (e.g. iron in sewage sludges using chemical precipitation), economic and environmental costs especially for sites with low amounts of waste.

In discussion, participants noted that spreading of organic residual materials to land (e.g. sewage sludge or manures) is cost effective but does not necessarily mean effective recycling, for example if application rates exceed crop needs for phosphorus, or if cows are drinking in water courses resulting in manure going directly into surface waters so causing pollution rather than fertilising land.

Agronomic value

Christian Morel, INRA, outlined the qualities of organic fertilising residual materials (MAFOR), discussing phosphorus availability, physical form and contaminants. He underlined that their agronomic value is related to the nutrient content (N, P, K, other nutrients and micro-nutrients), and also as a soil amendment (organic carbon, liming). The societal value of their application should also take into account: carbon storage in soil (climate change mitigation), substitution of primary mineral fertilisers and upstream bio-energy production (methane). However, they must be safe (contaminants), adapted to farmers' requirements (spreading), must not emit ammonia in storage or use, and face challenges concerning geographical separation of production and use and regulatory obstacles.

He summarised long-term field studies showing that, after 13 years application to crops of different MAFOR (composts of different organic wastes, cow manure sewage sludge), with different phosphorus contents and P/C ratios, had differing impacts on soil phosphorus and soil carbon (Houot et al: Innnovations Agronomiques, *2009*, vol. 5, pp. 69-81 ; Agriculture, Ecosystems & Environment, *2016*, vol. 216, pp. 23-33 – see *http://www6.inra.fr/qualiagro*).

Pot trial and field trial data suggest that raw biological P-removal sewage sludge, agricultural digestate, pig manure and poultry litter and struvite show phosphorus availability similar to that of triple super phosphate in acid to neutral soils, and so can substitute to the use of mineral phosphate fertilizer. However, some MAFORs (e.g. certain biochars or sewage sludge incineration ashes) may contain poorly-available forms of phosphorus (such as amorphous calcium phosphates or apatite).

Christian Morel notes that in pot trials there are reactions between MAFOR, phosphate fertilisers and soil phosphorus. Isotopic labelling enables to distinguish between P taken up by the plant from these different sources. He suggests that soil – MAFOR incubation tests (without plants) are also a simple method to assess plant availability of MAFOR phosphorus.

Regulatory obstacles

Loïc Lejay, French Ministry for the Environment, summarised the Ministry's current position on the regulatory status of recycled phosphate products use in agriculture. The Ministry's concern is to ensure that recycled nutrient products are safe for health and for the environment. He indicated that the French Ministry considers that sewage works are "principally for treating waste water" and therefore that sewage sludge and other solids coming out of the works are legally "waste". This classification as "waste" guarantees traceability and waste-producer responsibility. The Ministry indicates that this waste status for struvite is not a barrier for its further reuse, in the case where an authorized fertilizer production unit would use this struvite (still legally considered as waste when shipped from the sewage works) as an input instead of mineral phosphorous in its process. The Environment Ministry suggests that struvite may also be classified as a "by-product" if reused-treated-water itself is considered as a product or if an "End-of-Waste" dossier could be developed, but any of these routes would not exonerate from the obligation in France to prepare and submit a dossier for authorisation for use as fertiliser

Participants questioned how the Environment Ministry's vision of sewage works as "waste treatment" installations and of all recycled products produced within them as "waste" could become compatible with a circular economy vision where sewage works are operated as energy, water and resource recovery factories.

Bruno Canus, French Ministry for Agriculture, confirmed the French State's objective of ensuring that recycled nutrient products are safe for farmers and for public health, for soil and for the environment. Certain recycled materials product in France (e.g. sewage sludges) can be applied to farmland under authorised "waste" spreading plans, which ensure safety and

traceability. In order to not be treated like this (as "waste"), fertiliser products must apply for authorization to be sold in France as a fertiliser product ("AMM" homologation for an individual company's specific product, delivered by the French Health and Risks Agency ANSES) or develop, by derogation, a technical dossier for submission to BN-Ferti (Fertilization standardization office) and so a NFU standard for the category of product. Both of these applications require for risk assessment by ANSES.

The principle of "Mutual Recognition" (by which a product allowed for sale in one EU Member State should generally be accepted in other States) could be applied to a product authorised in another country (e.g. struvite in Denmark), but a formal application with a dossier must nonetheless be submitted to ANSES before acceptance in France. Mr Canus also notes that this only applies to (in this case) struvite produced in countries in which it is legally authorised as a fertiliser category (e.g. Denmark, Netherlands), not to struvite produced in France, which must follow the procedure specified in the paragraph above.

One participant noted that these procedure are time consuming and expensive. Another participant indicated a cost of around 200 000 € for an AMM homologation, inaccessible for small volume products.

One participant, from BN-Ferti, noted that France's NFU 44-095 and NF 44-051 standards enable composts respecting specific criteria for input materials (NF 44-095 can include sewage sludges, NF 44-051 cannot), processing, contaminant levels, etc. to be sold in France as a product (End-of-Waste status). Work is currently underway to develop new French NFU standards for manure digestates and for wood and forestry by-products.

General discussion showed that many participants consider that the time and investment necessary to obtain legal authorisation of recycled nutrient products as a fertiliser or soil amendment in France represent a significant obstacle to development of new products, markets and recycling processes. On the other hand, French NFU standards once established are exemplary, ensure quality for farmers and safety, and provide recognised and reliable market clarity once established.

It was also noted that the situation will change significantly with the new EU Fertilisers Regulation, when this is implemented, hopefully within around two years. Products which have obtained the CE label (e.g. CE composts, CE digestates, recovered struvite if STRUBIAS is implemented) will be then authorised in France, without any additional ANSES opinion or other dossier. France will be able to also have, as national fertiliser (cannot be sold outside France, unless the other country specifically implements 'Mutual Recognition') products which are not CE-label but which are homologated or NFU in France.

The conference included four workshops on bioavailability of phosphorus in recycled nutrient products, secondary phosphorus resources and flows, circular economy policies and contaminants.

Workshop: bioavailability of phosphorus in secondary products

Emmanuel Frossard, ETH Zurich, and **Pascal Denoroy, INRA Bordeaux,** summarised the discussion which concentrated on the effects of MAFOR (organic fertilising residual materials) on the availability and uptake of phosphorus by crops. The use of MAFOR within the overall application of good agricultural practice was considered a prerequisite in this discussion.

The group made a plea for a structured approach to understand how the addition of MAFOR could affect P availability and uptake by crops due to the complex interactions occurring in MAFOR-soil-plant systems. In a first step, P availability (and forms of P) in MAFOR should be assessed as well as the MAFOR's basic properties, and only then their effects in the overall MAFOR-soil-plant system. Given the diversity of MAFOR, the acquisition of additional references by research was considered essential.

The importance of indirect effects of MAFOR on P availability and uptake was emphasised, related to their effects on e.g. organic carbon and nitrogen inputs, and on soil pH, microbiology or structure. Consequently, the use of standard soil phosphorus tests may often not be meaningful – whereas, on the other hand, studies with radiolabelled P cannot be used in routine testing. Therefore new soil P test methods might be needed to provide appropriate information to farmers to manage fertilisation with MAFOR, e.g. using soil incubation methods. But testing must also be low-cost and rapid for farmers.

A matrix of results comparing standard soil P extraction results (in particular those referenced in regulation) to incubation tests (by region, crop, soil type …) and standardised plant experiments, organized by basic MAFOR characteristics, could provide such a tool.

Phosphorus flows and secondary resource potentials

Thomas Nesme, Bordeaux Sciences Agro, and **Sylvain Pellerin, INRA Bordeaux**, presented the discussions of this workshop which identified different secondary resources from which phosphorus can be potentially reused or recycled, obstacles to phosphorus recycling and progress needed to enable recycling. It was underlined the considerable differences in phosphorus flows (secondary resources and crop needs) between different regions.

For certain phosphorus waste flows, there is significant potential to increase recycling in France:

- Phosphorus stored in agricultural soils. In some regions, the stock resulting from past fertiliser over-application can be reduced without impacting productivity. At the global scale, around half the P applied as fertilising materials to cropland soils (550 kg P/ha over the period 1965-2007) has accumulated in soils.
- Livestock manures: efficiency of use can be improved: closer connection with crop production, avoid over-application, adapt to crop needs, appropriate timing …
- Municipal solid organic waste: France is behind in separate collection.

Obstacles identified to increasing phosphorus recycling to agriculture included in particular: regulatory complexity and lack of clarity in defining legal responsibilities, lack of farmer confidence in the nutrient value of organic products (less knowledge about phosphorus in secondary materials than about nitrogen), concerns about contaminants, costs and logistics of collection and recycling, including geographical distances and transport.

The workshop proposed a number of areas for possible actions:

- Options for flexibility in regulation
- Clarifying legal responsibilities between producers and regulators
- Data base on characteristics of secondary nutrient materials
- Standards for recycled nutrient products
- Regional nutrient recycling policies
- Re-linking livestock production and arable crops
- Nutrient circular economy investment policy
- Structuring of sectors such as municipal organic/food wastes, digestates
- Reduce phosphorus losses, e.g. soil erosion, improving animal feed efficiency
- Science research: P availability in soil, P-efficient crop strains
- Farmer outreach: revising fertilisation practices “feed the crop not the soil”
- Economic and Life Cycle Assessment of pilot nutrient recycling projects

Nutrient circular economy

Christine Le Souder, Arvalis, and **Benjamin Balloy, Permanent Assembly of Chambers of Agriculture**, summarised conclusions of this workshop which emphasised the importance of economic, communication – image and regulatory issues for developing the nutrient circular economy.

New policies may be needed to enable nutrient recycling to achieve profitability or to facilitate investments, and these need to be harmonised across European countries. Innovation should be supported, and the idea of inter-country actions to facilitate emergence of a market of innovative products or processes was proposed – the example of the North Sea Resources Roundabout was cited (see SCOPE Newsletter n°*120*).

One immediate proposal is to integrate recycling, carbon impact and life cycle analysis into Public Procurement criteria

Communications actions are needed, targeting decision makers, local authorities, users and stakeholders, to develop a positive image of nutrient recycling and ensure acceptance of recycled nutrient products based on “wastes”.

A number of regulatory issues were raised:

- In order to facilitate innovation in new recycled nutrient products, dispositions enabling temporary market authorisation should be enlarged to cover not only research/testing but also initial implementation

- Nutrient recycling investments should not be treated as Nitrates Directive 'conformity' costs for manure treatment (this excludes from Water Agency subsidies)
- Manure use plans required under the Nitrates Directive (in Vulnerable Zones) are too complex, inciting farmers to prefer to use mineral fertilisers

Jean-François Gaillaud, Ministry of Finance, noted that the "France Expérimentation" regulatory tool is *currently* being used to allow testing of re-use of treated water from sewage works. The objective is that the derogatory criteria developed in the full-scale testing will then be transferred into adaptation of regulations. He also cited the 2015 law on Energy and Green Growth (Loi 2015-992 du 17 août 2015) *which* promotes the circular economy and includes dispositions on reducing food waste, improving separate collection of organic wastes and updating waste regulation.

Contaminants in secondary materials

Florence Catrycke, UNIFA Union des industries de la fertilisation, and **Chris Thornton, ESPP**, summarised this workshop. The range of participants, including farmers, regulators, industry and environment NGO France Nature Environnement, showed that agricultural application of sewage sludge today is seen as positive, for the environment and for the economy, but that there are concerns about contaminants and a perceived lack of information about these.

Heavy metal contaminants are considered known and increasingly controlled, but a complex variety of other possible contaminants are of concern: pathogens including plant diseases, organic contaminants including pharmaceuticals, nanoparticles, micro-plastics …

Information about contaminants in sewage sludge is considered insufficient concerning

- Organic contaminants in sludge (more information about these in the water phase)
- Impacts on soil biology
- Antibiotic resistance in soils
- Risk analysis
- Ecotoxicity of combination of contaminants in sludge
- How and what to analyse
- Effectiveness of treatment processes in reducing pharmaceuticals in sludge

The importance of upstream action to reduce contaminant inputs to sewage was emphasised, including reducing use of pharmaceuticals (France consumes high levels of antibiotics, antidepressants), source separation in hospitals, development of less persistent pharmaceutical molecules. However "zero contaminants" is not possible, so it is important to develop, in dialogue with different societal stakeholders, a balance between nutrient recycling – safety and costs.

Mathieu Delahaye, Suez, underlined the importance of assessing contaminants according to application to land (per kg nutrient) in order to reach meaningful conclusions on risk and safety.

Panel discussion

The conference concluded with a panel discussion:

- **Valérie Maquère, Agriculture Ministry**, underlined that the 2015 French *law* on Energy and Green Growth requires (art. 110-1-2-4) to "*increase the quantity of waste which undergoes material valorisation, particularly organic … to 55% in 2020 and 65% in 2025 (by mass)".* France's bioeconomy *strategy* 2017 refers to digestates as a route to reduce dependency on mineral fertilisers. The nutrient circular economy is an important opportunity for agricultural businesses and for the environment. However, ensuring quality and safety must be the priority, to ensure food security and protect soil quality. There is a need for work together between the different concerned French Ministries.

- **Jean-Philippe Bernard, Charente Maritime Chamber of Agriculture**, considered that farmers are positive towards the development of the bio- circular economy. This will require moving beyond the current image difference between "waste" and "fertiliser" by structuring nutrient recycling to ensure professionalism and reliable product quality.
- **Kees Langeveld, ICL Fertilizers**, reminded that phosphorus recycling can be through recovery of high added-value products for industrial applications as well as recycling into fertilisers. ICL is active in both directions, using sewage sludge incineration ash in fertiliser production and testing technology to recover P4 (white phosphorus). He noted that this conference has identified many regulatory obstacles and questions. Cooperation between EU Member States can help find realistic solutions. Contaminant limits, including in the new EU

Fertilisers Regulation, must be based on risk assessment and not arbitrarily low, or recycling will be blocked.

- **Pascal Denoroy, INRA** and **COMIFER**, emphasised the need for dialogue between different stakeholders, as initiated through this conference, including exchange between agronomic scientists and farmers and field tests to better use recycled nutrient products. In particular, long-term field trials are necessary for MAFOR products because of the complexity of interactions between different compounds in MAFOR, soil components and biology and crops.

In discussion, **Charlotte Berens, Véolia**, regretted the probable disappearance of the public guarantee fund for risks related to sludge application (*abolition* 2017 of TCA tax funding this). Participants underlined the need to anticipate accidental pollution and the current absence of a financial tool for polluted agricultural soils.

Conclusions

The conference demonstrated a strong interest in France in recycled phosphorus products in agriculture, with participants from a range of organisations and industries.

France today recycles most of its organic residuals (MAFOR) back to agriculture. Priorities today are: to maintain the current 75% of sewage sludge recycled to farmland by addressing concerns about contaminants, and to improve separate collection and valorisation of municipal organic waste, including food waste.

France has strong competence and experience in quality standards for recycled products and a very structured regulatory system (NFU, AMM). This is important in developing the professional, reliable, quality recycled product sector wished by farmers, and also in ensuring safety for health, soil and the environment. However, this structured system also lacks flexibility to facilitate innovation and enable new products, especially in the field of waste valorisation which requires the coordinated action of three Ministries.

Development of the nutrient circular economy will be driven by French policies including the law on Energy and Green Growth, BioEconomy Strategy, as well as by EU policies (Circular Economy package, new Fertilisers Regulation, phosphate rock on EU Critical Raw Materials List …).

Specific regulatory issues were raised by the conference which should be addressed:

- Guarantee fund for sludge application, MAFOR contamination and polluted agricultural soils
- Derogatory regimes for temporary launch authorisation of new products, niche recycling products
- Flexibility for funding of manure recycling investments
- Clarification of producer responsibility and traceability

Concerning scientific knowledge, key needs identified are a better understanding of how organic recycled nutrient materials interact with soil, matrix of region – soil – crop fertilisation data for different MAFOR, valuation of the positive aspects of organic carbon input to soils, and long-term field trials (ten years plus).

A range of concerns about contaminants in organic residual materials were expressed. Both information and dialogue need to be developed, in particular organic contaminants in sewage sludge (e.g. pharmaceuticals) which are a relatively "new" concern and could pose a threat to France's currently high rate of sewage sludge recycling to farmland (nutrients, organic carbon).

This first French conference on phosphorus recycling in agriculture showed the need for further dialogue between different Ministries, between science, farmers and industry, and with other societal stakeholders, in particular opening discussion with the agri-food industry. This should address the implementation of the nutrient circular economy (regulation, economy, logistics, organisation) and also the societal aspects of acceptance of organic residual use in farming (contaminants, risk assessment, image of secondary products).

Conference, AgroParisTech, 11th April 2017 "Le phosphore recyclé en agriculture: gisements, produits, qualité, réglementation" (Recycled phosphorus in agriculture: secondary resources, products, quality, regulation), co-organised by COMIFER (French national committee for the study and development of rational fertilisation) and ESPP, with the patronage of the Ministry for Agriculture Food and Forestry. This summary will also be available in French at www.comifer.asso.fr