SYSTEMIC
Circular solutions for biowaste

Cover Delivery Report

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Enabling a Circular Economy: How to encourage a viable agricultural market for nutrients recovered from biowaste.

WORKSHOP REPORT

A SYSTEMIC Science-Business-Policy Workshop
A Green Week Event

On 27th May 2021, the SYSTEMIC project held its second science-business-policy workshop on nutrient recovery and reuse (NRR). The aim of these workshops is to bring the different stakeholder communities together to discuss and debate ways forward to create a more circular nutrient economy in Europe. The event was attended by 150 people, including policy makers, academics, interest groups and industry.

The background

The recovery of valuable nutrients from biowaste – be that food waste, manure, sewage sludge or municipal green waste, - and adapting those recovered nutrients into a form that can be used effectively in agriculture, is a vital and integral part of moving agriculture from a linear to a circular system.

Our livestock systems, our cities and our municipalities produce an enormous amount of nutrient rich organic matter. some of which is applied directly to farmland and some of which is currently labelled as 'waste' and so being brings with it a price tag of waste disposal. Yet we simultaneously produce fertilisers for agriculture with phosphate rock and through converting nitrogen – a highly energy intensive process. This linear approach is resulting in the damaging release of unused nutrients into our water, into the air and into our soils and contributing to climate change.

The SYSTEMIC project is an EU H2020 project which started in 2017. The project's objective has been to identify novel, innovative approaches to recover nutrients from digestate bio waste at biogas plants, and the application of the resulting products for the fertilisation of crops. Through this process, it has become evident to SYSTEMIC partners that the growth of nutrient recovery for reuse in agriculture will remain a niche and limited sector, unless steps are taken to make it financially viable.

The recovery of nutrients often cost more than a large part of their synthetic equivalents to produce, and therefore cost more on the market. In addition, biogas plants that develop biofertilisers have less direct access to farmers, and farmers are often wary of their agronomic efficacy vis a vis synthetic equivalents, or possible pollutants they may contain. This limits the market and makes NRR potentially non financially viable for the majority of plants. It is the opinion of SYSTEMIC, that positive incentives are required to stimulate market uptake of recovered nutrients if a circular nutrient economy in Europe will ever be achieved.

In this webinar we ask the questions: **how can we make the recovery and reuse for agriculture of nutrients financially viable; how can we create a level playing field?**

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The Speakers

William NEALE, European Commission Directorate General for the Environment, Advisor, Circular Economy and Green Growth

Speaking on the New Circular Economy Action Plan, and the Green Deal, Mr Neale emphasised that making a nutrient recovery and reuse system work is all about getting the economics right. We have the comprehensive legislation; we have the feedstock and we have the technology. But now we need to get the markets to work and boost demand to get the right incentives in place to change behaviour.

Whilst we have decades of environmental legislation in Europe that has been very effective in making our water, air etc. cleaner, it is better to avoid pollution at source, than to punish polluters. By time the pollution is there, it is extremely costly to clean and it up and often the cost is borne by those other than the polluters themselves. The Circular economy lies at the heart of this shift. It aims to bridge incentive gaps along the value chain, at all stages of the lifecycle, increasing reuse, use efficiency, minimising waster and managing waste when it cannot be avoided.

There is no shortage of legislation when dealing with nutrients in agriculture[1], but question is, will this be enough to reach the goals of the Green Deal? It will be necessary to have a holistic approach in order to reach these goals which will be encapsulated in the Integrated Nutrient Management Action Plan (INMAP). This is a tool that has been announced in both the Green Deal, and across its strategies, and will be developed over the coming year with the aim of being adopted at the end of 2022. It will address the more sustainable application of nutrients, nutrient pollution at source, circularity, increase the sustainability of the livestock sector and identify actions needed at the national, regional and European levels to make this happen, including the stimulation of markets for recycled nutrients.

In three years' time, due to a recent revision of the Waste Framework Directive, all municipalities will be obligated to separate the collection of biowaste (about one third of all municipal waste). This will generate an important new stream of biowaste for treatment. Yet, to date there has been no great investment in facilities to treat this waste. Clearly work is needed to increase demand, create a level playing field between synthetic and non-synthetic fertilisers and to generate confidence in the sector. The European Emission Trading System (ETS), through the internalisation of positive externalities (such as avoiding methane emissions) can play a role, as can the National Recovery and Resilience Plans. Member States have been allocated 670 billion Euros in grants and loans for the post COVID recovery and through their plans have to ensure that at least 37% of the plan is dedicated to stimulus investment and reforms for climate goals; a clear opportunity to bridge investment uncertainty.

In conclusion, there is a need to make the legislation work *with* the investment and technology and the INMAP will give us an excellent opportunity to make these elements work together, and in the right direction.

Katja Klasinc, European Commission Directorate General for Research and Innovation

The second speaker, Katja KLASINC focuses her work on Circular Economies and Biobased Systems at DG Research and Innovation, and gave the audience an overview of the nutrient research activities planned in the upcoming Horizon Europe Research funds (2021-2027).

The targeted long-term impacts for nutrient activities in Horizon Europe will act to meet the following goals: climate neutrality and adaptation to climate change; preservation and restoration of biodiversity and ecosystems; sustainable and circular management and use of natural resources as well as prevention and removal of pollution and food and

[1] The Nitrates Direction, the Fertilising Products Regulation, the Urban Waste Water Direction, the Sewage Sludge Directive, the Water Framework Direction, Biowaste aspects of the Waste Framework Directive, as well as, cross compliance and the eco conditionality in the CAP.

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nutrition security for all, within the planetary boundaries. In order to design the focus of the research areas, an analysis was carried out to assess the R&I gaps on nitrogen (N) and phosphorus (P). The identified gaps are:

- Basic research to fill knowledge gaps of N and P thresholds (flows/concentrations) in air/water/soil to protect ecosystems and biodiversity.
- Modelling/assessing N and P emissions from sources not included in reporting from Members States and consolidated statistics (e.g., Eurostat).
- Stimulating the uptake of technologies recovering N and P fertilisers from waste streams/waste waters.
- Assessing the environmental impact of recycled (biobased) fertilisers, render techniques affordable, reliable and socially accepted.
- Identifying transition pathways to apply place based integrated nutrient management solutions, incl. nutrient load targets and ecosystem friendly practices, based on safe regional boundaries, involving all relevant governance levels/actors.

Related to this, the following activities are planned on nutrients in Horizon Europe:

- Regional N and P load targets approach within safe ecological boundaries.
- Optimising nutrient budgets in agriculture.
- Environmental impacts and trade-offs of alternative recycled fertilising products at global/local scale.
- Innovative governance solutions to limit N and P emissions in different environments.

Ludwig Hermann, Proman and member of the SYSTEMIC Consortium

Ludwig Hermann asked how one can create a policy framework to enable a circular nutrient economy?

The greatest challenge, Ludwig explained, for a circular nutrient economy, is making it financially viable. In all the demonstration plants in SYSTEMIC, nutrient recovery, whilst generating an overall benefit to the plant, does not generate a positive cash flow in of itself. As an example, if a plant sells their biobased fertiliser at €5 Euros per tonne and when considering handling and transport costs, the system may save costs but as such does not generate a profit.

The Green Deal, and its integral strategies, are a very positive step forward, and, if effectively implemented it can do much to support industries that prioritise the use of secondary recovered products. And vis a versa, the growth of the biobased fertiliser market can help the EU to meet its own climate targets, increase nutrient use efficiency and reduce nutrient emissions into the environment and create additional green jobs. Yet biobased fertilisers struggle to compete with synthetic fertilisers in both price, and access to market. To support the financial viability of nutrient recovery and reuse, the SYSTEMIC project proposed four possible incentive measures:

1. **Limiting the application of untreated manure**

The RENURE criteria, born out of the SAFEMANURE project, is a set of criteria for livestock manure derived fertilising production with a high nutrient use efficiency (NUE), equal to that of synthetic N fertiliser. SYSTEMIC proposes that simultaneous to the adoption of the RENURE criteria, and there should be stricter limits for the direct application of untreated, low NUE raw manure onto agricultural fields. This would support the Farm to Fork's (F2F) objective of increasing NUE and reducing nutrient losses to the environment, as well as stimulating the market for the recovery and reuse of nutrients from manure.

2. **European Emission Trading System (EU ETS)**

Extending the ETS to farms is already widely discussed and may be proposed by the European Commission in the context of the Carbon Farming Initiative expected for Qu3/2021. Examples for an ETS-based rewarding system for bio-based fertilises are outlined hereafter.

<u>For the producers of biobased fertilisers</u>

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Currently biogas plants and nutrient recovery plants are not part of the EU ETS, but the system is still under discussion and presents a unique opportunity to provide incentives for the sector. Nitrogen fertilisers produced through Haber Bosch process produce 3 - 4 tonnes of CO_2 per 1 tonne of nitrogen. The production of a biobased nitrogen fertiliser produces much less CO_2 than a conventional N fertiliser due to using residual heat, renewable electricity and, where available, secondary materials (e.g. gypsum from flue gas cleaning). Therefore, producers of biobased fertilisers could receive a payment for the comparable saving of CO_2 emissions. As an example, a plant that produces the biobased Ammonium Sulphate (21% Nitrogen) would receive up to 4 * 55 (current carbon price) * 0.21 = €46.2 per tonne of Ammonium Sulphate (fertiliser) product.

<u>And through the production of biomethane</u>

Biogas plants can upgrade their methane production into biomethane which can be used as a renewable replacement to natural gas emitting 2 kg CO_2/m^3 methane and can therefore apply an equivalent carbon price for avoided emissions of € 0.11/m³ (at current prices of € 55/t CO_2). This approach could replace the current feed-in tariff system that varies per member state and is typically perceived as too expensive for consumers or tax payers. An ETS scheme-based incentive would be applicable EU wide and could provide a level playing field for biogas producers.

<u>For the farmers</u>

This could be based on the same calculation as for the producers of the biobased fertilisers. For every tonne of synthetic nitrogen fertiliser replaced by biobased nitrogen fertiliser they would get ½ the carbon price based on the evidence based assumption that synthetic nitrogen fertiliser is twice as nutrient efficient as untreated manure.

<u>For the fertiliser industry</u>

The fertiliser industry is already a part of the ETS and in theory, has to buy carbon credits. However, we currently have a system whereby around 90% of industry credits are given for free, leaving little incentive to reduce emissions. However, if these 'free' credits are phased out, it will become increasingly advantageous for the fertiliser industry to buy in recovered N and P rich products to blend into their own fertilisers. Such a scheme would have to be flanked by a Carbon Border Adjustment Mechanism (CBAM) to provide a level playing field for European nitrogen fertiliser producers in the global context.

Failing that, the second option would be to establish and incremental obligatory binding quota system for biobased ammonia in synthetic N fertilisers with clear targets, such as 5% by 2030 (as for ethanol quotas in gasoline).

Oscar SCHOUMANS, Wageningen University & Research, Coordinator of the SYSTEMIC project

Oscar gave the audience a glimpse of how nutrient recovery and reuse technology and the production of biobased fertilisers is working at an industrial scale through the SYSTEMIC project. The EC funded H2020 project has been working through five biogas plants who have implemented nutrient recovery and reuse technologies and/or upscaled their nutrient recovery technologies from pilot to industrial scale. With the help of the SYSTEMIC consortium, the performance of the plants has and their economic feasibility been analysed, as have the agronomic performance and sustainability of their products (LCAs and EIAs). Using the collected data and knowledge obtained from and developed by these pioneer plants, the project ensures that the work is taken up through its continued involvement with another 28 outreach plants that are keen to follow suite.

No one plant is the same. Each is adapted to its own business case, and regional circumstances. They use different feedstocks (pig manure, poultry litter, sewage sludge, energy crops and agro-industrial wastes). They use different technology (reverse osmosis, evaporation, nitrogen stripping, phosphorus stripping) and produce different products (nitrogen-potassium concentrate, ammonium sulphate, calcium phosphate and struvite, organic soil improvers and organic fibres). Plants cannot just produce a product and expect it to be successful on the market. Rather, they need to target products that suit their own markets.

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Below is a brief overview of how three of the demo plants are doing this in SYSTEMIC. For a more detailed overview of the demo plants, go to: https://systemicproject.eu/plants/demonstration-plants/

Acqua e Sole, Italy

The plant uses a feedstock of sewage sludge and domestic waste. The plant had to install nitrogen stripping at an early stage due to the high nitrogen content of the feedstock which reduced the biogas production, and to minimise the odour and ammonia emissions from the plant. The plant created its own market early on through a cooperative agreement with local farmers on the 5000 ha surrounding the plant. It has supplied farmers with a low ammonia, high carbon soil improver and mineral ammonium sulphate as a synthetic mineral fertiliser replacement. Through continuous soil testing and working with local farmers, they have been able to show that their products meet crop demands, show considerable soil improvements (and associated benefits) and save the farmers money.

Groot Zevert Digestion, the Netherlands

Without plants such as Groot Zevert, the digested excess manure in the area is transported mainly to Germany at a high cost due to phosphate application limits in the region. Groot Zevert takes in the excess manure and through anaerobic digestion and nutrient recovery, produces three biobased fertilisers. In addition, the now cleaned water is allowed to be discharged to surface water. The biobased fertilisers are an NK concentrate, a recovered phosphorus fertiliser and an organic soil improver with a reduced P content. The NK concentrate is blended with other biobased products produced in the region (ammonium sulphate) and a synthetic fertiliser to create a product that is tailored to different crops at different times in the growing season. About 80% of phosphorus is recovered from the digestate and can be applied in concentrated form in P poor areas, and can also be used as an input for the fertiliser industry to replace phosphate rock. The remaining stable organic matter with a low P and N content can be used as a soil conditioner or replacement in peat dependant industries such as the potting industry and mushroom sector.

Benas, Germany

Using a mixture of silage maize (an energy crop they produce themselves) and poultry manure, Benas produces ammonium sulphate, lime, and liquid and solid fraction digestate, which they apply directly to their own farmland. The remaining recovered fibres are also used to produce paper, packaging, plant pots, mulch for vineyards and much more.

All three plants also produce biogas and so contribute to renewable energy targets.

These plants show that it is possible to recover nutrients from digestate at an industrial scale, and that biobased fertilisers can compete with synthetic mineral fertilisers from an agronomic and environmental point of view. However, scaling up is extremely high risk. Nutrient recovery technology requires a high level of investment, with little certainly of a market.

Summary of the main responses during the Q&A

The **issue concerning the growth of NRR in Europe is not feedstock, or technology, but rather it is the development of a market to make it financially viable**. In order to generate investor interest, the sector needs to prove that there is the potential for long term growth market.

Nutrients recovered from biowaste could be beneficial to the organic sector, especially in terms of the phosphorus question. Phosphorus, as other nutrients, can be a limiting factor for many organic farms that do not integrate animals into their farming model. Recovered nutrients are compliant with organic farming principles, but are not yet approved for use.

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Whilst policy mechanisms will be crucial in promoting this circular economy, and the recent Green Deal and associated strategies are a major step forward, they, like the CAP will only be realised *if* member states are prepared to support their clear practical implementation. However, current negotiations around the CAP and the Farm to Fork strategy have shown the ongoing pattern of Member States trying to weaken rather than strengthen these policy agendas. **Linking NRR into the EU ETS scheme is a concrete way of supporting the sector and securing the Green Deal objectives**.

Engagement of farmers is crucial. A major component of this transition will be the engagement of farmer **and the agricultural sector** and their acceptance of the products, and motivation to invest collectively in NRR technology and recycle the nutrients. Part of the SYSTEMIC project has been to carry out tests on the products from the plants to identify, for example, heavy metals, pharmaceuticals and antibiotics (especially important when dealing the sewage sludge). So far, no such residues have been found in the SYSTEMIC project. It will be crucial for farmers confidence that biobased fertilisers are consistent, stable, safe, quality products that is assured by a robust methodology. Increasing the agronomic, environmental and economic acceptance of the products is still work in progress.

Access to market. Individual farmers are difficult for biogas plants to reach. There needs to be a more simplified and direct way to bring biobased fertilisers to the market so that farmers have equal access to both biobased and synthetic fertilisers.

Equal playing field for biobased fertilisers. Biobased fertilisers are developed from organic waste, a highly complex material that requires high value technology for processing. This inevitably increases the cost of production. In addition, biogas plants lack the economy of scale cost advantages enjoyed by the synthetic fertiliser plants. To give an example, what the Haber Bosch process produces in one day in terms of nitrogen, biogas plants produce in one year. These cost advantages afforded to synthetic fertilisers create an unequal playing field for biobased fertilisers.

Carbon footprint. However, *all* biobased fertilisers generally have a favourable carbon life cycle analysis as compared to synthetic fertiliser. One tonne of nitrogen produced using the Haber Bosch process produces 3-4 tonnes of CO_2. One tonne of nitrogen produced using the ammonium stripping process for biowaste does not produce any additional CO_2, as even the energy used in the process is generated by the biogas plant itself. The difference is not so impressive for phosphorus recovery as the development of P fertilisers is less energy intensive. There are however, still CO_2 savings as P biobased fertilisers are again developed using renewable energy generated in the biogas plant. This is a strong argument to support the sector by charging those who create emissions *and* crediting those who are saving emissions, creating a level field. Hence the argument of SYSTEMIC to include such plants in the ETS scheme.

Argument was put forward by Ludwig Hermann that **all biowaste streams should in fact go through anaerobic digestors** for two reasons. Firstly, the process produced biomethane – an important and required component in all EU member state CO_2 zero scenarios. Secondly the digester stabilises the produce, making it more nutrient efficient and finally because by removing the nutrients, plants are left with a nutrient poor, carbon rich product which can be applied to agricultural land locally, thereby contributing to the carbon concentration in soils and saving on CO_2 emissions generated by the transport of biowaste out of a region.

END.

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