Interreg
Baltic Sea Region

Co-funded by
the European Union

CIRCULAR ECONOMY
CiNURGi

CiNURGi Webinar #2

Project update and results after year 1

Erik Sindhöj & Cheryl Cordeiro, RISE

interreg-baltic.eu/project/cinurgi

CLIMATE-NEUTRAL SOCIETIES

CiNURGi Webinar #2

Project update and results after year 1

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Agenda

- Project objectives and goals
- Preparing solutions
- Piloting solutions
- Transferring solutions

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Interreg Baltic Sea Region

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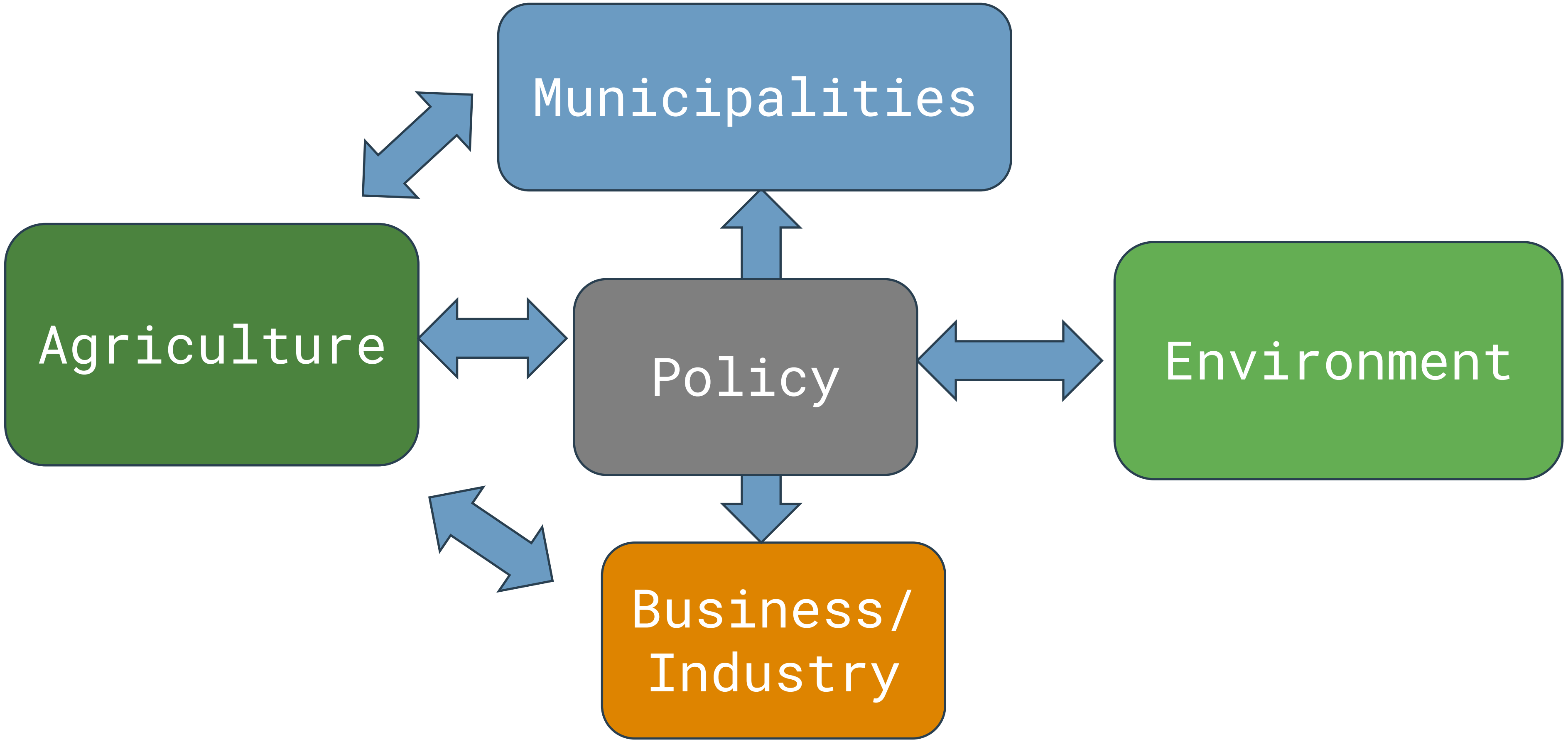
Vision and Long-term impact

Support the implementation of the Baltic Sea Regional Nutrient Recycling Strategy:

- Develop and promote standards for safe and sustainable recycling of nutrients
- Develop strategies for implementing nutrient recycling as a measure to improve national and regional nutrient balances
- Increase the acceptance and use of recycled nutrients
- Create business opportunities around nutrient recycling
- Improve policy coherence concerning nutrient recycling in the BSR

Baltic Sea Regional Nutrient Recycling Strategy

Need for Cross-Sector Collaboration



WP1 – Preparing solutions

CiNURGi Webinar 18.11.2024
Sari Luostarinen, Luke

interreg-baltic.eu/project/cinurgi

A1.1 Assess potential for nutrient recycling (NR) to improve national and regional nutrient balances

Luke NATURAL RESOURCES INSTITUTE FINLAND

- **Quantification and spatial distribution of recyclable biomasses (mass, N, P)**
- **Identification of regions with nutrient surplus/deficit as a comparison between available recyclable nutrients and their need in fertilization**
- **Description of current status of NR in the BSR**
- **Identification of bottlenecks for NR and creating regional/national draft strategies for solving them**

Potential for nutrient recycling

- Produced biomasses (amount, N, P content)
- Spatial distribution

Nutrient surplus/deficit areas

- Fertilization need
  - Fertilization limits, soil nutrient status, cultivated crops

Current status

- Current processing of biomasses in countries/regions, recycling/reuse technologies and practices already in use

Identification of bottlenecks & draft NR strategy

- Target groups involved to facilitate discussion

A1.1 Quantification and spatial distribution of recyclable biomasses

- Potential for nutrient recycling is needed to plan what kind of measures and where could be done to promote nutrient recycling
    - How much and where recyclable nutrients are produced
- Data on recyclable, nutrient-rich biomasses is collected via two routes:
    - Eurostat-based method created in HE-project LEX4BIO
        - Number of animals, population data and some side stream data that is available in Eurostat complemented with nutrient coefficients from literature
    - National data collection
        - Assumption: more detailed information available nationally than in Eurostat
            - Data on the national quantity and properties of biomasses better describing the national situation compared to general coefficients
            - Better spatial resolution of the origin of biomasses

Preliminary data: BSR (total nutrients)

	Eurostat N (t/a)	Eurostat P (t/a)	National N (t/a)	National P (t/a)
Livestock manure	2 049 045*	378 186*	2 169 731	383 828
Sewage sludge	111 080	75 015	107 543	71 681
Municipal biowaste	105 295	13 660	86 385	14 424
Animal by-products	137 121	30 409	132 974	28 880
Industrial side streams	2 640**	113**	Added later	Added later

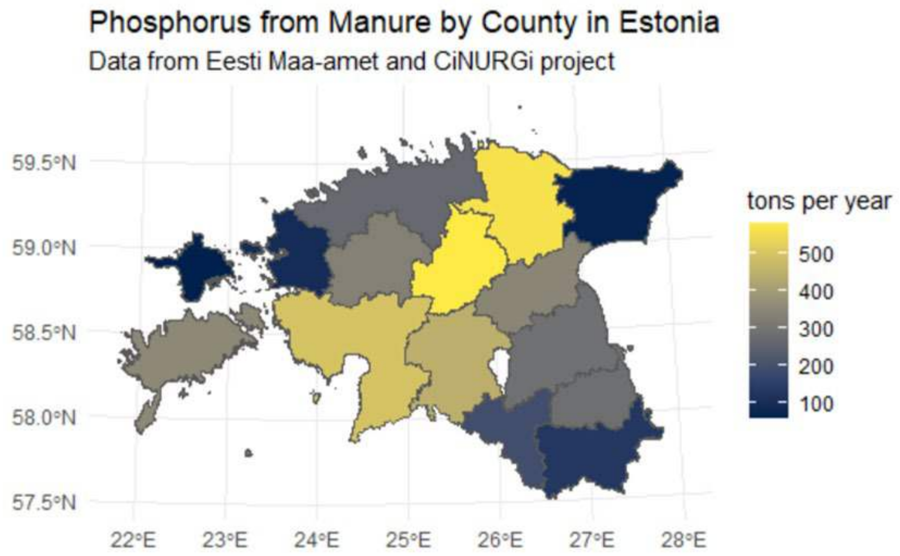
*manure ex animal
**grape pomace

- **NOTE! Not all national data for all countries available per biomass category. Some check-ups for Eurostat-based data needed.**

- **Spatial distribution**
  - Eurostat-based method: NUTS2
  - Nationally varies
- **Manure**
  - Eurostat: cattle, pigs, poultry, sheep, goats
  - Nationally: variable categories
- **Industrial side streams:**
  - Eurostat: grape pomace
  - National: variable streams

Example:
Estonia (total nutrients)

	Eurostat N (t/a)	Eurostat P (t/a)	National N (t/a)	National P (t/a)
Livestock manure	21 069	3 346	20 104	4 764
Sewage sludge	838	566	803	542
Municipal biowaste	162	21	163	21
Animal by-products	474	109	726	168
Industrial side streams	-	-	531	166



A1.1 Report: Background data for planning and promoting nutrient recycling in the BSR

- Potential for nutrient recycling: biomass data
- Comparison between recyclable phosphorus and need for P fertilization
    - kg P per hectare of utilized agricultural area
    - Potentially more detailed comparison taking into account e.g. P status of field soils
- Description of the state-of-the-art of nutrient recycling in the BSR
    - Per country and as conclusions for the entire region
- Draft of a national nutrient recycling strategy
    - A template to support developing national strategies around the BSR including suggestions of what kind of things should be considered

A1.2 Draft industry standards for evaluation and quality assurance of recycled nutrient fertilizers

Objective: Develop a comprehensive assessment scheme for recycled nutrient fertilizers (RNFs) focusing on agronomic efficiency, economic considerations, and environmental safety to ensure high-quality and economically viable RNF products.

Agronomic Assessment: Evaluate the agronomic efficiency of RNFs, specifically focusing on nitrogen (N) and phosphorus (P) content, amount of micronutrients, pollutant levels, and nutrient availability for plants.

Economic Considerations: Analyze the economic aspects related to the use of RNFs, including transportation costs, storage stability, and the capabilities and techniques required for applying RNFs.

Safety and Environmental Compliance: Develop standardized safety requirements for RNFs, setting limits on harmful substances, and proposing ecotoxicological evaluations to ensure environmental safety. Publish industry guidelines and recommendations for the maximum application rates of RNFs based on these standards.

A1.2 Draft industry standards for evaluation and quality assurance of recycled nutrient fertilizers

Julius Kühn-Institut

Collection of data and information of RNFs

RNF Description	• RNF/Fertiliser trade name • Original source • CE-marked accoring to the EU fertiliser regulation
RNF Chemical properties	• Dry matter • Macro-/Micronutrients • Carbon content/ C-N ratio
RNF Physical properties	•Form of RNF
RNF Pollutans	•Heavy metals •Pharmaceuticals •Persistent organic pollutants" (POPs)
RNF Economics	•Production technique (e.g. gasification, precipitation, hydrolysis...) •Quantity produced
RNF Practical use	•Application techniques •Storability •Transportability

Collecting data on RNFs helps develop effective assessment criteria for agronomic efficiency, economic viability, and environmental safety, ensuring high-quality, sustainable RNF products.

A1.2 Draft industry standards for evaluation and quality assurance of recycled nutrient fertilizers

Potential Workshop Questions for every country

Industry Standards

How can we adapt existing industry standards to suit recycled fertilizers while ensuring they meet environmental and health regulations?

Quality Standards

What quality benchmarks are essential for recycled fertilizers, and how should they be monitored continuously?

Economic Considerations

Transportation Costs: How can transportation costs be minimized, particularly considering the water content in recycled fertilizers?

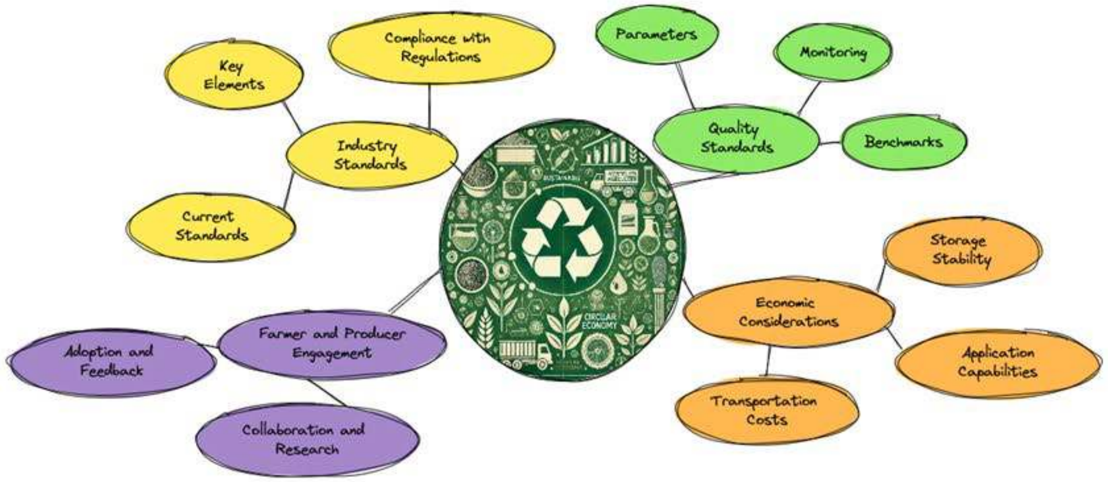
Storage Stability: What conditions optimize storage stability and reduce associated costs?

Application Capabilities: What adjustments to equipment and techniques are needed to handle recycled fertilizers effectively?

Farmer and Producer Engagement

Adoption: What barriers do farmers face in adopting recycled fertilizers, and how can we address them?

Economic Viability: How do recycled fertilizers compare economically to traditional options, and what incentives could boost adoption?



A standardized workshop involving diverse stakeholders can help develop consistent assessment criteria and best practices for RNFs, ensuring agronomic efficiency, economic viability, and environmental safety.

A1.2 Draft industry standards for evaluation and quality assurance of recycled nutrient fertilizers

Collecting Fertilizer Products Regulations parameter for each country concerning:

- Information on limits for contaminants
- Requirements for pathogenic organisms
- Requirements for organic pollutants
- Nutrient requirements
- Requirements regarding the time-temperature profile for treatment
- Regulations on impurities like glass, metal, or plastic
- Stability criteria for recycling fertilizers

The Collecting of Fertilizer Products Regulation arameters file aids in establishing regulatory compliance for RNFs by detailing required standards for contaminants, pathogens, and nutrients, ensuring safe and effective fertilizer use.

A1.2 Draft industry standards for evaluation and quality assurance of recycled nutrient fertilizers

Julius Kühn-Institut

Bottlenecks in Developing the RNF Assessment Scheme

Current Status

Data collection phase is complete.

Initial evaluation of data reveals significant inconsistencies.

Limited interest in workshops or surveys aimed at gathering stakeholder insights.

Key Challenges

High Variability in Data Quality

Data is extensive but lacks uniformity, with inconsistent formats and standards across sources.

Interpretation Difficulties

Complexity in interpreting data due to non-standardized measurements and metrics.
Diverse methodologies make it challenging to derive clear insights.

Assessment Scheme Development

Lack of cohesion in data prevents direct application for creating a comprehensive assessment scheme.
Need for extensive data harmonization to ensure reliable and consistent evaluation criteria.

Next Steps

Further evaluation and standardization of data is necessary.

Develop an assessment scheme, considering both existing and additional data deemed essential for the future.

Formulate recommendations based on findings.

A1.3 Market evaluation and review of policy affecting nutrient recycling (NR)

Organe Institute ApS

Identify innovative solutions – create "long list"
Identify innovative and optimized solutions (environmentally, economically and with respect to GHG)

Assess market potentials
Assess the BSR market size for identified and described optimal solutions for nutrient recycling – i.e. evaluate the "long-list" in terms of market potential.

End-user acceptance
Conduct surveys of potential end users of recycled nutrients to determine willingness to use recycled nutrients and potential issues of relevance – i.e. evaluate the "long-list" in terms of end-user acceptance.

Policy analysis
Evaluate current legal framework and policy instruments that either acts as barriers or supports and promote a market development towards higher use of the identified solutions, the long-list.

Reviewing EU and national bio-based fertiliser related legislation

Short-list - at least 2 x 3 = 6 cases (two solutions for farming, two for wastewater and two for food processing and other industry)

Qualified basis for formulation of policy recommendations for promotion of optimal solutions

Over the first 1½ project year, we will identify and prioritise the best solutions to be promoted by later project activities.

A1.3 activities

Preparing a "Call" for best cases

Many discussions have taken place in Task A1.3 meetings among the 28 registered participants in the task; we have averagely been 16-18 persons in every meeting, which is good, it shows a high interest for this task, and that people recognise the importance of coming to a common understanding of "best practices and most innovative solutions" within the CiNURGi context. Some main conclusions were:

- We will consider entire value chains and real cases from production of the nutrient containing organic wastes and until the resulting fertiliser is used as such.
- We want to see additive net positive effects on climate and environment in both the organic waste collection and processing steps, and in the fertiliser distribution and use, and an overall assessment should be based on the value for money principle.

A1.3 activities

The "Call"

Having clarified what we searched for and how we should assess reponses, a "Call" was announced on the project webpage, via newsletters and in social media in May 2024.

The initial deadline of 31 August was postponed until 30 September to get more responses. Companies were reluctant to respond due to

- fear of spreading business insights;
- time spend on providing requested information; and
- probably because they did not always see how spending time on this would help them.

A1.3 activities

Responses

We have received 24 responses, covering :

- 8 dealing with value chains based on household wastes (wastewater and food wastes), 6 on farming wastes, 3 on industry wastes, and 7 solutions that are based on different waste types.
- The value chains are situated in SE, FI, LT, PL, DE and DK, with the majority in FI.
- From the 24 responses, we have now made a pre-selection of 12 value chains – we call it a long-list, which we will analyse further concerning market potential, end-user acceptance and policy implications. We will also see to improve the quality of some basic information about the cases.
- The long-list had to be established mainly on basis of subjective impressions, since we did not succeed to get very detailed information collected via the call about the economy and the environmental and climate impacts of the cases.

A1.3 activities

Coming

The analysis of the "long-list" of 12 value chains will lead to:

- Prioritisation of the best 6 cases, a "short-list", comprising both farming, industry and households, which will be promoted in different ways in the remaining part of the project.
- The will candidate for the "Best Recycling Award" and they will be promoted in international fora, which CiNURGi organise or participate in.
- The Task A1.3 analysis of policy implications will be considered in later formulation of policy recommendations.

A1.4 Planning nutrient recycling investments to increase production of recycled nutrients

Centre of Estonian Rural Research and Knowledge

Four investments are planned

A1.4 involves:

A) Composing a peer-review group to review and advise each investment.

B) Planning the procurement for the investments, installation and commissioning of the investments.

Peer-review group
- Composing of transnational, cross sectoral group
- Dividing the group between investments
- Group meetings connected to the planning of investments

Planning the procurements
- Procurement plans of investing partners
- Review and advice of planning of procurement

Planning the installation
- Installation plans of investing partners
- Review and advice of planning of installation

Planning the commissioning
- Commissioning plans of investing partners
- Review and advice of planning of commissioning

M1-36: Planning nutrient recycling investments to increase production of recycled nutrients
M30-36: D.1.4: Implementation of nutrient recycling, Contribution to the output: O 2.4 Implementing nutrient recycling solutions

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Planned investments in the project application

- **Nutrient recycling from biogas digestate**

PP 1 - RISE - Research Institutes of Sweden; PP 9 - Swedish University of Agricultural Sciences; PP 23 - The Rural Economy and Agricultural Society (HS); PP 24 - More Biogas Drift Småland AB

- **Source-separated urine-based recycled fertilizers**

PP18 - Peab bostad AB, Sweden

- **Precision nutrient application for increasing nutrient recycling**

PP25 - Kuljetus Tero Liukas Oy , Finland

- **Biochar and ash based recycled fertilizer production**

PP 6 - The Institute of Fluid-Flow Machinery Polish Academy of Sciences (IFFM PAS)
PP 27 - RENDBEN Limited Liability Company

Status of investments

- ## More Biogas Drift Småland AB

Originally the MB investment plans were bigger than that included in CiNURGi: the CiNURGi investment was only intended to co-finance the MB investment. Unfortunately, the main funders of the investment have backed out, so now the ionvestment needs to be scaled down from the original plan to something that could fit within the CiNURGi budget. Currently we are discussing potential solutions.

- ## Peab bostad AB

The investment is not active in the project due to the building process not fitting the timeframe of the project. Other possibility to replace this investment is being discussed.

- ## Kuljetus Tero Liukas Oy

Investment is a NIR-device, which is installed to a truck (Scania r660) with tank trailer: capacity 45 m^3.
The truck is used to transport slurry to biogas plants and digestate from biogas plants.

- ## RENDBEN,

1. IMP PAN prepared the feedstock mixing sheet, where based on properties of 4 feedstock materials (digestate, sewage sludge, biomass ash, biochar), we calculated theoretical values, such as TS, VS, Total N, Total P_2O_5 , Total C, Total K_2O
2. IMP PAN will now prepare 5 mixtures and analyze them
3. Then IMP PAN with RENDBEN will test mixing process of the given feedstock materials which will be an input knowledge to further design the prototype

Circular nutrients for a sustainable Baltic Sea Region – An overview of CiNURGi project activities and progress

01:26:00

Ta | Öppna nytt | Chatt | Deltagare 58 | Hand | Reagera | Visa | Anteckningar | Mer | Kamera | Mikrofon | Dela | Lämna

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A1.2 Draft industry standards for evaluation and quality assurance of recycled nutrient fertilizers

JKI Julius Kühn-Institut

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Formulate recommendations based on findings.

| 17

Eetu Virtanen (Extern)

Möteschatt

Vissa personer i den här chatten befinner sig utanför organisationen. Det är möjligt att de har meddelanderelaterade principer som gäller för chatten. Mer information

Privacy Policy: https://www.read.ai/pp

Bose, Cezary (Extern) 12:09

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Cheryl Marie Cordeiro 12:27 Översätt

Should anyone have questions, plesae type them in this chat. We will try our best to get back to you. Thanks.

Skriv ett meddelande

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WP2 – Piloting solutions

CiNURGi Webinar 18.11.2024

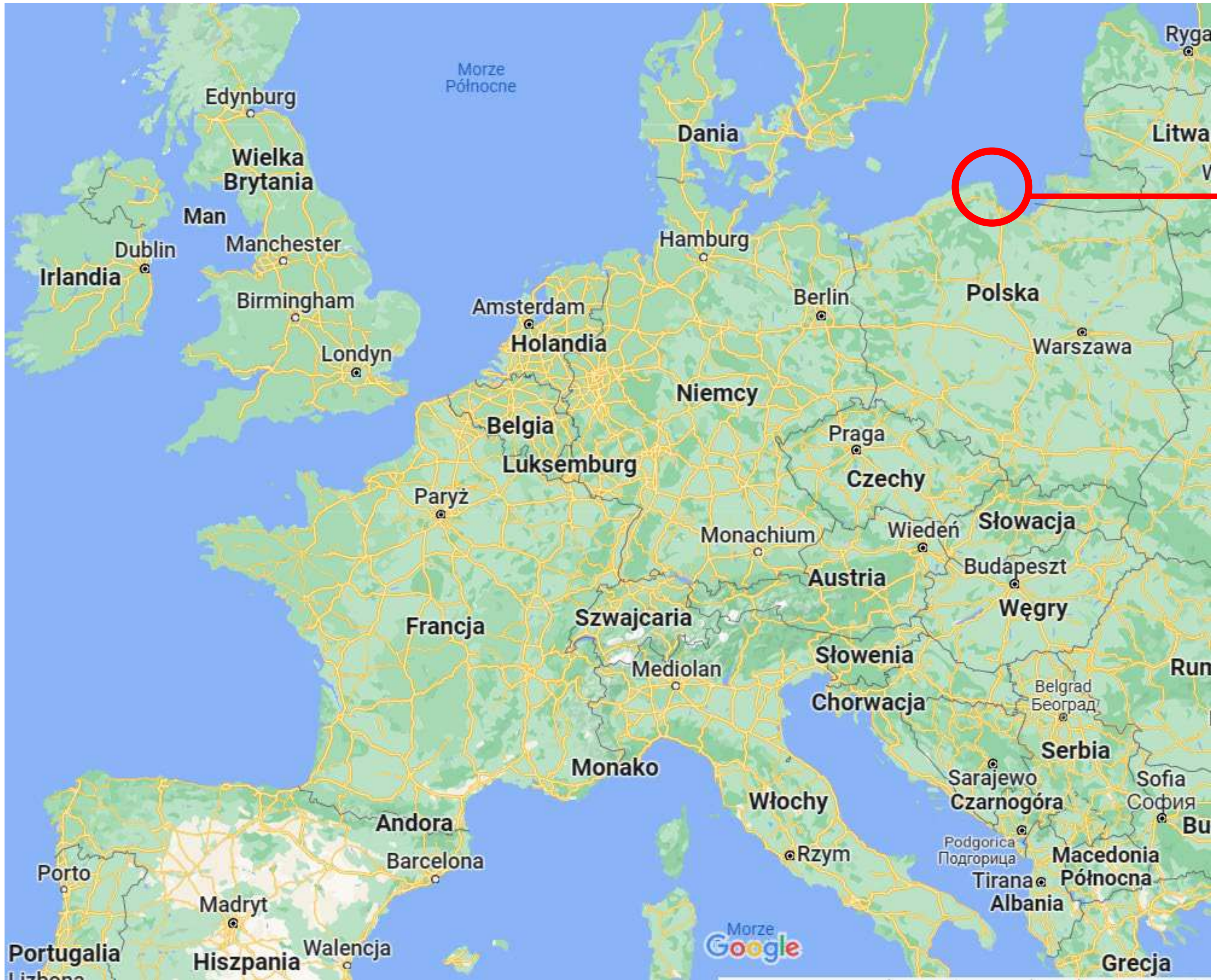
Ksawery Kuligowski,

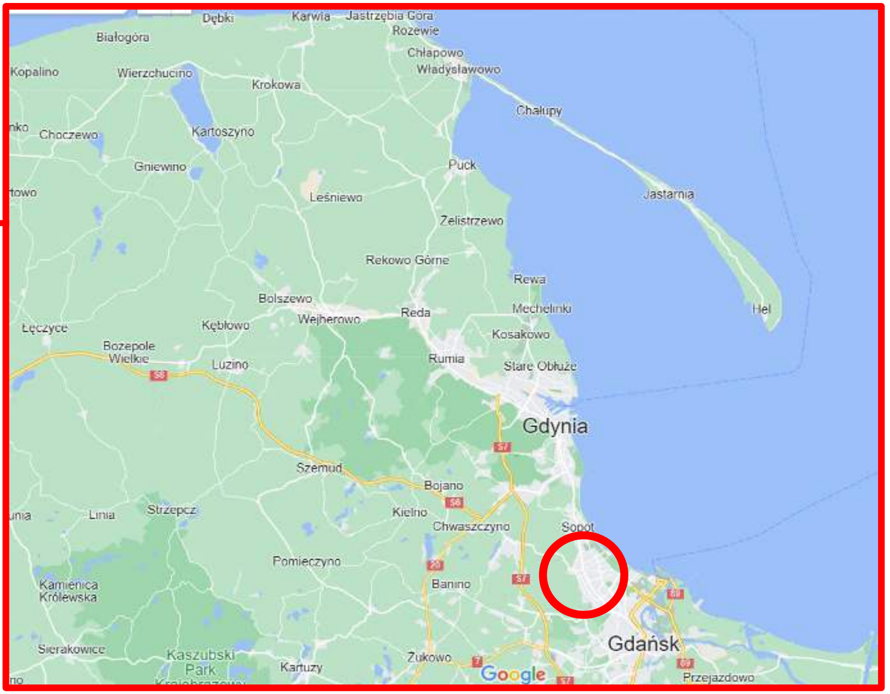
Institute of Fluid-Flow Machinery
Polish Academy of Sciences
(IMP-PAN)

interreg-baltic.eu/project/cinurgi

WHERE ARE WE FROM?

Institute of Fluid-Flow Machinery Polish Academy of Sciences: www.imp.gda.pl
GDAŃSK, Poland





CENTRE OF PLASMA AND LASER ENGINEERING

The Department of Physical Aspects of Ecoenergy

focuses on a wide range of topics such as nanotechnologies for water splitting and functional materials, ecoenergetics (production of biofuels: biohydrogen, biogas, bioethanol, etc.; photovoltaic systems), circular economy, waste management and biofertilizer technologies (digestate, compost, etc.). The Department also conducts research related to plasma diagnostics, engines and medical lasers.

The present scientific activities are focused on:

- nanotechnology and advanced functional materials,
- waste anaerobic digestion and waste pre-treatment methods (enzymatic, pressure, temperature, chemical treatment),
- bioethanol production from lignocellulosic biomass,
- circular economy, as well as management of: food, industrial and agro- waste, waste plastics,
- biogas purification technologies and gas engine diagnostics,
- digestate nutrients recovery and fertilizers/soil amendments preparation,
- agronomic effectiveness verification via glasshouse tests and agri-environmental modelling,
- microbial bioremediation of polluted soil and water (remediation of heavy fuel spills from shipwrecks and polluted lake beds),
- plasma and laser diagnostics and application.

My Group's reserch

Presentation Outline

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A2.1 Pilot updates from nutrient recycling knowledge centers

A2.2 Evaluation standards for quality control

A2.3 Increasing acceptance of recycled fertilizers

A2.4 Implementing nutrient recycling solutions

Presentation Outline

Vision of the Support Centres

2.1 Technology → 2.2 Product Evaluation → 2.3 Product Validation → 2.4 Implementation

A2.1

The activity subtasks

1. Establish 4 support centers for circular nutrient solutions.
2. Establish a transnational, cross-sectoral peer-review group to review
3. Case-studies of ongoing NR initiatives will be found and evaluated for their potential to contribute to regional redistribution of nutrients from areas with surplus to areas with def (min. of 2 per country).

Main Pilot Investments

1) Nutrient recycling from biogas digestate

More Biogas plans to use a **mechanical decanter centrifuge**, which they've invested in, **to extract phosphorus from their digestate**. After separation, the phosphorus-rich fiber fraction needs drying and pelleting for stable storage and transport. This investment is specifically for the equipment needed for drying and pelleting, completing their process to produce recycled nutrient fertilizers.

PP 1 - RISE - Research Institutes of Sweden
PP 9 - Swedish University of Agricultural Sciences
PP 23 - The Rural Economy and Agricultural Society (HS)
PP 24 - More Biogas Småland AB ?

2) Source separated urine based recycled fertilizers

PEAB Bostad has been planning on building an office building for approx. 120 people. They plan to install **urine separating toilets and a urine collection and drying unit** in the basement to produce dried urine crystals that can but used to produce granulated recycled nutrient
fertilizers.

PP 18 - Peab bostad AB ?

3) Precision nutrient application for increasing nutrient recycling

Real-time NIR measuring of nutrient contents on slurry tankers while spreading on fields will allow liquid organic fertilizers to come into the age of modern precision farming. Dosing can be controlled in real time according to nutrient contents and crop needs to reduce over fertilization resulting in surplus of nutrients.

PP 25 - Kuljetus Tero Liukas Oy (KTLO)

4) Biochar, ash, digestate and sewage sludge based recycled fertilizer production

ECOSTAB LtD. plans to develop a pilot line for the biomass biochar/ ash - based fertilisers production utilising local biomass for fertilisers/ liming agents for agriculture with high replication capacity in BSR.

PP27 – RENDBEN LtD.

Internal Pilot Investments

5) Mobile support center for producing recycled nutrient fertilizers
A mobile support center for small-scale production of recycled nutrient products will be built to offer start-ups, SME's, farmers and municipalities the possibility to process small quantities of their biomass streams into recycled nutrient fertilizers which will then be evaluated. This is often a bottleneck for many startup ideas, just to see what can be done with their biomass stream and then evaluate being able to make better business plans around nutrient recycling.
PP 1 - RISE - Research Institutes of Sweden

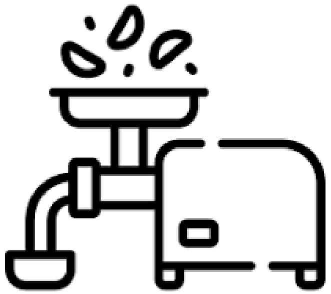
6) Prototype pyrolysis reactor
The pyrolysis reactor will be part of the A2.1 support center to test making biochar from various biostreams. The reactor will allow for efficient execution of tests to obtain samples of at least 1 kg for further evaluation. The reactor is intended to consist of four slots for reactor placement, each station equipped with the capability of heating up to 800°C, precise temperature control with increments of 1°C. This will enable simultaneous pyrolysis and increase work efficiency in the project.
PP 6 - The Institute of Fluid-Flow Machinery Polish Academy of Sciences (IMP PAN)

7) Irrigation/ automation system for the digestate/ biochars verification test bed
This investment will pilot the A2.2 Evaluation centers. This will be integrated into a 24m2 glasshouse facility that will serve as a validation research station used for novel recycled nutrients in the form of fertilisers, biostimulators and soil ameliorants. The materials will be derived from various digestates, biochars, ashes and mineral/ organic waste streams produced by the support centers.
PP 6 - The Institute of Fluid-Flow Machinery Polish Academy of Sciences (IMP PAN)

Reactor design and construct for this project

- Pyrolysis proces 300-500° C
- 4 reactors operating in parallel
- one reactor enabling the process of increasing the specific surface area of the char, 800° C

Food industry and agriculture waste biomass



Waste biomass
Rye bran
Wheat bran
Beetroot waste
Corncob
Walnut shell
Hazelnut shell
Cherry pits
Sunflower husk
Oat husk
Brewer's spent grain

Waste biomass
Coffee husk
Chokeberry pomace
Rice husk
Dried apple presscake
Dried chokeberry
Ground coffee
Rye straw
Wheat straw
Barley straw
Spelled husk

Charcoals of biomass







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Main Pilot activities

1. SWEDEN: PILOT 1: Nutrient recycling from biogas digestate, More Biogas Småland AB, awaiting…
2. SWEDEN: PILOT 2: Source separated urine based recycled fertilizers, TBD who…
3. **FINLAND: PILOT 3: Precision nutrient application for increasing nutrient recycling, by *Kuljetus Tero Liukas Oy (KTLO)***
4. **POLAND: BAD-SS (Biochar-Ash-Digestate-Sewage Sludge) granulated fertilizer production in the mobile pilot line, by *Rendben LtD.***

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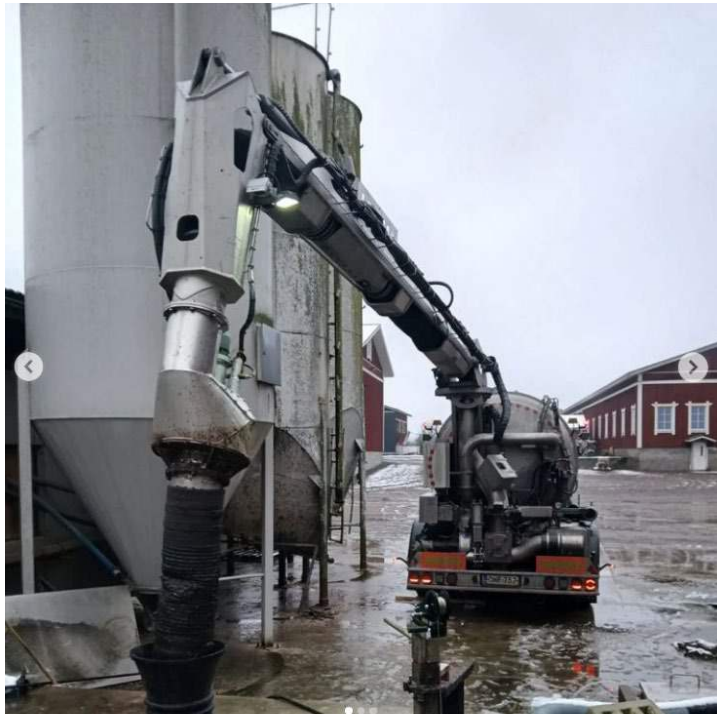
Pilot 3 activities – Kuljetus Tero Liukas Oy

Kuljetus Tero Liukas has procurred and purchased a **NIR-device** which is installed into a truck (45 m3) used for transporting **slurry/sludge into biogas plants/other users** and **digestate** from biogas plants. The idea is that the company develops its logistic services for livestock farms and processing plants with **simultaneous measurement** of the slurry/sludge/digestate properties (dry matter, N, P, K). **The farmer/processing plant** gets thus **more precise data** on the nutrient content of the slurry/digestate when they are being transported to plants prior to digestion/storage prior to field application.



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Pilot 3 activities – Kuljetus Tero Liukas Oy

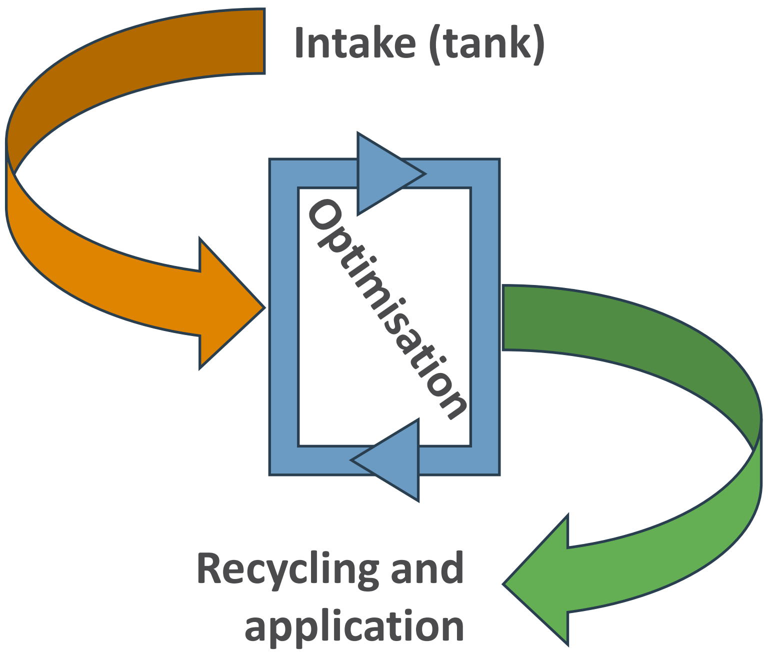
1. A case study:

1. A pig farm **settles its slurry** in tank with a sloped bottom.
2. The **settled solids**, containing most of the manure phosphorus, **can be sucked** from the bottom with a 300 mm pipeline from the deepest section of the tank (10 cm from the bottom).
3. NIR-device will be used **on the farm to measure** how much of the phosphorus can be separated into the settled solids **with different mixing routines of the tank**.
4. The settled solids are transported to a biogas plant nearby.
5. The data collected with the NIR-device support the reports the biogas plant needs to make on manure phosphorus recycling to receive a **nutrient recycling support**, a novel subsidy for biogas plants digesting manure and trying to improve manure phosphorus reallocation. The subsidy is paid by the *Finnish Ministry of Agriculture and Forestry*.

3. General use of the NIR-device:

Kuljetus Tero Liukas transports approx. 200 000 m3 of slurries/sludges/digestates, half od which is livestock slurry. NIR-device is expected **to improve the data** on the properties for the **substrate/ product quality control**. NIR-device can also be used if a slurry on a farm is enriched with other biomasses, e.g. digestates, solid manures and fractions, with simultaneous optimization of the nutrient content.

Focus: P in slurry solids



A2.1 Pilot 3

Support from project partner LUKE

1. Taking the samples of the slurries and digestates the truck will transport and simultaneously measure with the NIR device.
2. The samples will be taken to Luke's laboratory for the needed chemical analysis.
3. The results can then be used in calibrating the NIR device even better.

A2.1 Pilot 4

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Pilot 4 activities – RENDBEN LtD. And suport from IMP PAN

1. Development of the BAD-SS (Biochar-Ash-Digestate-Sewage Sludge) granulated fertilizer production in the pilot line
2. Feedstock mixing calculation sheet
3. Samples collection – Biochar, Ash, Digestate, Sewage Sludge
4. Pelleting tests
5. Optimization of the pelletization process and product composition
6. Analysis of the test products

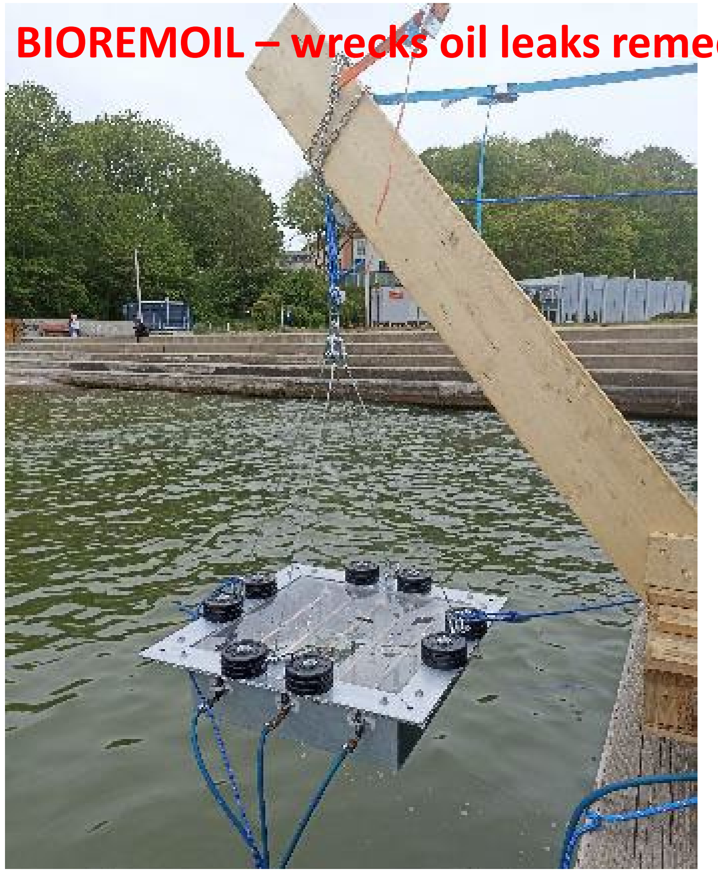
A2.1 Pilot 4

Rendben

1. Prototyping in Mechanical, Chemical and Process Engineering,
2. Designing and installations,
3. Installation service
4. https://www.rendben.eu/

Dimethyl ether for the development of small hydrocarbon deposits

BIOREMOIL – wrecks oil leaks remediation



A2.1 Pilot 4

Rendben

Prototypes portfolio

BIOREMOIL "Development of a method for bioremediation of oil spills from Baltic wrecks - microbiological studies and the first prototype".

1. MICROBIOLOGICAL RESEARCH (industrial research). Bioremediation tests of collected oil samples in laboratory conditions (TRL 3-5).

2. PREPARATION OF THE PROTOTYPE CONSTRUCTION (development work). Production of a prototype construction of an installation based on a caisson in real conditions (TRL 6-7).

3. EQUIPPING THE PROTOTYPE WITH DEDICATED INSTALLATIONS (development work).

"Pretreatment of waste substrates for fermentation - construction of the installation and process testing"

Cooperation with the Institute of Fluid-Flow Machinery of the Polish Academy of Sciences in Gdańsk as part of the Implementation Doctorate program - 5th edition with the support of the Ministry of Education and Science, no. DWD/5/0554/2021. Partner of the Tri-City Doctoral School of the Polish Academy of Sciences in the implementation of the implementation doctorate within the discipline of mechanical engineering.

„Development of technology for obtaining dimethyl ether for the development of small hydrocarbon deposits" including:

The delivery of elements of the construction of the demonstration installation together with assembly in the project, including:

- Elements of the product separation system after DME synthesis
- Elements of the DME synthesis system on a demonstration scale
- Elements of the catalyst exchange and recovery system.

A2.1 Pilot 4

Feedstock Mixing Calculation Sheet

BASIC CHARACTERISTICS OF FEEDSTOCK MATERIALS

		Total Solids	Volatile Solids	Total N	Total P2O5	Total C	Total K2O	Reference
		%	% TS	%	%	%		
OSAD	Sewage sludge	20	55	1.00	0.39	11.00	0.24	*IMP PAN own literature study*
		35	60	2.00	0.79	21.00	0.12	*IMP PAN own literature study*
				3.00	1.18		0.36	*IMP PAN own literature study*
				4.00			0.48	*IMP PAN own literature study*
				5.00				*IMP PAN own literature study*
	AVG	27.50	57.50	3.00	0.79	16.00	0.30	
POFERMENT	Digestate (manure)	5	42	1.15	0.50	2.10	0.90	*AgroTechnologyATLAS*
		7.9		4.80				*AgroTechnologyATLAS*
				3.02				*AgroTechnologyATLAS*
				3.90				*AgroTechnologyATLAS*
		12.7	97.3	4.90	0.49	12.36	0.10	*AgroTechnologyATLAS*
		1.50	8.50	0.60	0.03	0.13	0.38	*AgroTechnologyATLAS*
	AVG	6.78	49.27	3.06	0.34	4.86	0.46	
POPIÓŁ	Biomass ash	99	0	0	18.14	0	1.06	*Incinerator bottom ash from pelleted solid fraction of pig manure digestate*
		99	0	0	24.06	0	3.36	*Incinerator bottom ash from pelleted solid fraction of pig manure digestate*
		99	0	0	22.29	0	4.12	*Thermal gasifier ash from pelleted solid fraction of pig manure diegstate*
	AVG	99.00	0.00	0.00	21.50	0.00	2.85	
KARBONIZAT	Biochar	96	80.6	26.60	6.51	39.8	7.83	*Biochar from chicken litter*
		96	75.4	17.50	5.13	52.2	3.88	*Biochar from poultry litter (starter turkey)*
		97	45.4	16.70	6.63	22.7	6.81	*Biochar from poultry litter (broiler)*
	AVG	96.33	67.13	20.27	6.09	38.23	6.17	

CALCULATED CHARACTERISTICS OF MIXTURES

	Total Solids	Volatile Solids	Total N	Total P2O5	Total C	Total K2O
Mixture 1	30.37	53.46	3.73	2.00	14.08	0.75
Mixture 2	37.39	51.07	4.44	3.30	14.40	1.17
Mixture 3	49.02	46.21	5.00	5.66	14.46	1.72
Mixture 4	60.64	41.35	5.56	8.02	14.53	2.26
Mixture 5	65.59	38.14	6.28	9.27	13.73	2.69
Mixture 6	73.64	36.16	6.99	10.59	14.60	3.11
EXAMPLE FINAL PRODUCTS						
Soil organic fertilizer PL req.		30	0.30	0.20		0.20
Biovakka Granulate			3.60	2.20		6.80
IMP Kitchen Waste gr.	25.4	93.1	3.40	0.34		1.02

REOLOGICAL PROPERTIES - OBSERVED DURING MIXING

MODIFY HERE

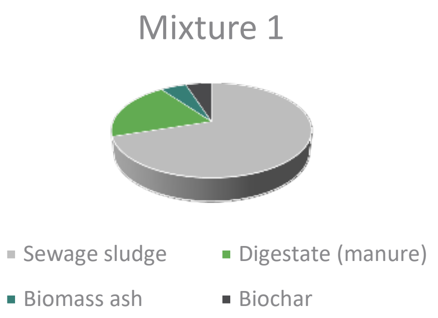
	Mixture 1	Mixture 1	Mixture 1	Mixture 1	Mixture 1	Mixture 1
	%	%	%	%	%	%
Sewage sludge	70	70	70	70	70	70
Digestate (manure)	20	20	20	20	20	20
Biomass ash	5	5	5	5	5	5
Biochar	5	5	5	5	5	5
	Mixture 2	Mixture 2	Mixture 2	Mixture 2	Mixture 2	Mixture 2
Sewage sludge	60	60	60	60	60	60
Digestate (manure)	20	20	20	20	20	20
Biomass ash	10	10	10	10	10	10
Biochar	10	10	10	10	10	10
	Mixture 3	Mixture 3	Mixture 3	Mixture 3	Mixture 3	Mixture 3
Sewage sludge	50	50	50	50	50	50
Digestate (manure)	15	15	15	15	15	15
Biomass ash	20	20	20	20	20	20
Biochar	15	15	15	15	15	15
	Mixture 4	Mixture 4	Mixture 4	Mixture 4	Mixture 4	Mixture 4
Sewage sludge	40	40	40	40	40	40
Digestate (manure)	10	10	10	10	10	10
Biomass ash	30	30	30	30	30	30
Biochar	20	20	20	20	20	20
	Mixture 5	Mixture 5	Mixture 5	Mixture 5	Mixture 5	Mixture 5
Sewage sludge	20	20	20	20	20	20
Digestate (manure)	20	20	20	20	20	20
Biomass ash	35	35	35	35	35	35
Biochar	25	25	25	25	25	25
	Mixture 6	Mixture 6	Mixture 6	Mixture 6	Mixture 6	Mixture 6
Sewage sludge	15	15	15	15	15	15
Digestate (manure)	15	15	15	15	15	15
Biomass ash	40	40	40	40	40	40
Biochar	30	30	30	30	30	30

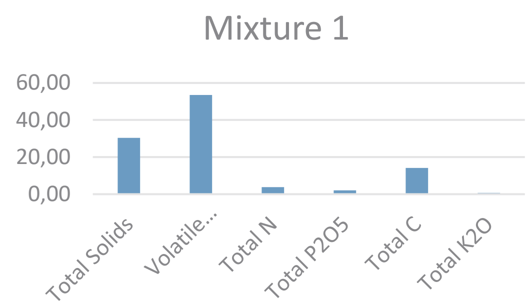
DEFINE SHARES OF INGREDIENTS

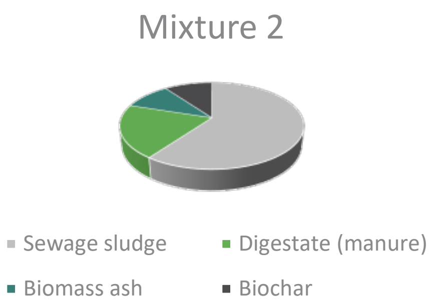
GET THE END PRODUCT PARAMETERS

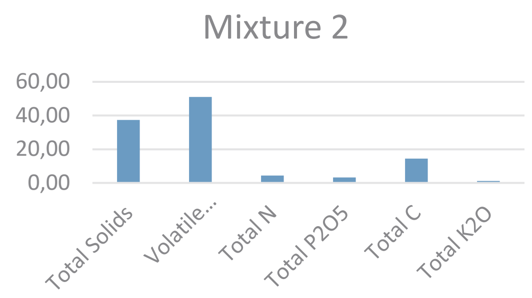
A2.1 Pilot 4

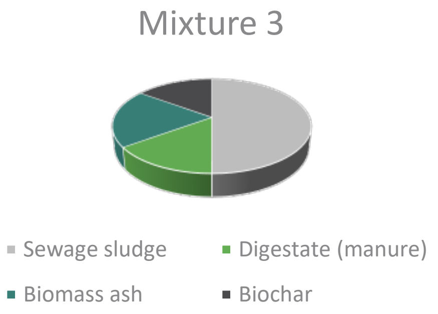
Assumed compositions

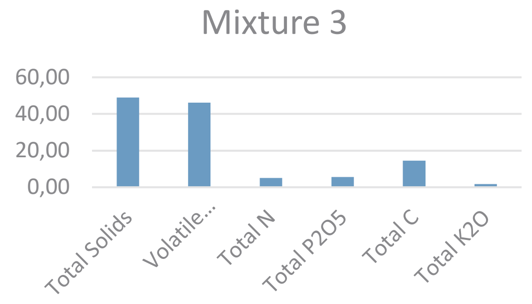


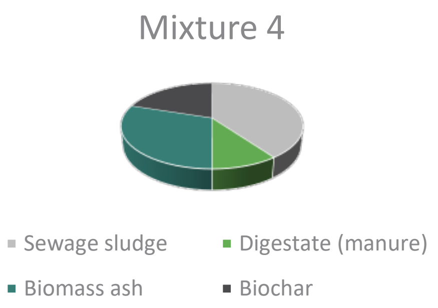


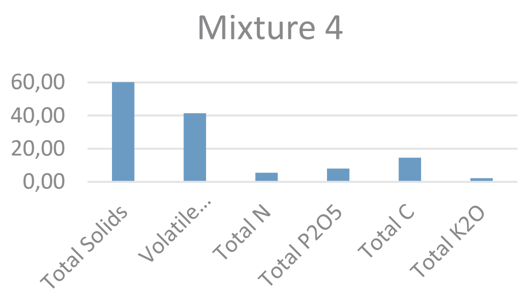


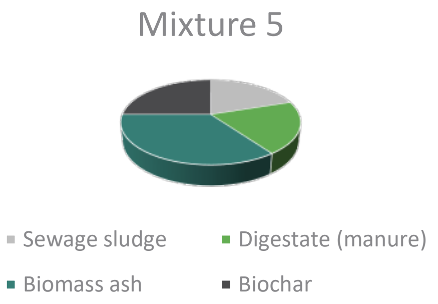


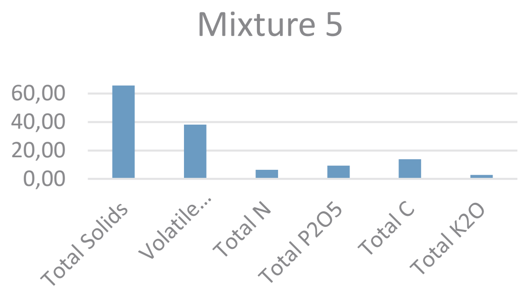


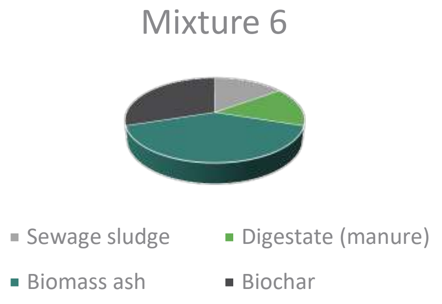


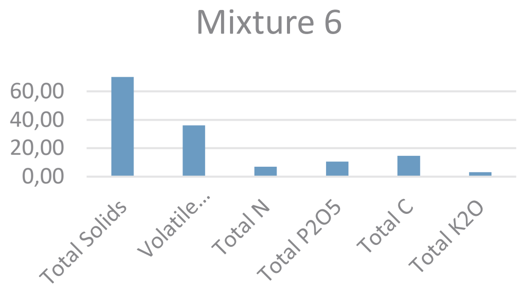












A2.1 Pilot 4

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Pelleting tests for mixes 1-6

A2.1 Pilot 4

Pelleting tests for mixes 1-6

A2.1 Pilot 4

Observations

Mixture	Composition (%)	Mixing Observations
Mixture 1	Sewage sludge: 70%, Digestate (manure): 20%, Biomass ash: 5%, Biochar: 5%	- Wet and plastic mixture, easy to mix. - Consistency resembles clay, forming a cohesive mass without clumps. - Mixes easily without clumping issues.
Mixture 2	Sewage sludge: 60%, Digestate (manure): 20%, Biomass ash: 10%, Biochar: 10%	- Similar to Mixture 1 but more compact. - Forms clumps, especially with the increased ash content. - Gradual addition of ingredients recommended to prevent excessive clumping.
Mixture 3	Sewage sludge: 50%, Digestate (manure): 15%, Biomass ash: 20%, Biochar: 15%	- Drier mixture, more prone to forming clumps. - Requires careful and gradual addition of ash and mixing in stages.
Mixture 4	Sewage sludge: 40%, Digestate (manure): 10%, Biomass ash: 30%, Biochar: 20%	- More granular, harder to mix, prone to forming larger clumps. - Proper order of adding ingredients is crucial to achieve a uniform consistency.
Mixture 5	Sewage sludge: 20%, Digestate (manure): 20%, Biomass ash: 35%, Biochar: 25%	**- The driest and most granular mixture**. - Difficult to mix requires special attention when adding ash to avoid clumping. - Preferred to mix in stages for a more even mass.
Mixture 6	Sewage sludge: 15%, Digestate (manure): 15%, Biomass ash: 40%, Biochar: 30%	- Very dry and granular, with high clumping tendency due to the large amount of ash. - Requires even more careful, staged mixing. - **Best suited for granulation** due to its dry consistency, though challenging to mix uniformly without clumping.

A2.1 Pilot 4

Nitrogen contents

Maybe N underestimated?

Mixture	Average Nitrogen Content (% NH_4)	Nitrogen Content (g N/kg)	Coefficient of Variation (RSD)	Comments
Mixture 1	0.08% NH_4	6.5 g N/kg	6.51%	Results out of range. instrument check recommended.
Mixture 2	0.07% NH_4	5.8 g N/kg	2.81%	Stable results, but out of acceptable range.
Mixture 3	0.02% NH_4	1.7 g N/kg	17.79%	High variability, possible mixing difficulties.
Mixture 4	0.05% NH_4	3.7 g N/kg	18.10%	High variability, challenging for mixing and granulation.
Mixture 5	**0.14% NH_4**	10.5 g N/kg	0.05%	**Most stable results, suitable for granulation.**
Mixture 6	0.00% NH_4	0.4 g N/kg	35.04%	Very high variability, careful handling required for consistency.

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Pilot 4 – Conclusions and recommendations

1. Effect of Composition on Mixing and Clumping

1.1 Mineral components (Biomass ash and Biochar) significantly increase the dryness of mixtures but also contribute to clumping. This is particularly evident in mixtures 3-5, which have higher proportions of these ingredients.

1.2 Mixing Recommendations:

1.3 Gradual dosing of ash is key to minimizing clumping.

1.4 Adding ingredients in the right order is essential for maintaining a homogeneous mass. It's recommended to start with more moist ingredients (Sewage sludge and Digestate) and then gradually add Biomass ash and Biochar.

1.5 Mixtures with higher Sewage sludge and Digestate content (mixtures 1 and 2) are more moist and less prone to clumping, making them easier to mix.

2. Use of Mixtures as Granulated Fertilizers

2.1 Mixtures 4 and 5 have the best potential for granulation due to their dry, granular consistency and ease of drying after being shaped into granules. Their higher mineral content supports a slower release of nutrients.
2.2 Mixture 3 can also be granulated, although it requires additional caution in mixing due to clumping.
2.3 Mixtures 1 and 2 are more challenging to granulate due to their higher moisture and stickiness. They can be applied as bulk fertilizer or granulated with additional drying aids.

3. Fertilizer Efficiency

3.1 Nitrogen content is highest in Mixture 5 (10.5 g N/kg), making it the most efficient for nitrogen delivery in soil. The low variability (RSD 0.05%) suggests this mixture's stability.
3.2 Mixture 1 has moderate nitrogen content but higher result variability. It may be better suited for short-term nutrient delivery applications.
3.3 Mixtures 3 and 4 have lower nitrogen content and higher variability, which may impact their predictability as fertilizers, especially for granulation.

4. Production Process Recommendations

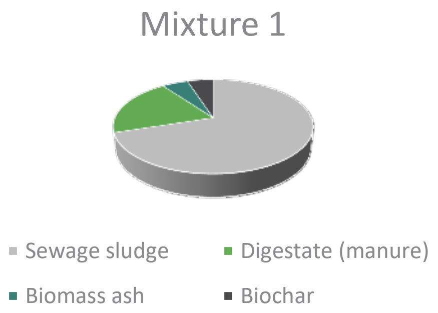
4.1 Gradual Mixing: Staged mixing is recommended, especially for mixtures with higher ash content, to avoid excessive clumping.
4.2 Drying Optimization: Drier mixtures (4-6) require less energy for drying, potentially reducing granulated fertilizer production costs.
4.3 Quality Control: For mixtures with high variability (RSD), particularly 3 and 4, regular monitoring of the production process is advised to ensure consistent fertilizer quality.

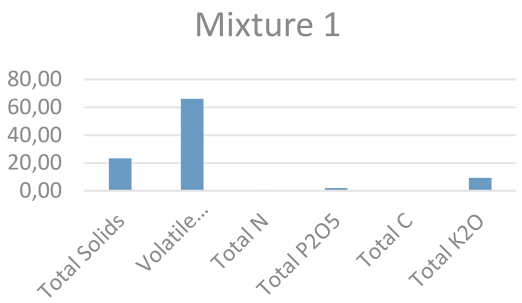
Summary

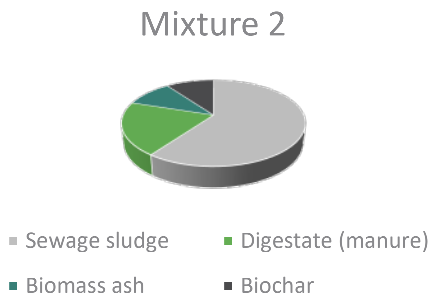
Mixtures 4 and 5 are the most suitable for producing granulated fertilizers due to their dry structure and ease of drying. Mixtures 1 and 2, due to their higher moisture content, are better suited for bulk fertilizer application or require additional steps for granulation. Gradual addition of ash and appropriate mixing order are essential to prevent clumping and achieve a uniform product.

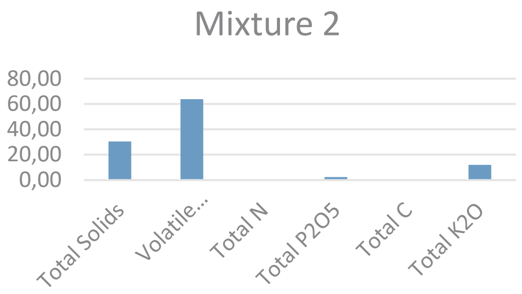
A2.1 Pilot 4

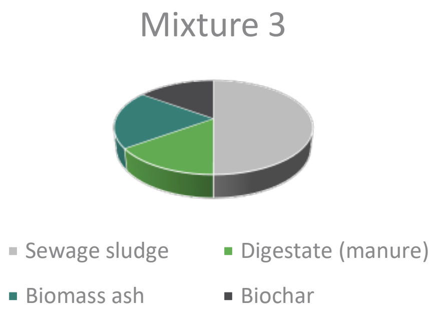
Measured compositions

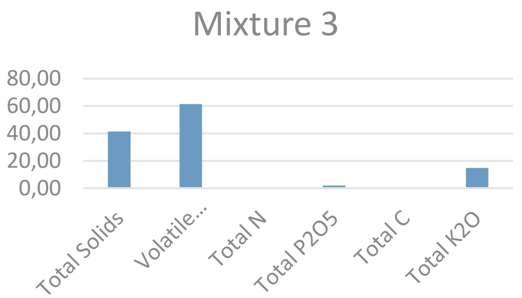


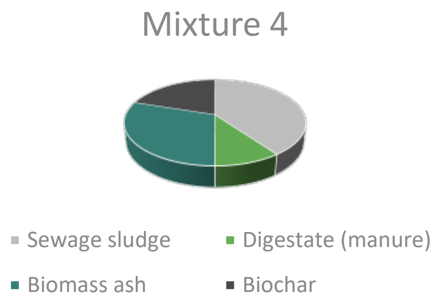


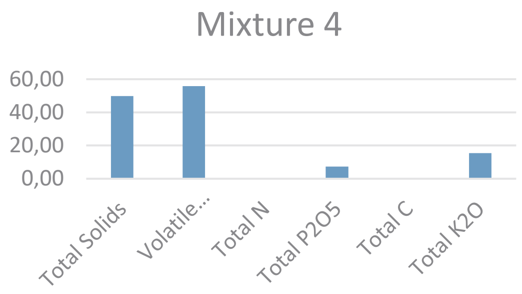


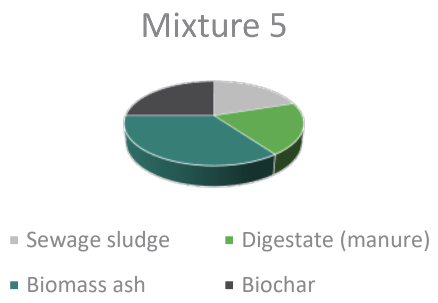


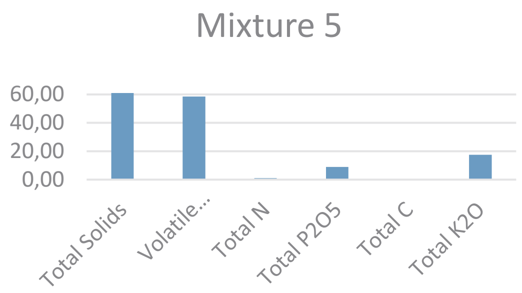


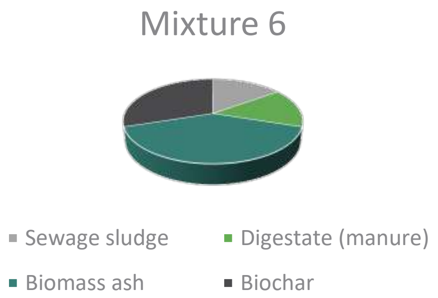


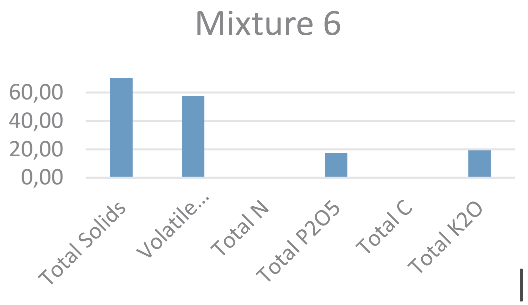












A2.1 Pilot 4

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Theoretical vs. Measured values

CALCULATED CHARACTERISTICS OF MIXTURES	Total Solids %	Volatile Solids % TS	Total N %	Total P2O5 %	Total C %	Total K2O %
Mixture 1	30.37	53.46	3.73	2.00	14.08	0.75
Mixture 2	37.39	51.07	4.44	3.30	14.40	1.17
Mixture 3	49.02	46.21	5.00	5.66	14.46	1.72
Mixture 4	60.64	41.35	5.56	8.02	14.53	2.26
Mixture 5	65.59	38.14	6.28	9.27	13.73	2.69
Mixture 6	73.64	36.16	6.99	10.59	14.60	3.11

MEASURED CHARACTERISTICS OF MIXTURES	Total Solids %	Volatile Solids % TS	Total N %	Total P2O5 %	Total C %	Total K2O %
Mixture 1	23.28	66.15	0.65	1.83		9.35
Mixture 2	30.58	63.84	0.58	2.44		12.13
Mixture 3	41.32	61.35	0.17	2.00		14.79
Mixture 4	49.89	55.84	0.37	7.34		15.34
Mixture 5	61.01	58.42	1.05	8.87		17.46
Mixture 6	71.78	57.56	0.04	17.32		19.34

Maybe N underestimated?

A2.1 Case Study in PL

Phosphorus recovery from wastewater

The wastewater treatment plant in Cielcza near Jarocin is implementing a pioneering project for phosphorus recovery from sewage sludge and wastewater. This is the first investment in Poland and one of the few in Europe.

https://pwikjarocin.pl/kontakt/

A2.1 Case Study in PL

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The municipality of Jarocin plans to use this recovered phosphorus from sewage sludge for fertilizing and maintaining green spaces. The wastewater treatment plant in Cielcza is undergoing significant modernization, with the primary goals of reducing excess sewage sludge, lowering the concentration of biogens (P and N) in treated wastewater, and recovering water.

WWTP basic parameters:

- **Maximum Flow (Qmax)**: 12,500 m^3/d
- **Population Equivalent (PE)**: 93,285
- **Sewage Sludge Mass**: 8,000 kg Dry Matter (DM) per day
- **Modernization Cost**: €66.2 million
- **End of implementation:** 2024

Goals after modernization:

- **Sewage Sludge Mass Reduction**: 40-50% in the mass of sewage sludge produced.
- **Phosphorus Recovery**: 80% recovery of PO_4^{3-}
- **Ammonia Recovery**: 15% recovery of NH_3
- **Fertilizer Production**: 170 Mg/year
- **Water Recovery**: 700,000 m^3 of water annually for reuse

Mineral fertilizer composition:

5% - Nitrogen (NH_4)

28% - Available Phosphates (P_2O_5)

10% - Magnesium

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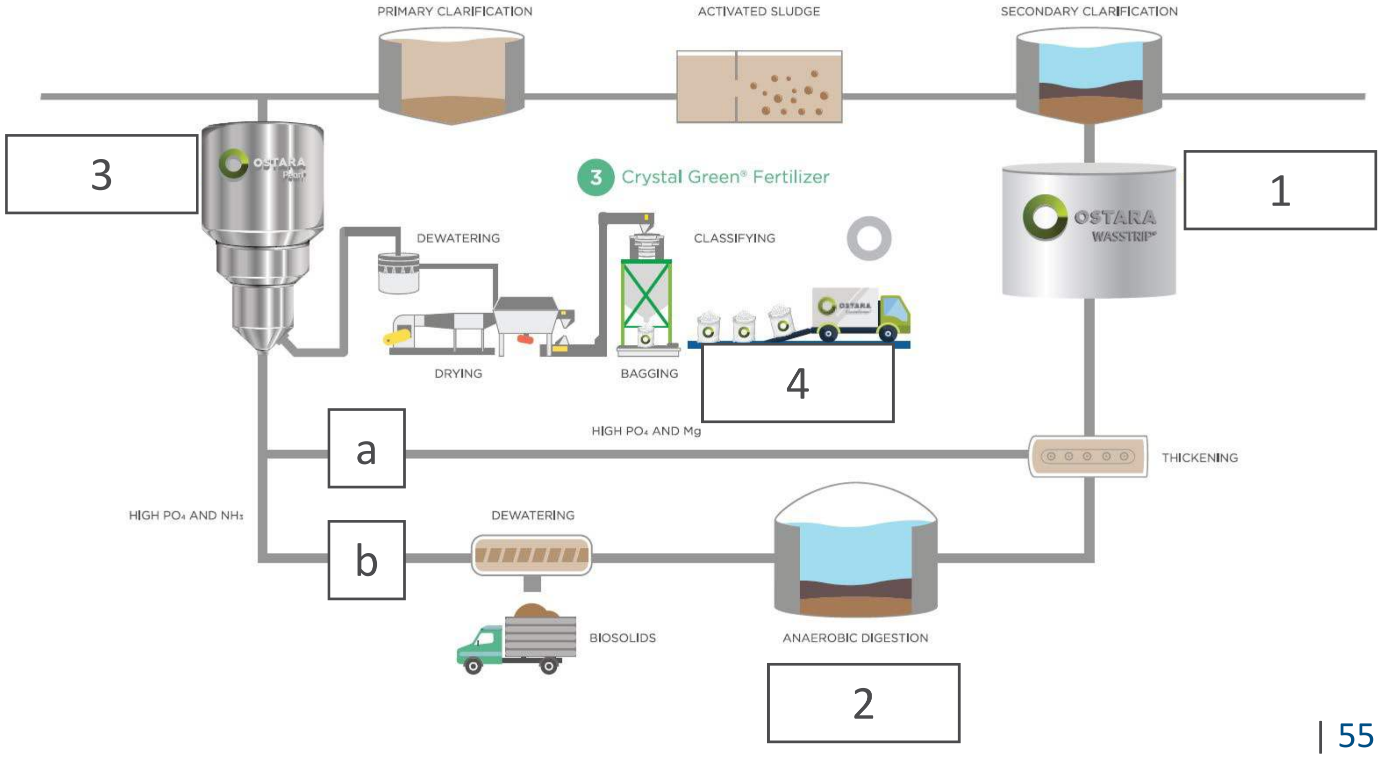
A2.1 Case Study in PL

Ostara technology

The Ostara technology operates based on the crystallization of magnesium-ammonium phosphate (struvite) in a fluidized bed reactor. This process requires the introduction of an additional magnesium source, pH regulation, and flow control. The wastewater or leachate from the sludge is passed through the reactor, where small struvite crystals form and gradually grow to the desired size. Once the crystals reach a certain size, they sink to the bottom of the reactor, from where they are collected.

Main proces steps

- **Sludge preparation (1)**
  - The sewage sludge is first separated and trated anaerobicly to release nutrients into the liquid phase
- **Energy recovery (2)**
  - The sewage sludge undergoes anaerobic digestion, where it is thickened and fermented. The liquid effluents (a and b) are then directed to the fluidized bed reactor for further processing.
- **Crystallization and struvite separation (3)**
  - In the fluidized bed reactor, magnesium-ammonium phosphate (struvite) crystals are formed through a continuous crystallization process.
- **Struvite drying and pellet formation (4)**
  - After separation, the struvite is dried and shaped into granules, creating a nutrient-rich fertilizer.



A2.2 Evaluation standards for quality control and agronomic value of RNFs

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Objectives

- Establish min. 4 evaluation centers for RNF products

- Evaluate the agronomic value of RNFs and their potential to substitute min. fertilizers

Methods to characterize RNFs → Approaches to assess RNFs fertilizing value → Common approach for the experimental studies in A2.2

- Conduct workshops and feedback/communication events with stakeholders and target groups

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Agronomic evaluation of RNFs

Selection of RNFs

- Luke (Meat bone meal pellets, cow manure digestate and derived fractions)
- LNU (Sludge biochars)
- IMP (Straw-biochar blended with various organic waste
- METK (Struvite granules, SF-Soepenberg GmbH)
- JKI (Struvite granules, SF-Soepenberg GmbH)
- SLU (Struvite granules, SF-Soepenberg GmbH, solid digestate and the derived compost and biochar, pig manure pellets, digestate pellets)

Common approach

- Pot trials
- Use of representative soil, low P soil
- Biomass yields and N,P plant uptake
- RNFs comparison with plant response under mineral fertilizers
- Mineral fertilizer reference treatments, triple superphosphate, ammonium nitrate and calcium nitrate
- Residual nutrient content in soil after the end of the trial

A2.2 Evaluation standards for quality control and agronomic value of RNFs

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Results

TSP (Triple Superphosphate) and STR (Struvite) increased total ryegrass root surface area and volume compared to the control.

TSP had a slightly stronger effect than STR, indicating it may be more effective in promoting root growth.

Liquid digestate showed higher dry matter yields compared to the solid fraction when applied at equal N rates

Meat-bone meal showed different ryegrass yields when applied as pellets and after milling

High biochar (15-40% v/v dose) doses inhibit Miscanthus growth,

Organic waste additions supported stable growth (<150 cm) across doses,

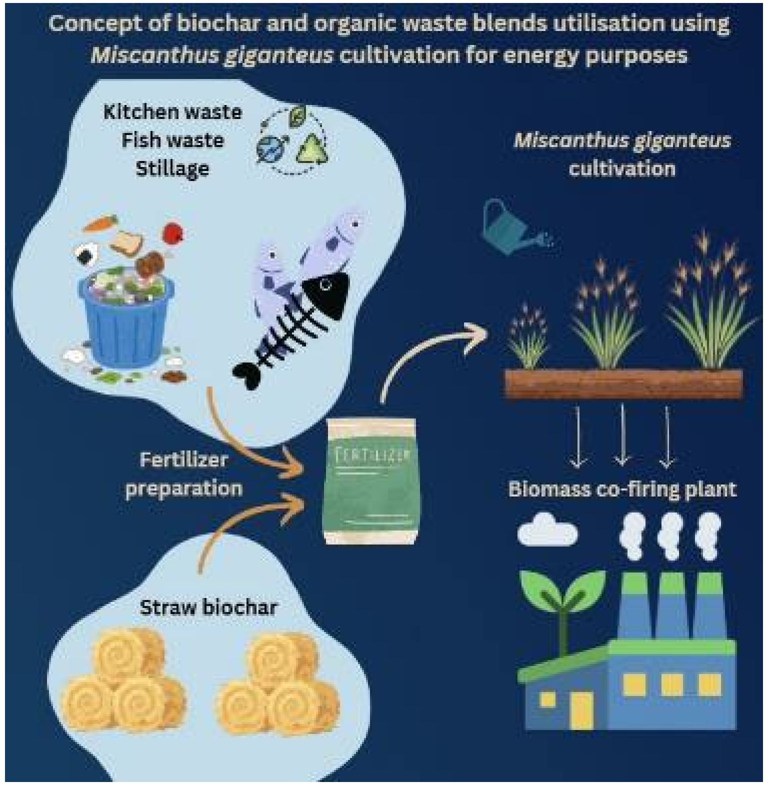
Calculated fresh matter yields ranged from 11.4 (30 days) to 91.3 Mg ha-1 (120 days),

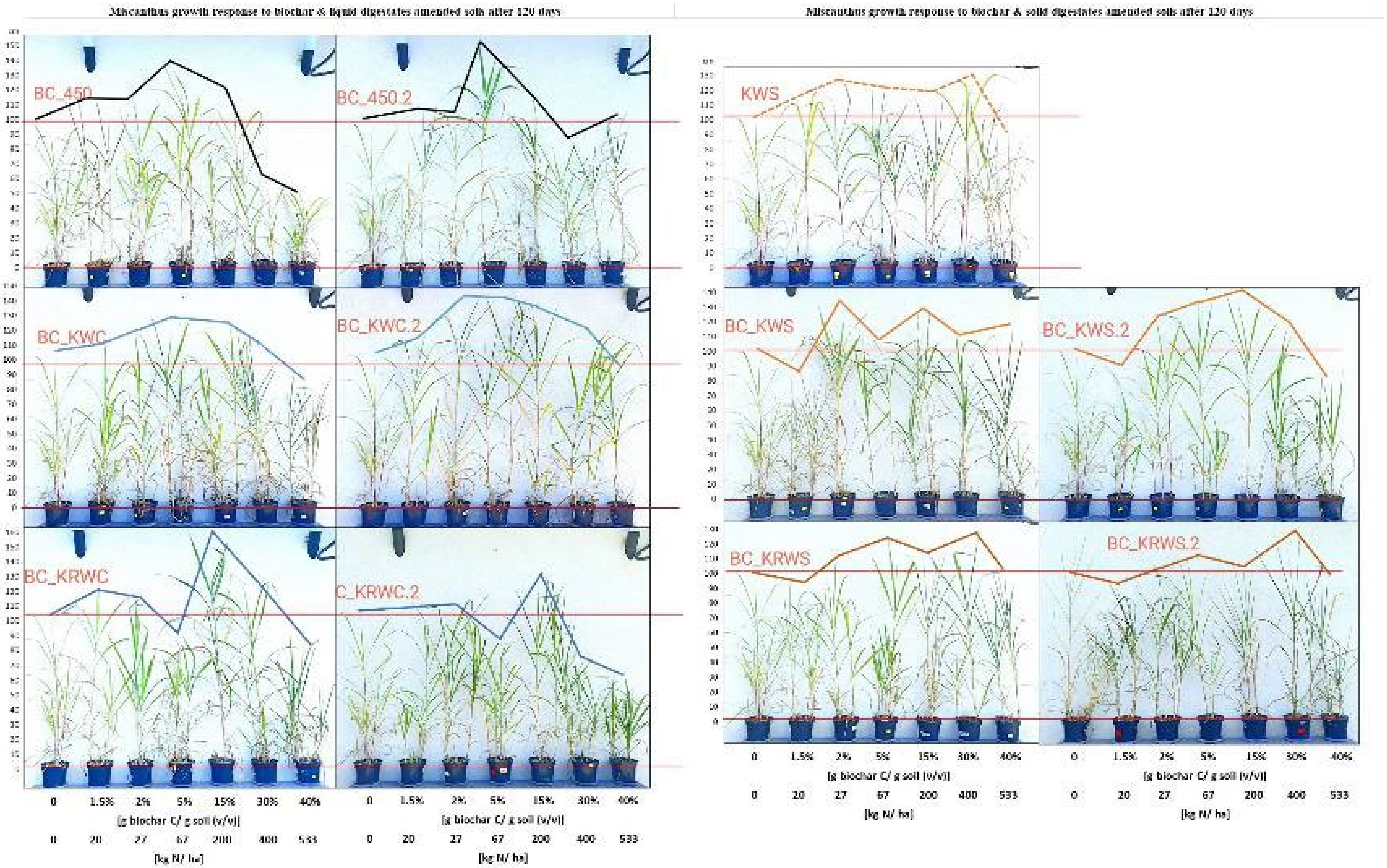
The moderate photochemical efficiency (<0.79) followed the plant's height trend,

Biorefineries could tackle both dry and wet waste streams beneficially.

A2.2 Evaluation standards for quality control and agronomic value of RNFs

Results





A2.2 Evaluation standards for quality control and agronomic value of RNFs

Interreg Baltic Sea Region

Co-funded by the European Union

CIRCULAR ECONOMY CiNURGi

Ongoing and upcoming studies

Evaluation of the optimal amount of struvite-P for cruciferous plants

Spring oilseed rape growing in low P arable soil

4 different struvite application rates will be compared against 4 reference treatments

Soluble P concentration will be determined in biochars from sewage sludges

Nutrient plant uptake will be estimated in pot trials

In an adjacent project AI and machine learning will reveal what determines biochars P availability

Evaluation of the P fertilizing value of different RNFs in two contrasting sandy soils

Ryegrass nutrient uptake will be estimated in pot trials

Reveal the treatment effect (composting, pyrolysis) on the agronomic value of digestate solids

A 2.3

Piloting increased acceptance of RNFs and supporting a circular economy for nutrients

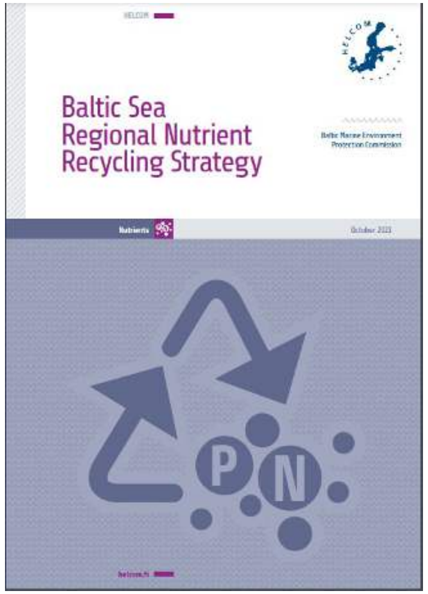
Objectives:

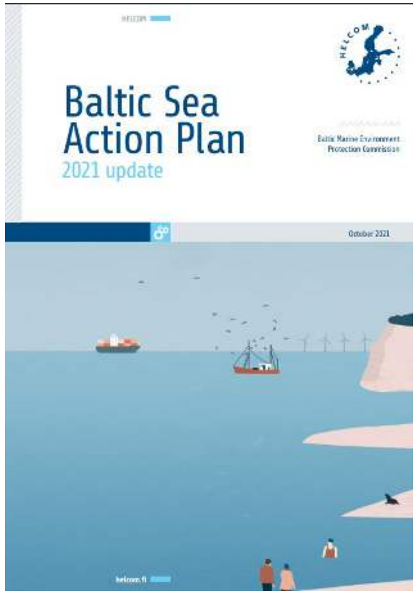
- **Piloting field-scale application use of RNFs products to show the effects of RNFs in real conditions (2 years)**
- **Develop and pilot policy recommendations to enable well-functioning incentives to support the development of a market for RNFs**
- **Workshops and feedback events with stakeholders to discuss and revise the policy recommendations**

Policy reccommendations

- Supporting enhance the use of RNFs and to build and promote a market for RNFs
- In line with the **HELCOM Baltic Sea Action Plan** **action E35** and parts of E34 & E36
- Takes into account feedback from stakeholders and experts
- Covers 3 areas of action, around **objectives 5**, 4 and 6 of **HELCOM Baltic Sea Regional Nutrient Recycling Strategy**

A 2.3 Policy recommendations





OBJECTIVE 4 — Knowledge exchange and awareness raising

SUB-OBJECTIVES

- *Promoting new research and technological development*
- *Facilitating knowledge transfer and information exchange on nutrient recycling*
- *Cooperating with other regions and global organizations to exchange information on the most up-to-date knowledge and techniques*
- *Raising awareness of the benefits of nutrient recycling*
- *Promoting a holistic view of food production*

E34 E11 E12

E34 Increase the knowledge and promote education and advisory services on NR

E11 Improve knowledge exchange by establishing dialogue between farmers, authorities and decision makers.

E12 Enhance mutual learning among farmers on best practices and innovative technologies

BSAP Actions

OBJECTIVE 5 — Creating business opportunities

SUB-OBJECTIVES

- *Encouraging new business models with cross-sectoral cooperation*
- *Improving the economic viability of nutrient recycling*

E35

E35 Improve the conditions for the development of a market for RNF products by setting incentives with the aim of making the use of such products equally attractive to farmers as the use of mineral fertilizers

OBJECTIVE 6 — Improving policy coherence

SUB-OBJECTIVES

- *Increasing cooperation of governmental agencies to improve policy coherence*
- *Updating the legal framework to facilitate nutrient recycling*

E36 E18

E36 Enhance cooperation and share experiences between sectors and actors to create a holistic view on sustainable food systems including NR across sectors.

E18 Investigate opportunities for taxation of mineral fertiliser and/or taxation of nitrogen surplus and/or payments for agri-environment measures by 2024 and implement them building on the experiences available in various countries

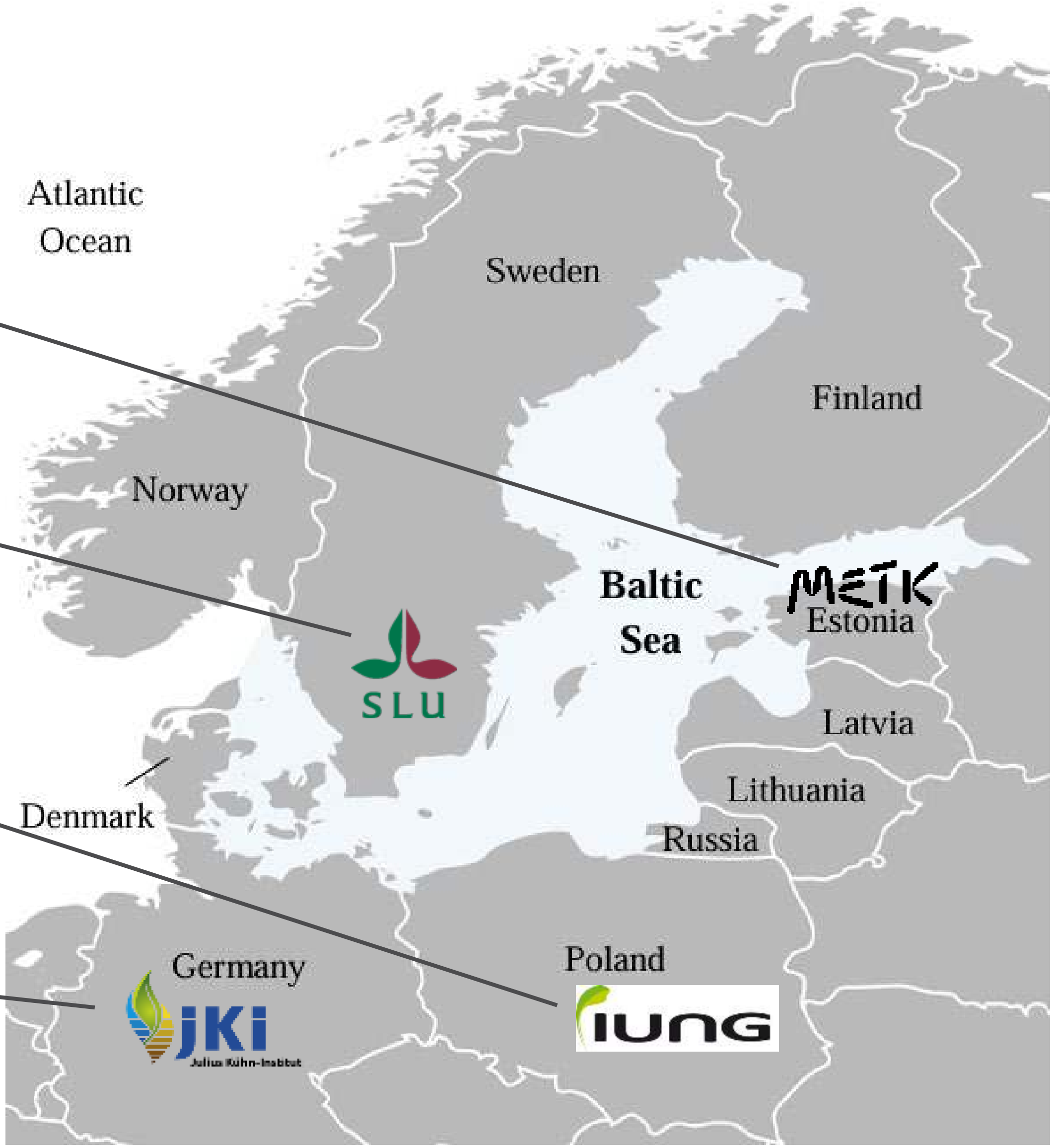
A 2.3 Field trials

Estonia
Jõgeva field trial station, METK
RNFs: **Composted horse manure, Struvite**

Sweden
Lanna research station, SLU
RNFs: **Compost, Pelletized fertilizer, Biochars**

Poland
Grabów experimental station, IUNG
RNFs: ASL, Struvite, plant-based digestate pellet

Germany
Braunschweig, JKI-PB
RNFs: **Organic NK 5+5 fertilizer, Hair meal pellet**



A 2.3 Field trials

18 March 2024

CiNURGi A2.3 field trials basic configuration

1. **Objective.**

The main objective of the trials is to evaluate t
standard fertilization (mineral fertilizer and/or ma
show the potential of replacing part of mineral fert
These experiments will allow assessing the impa
growth, and development, and can also be used to
them as valuable fertilizers. The impact of RNFs on
available forms of NPK, the content of organic mat
be assessed.

2. **General characteristics of the trial.**

- The experiment will be conducted during two c one fertilizer for two years to obtain more reliab on various plant species. A one-year experime larger number of fertilizers, especially those impl
- Plant species and widely cultivated varieties ap Project partner research experiences will be take
- Crop maintenance will be carried out following g soil preparation and plant protection,
- Fertilization will be adjusted to the crop nutrition
- The rate of macronutrients (N, P, K) used in co fertilization variant (NRF/standard fertilizer/man
- The size of the plots should be adapted to the units conducting the experiments and should allo
- To demonstrate the full performance of fertiliza soils with low nutrient content.

3. **Design of the trial.**

- A one-factor field experiment should be carried
- At least two NRF fertilizers should be tested in th be the NRF produced by the CiNURGi project p local or EU market but should be registered at th requirements for fertilizers,
  - It is proposed to choose one NRF fertilizer fertilizers (such as struvite, ASL) and anoth fraction of digestate, compost). However, it is group (two "mineral" or two "organic" NFR),
- The fertilizer treatments will be divided into two

3 April 2024

CiNURGi A2.3 RNF-M Field trials manual IUNG-PIB

RNF "mineral" fertilizer

1. **Objective.**

The main objective of the trials is to
and struvite) compared to standard fert
Replacement Value (MFRV) for RNF fert
obtained at RNF fertilizers treatment com

2. **Design of the trial.**

- **Type of experiment:** one-year, one-fac
- **Location:** Grabów IUNG-PIB Experimen
- **Crop:** spring wheat, silage maize,
- **Statistical experimental design:** long s
- **Experience factor:** type of fertilizer.

3. **Scheme of the experiment.**

Repetition 1							
A	B	C	D	E	F	F	E
A	B	C	D	E	F	F	E
Repetition 3							

A. 50% of expected N demand delivered b
B. 100% of expected N demand delivered (control)
C. 125% of expected N demand delivered
D. ASL – 100% nitrogen delivered by ASL,
E. Struvite – 100% phosphorus delivered b
F. ASL + Struvite – 100% nitrogen delivere in control

- Plot dimensions:
  - Gross area: 6m x 25m = 150m^2,
  - Net area: 3m x 20m = 60 m^2

16 April 2024

CiNURGi A2.3 RNF-O field trials manual IUNG-PIB

RNF "organic" fertilizer

1. **Objective.**

The main objective of the trials is to evaluate the agronomic efficiency of 'organic' RNF (p
based digestate pellet) and its influence on soil microbiological activity and soil organic ma
compared to manure in agricultural conditions.

2. **Design of the trial.**

- **Type of experiment:** one-year, one-factor,
- **Location:** Grabów IUNG-PIB Experimental station,
- **Crop:** silage maize,
- **Statistical experimental design:** long stripes with a mirror image,
- **Experience factor:** type of fertilizer.

3. **Scheme of the experiment.**

Repetition 1				Repetition 2			
A	B	C	D	D	C	B	A
A	B	C	D	D	C	B	A
Repetition 3				Repetition 4			

A. control without fertilization 0 kg N, P, and K as 100%
B. 25% of expected N (45kg) demand delivered by Standard Mineral Fertilization (NPK), P, and K as 100%
C. "organic" RNF (9 t/ha)
D. dairy cow manure (33 t/ha)

- Plot dimensions:
  - Gross area: 6m x 25m = 150m^2,
  - Net area: 3m x 20m = 60 m^2,

Field trials in Estonia

Trial location: Jõgeva field trial area

Crops

Block1	2024 june- 2024 august	2024 September- 20
Crop	Broccoli	Winter cereal

Block2	2025 june- 2025 august	2025 September- 20
Crop	Broccoli	Winter cereal

Reasons to choose broccoli:

1. Broccoli is vegetable crop and the planned RNF-s are mostly used in Estonia. The amounts of the RNF-s, tested in present field trial, too high for arable crop productions.
2. Broccoli was used in Sea2Land project field trial in year 2023 (also produced form fish industry residues. Thus, the results from differ compared.
3. In Estonia has not been earlier trials with RNF-s planned in CiNUR crop-RNF combination is novel.

Winter wheat is grown next year on same trial plots after broccoli, to study af

Fertilising variants

1. Control
2. Mineral fertilizer NPK (120:40:150) NPK as elements.
3. Composted horse manure
4. Horse manure
5. Struvite

Fertilising variants are in 3 replications, thus 15 trial plots are in one trial block randomised.

Trial plan on Block 1

Year	Month	Event
2024	April	Preparing the trial site. Fertilisers are acquired.
2024	May	Broccoli seeds are sown to the cassettes in beginnin
2024	May	Trial plots are established, initial soil samples are col applied to fertilisation plots.
2024	June	Broccoli plants are planted to the trial plots in begin
2024	July	4 Broccoli plant /plot as samples are collected in the 4 Broccoli plant/plot sampling in the end of July(GS
2024	August	10 Broccoli plants/ plot yield sampling in the end of Soil samples are collected after harvest
2024	September	The plots are prepared and winter wheat is sown un
2025	April	Soil samples are collected from plots.
2025	August	Winter wheat yield samples are collected. Soil samp after harvest

Field experiment in Sweden Cinurgi (task 2.3)

Planned by Helena Aronsson, Athanasios Pantelopoulos, Sofia Delin and Oksana Valetska

Field site: The experiment is situated at Lanna experimental station (SLU), southern part of Sweden. The soil is a clay soil (approx. 40% clay). The top-soil has a low content of available P (1-3 mg/100) and the subsoil moderate P content (4-8 mg/100 g). Soil P content was analysed as ammonium-lactate soluble P. Sofia Delin will be responsible for execution of the field experiment.

Investigated NFRs: One of the two investigated organic fertilizers origin from digestate which was produced by digestion of manure (80%), food industry waste and slaughtery waste. The digestate was separated into a solid phase which was biothermally dried into aprox 90% dry matter content. The other biofertilizer is an NP fertilizer in pellet form from the Swedish market.

Experimental design: The NFRs are investigated with respect to P effects in comparison to mineral P during 2-3 consecutive years, table 1. The use of repeated treatments over time enables evaluation of build-up effects. A control without any fertilizer provides information about the contribution of nutrients from the soil. The experimental treatments on plots 3m * 12m will have four replicates, in randomized design.

Crop and fertilizer application: The NFRs will be applied at sowing of a spring cereal. The digestate solid will be surface applied and thereafter incorporated to 5 cm depth, while pellets and mineral fertilizers will be combi-drilled with the crop, as is the common procedure.

Sampling procedures, and analyses: Table 2.

Table 1. Treatments

	Organic fertilizer	Mineral Fertilizer	
A	No	No added fertilizer	Control treatment
B	Compost (16 kg P)	Min-NKS, excess	B-E for evaluating P effects
C	Pellets (16 kg P)	Min-NKS, excess	
D	No	Min-P 8 kg + NKS, excess	
E	No	Min-P 16 kg + NKS, excess	

Table 2: Sampling, procedure and analyses

Time for sampling	Type of sample	Procedure	Analyses
Before sowing	Soil sample 0-30 cm depth, one for whole field	10 soil cores to a composite sample, frozen	Min-N, pH, P-AL, K-AL, Tot-C, Tot-N, Tot-P
Before ear emergence	Whole crop	3 subplots (3* 0.25 m^2) mixed into one sample per plot, dried	Dry matter content
At harvest	Grain	Harvest of each plot with combine, dried	Dry matter, N, P, K
After harvest	Soil samples in each plot	10 soil cores in each plot to a composite sample, frozen	Min-N, pH, P-AL, K-AL, Tot-C, Tot-N, Tot-P. Ome plans also to do PLFA analysis and analysis of DOC.

A 2.3 Field trials

IUNG Institute of Soil Science and Plant Cultivation

Poland

- Evaluation of the agronomic efficiency of „Mineral” RNFs-M for ASL & Struvite
- Determination of Mineral Fertiliser Replacement Value (MFRV) for ASL
- Evaluation of the agronomic efficiency of ”Organic” RNF-O for Plant-based digestate pellet

Location: Grabów experimental station, IUNG

Crop: spring wheat, silage maize

Tested RNFs: ASL, Struvite, Plant-based digestate pellet

METK Centre of Estonian Rural Research and Knowledge

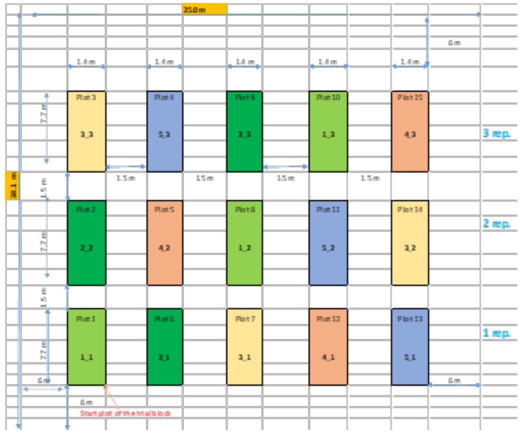
Estonia

- Demonstrate RNFs compared to mineral fertilizer: first and second-year effect on yields

Location: Jõgeva field trial station, METK

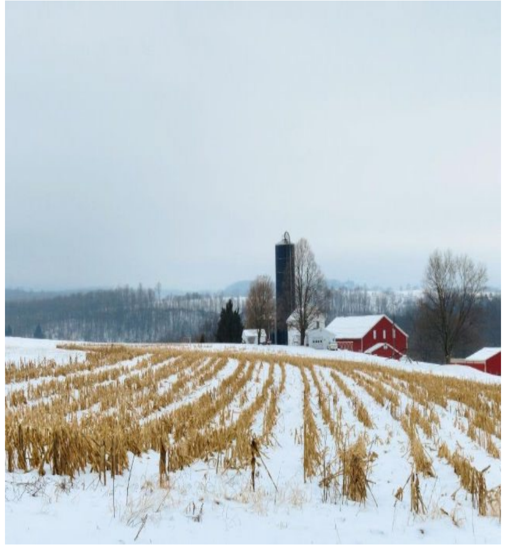
Crop: Broccoli, Winter wheat

Tested RNFs: Composted horse manure, Struvite



A 2.3 Field trials

Sweden



- To study direct P fertilizer effects of different RNFs in comparison with mineral fertilizers
- To study effects of 2-3 years repeated applications on nutrient cycling and microbiological activities

Location: Lanna research station, SLU

Crop: Oat

Tested RNFs: Compost (digested manure), Pelletized fertilizer, Biochars (sludge, plant biomass)

Germany

- Effects of different RNFs on soil and plant properities in comparison with conventional mineral fertilizers
- Quantifying Root and Soil Parameters Using Micro-CT Analysis and Examining Soil-Root Relationships

Location: Braunschweig, JKI-PB

Crop: Ryegrass „Lolium perenne“

Tested RNFs: Universal Phosphate-Free Organic NK 5+5, Hair meal pellets

Thank you for your attention

Life is not only work…

Institute of Fluid-Flow Machinery

Polish Academy of Sciences

Dept. of Physical Aspects of Ecoenergy

(Head - prof. Adam Cenian)

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Interreg Baltic Sea Region

Co-funded by the European Union

CIRCULAR ECONOMY CiNURGi

WP3 – Transfering solutions

CiNURGi Webinar 18.11.2024

Eetu Virtanen, HELCOM
Paula Biveson, Centrum Balticum

interreg-baltic.eu/project/cinurgi

A3.1

Regional policy dialogue for enhancing nutrient recycling

WP 1 Preparing solutions

WP 2 Piloting and evaluating solutions

WP 3 Transferring solutions…

…into regional policy recommendations implementing the Baltic Sea Action Plan (BSAP) and the Baltic Sea Regional Nutrient Recycling Strategy (A 3.1)

A3.1

Regional policy dialogue for enhancing nutrient recycling

BSAP action E32

Enhance the use of recycled nutrients in agriculture making use of best available technologies and fertilize according to crop needs.

- Criteria for achievement: Evaluation of substitution of mineral fertilizers by recycled nutrients is carried out.
    - A 1.1 Description of current status of nutrient recycling

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Regional policy dialogue for enhancing nutrient recycling

BSAP action E33

Develop by 2027 safety requirements for recycled fertilizer products and minimize the occurrence of harmful compounds in these products to comply with the requirements.

- Criteria for achievement: Regional document on the safety requirements for recycled fertilizer products is developed.
    - A 1.2 Develop standardized safety requirements for RNFs
        - HELCOM Recommendation on safety requirements for recycled fertilizer products

A3.1

Regional policy dialogue for enhancing nutrient recycling

BSAP action E33

Improve the conditions for the development of a market for recycled fertilizer products by setting incentives with the aim of making the use of such products equally attractive to farmers as the use of mineral fertilizers.

- A2.3 Develop and pilot policy recommendations to enable well-functioning incentives to support the development of a market for RNFs, input also from A 1.3.
    - HELCOM Policy brief/Guidelines for market development

A3.1

Regional policy dialogue for enhancing nutrient recycling

In close collaboration with relevant HELCOM groups

- Working Groups (policy) and Expert Groups (technical/scientific) meet usually twice a year
    - WG Source to Sea = The Source to Sea Management of Nutrients and Hazardous Substances and Sustainable Agricultural Practices Working Group, also EG Haz = Expert Group on Hazardous Substances
- Regular updates and proposals from the project to HELCOM groups for consideration
- Inviting HELCOM representatives to project events = widely introduced, discussed and becoming established in the regional environmental policy
    - also supported by the EUSBSR PA Nutri and PA Hazards

A3.1

Regional policy dialogue for enhancing nutrient recycling

International workshop on 20 October 2025

- A thematic event for regional key stakeholders with outputs for HELCOM WG Source to sea consideration, in connection to the WG Source to sea meeting
- Results, outputs and drafts from WP1 and WP2 introduced and discussed for further development to regional policy documents.

3.2. Support centers

Overview of Technical and Evaluation support centers

- **Technical Support Centers** play a pivotal role in advancing nutrient recycling by developing and refining technologies for processing biomass into usable products.

- **Evaluation Support Centers** ensure the quality and agronomic potential of recycled nutrient fertilizers (RNFs). By assessing products and validating their performance, these centers uphold the project's commitment to high standards.

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Promoting Support Centers & Pilots – local and national

Promotion of the support centers, pilots and field trials can include:

- Events (onsite and online)
- Field visits
- Presentations in relevant events, seminars, conferences, agri fairs etc.
    - brochures, roll-ups, posters
- Presentations and news about activities in organizing partners website
    - Digital promotional material, photos, film clips, etc.
- Posts about activities in the organizing partner’s social media profiles

These promotion acts and materials will be done by organizing project partner.

Promotion in the international level

CiNURGi communication team (Centrum Balticum) will be supporting partners with promotion by publishing invitations, presentations, news, photos and other materials about support centers, pilots and field trials in:

- CiNURGi website
- LinkedIn profile
- internal Newsletters and
- external Newsletters.

Centrum Balticum will create stories and posts about the support centers, pilots and field trials and publish them in CiNURGi communication channels.

Centrum Balticum will also create three CiNURGi films, which promote both the project in general and WP2 activities.

A3.3

CiNURGi communications

CiNURGi website: CiNURGi - Interreg Baltic Sea Region https://interreg-baltic.eu/project/cinurgi/

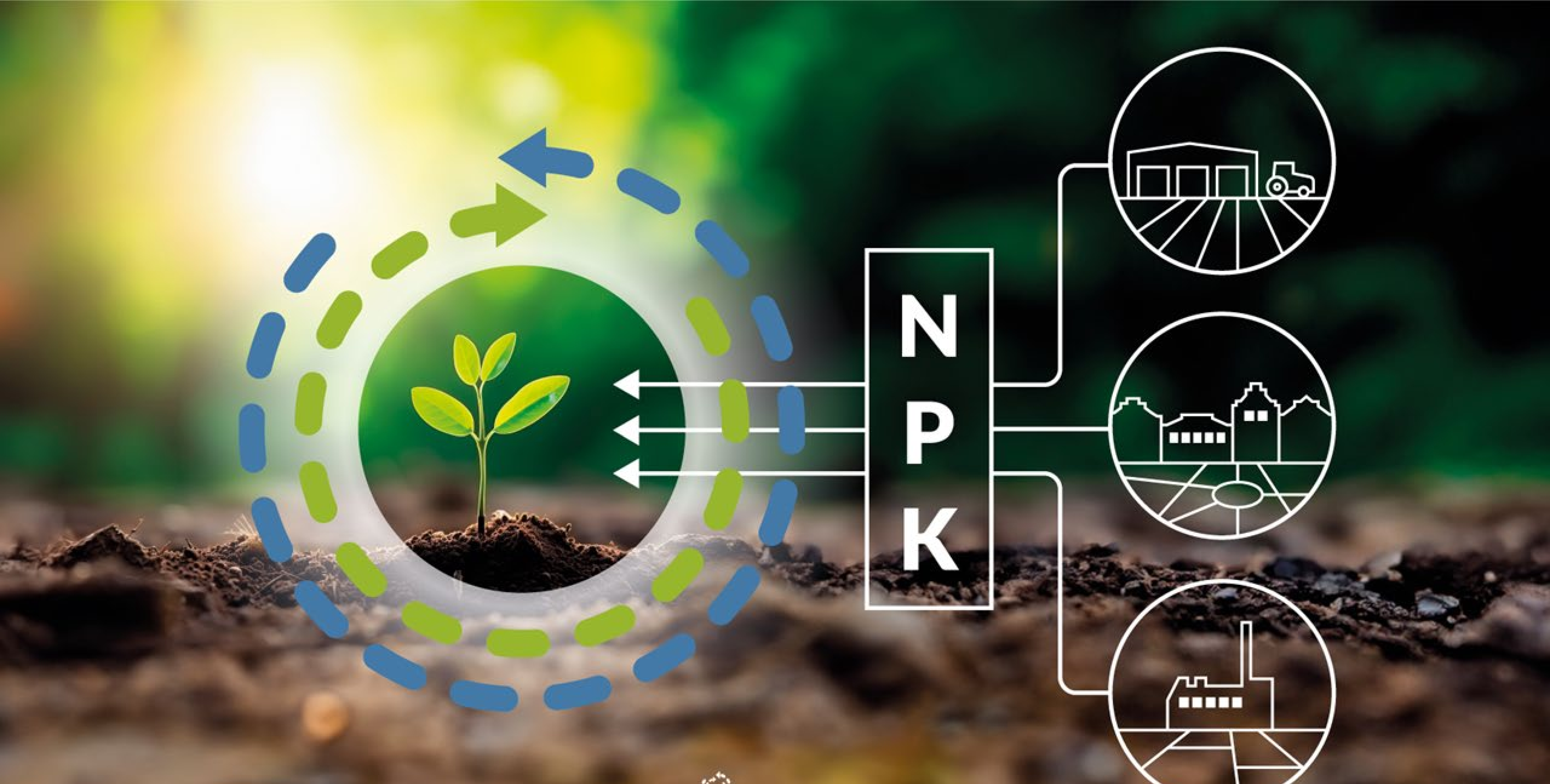
CiNURGI LinkedIn profile: CiNURGi: Overview | LinkedIn

CiNURGi External Newsletter – Subscription page in the website – 1/2024 to be published in Dec

CiNURGi events:

- Sustainable nutrient management will be part of the 17th annual Baltic Sea Region Forum arranged in Turku, Finland in May/June 2025
- CiNURGi will join HELCOM Source-to-Sea event in 20th October 2025
- CiNURGi will organise a hybrid event in Brussels in 2026

CiNURGI films: general CiNURGi presentation January 2025, Pilots and field trials September 2025, CiNURGi results autumn 2026.



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