

Nutrient recovery and reuse EXPO session on 23rd Sept. 2015, Milan.

Notes

Venue: EC pavillion at the EXPO Milan / CASINAZZA

Time: September 23rd, from 10:00 to 19:00

Sessions at the EXPO Milan Pavillion:

Janez Potocnik – keynote speech

Janez Potocnik welcomed the participants and delivered a keynote speech.

In his speech, Dr. Potocnik talked about the role of nutrient recovery and reuse in the transformation to a new economic model. He started by mentioning some facts about growing population and food security in the world and stated that achieving sustainable development goals for end of hunger and malnutrition would demand an increase in agricultural production adapted to new circumstances but which should not cause a decrease in environmental services. He then introduced the concept of Circular Economy and stressed its importance for both technical and biological cycles. These include nitrogen and phosphorus, two central components of agriculture which face different challenges. Excess nitrogen and phosphorus application in EU agriculture is leading to significant environmental problems (water eutrophication for nitrogen and phosphorus and air pollution in the case of nitrogen). Current low nutrient use efficiencies throughout the food chain must be increased through technical improvements and by reducing waste. On this behalf, Dr. Potocnik stressed the importance of the Circular Economy (to reduce waste and convert it into a resource) and of implementing holistic policy frameworks that allow for regulatory coherence within the EU.

SESSION 1 – drivers

Opening speech:

Allan Buckwell – Director of the RISE study on Nutrient Recovery and Reuse

Allan Buckwell presented in a few slides the work that has already been done in the RISE study on nutrient recovery and reuse.

He explained the goal of the NRR project and why it focuses on N and P, alongside soil organic carbon. The project aims at assessing the relative importance of a set of concerns for NRR in agriculture and determine how nutrient recovery can be enhanced to improve nutrient stewardship. In fact, a few central questions that lie in the core of the study are: how big a contribution will NRR make to nutrient stewardship? What are the economics and conditions necessary to make it work?

Prof. Buckwell went on to clarify the terminology used in the project and said that the scientific committee of the EXPO Milan is focusing on food & nutrient security and that this must not be forgotten. He challenged the audience with questions such as: Most of our agriculture is uneconomic? Is it unsustainable or not achieving appropriate sustainability standards?

A slide showing goals for nutrient recovery was presented and the rest of the speakers were asked to rank the goals according to the importance they thought each had. Among these goals were:

- **Finiteness** of phosphate rock and natural gas?
- Air and water **pollution** including eutrophication of rivers, lakes and the oceans?
- Accumulation of nutrient **surpluses** in agricultural soils
- Accumulation of **wastes** through the food chain, and especially associated with livestock production?
- The **inefficiency** of use of nutrients by plants, farm animals and humans?
- The decline in **soil organic matter**?

Waste, he reminded, is involved in our food systems. The waste hierarchy in the EU starts by focusing on reducing the amount of waste that we annually produce.

During the presentation Prof. Buckwell showed slides with nitrogen and phosphorus flow assessments at EU level and stressed that much data is still needed. There are, for instance, no time series available and the data available in different countries is not always for the same year or the same flows.

Panellists:

Morten Rossé - *Expert associate from the McKinsey Center for Business and Environment*

The first panellist to talk was Morten Rossé, he started by saying that we live in a defining point in time. World population is increasing and we need to make a response to feeding the growing world population. We currently count with two options: a linear one (BAU) and a circular solution (NRR at the heart). The circular solution is not new but scaling it to the whole world is what makes it a challenge.

Why transition towards a circular economy? As explained in the growth within report, 1.8 trillion euro would be gained if a move for Circular Economy is done in the EU. It would also have a very positive impact on the environment. Consumers would have a largest pay rise and would increase their purchasing power. In the long term, a Circular Economy seems like a good investment.

When asked to rank the goals for nutrient recovery and reuse that Allan Buckwell presented, he chose number 5 (the inefficiency of current nutrient use) as the most appropriate to Tacke food security. He mentioned that it's hard to make EU consumers see that food security may be a concern for them. However, our current unhealthy food system poses several challenges. Up to now we have only been good at increasing our diets and our unhealthy intake. He said that tackling nutrient inefficiency was one thing that could lead to a behaviour change among population. It is something, he said, that people can see. He also mentioned that resource scarcity and security is also a big issue for many of their clients and that it can also get them going as well. China export tax on phosphate can also hamper P supply.

Nutrient inefficiency is throwing away money and resources. (he made the simile to the car in the CE... only a slow % of the fuel is actually going to moving the car itself and a large percentage is lost as heat). In their report, the focus of their narrative has been placed on the waste in the system.

He also mentioned the importance of resource security.

Mark Sutton - *Chair of the International Nitrogen Initiative (INI) and Co-Chair of the UNECE Task Force on Reactive Nitrogen. His work has been focused on nitrogen emissions, the atmospheric transfer of reactive nitrogen compounds, especially ammonia, and eutrophication.*

When asked to rank Allan Buckwell's goals he chose number 2: pollution, as the key goal to tackle initially. Also number 5 (nutrient inefficiencies).

In his 5 minute speech, Sutton decided to stress the importance of public communication, especially finding positive narratives that will make people interested in the subject. For instance, instead of saying that we must reduce pollution, we can talk about how increasing nitrogen use efficiency will have a positive impact on the economy. He said that there is currently large awareness for carbon but not for nitrogen or other nutrients. He gave several reasons for which we should be aware of nitrogen:

- 48% of people's food relies on fertilizers
- Ammonia is volatile. It derives from manures and fertilizers and is emitted into the atmosphere. Will the EU reduce its ammonia emissions? The REACH is being discussed. Under warmer world, we will see even larger ammonia emissions. Reducing pollution is a negative narrative and people react against it. We should go for more positive narratives. The ENA highlighted fragmented issues on N and legislation, also in relation to international conventions. We should aim at an integrated approach.

Climate costs for EU are high. So it's interesting to take action.

Finally, Prof. Sutton mentioned 3 key actions for change:

- a. Low emission manure spreading. Right at the point of delivery. More N into the crop. Large contribution to reduce ammonia emissions and to increase efficiency. Will REACH make a change?
- b. NOx recapture and recycling. 4 million tonnes of NOx in the world. How to develop dilute scrubbing systems. Collect it, sell it and reuse it.
- c. Food choice. Demitarian (half meat consumption) would reduce pollution by 40%. Would double nitrogen efficiency of food system.

He mentioned WAGE: Water air greenhouse ecosystems soils.

Chris Thornton - *Secretary of the European Sustainable Phosphorus Platform*

The third panellist was Chris Thornton. Mr. Thornton did a short intervention by mentioning four reasons for which the EU should focus on nutrient recovery and reuse.

Why do we need to do something about NRR?

- 1) There is a big issue with pollution. For P it is a major issue with eutrophication. We don't know the costs of P pollution.
- 2) CE for bionutrients will create jobs which are spread out all over the territory. Generate income for farmers. (key issue). It is different from the CE consumer goods.

- 3) Synergies between nutrient recycling and production biogas, mechanisation, making sewage works more efficient, improving SOC management in soil. So, don't look at it separately, but see all the combined benefits (p.e. reduce soil erosion)
- 4) Sustainable intensification. Concentrate humans, livestock... these two tendencies will not change in the near future (it's like this because it's more economically efficient). There are good reasons to concentrate livestock production. But the result is that we are concentrating the nutrients in one place. So, there are opportunities to get these nutrients and move them to other places where they are needed. Intensification brings along large opportunities. Let's take that forward.

Chris Thornton did not want to rank the drivers.

Discussion

There was time for discussion after the intervention of the panellists.

Allan Buckwell mentioned that at the beginning of the project, he thought the main issue would be resource finiteness. However, he said not that the main drivers of nutrient recovery and reuse are related to the environment and public health. He asked the audience how to motivate change. He raised the point on why are we still talking about nutrient efficiencies if it has been talked about for so long? Is there much more that can be done?

Chris added another point to the list that Allan presented: creating jobs and rural development.

An attendee from Wageningen mentioned that the list the Allan presented was a technical list of options (biophysical views on the problem). What about sustainability of farming? Is it not because the system is not economical that the farmers need to push it? If we find a way to get incomes to farmers, will all these problems be solved?

Mark Sutton replied that for many people SI could mean to put more resources in. And higher inputs usually lower efficiency of the system. Sustainable extensification might be a frame for certain contexts. He also talked about policy integration. Could we get REACH in ammonia to agree with the habitats directive?

Koen van Keer from Yara highlighted that several speakers had talked about the importance of communication. He said that messages such as "by reducing you gain" are very useful for public awareness and understanding. Language is important and we have to focus on how we pass the messages across. He also suggested calling NRR, NRRR (nutrient reduction, recovery and reuse)

Ludwig Herman from Outotec asked Morten about the savings presented in the study. If we are saving volumes, would this be a contraction of the economy? How will it trigger jobs, income and growth potential? Morten replied that the gains would come from tax reduction for consumers with savings. Higher incomes would lead to higher purchasing power and, in turn, more investments.

A former member of parliament argued whether present nutrient legislation is adequate and if the current water framework directive can tackle the problem.

Sutton replied that the nitrates directive is indeed a powerful tool. But it only focuses on nutrients to water courses, not to the air. In the Gothenburg protocol (negotiated 2 years ago

on NOx) a 2% reduction on ammonia was agreed while a 30% reduction on the rest of gases was set. He believed much more can be done.

Chris Thornton mentioned that the WFD is extremely demanding on reducing losses to eutrophication but it requires it to be cost effective. The cost of measures need to be passed to consumers. There is still work to ensure coherence in the environmental part of regulations. In the Circular Economy package, policy needs to be developed. What kind of tax, incentive, quota will ensure that nutrient Circular Economy works? Will the money go to farmers to supermarkets, industry... ? Through the Circular Economy the EU should make sure the nutrient framework will be brought forward.

Corrado reminded that in the EU-15 no one respected the nitrates directive. Netherlands gave state aids to reduce livestock stock. The government paid farmers to reduce the stock. Without incentives and compensations it will not work. He stressed the importance of MOTIVATION and COMMUNICATION (both are needed).

Allan added that this will be a slow processes. Get farmers to take legislation seriously is a long term thing. Further work needs to be done on this. The regulation question is a critical one. Defining fertilizers, waste, soil improvement, etc is also important.

Koen raised the issue about data on nutrient fluxes. Do we have enough data? About biowaste streams? We need time series. If the EU wants to go seriously into CE, it needs to support people gathering data. New innovation, technologies, factories will be needed but they will demand convincing information before investments are done. He mentioned that large projects in the Netherlands have attempted the larger scale in the 1990s and have failed. These are all challenges.

Morten said that there are inefficiencies in the system that have not been recognised previously. BIG Data is providing new opportunities for people to share, etc.. Inefficiencies in the agric system can be challenged with BIG Data. We need to put forward strong business cases to show everyone how this can be done.

Mark Sutton suggested that there are already many motivations derived from the data that is available (management losses, better manure management). Much more could be done with what we already know. Where are the good practices being implemented and what is the progress being made?

Janez posed a set of questions. He said that we have to be aware that we are all homo economicus. Money will always come first for people. But there are side effects of our economical activities. Are we ready to acknowledge them? Are we ready to pay them? Who will pay for them? The questions distributed by Allan are a list of debts accumulated, and we continue to create them. It's a debt someone will have to pay at some point. We are not ready to pay for them. We want to continue living on the short-term. This will finish when the balloons explode. N, P are stories of awareness that we have to incorporate in our decision making to start lowering our debts.

SESSION 2 - challenges

Opening speech:

Nina Sweet – WRAP, UK

Nina Sweet talked about challenges and opportunities for nutrient recycling.

- How to put renewable fertilizers into the market?
- How to design things so that we don't produce waste?

The world needs to re-think (consumption and use), re-invent (design and production) and re-define (reuse and recycling).

Our food system needs to change to feed a growing population. We are wasting too much (15 million tonnes of food annually only in UK).

There are large inequalities in consumption. Obesity is costing our health and social care large amounts of money. We need to understand the numbers we are dealing with.

In terms of the cost of waste, we are only looking at the point of the iceberg. The true cost of wasted materials is on average ten times the cost of their disposal.

We should target:

- Biodegradable waste out of landfill
- Challenging targets set by the WFD
- Renewable energy targets
- Climate change objectives
- Management and recovery of valuable organic resources is critical to delivering all of the above

Solutions will come from:

- Understanding where resources arise and where they are headed. Look into the fluxes!
- Harnessing research
- Delivering processes
- Developing products for real markets
- Investment
- All linked

We must support the creation of renewable fertilizers in the EU.

An example of a challenge: change our tank of sludge in something that can be easily used for farmers.

The development of new markets will demand public perception, good scientific evidence, communications and safe products with good advice.

They have worked with recovered nutrients. They have knowledge on composition and how to apply them. Focus must be placed on the sort of products being delivered: waste to resources to products. We need standards for operation, compliance. With compost and anaerobic digestate it has already been done.

See Highlands and Islands Enterprise (what have they done?) – SBRI challenge (what I heard at Edinburgh)

The time is right to deliver the innovations to the market place.

New technology, new products, new markets ... needed. OPPORTUNITIES. Growth and jobs will come from here. Yet, we need to be careful with the products and the markets.

It is time to turn the discussion of why into a discussion of how.

Panellists:

Reinhard Buescher – European Commission

Mr. Buescher spoke about the draft a new regulation for Fertilizers that will be part of the Circular Economy package. Its main objective is to create a player level field between conventional fertilizers and new fertilizers. Moving towards the concept of the circular economy, they want to foster the creation of new markets and stimulate investments in regions that are not typical chemical regions. The charm of Circular Economy is that it can happen everywhere, everywhere where there is waste. Close the gap between regions with too much and those with too little. Bring resources to the market.

The regulation will create an internal market and define the recovery rules (conditions under which waste can become a product). It will rely on work already done (JRC for instance). For some waste materials there is no work done so they won't have a place in the revised regulation (may be added later on).

There must be an agreement on the safe use of new materials and their efficiency. Define end-of-waste criteria of materials that can be used as fertilizers. Ensure safety of such materials (by tracking them...) Control mechanisms to trace such products and certify their quality. This will require following a new approach, apply new legislative approach to bring certification bodies into work. The market is being developed. Starting with materials that already are seen as safe materials (consensus). Leave out those products for which there is no consensus.

Ruben Sakrabani – Cranfield University, P recovery from sludge and soil effects

We are going back to where we had started from (types of new materials).

Conventional fertilizers are well understood. We know when the nutrients become available. This is still not the case for those from alternatives sources. These materials do improve the health of the soil. In the list of goals presented by Allan, he placed focus on the decline in soil organic matter. It is the currency for the farmer and farm land is a finite resource. Fertilizing, irrigating, ... uptake by crops will be more efficient and less leakiness will occur if soil condition is good. He mentioned to look also at technologies that are already out there. Using cultivars that have got roots that can obtain nutrients with increased efficiency. We need a toolbox to know what we can do. Improve efficiency of crop itself by increasing its resilience.

Advancing in the managing of phosphorus: there are currently 20 different methods of analysing phosphorus worldwide. In the UK, 3 different methods. How to interpret what is available to crop needs with these methods? Could we use some methods in synergy to have prediction capabilities and improve resilience and use innovation to improve the quality?

Laetitia Six – Fertilizers Europe

She highlighted the importance of finding ways to have a more even distribution of nutrients in the EU.

Fertilizer industry focuses on the field level. The task is to sell fertilizers but to make sure they are used in a good way. They develop tools to allow farms to predict what they will need. They are interested in good practices in field (adding nutrients in farms), SOM at good levels (fertilizers won't work properly unless SOM is at a good level).

Use leakages. See how it can be recovered and reused in a good way. In agriculture but also in other chemical sectors. For FE it's a challenge to look for sources of raw products. Social pressure. License to operate in Europe.

Some products are mature enough to go ahead in the market. Fertilizers Europe are looking at sources that will be suitable for their needs. Not all of them will work but some will. Struvite, ashes.. are some of the materials they are looking into.

We must keep in mind that the options need to remain economically viable. We all need to make our economic balance, make profit.

She said that we are sometimes comparing amounts of P in this and that part of the fluxes but these forms are often not comparable.

Ammonium phosphate is by far the most popular fertilizer. Match crop needs with their fertilizers. In the future, more synergies between organic and mineral fertilizers. The NPK ratio needed must be met.

Discussion

The discussion started with Mr. Reinhard Buescher. He emphasized that we are talking about a new emerging industry. At the end of the day the farmer will have more choices and options (more competition). Their aim with the new fertilizer regulation is thus to create a framework that is neutral, that promotes equal opportunities. The markets will have to make choices and the farmers as well. They are hoping for cross investments (like from mineral fertilizer companies that want to stay in the business). What is sure is that the number of actors in the business will increase.

Nina Sweet insisted on the fact that waste disposal needs to be converted into resources. She also suggested that more than one product might be used in the field and that we can't expect farmers to use low quality products. We have to see what is out there and how it can be used.

Morten Rosse asked Laetitia Six if fertilizers Europe should take responsibility for the whole nutrient chain. Laetitia Six replied that they only take responsibility for inputs but she said that a task for them is certainly to engage with other partners in other parts of the food chain. Motivate suppliers to transition towards nutrient recovery.

A bureaucrat from the Lombardia region said that new plants for nutrient recovery will have to deal with a complex set of regulation systems and wondered how easy it would be to make the transition.

Reinhard Buescher insisted that they are aiming at converting biomass, manure and digestate into standardised products. He reminded that the alternative fertilizers will also be produced in plants that respect legislation (CO2 emission certificates, etc.). New forms of industrial cooperation will be needed. Creating a market will demand to define product quality, standardised process, and to reach out to clients in other regions. Farmers will be part of different chains. He stressed that this are new opportunities for businesses to make money. The chain for nutrients is: agriculture->bioenergy->fertilizer production. First biogas, then digestate back to market as fertilizer (by products are also subjected to hygiene controls from the internal market surveillance). It's not only about defining end-of-waste but to define a system that allows us to take advantage of industrial production. He has the expectation that the C footprint may be lower for the new products which should make it easier for these new

plants to get licenses. Consumers will have to be informed own hat they are buying. This is still being elaborated. How to demonstrate C footprints? Enough room should be left for choice by better informing the consumers. There is a need to demonstrate the feasibility of new technologies at the large scale. We may have to build demonstration plants to stimulate investments.

Chris Thornton pointed out that there is a lot of work to only produce documentation. Digestate will be different each time. On this behalf, the Circular Economy can be expected to create a high number of jobs (many people will be needed to certify the products and its quality/content). A level playing field in terms of regulation is for sure needed, but probably not in job creation. He stressed that the main objective of the Circular Economy is to create jobs. Jobs cost money, but in this framework jobs may also bring jobs/money? back to society.

Reinhard Buescher started the debate on 'who will pay'. According to him, developing the circular economy based on subsidies would be a mistake (check). Laetitia Six agreed and said that subsidies won't push the circular economy. Farmers are aware that SOM is important. They don't want to pay for it, it will be a big change for them when they've had it for free over time.

Mark Sutton said that allowing fertilizers to be used but does not imply that users will know how they should be used. Take the case of ammonia carbonate that results in high in ammonia emissions. Same with urea. Buescher said that the regulation wouldn't say how farmers should apply fertilizers. Sutton replied that He said that if the fertilizer regulation is not the place for setting requirements, are there other places to address how these fertilizers are used?

Reinhard replied that the issue is being addressed. It will basically be up to the member states to decide on this. At the product level only the usages that would lead to "real" problems, he said, are regulated (like explosions).

Session at the Casinazza:

SESSION 3: PROJECT PRESENTATIONS

Carl Dewaele (NuReSys, Belgium)

Carl Dewaele presented an overview of some of the plants in which they are operating. He mentioned that currently most WWTP are removing phosphorus to avoid operational problems. NuReSys proposes to recover phosphorus. He showed us what they have accomplished up to know by reusing struvite as a fertilizer and finally presented some barriers and recommendations for the future.

He showed how in the anaerobic digester of the waste water treatment part of the biomass is broken down and transformed into biogas. However, nitrogen and phosphates are not removed and remain in the water.

In traditional phosphate removal processes, iron or aluminium salts are added to the effluent to remove the phosphate. The phosphates bind to the metal salt and co-precipitate into the sludge. In their plants, P and N are bound to magnesium, resulting in the precipitation of struvite. These precipitates can be harvested and used directly as fertilizer. Higher volumes of water and higher phosphate concentrations make the process more interesting from an economic point of view.

With the 8 plants they currently have in operation, they recover about 2.000 tons of struvite annually.

Not all WWTPs are interesting for them. The most useful waters come from the following industrial processes: potatoes (deep frozen fries), dairies (cheese), bio-digesters, slaughter houses, bio-oil production and metallurgy.

He mentioned that struvite is not equally suitable for all crops, maize is typically used in trials.

What to do with the struvite. In Flanders, all is taken by 1 company. Replaces 1/5 of P₂O₅ with struvite. So the consumer always get the same P₂O₅ (20% will be slow fertilizers). In areas with acid soils where struvite will be available.

Another customer uses struvite on maize. In the lab they discovered that struvite works well with maize. (only pot trials). Up to now it's been a pot trial, given the success they will implement full scale.

Barriers and recommendations:

- Technology is ready to roll out
- Economic benefits come from operating savings

What is needed to move to wider implementation of P recovery:

- Remove obstacles and create a level playing field (in different states, different interpretations)
- Fertilizer regulation revision
- REACH, not clear if it applies to struvite (different questions give different answers)

Policies needed:

- Internalise externalities of mineral P use (geopolitical insecurity, eutrophication)
- Incentives (tax advantages for investments in circular economy)
 - o Set targets for P recovery and reuse
 - o Funding programs targeted on P recovery and reuse, shift from research/pilot to first implementation. Fund REPLICATION (not only research) (So far, the EU has funded first pilot, first implementation. But it should also fund replication (to advance in this field)).

P recovery through struvite precipitation on manure (graph). Manure will be a big share of supply of nutrients in the future. Applying this technology on manure will be very interesting.

Sébastien Homo (COOPERL)

COOPERL is a French cooperative with a turnover of 2 billion Euros and 5.000 employees.

Through their cooperative model, only a few industrial plants will be built for (thousands of) farmers.

He focused his presentation on the pig industry. Up to now, their plants have produced dried slurry that contained N and P. Now they are building new plants that also use pig's mud and recover SOM, N and P and biogas production with an increase of 40%. Mud is collected with a

scrapping technology (called TRAC). As a result, there is better air quality in the region (ammonia and nitrous oxide emissions are reduced by 50%)

They recover N and P. Dried slurry constitutes an organic fertilizer. Different type of fertilizer are produced depending on the client's needs. 11 Euros /m³ to treat slurry.

Farm slurry treatment on farm (own) – centrifugation/nitrification/gentrification/→ dry matter

Companies keep innovating in the sector, aiming to close the gap, recover more nutrients and reduce environmental impacts.

Old buildings have to be replaced by new buildings with the scrapper system (good economic conditions for this needed).

In relation to obstacles and challenges he said that favourable economic conditions must be created for users to replace chemical fertilizer by organic fertilizers. In addition, favourable economic conditions must be maintained to enable pig farmers to replace old buildings by piggeries equipped with scraper system.

He also proposed the creation of a European Label for organic fertilizer.

Aki Heinonen (Punkalaidun municipality)

Punkalaidun municipality has very high numbers of livestock for production.

What to do with manure?

Manure has to be spread in fields. N, P concentrations farmers buy conventional mineral fertilizer due to legislation. Manure spreading is controlled by the nitrates directive and phosphorus legislation. Spreading implies high costs due to work and investments, in addition to air emissions and discharge of nutrients into water.

Farmers still have to buy nitrogen fertilizer due to the unbalance of N and P in manure.

The aim of their project is to find environmentally and financially best way to treat manure and recycle the nutrients. They are also looking for cooperation partners for the distribution and marketing of the produced biogas.

They are specifically looking into anaerobic digestion with grass, straw and mixture of manure by dry plug flow digestion systems is under great interest. In this process pig manure TS concentration is raised from 6 % to close 30 % in farms. -> Liquid is used as fertilizer at the farm and solid phosphorous is transported into process. The project has funded a series of tests to study gas production capacity and concentrations of nutrition at digestion residue.

The first results obtained: nitrogen 60 g/kg TS and gas production 200 L/kg VS. High nitrogen concentration inhibited the process -> Concentrations of mixture was changed to increase the carbon/nitrogen ratio over 20:1

Baltic Sea action Group Commitment: Municipality of Punkalaidun made commitment to research and develop process to reduce local nutrition leakage into local water system. First municipality in BSAG history!

They want farmers to realize that by mixing manure, grass and straw and processing the mix it is possible to improve the nitrogen phosphorous ratio, possible increase the carbon

concentration and reduce the amount of work and money is put into manure controlling at the farms.

So, they plan on using not only pig or cattle manure to create biogas but to combine it in a good mixture with green biomass to get biomass and digestate. The next step will be what to do with the digestate.

Challenges he highlighted: communication problems within Finland to advance in this area, developing a local organic fertilizer market, taking the nitrogen in liquid form and converting it to solid fertilizer without using excessive energy and losing nitrogen.

Cecilia Bertholds (Käppala Association, Sweden)

Talked about sludge application in agricultural soil (issues, perception and regulations).

The Käppala association treats wastewater from over 500 000 inhabitants in eleven municipalities located north and east of Stockholm. Their treatment plant, the Käppala wastewater treatment plant, is Sweden's third-largest, and employs a very effective treatment process. They produce 30.000 tonnes of dewatered sludge (27% solids).

Sludge utilization in farmland is considered by them the most efficient application. Goal 90% of sludge to farmland (currently 75%). The major challenges they encounter are related to policies and public opinion on sludge in farmland and new restrictions.

Policies and public opinion:

- The flour milling industry does not accept crops fertilized with sludge
- Thus, sludge is mainly used on crops that are exported or for animal food
- There are no restrictions when food is imported!
- There's an ongoing debate about environmental and health risks. The discussion revolves around pharmaceuticals and organic substances. It was previously on metals.

When asked about sludge use in agriculture, 30% of farmers replied that they were not using sludge because of market restrictions, 20% said that for no specific reason.

In relation to phosphorus recovery, the Government has set a target of 40% of phosphorus in waste water to be recycled to farmland. The government has also said that sludge must be free from undesirable substances.

New requirements for pathogen control and stricter threshold values are being developed by the SEPA.

The Revaq certification system was established in 2008 to ensure safe recycling of nutrients to agricultural land and improve water quality. It is operated by several Swedish associations and federations (The Swedish Water and Wastewater Association; The Federation of Swedish Farmers; The Swedish Food Federation; The Swedish Food Retailer's Federation). This system has increased the acceptance of sludge application on farmland.

The certification system demands :

- Upstream work/source control,
- Constant improvement of the quality of the incoming wastewater
- Stricter metal limits than current Swedish legislation

- Pathogen control
- Full traceability
- Transparency

The upstream work was set to prevent unwanted substances to be discharged into the sewage. Their goal was to educate people upstream so that less substances will get to the WWTP. People were motivated by being informed, in the case of industry, they would be disconnect them from sewage system if they didn't cooperate. Communication played an important role.

A major challenge for them continues to be the discharge of diffuse pollutants from households.

Based on their experience, they recommend working together with farmers to learn more about the market and develop products that are suitable for their needs.

The whole picture must also be seen. In their case, Sludge use on farmland encouraged upstream work – This results in high quality sludge as well as cleaner water and decreased use of harmful substances in the society.

Create a close cooperation between WWTP and industry to increase the willingness to perform voluntary actions to identify and remove harmful substances – The Revaq certification system is an example of how this can be done.

When asked about how to deal with pathogens, she replied that soil microorganisms degrade most organic substances in sludge. Pharmaceuticals are the most discussed. They cannot be avoided. They will be the greatest challenge. 5% in sludge, 95% in water. It is an issue for water treatment.

It's a region with more horses than cattle. They lack organic material. So pushing farmers to use organic materials is an easy task, they just need it.

Sludge is applied to soil after digestion (stabilisation). Other than that there is not treatment.

Closing remarks: Allan Buckwell

Allan closed the day with a short set of remarks.

He noted that there seem to be no disagreements in the way that agriculture is being done and how we are dealing with N and P. The level of understanding of these issues is also not very wide, so there is a task to get better in our understanding: public perception, policy community, farmers.

He emphasized that there are solutions for these issues. There's plenty of ideas. What's less clear is what are the most important obstacles, which seem to be many. There are also economic issues about making it work (what are the appropriate incentive systems? Carrots or sticks).

Our idea with the project is to show these issues. The report will be presented next March.

Allan finally thanked the audience for attending the sessions. The speakers for simplifying complex issues and thanked our hosts at Casinazza and the organizing team for a well organised day.