Novafert

ATLAS OF THE EU NUTRIENT ORIENTED LIVING LABS

Funded by
the European Union

Outline of Atlas

Introduction

The European Green Deal is a set of policy initiatives aimed at making the European Union (EU) more sustainable and environmentally friendly. One of its main goals is to make the EU climate climate-neutral by 2050. The biodiversity strategy 2030, the Farm to Fork strategy, and the European Climate Law are three of the key policies measures introduced under the EU Green Deal. In particular, the Farm-to-Fork strategy includes measures to reduce pollution from soil by implementing targets such as reducing chemical fertiliser input by 20% and a decrease in nutrient losses by at least 50% (Montanarella & Panagos, 2021). The agricultural sector faces pressures to not only cut its reliance on chemical fertiliser input and improve ways to enhance nutrient use efficiency but to also increase productivity to feed a growing population which is expected to reach 9.8 billion by 2050 and 11.2 billion by 2100 (UN, 2023).

The Horizon Europe Novafert project employs an approach to create an effective framework for action in the wider area of nutrient recycling by identifying criteria for Living Labs (LL) and lighthouses (LH) to enable experimenting solutions and co-design and co-creation by a variety of factors.

The aim of this publication is to display an inventory of selected NoLLs across Europe following selection criteria which is outlined in section 1.1.1.

Living labs are defined by the EU Commission as user-centred, place-based and transdisciplinary research and innovation systems (Maring, Ellen, & Brils, 2022). They are understood as collaborative initiatives between multiple partners to co-create, test, monitor and evaluate solutions to a common problem (Maring, Ellen, & Brils, 2022).

The mapping of NoLLs follows outcomes and reports from various other EU projects e.g. the national task forces that are in place within Nutri2cycle, Nutriman farmer platform, recently published book of success stories of companies actively adopting recovery technologies under the project RENU2FARM, other EU projects and information collected on recovery technologies and products for the Novafert inventory https://www.novafert.eu/inventory/.

Methodology for selecting Nutrient-orientated Living Labs (NoLLs)

A procedure for validation is proposed here to assess if a LL would qualify as a NoLL, i.e. if it matches the most important characteristics as proposed below. Novafert sees NoLLs as instruments to accelerate the creation and uptake of alternative fertilisers on farms across Europe.

Scale	Multiple experimenting or test sites, nutrient recovery technologies etc.; operation of the LL sites is conducted on regional/landscape scale
Aims	Aimed at achieving environmental and societal benefits in relation to Novafert objectives.
Activities	Co-creation/co-design/co-development of research and innovation in a transdisciplinary and multi-actor approach and robust setup. Monitoring/evaluation on recovery and use of nutrients to support plant growth
Participants	Multiple participants from the quadruple helix including real users
Context	Participatory and open approach in a real-life context (place-based) and within a context familiar to the users
	Living labs are conducted on the middle to long term

SCALE

NoLLs for the Novafert project can take on a wide range of geographical scales, from small-scale individual locations to a region-wide scale. The scale of a NoLL needs to be able demonstrate a real-life practice of efficient nutrient use or recovery from different waste streams outlined within the Novafert grant agreement.

AIM

NoLLs can pursue various aims or purposes, they are a powerful instrument for transition and change making. However, the overall aim of NoLLs is to achieve societal and environmental benefits in terms of nutrient recycling. Therefore, the aims of NoLLs are divided into two criteria. First, NoLLs are aimed at obtaining societal and environmental benefits in light of Novafert objectives. Secondly, NoLLs aim to conduct this by means of co-creation or co-design processes (Maring, Ellen, & Brils, 2022).

ACTIVITIES

Because living labs can serve multiple purposes for which open-innovation will add business and social value and produce accessible knowledge, various activities can play a role within NoLLs. Content of activities within NoLLs can vary, a central element of living labs is that they deal with certain challenges by developing solutions or innovations by processes of co-design, co-creation or co-development. This takes place in a transdisciplinary and multi-actor approach, covering technical, economic and social aspects (Maring, Ellen, & Brils, 2022).

PARTICIPANTS

A central part of NoLLs is the user-integrated approach aimed at certain challenges and transitions. A broad range of participants or stakeholders can be a part of NoLLs. Land owners/managers, researchers, advisors, specialists, experts from businesses, various future users or funding agencies can be involved in NoLLs. For Novafert NoLLs concern all parties that have a certain interest in the contribution of nutrient recycling and safe use of nutrients within agricultural systems. For NoLLs a core criterion for the Novafert consortium is that real users involved in nutrient recycling should be at the centre of the innovation process. However, every NoLL does not always have to include stakeholders from every part of society. It is about finding and assembling a stakeholder composition based on the NoLL main aim.

CONTEXT

For NoLLs a core criterion is that there in a “real life” context. NoLLs need to be mostly conducted in contexts that are familiar to the users that are involved in the NoLL. They are conducted in a physical environment where the challenges occurs, or the transition/innovation is needed. This also helps to distinguish NoLLs with other experimentation tools or environments.

Inventory of the European NoLLs

Inventory of the European NoLLs - IRELAND

Ireland

Teagasc arable trial

Name: Teagasc
Location: Wexford
Type of system: Research
Geographical scale : National
Living Lab manager/promoter/coordinator:
Dónal Kinsella & Patrick Forrestal

Partners involved in the LL:
Teagasc, semi-state body

Overall concept of the activities to be implemented

Teagasc research is carrying out field based plot trials to mimic farmer's practice of crop production in a conventional arable system. The purpose of the demo trial is to assess agronomic benefits of different bio-based recycling derived fertilisers at a field-scale level. The primary goal is to determine how these fertilisers can displace a proportion of main stream fertilisers while enhancing soil fertility by increasing carbon and major nutrient levels in the soil. Progress is being monitored by analysing crop yield and quality. The aim of this living lab Is to promote nutrient recovery and recycling from different agri-food processing waste resources. Additionally, the focus is on helping farmers understand and adopt these bio-based recycled fertilisers as options for their system.

The rotational arable trial is currently in its 5th year. The crop rotation history consists of maize silage, spring wheat, oilseed rape, winter wheat & spring beans. The trial consists of seven fertiliser treatments consisting of zero fertiliser, main stream fertiliser, and five alternative sources of fertiliser including cattle slurry, pig slurry solids, poultry manure, and two types of dairy processing sludge to supply part of the crops nutrient requirements based on soil test data and targeted yield. These five alternative fertilisers were analysed to assess both their nutrient value and nutrient availability to the plant. As the alternative fertilisers did not provide all the crops N, P, K and S requirements, these treatments were supplemented or "balanced" with main stream fertiliser in order to ensure all plots received the same amount of nutrients for optimal yield.

The demo plot trials are considered to be at TRL 6. Funded under EU Horizon 2020 project Nutri2cycle.

Existing LCA analyses: N/A

Ireland

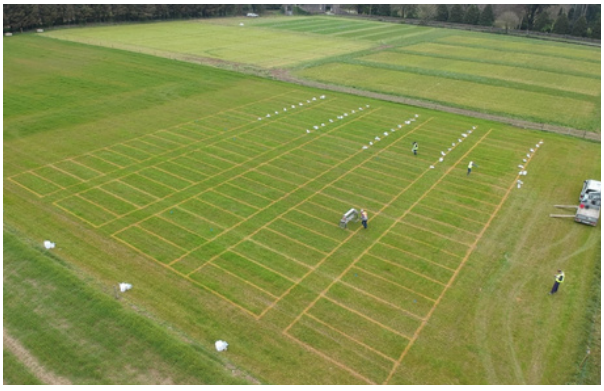
Teagasc grassland trial

Name: Teagasc
Location: Wexford
Type of system: Research
Geographical scale: National
Living Lab manager/promoter/coordinator:
Dónal Kinsella & Patrick Forrestal

Partners involved in the LL:
Teagasc, semi-state body

Overall concept of the activities to be implemented

Teagasc established a grassland sister trial to the arable trial and is also in its 5th year. The purpose of the demo trial is to assess agronomic benefits of different bio-based recycling derived fertilisers at a field-scale level. The primary goal is to determine how these fertilisers can enhance soil fertility by increasing carbon and major nutrient levels in the soil. Progress is being monitored by analysing crop yield and quality. The aim of this living lab Is to promote nutrient recovery and recycling from different agri-food processing waste resources. Additionally, the focus is on helping farmers understand and adopt these bio-based recycled fertilisers as options for their own grassland system.



The demo plot trials are considered to be at TRL 6. Funded under EU Horizon 2020 project Nutri2cycle.

Existing LCA analyses: N/A

The grassland trial consists of a perennial ryegrass sward. The trial consists of nine fertiliser treatments with five replicates of each, along with three zero fertiliser plots. The nine fertiliser treatments consists of main stream fertiliser and eight alternative sources of fertiliser including cattle slurry, pig slurry solids, aluminum precipitated dairy processing sludge, calcium precipitated dairy processing sludge, struvite from potato processing wastewater, struvite from municipal wastewater, incinerated poultry litter and incinerated sewage sludge. The alternative sources of fertiliser did not provide all the crops N, P, K and S requirements, these treatments were balanced with main stream fertiliser to ensure all plots received the same amount of nutrients for optimal yield.

Ireland

Enva Ireland Ltd (AMS Project)

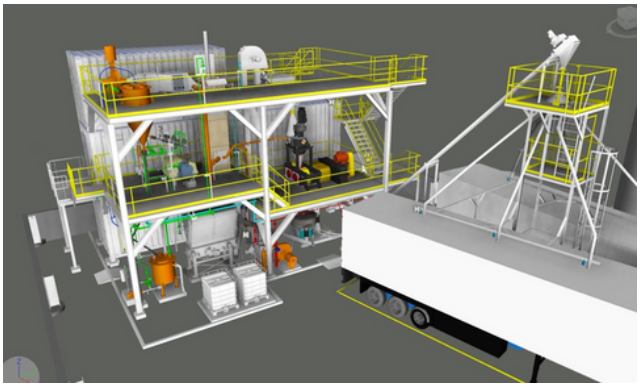
Name: Enva Ireland Ltd
Location: Greenogue Industrial Estate, Block 402, Rathcoole, Dublin, D24 AP04
Type of system: Industry
Geographical scale: Ireland and United Kingdom
Living Lab manager/promoter/coordinator: Kieran Staunton/Enda Cahalan

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

Circular Economy Project that redesignates a waste material via EPA Article 28 (End-of-Waste/EoW) into a marketable product. The process converts a spent acid into a high purity ammonium sulphate granule to a comparable physical and chemical specification to conventional chemical fertiliser.

The facility can process up to 14,000 tonnes of a waste ammonium sulphate liquor per annum, resulting in the production of c .4,500 tonnes of AMS fertiliser granules.



As per of EPA Eow Criteria the material will comply with:
i. comply with relevant provisions of the CLP regulation;
ii. comply with relevant provisions of the REACH regulation;
iii. comply with relevant provisions of the fertiliser regulation.

Each batch will have a unique identifier and be tested in a lab accredited to EN ISO/IEC 17025 and a declaration of conformity will be completed for each consignment.

Waste Code – 11 01 11* aqueous rinsing liquids containing hazardous substances (ammonium sulphate solution).

Technical dimension

AMS fertiliser is created in a 2-step process: 1) Desalination plant (DyVar process) + a dewatering and 2) Granulation stage,

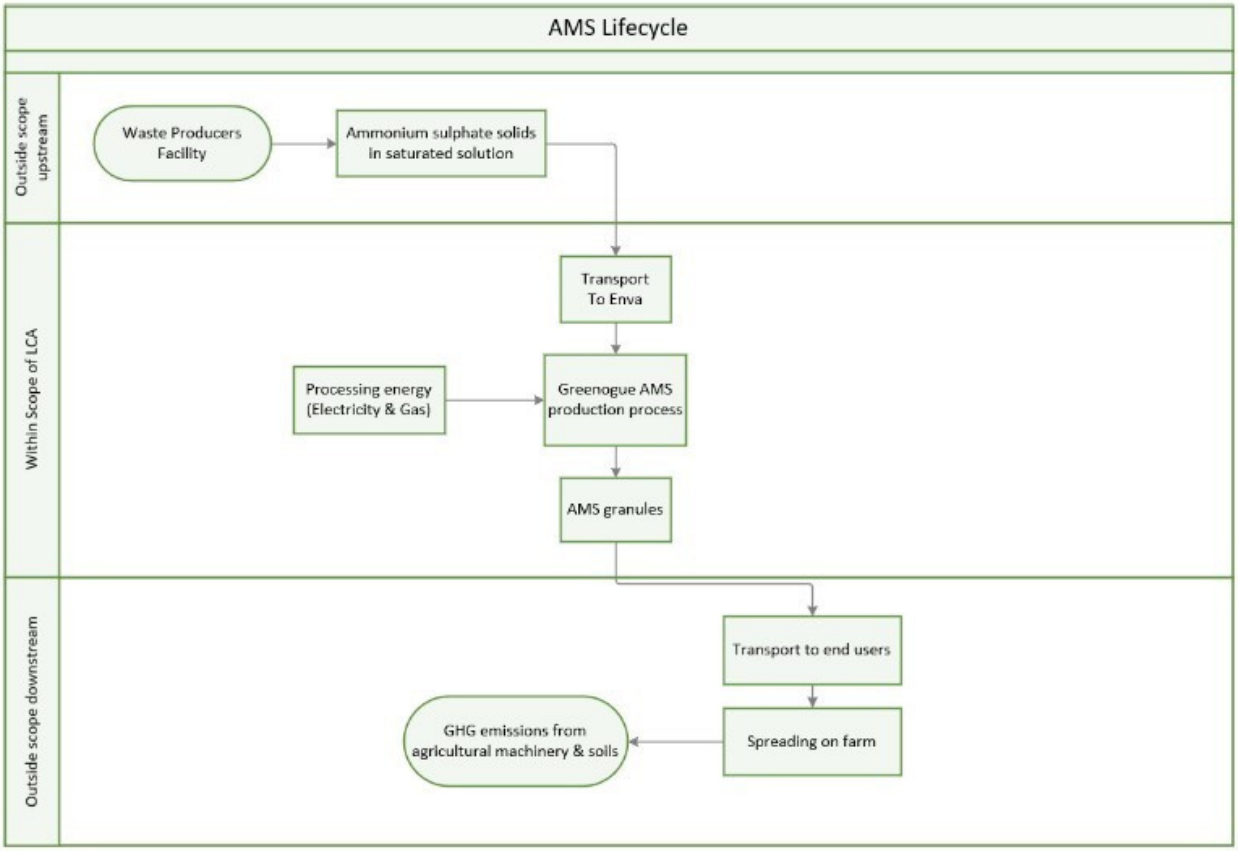
Stage 1 – Desalination step where salt solution is concentrated and precipitated via temperature and pressure in small cyclones. The salt slurry proceeds to Stage 2 and the residual water c. 66% of total throughput is reused on site for various other industrial processes.

Stage 2 – Crystalline slurry is centrifuged, then conditioned with hot air to separate crystals before being extruded and sieved to the correct size range for fertiliser use. This is a no waste produced from the process,all under/over spec granulate material is recirculated throughout the process until it reaches its target size.

Existing LCA analyses

Following a cradle to gate study it was found that Enva AMS would have a 92% to 98% lower carbon footprint than conventional ammonium sulphate. The range of emissions for conventionally produced ammonium sulphate being 500 to 700 kg CO2 per tonne as per the Eco-Invent database. The further discrepancy in range of carbon reduction is due to if grey electricity (92% saving) or green electricity (98%) saving was used in the production process.

See below the scope of the study:



More details are available upon request.

A full EPD will take place at the end of 2024 once operational data is available from the plant. The project is funded internally by Enva.

Ireland

Arigna Fuels

Name: Arigna Fuels
Location: Arigna, Carrick-on-Shannon, Co. Roscommon N41E527, Ireland
Type of system: Industrial manufacturer of biochar
Geographical scale: National and International
Living Lab manager/promoter/coordinator: Dr. Robert Johnson

Partners involved in the LL:
Hemp4Soil: Community Partnership
Maurice Deasy: Farmer/Teagasc
CREST: Research (NI)

Overall concept of the activities to be implemented

Arigna Fuels manufacture biochar from agricultural residues, most of which is destined for fuel briquette manufacture. A high carbon (>75%) product is also manufactured, which is far more valuable than the grade used for fuel (60-65%), given the potential for biochar to be used in agricultural applications - a fertilizer, peat replacement, for slurry treatment, carbon sequestration and GHG mitigation.

Biochar is already being sold to customers as a compost additive and as a growing medium for horticulture. Various trials are being undertaken with industrial partners, academia and farming representatives across the island to verify and corroborate literature research.

Due to the porous nature of biochar, addition to slurry provides a medium for bacterial growth, and absorption of nutrients, leading to a decrease in NOx and methane, but also prevention of gaseous ammonia. There have been promising results from the Hemp4soil project, located in the Loop head peninsula, Co. Clare on the synergistic effects of mixing slurry and biochar to grow hemp.

Maurice Deasy has used micronised biochar to coat seeds, with further field trials ongoing.

Arigna Fuels are currently constructing a 10 TPH biochar production facility, with a fully equipped laboratory for combustion and pyrolysis testing, characterisation of feedstocks and evaluation of final products.

Arigna can provide testing to evaluate biomass feedstock's, and in future, large scale trials to pyrolyze novel and densified biomass. Potentially, all residual agricultural by-products can be processed through the system, provided the material is sufficiently dense.
The technology is material agnostic, but there are limitations what we will have on site (no actual waste processing is allowed).

Technical dimension

TRL9 – Commercial production for torrefied biomass/ pyrolysis process, operating since 2018.

High carbon porous biochar, with trace plant nutrient elements. PAH, pesticide and heavy metal free.

Existing LCA analyses: Contact for details

Ireland

Sylvester Bourke

Name: Sylvester Bourke (Trading as Sylvester Bourke Farming Unlimited Co.)
Location: Killiniskyduff, Arklow, Co.Wicklow, Ireland
Type of system: Farmer
Geographical scale: Local
Living Lab manager/promoter/coordinator:
Dónal Kinsella, Martin Bourke & Patrick Forrestal

Partners involved in the LL:
Teagasc, Semi-state body

Overall concept of the activities to be implemented

Currently using a number of organic manures on the tillage crops including cattle slurry, farmyard manure, poultry manure and organic approved poultry manure pellets.

Tillage Farmer with poultry (layers) enterprise. Approximately 180ha farmed with 30ha in organic conversion. Crops grown include winter and spring cereals following break crops of beans, oilseed rape and maize. Majority of crops are established with a min-till system, although ploughing is occasionally used.

Technical dimension

Currently using a number of organic manures on the tillage crops including cattle slurry, farmyard manure, poultry manure and organic approved poultry manure pellets.

Bio-based fertilizing products recovered: N.A.

Existing LCA analyses: N.A.

Ireland

Teagasc trial (organic)

Name: Teagasc
Location: Wexford, Ireland
Type of system: Research
Geographical scale: National
Living Lab manager/promoter/coordinator:
Dónal Kinsella, Martin Bourke, Jack Nolan & Patrick Forrestal

Partners involved in the LL:
Teagasc, semi-state body
Department of agriculture food and the marine, State body

Overall concept of the activities to be implemented

Teagasc research is carrying out field based plot trials to mimic farmer's practice of crop production in an organic system. The field trial is performed within an arable system. The purpose of the demo trial is to assess agronomic benefits of different bio-based recycling derived fertilisers at a field-scale level. The primary goal is to determine how these fertilisers can enhance soil fertility by increasing carbon and major nutrient levels in the soil. Progress is being monitored by analysing crop yield and quality. The aim of this living lab Is to promote nutrient recovery and recycling from different agri-food processing waste resources. Additionally, the focus is on helping farmers understand and adopt these bio-based recycled fertilisers as options for their organic system.

Within the arable trial, seven different bio-based products are being assessed for their efficiency in enhancing soil fertility and nutrient recovery. These products are derived from various sources, including wastewater treated by-products from the dairy processing industry, poultry pellets from organic broiler units, free range poultry litter, cattle slurry and three different types of bio stimulants.

The demo plot trials are considered to be at TRL 6.

Bio-based fertilizing products recovered: N.A.

Existing LCA analyses: N/A

Ireland

Uisce Éireann

Name: Uisce Éireann
Location: Rings End, Dublin
Type of system: Waste Water Treatment Plant
Geographical scale: Regional
Living Lab manager/promoter/coordinator:
Robert van Spingelen (Ostara)

Partners involved in the LL:
Uisce Éireann, water authority
Murphy Ireland, building contractor and Operator
Ostara Nutrient Recovery, Reactor design and struvite offtake

Overall concept of the activities to be implemented

Recovery of ortho-phosphates and ammonium nitrogen from wastewater as magnesium ammonium phosphate (struvite) that will be used as slow-release fertilizer in agriculture. Ringsend treats around 40% of Ireland's wastewater and discharges into the nutrient Sensitive Area, Lower Liffey Estuary and Dublin Bay. Built in 2005, the current wastewater treatment plant is the largest in Ireland and was designed to cater for an equivalent of 1.64 million people. The Ringsend WWTP is currently overloaded as the average daily load received at Ringsend WWTP in 2019 was 1.98 million population equivalents ("PE") with peaks well more than this. Upon completion of the Ringsend WWTP Upgrade Project, scheduled for 2025, the Ringsend WWTP is projected to have the treatment capacity for a PE of 2.4 million. The Ostara's PEARL® struvite reactor has a design capacity to produce up to 14 MT of Crystal Green per day.

Technical dimension

Technology applied is a combination of Ostara's PEARL® struvite reactor (TRL9) and a WASSTRIP® (TRL9). WASSTRIP® transforms bacteria bound-phosphate into ortho-phosphates thus increasing the overall phosphate removal rate, while the PEARL® reactor controls the precipitation environment so that round struvite granules are made that can be used directly by farmers.

Crystal Green (5% N, 28% P2O5, 16 MgO) releases nutrients in response to organic acids naturally exuded by roots. As these organic acids solubilize Crystal Green, nutrients become over 90% plant available. As a starter fertilizer that is driven by crop demand and with ongoing access to phosphorus,

Crystal Green safely and precisely supplies crops with the nutrients they need to maximize yield. Farmers using Crystal Green are able to obtain similar or better yields with lower phosphate inputs thus increasing their PUE (Phosphorus Use Efficiency).

Inventory of the European NoLLs - POLAND

Poland

PolFerAsh

Name: PolFerAsh - Polish Fertilizers from Ash
Location: Center for Technology Transfer, Cracow University of Technology, Poland
Type of system: Research institute
Geographical scale: National
Living Lab manager/promoter/coordinator: Katarzyna Gorazda

Partners involved in the LL:

- Cracow University of Technology, University Mineral and Energy Economy Research Institute of the Polish Academy of Sciences in Poland, Research institute

Overall concept of the activities to be implemented

The solution relates to the production of multi-component solid and suspension fertilisers NP, NPK, manufactured based on, among other things, ashes from industrial sewage sludge as an alternative source of phosphorus and microelements, and/or ashes from chicken manure as a source of potassium. This allows for a reduction in the demand for conventional phosphorus sources and an increase in resistance to fluctuations in fertiliser and raw material prices in global markets.

Within the framework of the PolFerAsh project, an installation was developed for generating commercial products such as ammonium phosphate or calcium and ammonium nitrate. These products are derived from renewable sources. The PolFerAsh technology, resulting from this project, is an environmentally friendly method for manufacturing fertilisers using alternative phosphorus raw materials known as sewage sludge ash (SSA). According to legal definitions, SSA falls under the category of 'fly ash' excluding those specified in waste codes 19 01 13 and 19 01 14. In this research process, phosphoric acid was identified as an effective leaching agent due to its ability to achieve a high phosphorus recovery rate, reaching up to 99%. The solutions obtained from the phosphoric acid leaching process (which involves wet chemical treatment and neutralization) of SSA were harnessed for the production of phosphorus-based fertilisers. The residual waste left after phosphorus extraction was repurposed for use in construction.

·Main waste type treated: sewage sludge ash

Technical dimension

- Phosphorus ·recovery from sewage sludge ash with mineral acid:
- Stage I: Phosphorus leaching using nitric acid(V) and sulfuric acid(VI),
- Stage II: Precipitation (from the obtained extracts) of phosphorus compounds in the form of calcium dihydrogen phosphate $CaHPO_4 \cdot 2H_2O$ (DCP) using calcium compounds
- Available on the market (TRL 9)
- This project was supported by The National Centre for Research and Development (NCBiR) through the research grant PBS1/A1/3/2012 and by The National Centre for ·Research and Development together with the National Fund for Environmental Protection and Water Management through the research grant GEKON2/05/268313/8/2015

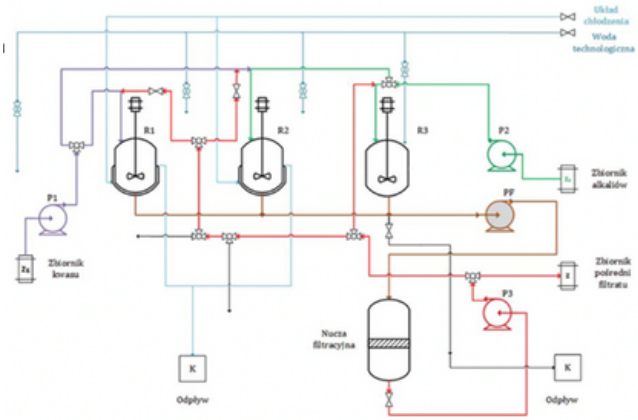
Biobased fertilising products recovered

The resulting product can be used as a suspension fertiliser or subjected to granulation, laking or direct drying. The technology enables the recovery of phosphorus as well as secondary nutrients (Ca, Mg) and microelements (Zn, Cu, Fe) from industrial sewage sludge ashes. The fertiliser product meet standard requirements in terms of nutrient content, solubility and heavy metal content (CD, Pb) and are ready for certification and introduction to the domestic market.

Existing LCA analyses

Life cycle impact assessment (LCIA)

The ILCD 2011 Midpoint+ V1.10 method was applied. It combines a midpoint and endpoint approach, which is presented for 16 following impact categories: Climate change [GWP100], Ozone layer depletion [OLD], Human toxicity: non-cancer effects [HT NCE] and cancer effects [HT CE], Particulate matter [PM], Ionizing radiation: human health [IR HH] and E (interim) [IR E], Photochemical ozone formation [POF], Acidification [AC], Terrestrial eutrophication [TEU], Freshwater eutrophication [FWEU], Marine eutrophication [MEU], Freshwater eco-toxicity [FEW], Land use [LU], Water resource depletion [WRD] and Mineral, fossil, and renewable resource depletion [AD].



Overall LCA results

The results of the LCA analysis of the technologies for the fertilisers production from secondary sources showed that the process contribute to a potential environmental impact. The results after the characterization step of the LCA are shown below. The presented results indicate that the highest impact is reported in the following categories: climate change, land use and freshwater eco-toxicity. This impact is caused by:

- emission of SO2, and nitrogen oxides affecting respiratory disorders, which are associated with the production of phosphoric acid and the sulfuric acid used in the PolFerAsh technology,
- emission of CO2 from the production of phosphoric acid and quicklime, which are important materials used in the fertiliser production,
- using primary fuels in the mentioned processes,
- avoided emissions of arsenic and antimony to water resulting from the elimination of the SSA storage.

Category	Unit	Results
Climate change (GWP100)	kg CO_2 eq	2287.2080
Ozone layer depletion (OLD)	kg CFC-11eq	0.0003
Human toxicity, non-cancer effects (HT NCE)	CTUh	0.0001
Human toxicity, cancer effects (HT CE)	CtUh	-0.0025
Particulate matter (PM)	kg PM2.5 eq	3.1836
Ionizing radiation, human health (IR HH)	kg U235 eq	201.0960
Ionizing radiation E (interim) (IR E)	CTUe	0.0007
Photochemical ozone formation (POF)	kg NMVOC eq	10.7783
Acidification (AC)	mol Hþ eq	42.9567
Terrestrial eutrophication (TEU)	mol N eq	32.0058
Freshwater eutrophication (FWEU)	kg P eq	30.4803
Marine eutrophication (MEU)	kg N eq	2.9067
Freshwater eco-toxicity (FWE)	CTUe	-145944.4500
Land use (LU)	kg C deficit	4591.3004
Water resource depletion (WRD)	m^3 water eq	336.6163
Water resource depletion (WRD)	kg Sb eq	3.7279

Poland

Ekotechnologie S.C.

Name: Ekotechnologie S.C. (Biorol Technology)
Location: Wolnica 57, 69-113 Górzyca, Poland
Type of system: Industry
Geographical scale: International
Living Lab manager/promoter/coordinator: Bożena Chmielina, Jarosław Kondrat

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

The Biorol Technology is a process used to produce a natural fertiliser (Biorol) from waste. The process is conducted using an innovative method that simultaneously processes stabilized municipal sewage sludge and ashes produced from biomass combustion.

- Capacity: 0,5-2 Mg/h waste mixture with the option of increasing the efficiency of the installation to 5 Mg/h
- Productivity: from 150-650 kg/h of organic fertiliser or soil improver with a structure similar to peat or compost
- Installation area: 100m2 – 150m2
- Installed electric power: from 50kW-100kW
- Service: 1 operator/shift and helper on the first change
- Main waste type treated: sewage sludge, ashes from biomass combustion

Technical dimension

The Biorol Technology is a process used to produce a product that is a natural fertiliser - Biorol from waste. The process is carried out using an innovative method of simultaneous processing of stabilized municipal sewage sludge and ashes resulting from biomass combustion. The technological line consists of the following modules:

1. Preparation of the mixture for drying with warehouses for raw materials and transmission,
2. Drying a standardized mixture of waste,
3. Packaging of the final product - biofertiliser,
4. Purification of gases and dust from the drying process and feeding the dryer,

5. Control and measurement equipment.

Available on the market (TRL 9)

The Biorol Technology was developed as a part of a project funded by the Natural Fund for Environmental Protection and Waste Management, titled "Development of innovative and environmentally friendly technology for production of natural fertilizer from waste"

The Biorol Technology enables the processing of municipal sewage sludge and biogenic ashes into fully-fledged organic fertilisers, organic-mineral fertilisers or soil-improvement agents, all while simultaneously eliminating pollutants and reducing the environmental risks to the natural ecosystem, human health, and the well-being of animals.

Biobased fertilising products recovered

The Biorol fertiliser is in granular form with dimensions ranging from 2-6 mm and a moisture content below 15%.
Chemical composition of Biorol fertiliser in dry matter:

- pH: 7.0-10
- organic matter: 30%
- phosphorus: 2.5%
- nitrogen: 1.0%

Existing LCA analyses

The Biorol fertiliser has a rich and unique composition, making it unnecessary to enhance or improve its quality further. Biorol also acts as a soil acidifier, thereby facilitating easier absorption of nutrients by plants. It enhances soil structure and properties and improves plant resistance to drought. Biorol is an ecological fertiliser with a carefully selected composition in terms of quality and nutrient properties, enabling proper growth and rapid development of plants. Biorol meets all the quality criteria required for commercial trade, and its permissible pollutant levels are below the required standards.
Biorol fertiliser qualifies as a biofertiliser for use in organic farming, home gardens, agricultural and energy crops, soil reclamation, green areas, lawns, and more.
In Biorol Technology, the compostion of the waste mixture for the process has been standardized to achieve the best quality characteristics of the resulting natural fertiliser - Biorol. For Biorol Technology, a dosing program has been developed for the quantitative addition of waste to the process, considering the variable morphology of the raw materials. The entire process is monitored for process parameters such as temperature, pressure, moisture content of the mixture and product, granule size, and efficiency. For safety reasons, the heating medium of the installation does not come into direct contact with the drying material.
One of the significant advantages of Biorol Technology is the innovative design of the dryer. Special blade constructions inside the dryer prevent the occurrence of the "sticky phase" during the drying process of the sewage sludge and ashes mixture. This solution reduces the demand for thermal energy during the reduction of moisture in the mixture. The dryer's design is sealed, minimizing the accumulation of dust on hall equipment or technological devices and preventing odor issues. Granulating the produced Biorol fertiliser allows for safe transport, storage and easy control of its application to the soil.

Poland

Municipal Water and Sewerage Company

Name: Municipal Water and Sewerage Company in Rzeszów
Location: Naruszewicza 18, 35-055 Rzeszów, Poland
Type of system: Industry
Geographical scale: National
Living Lab manager/promoter/coordinator: Dominika Pyś

Partners involved in the LL:

- Municipal Water and Sewage Company in RzeszówMIKROBIOTECH Ltd,

Overall concept of the activities to be implemented

Project "Transforming municipal sewage sludge into a product that is not considered waste" involved the development and implementation of a method for processing dried sewage sludge, which contains up to 93 % of dry matter, into a product that enhances plant growth or serves as a fertiliser.

Glebex+ is a soil improver from sewage sludge produced in the Municipal Water and Sewerage Company in Rzeszów. Dehydrated and dried sewage sludge is processed into a fertiliser. In the municipal sewage treatment plant, approximately 20 000 tons of sewage sludge are generated. Out of this amount, about 5 000 tons of sludge are dried. From these, approximately 1 000 tons of organic soil conditioner are produced (Glebex+).

- Main waste type treated: sewage sludge

Technical dimension

Glebex+ is produced from stabilized municipal sewage sludge dried at a temperature of 130C. It is enriched with microbiological preparations. The product is recommended for improving the quality of all types of soils by increasing the organic matter content. It is used, among other applications, in green spaces, in the cultivation of agricultural and ornamental plants.

- Available on the market (TRL9)

Biobased fertilising products recovered

Chemical composition of Glebex+ fertiliser (per ton):
- 38 kg of N,
- 39 kg of P,
- 5 kg of K,
- >50 % organic matter (d.m.).

Existing LCA analyses

The obtained product Glebex+ has been tested for physicochemical, bacteriological, and parasitological properties in an accredited laboratory of the Institute of Soil Science and Plant Cultivation (IUNG) in Puławy.
Based on the test results, it has received positive evaluations from the following institutions: Institute of Soil Science and Plant Cultivation in Puławy, Institute of Environmental Protection - National Research Institute in Warsaw, Institute of Rural Medicine in Lublin, Institute of Technology and Life Sciences in Falenty and National Veterinary Research Institute - National Research Institute in Puławy.

Poland

BIOEKO PJ

Name: BIOEKO PJ sp. z o.o. sp.k. (ROLPOWER fertiliser)
Location: Brodnia Dolna 24, 98-113 Buczek, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Pawel Ciechel

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

There are many benefits of using chicken manure. Unfortunately, you need specialized machines to spread it and not everyone has one. An alternative can be granulated chicken manure, which is sown with a regular spreader.

ROLPOWER fertiliser:

- gradually releases nutrients during the growing season,
- entirely natural,
- very convenient to use,
- ideal for degraded and depleted soils,
- natural pH,
- Easy to store.

ROLPOWER has a long shelf life when stored properly and can be applied manually or mechanically when in granulated form.

- Main waste type treated: chicken manure

Technical dimension

Poultry manure is obtained from free-range farms. The manure is composted and then air-dried (no dryer is used), then undergoes a granulation process. In the final stage, high temperature eliminates undesirable pathogens, weed seeds or eggs or young stages of insect development.

- Available on the market (TRL 9).

Unlike fresh manure, this manure can be stored as long as it is protected from sun and water.

Biobased fertilising products recovered

ROLPOWER organic-granulated soil conditioner can be used in field crops, orchards, vegetables, ornamental plants and lawns, on all types of soils, especially those with low organic matter content.

Chemical composition of ROLPOWER fertiliser (per ton):
·40 kg of N,
·30 kg of P_2O_5,
·20 kg of K_2O,
·65 % organic matter (D.M.).

Existing LCA analyses

The ROLPOWER fertiliser was introduced into circulation under the authorization of the Minister of Agriculture and Rural Development, Decision No. G-655/17 dated April 26, 2017, based on Article 4(2) of the Act of July 10, 2007, on Fertilisers and Fertilisation.
Positive opinions have been issued by the following state institutions:

- Institute of Soil Science and Plant Cultivation (IUNIG) in Puławy
- National Veterinary Research Institute in Puławy
- Institute of Horticulture - National Research Institute
- Laboratory for Cultivation and Fertilization of Ornamental Plants in Skierniewice
- Department of Horticultural Crop Breeding in Skierniewice
- Institute of Rural Health in Lublin
- Institute of Environmental Protection – National Research Institute in Warsaw

Poland

Water Supply and Sewage Company Ltd.

Name: Water Supply and Sewage Company Ltd. In Złocieniec (Zakład Wodociągów i Kanalizacji Sp. z o.o. w Złocieńcu)
Location: Piaskowa 6, 78-520 Złocieniec, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Wojciech Pawłowicz

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

OrCal®Zl pH regulator is an organic-mineral fertiliser with active calcium hydrate. The main goal is to improve the biological, chemical and physical parameters of soils (acidification, soil fertilisation and plant nutrition).

OrCal®Zl pHregulator is produced during the processing of sewage sludge directly in a modern production line located at the plant in Złocieniec. It is an agent improving soil properties made from partially dewatered municipal sewage sludge (waste code 19 08 05) in an amount of 70-85% from the Złocieniec Sewage Treatment Plant with the addition of WapCal® quicklime with high reactivity (15-30%). The amount of dry matter of municipal sewage sludge undergoing processing is 0.56 thousand. Mg/year.

Main waste type treated: municipal sewage sludge

Technical dimension

OrCal®Zl pHregulator is manufactured with FuelCal® technology. The technological line for processing organic waste into organic-mineral or organic-calcium fertiliser includes the following basic equipment:

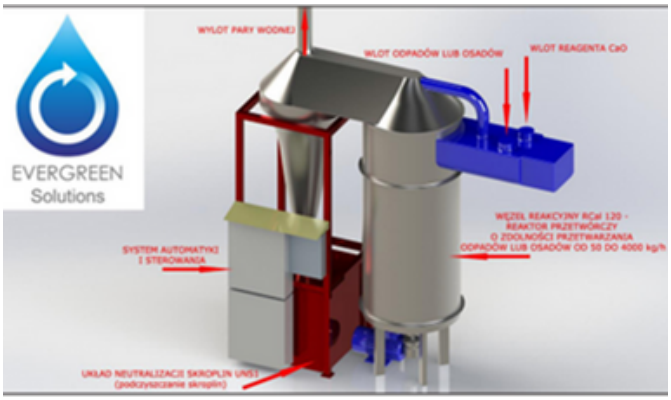
- organic raw material homogenizer and separator,
- CaO dosing system to the reactor,
- RCal 120 and RCal 250 reactors for processing
- organic raw material, along with a full automation and process control system,

•enclosed product receiving system,
•quicklime silo,

- Product packaging unit in a container type.
- Available on the market (TRL 9)

Biobased fertilising products recovered

Using a product containing nutrients:
·Calcium -30 (% D.M.)
·Nitrogen – 0.90 (% D.M.)
·Phosphorus – 0.60 (% D.M.)
·pH (reaction) ≥ 12.00;
·Organic matter - 35.8 (% D.M.)
·Potassium - 0.20 (% D.M.)



Existing LCA analyses

1. Quickly and safely increases soil pH
Thanks to the rapid improvement of the pH, the availability and efficiency of uptake of nitrogen, phosphorus, potassium, calcium, magnesium and sulfur by plants increases. According to The Institute of Soil Science and Plant Cultivation in Puławy, at pH = 7.0, the efficiency of uptake of macronutrients N, P, K is close to 100%.
2. Provides natural macro and microelements
OrCal® provides plants with an optimal pH in the root zone and basic, natural nutrients contained in organic matter: calcium, nitrogen, phosphorus, potassium, magnesium, sulfur, iron and other microelements and minerals, as well as proteins, amino acids and trace elements.

3. It fertilises the soil and develops the plant's root system
The organic matter contained in OrCal® initiates the process of fertilising deacidified soil. This results in an even greater acceleration of the uptake of macronutrients by plants and, consequently, better stimulation of cell division and plant development, especially the root system and, above all, hairy roots. A well-developed root system allows for more effective absorption of nutrients and water.
4. Increase in plant biomass by up to 40%
Well-rooted and nourished plants develop perfectly. According to research by The Institute of Soil Science and Plant Cultivation in Puławy, OrCal® increases plant biomass by 20-40%. According to research by customers using OrCal® products, they increase the protein content in cereal grains by approximately 30% compared to crops not fertilised with OrCal® fertiliser. For example, in fertilised spring wheat the average protein content exceeded 18% by weight compared to 13% of protein obtained in traditional crops.

5. Strengthening plant immunity
OrCal® strengthens the resistance of crop plants to pathogens and stress, e.g. droughts, heat, storms, hailstorms, floods, frosts and frosts, snowstorms and side effects of the use of plant protection products.
6. Reducing the pressure of harmful soil pathogens
OrCal® effectively limits the development of some soil pathogens, fungal and bacterial diseases, and pests, e.g. (nematodes, wireworms).
7. Neutralization of heavy metals - soil healing
After using certified OrCal® products manufactured using the WapCal® reagent, heavy metals present in the soil go to the so-called residual forms. Residual forms are not soluble in the soil solution, so heavy metals are not taken up and stored by plants. They are also less likely to enter groundwater.

Poland

Białystok Waterworks Ltd.

Name: Białystok Waterworks Ltd. (Wodociągi Białostockie Sp. z o.o.)
Location: Młynowa 52/1, 15-369 Białystok, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Beata Wiśniewska, Jarosław Poniatowicz

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

The purpose of producing GRANBIAL organic fertiliser was mainly to improve the condition of soils. It can be used on all types of soil. It is especially recommended for weak, mineral soils with low organic matter content. It can be used in the cultivation of agricultural plants (cereals, corn, rapeseed, industrial plants), for establishing lawns, green areas, and for fertilising trees, shrubs and ornamental plants grown in the ground.

Granbial fertiliser is produced at the Białystok Waterworks Ltd. The installation for its production is the entire technological process of the sewage treatment plant, based on wastewater treatment technology with activated sludge. Wastewater, which is the input product for the production of Granbial fertiliser, flows through the separate and combined sewage system from Białystok, the Wasilków commune and other neighbouring communes. Municipal sewage constitutes less than 95%, and industrial sewage - not much more than 5%. Currently, municipal sewage flows into the treatment plant in a total amount of approximately 60,000 m3/d, of which only 20% is industrial sewage. While sewage treatment produces large amounts of sewage sludge.

- Main waste type treated: sewage sludge

Technical dimension

Wastewater entering treatment plants is subjected to many technological transformations based on mechanical and biological purification methods. In each stage of the process, sediments are formed, which constitute the basis for the production of fertiliser. After dehydrating them too approximately 20% dry matter is sent to an indirect sludge dryer. The sediment is dried on heating trays at a temperature of approximately 205-270˚C.

The temperature of the granules after drying is approx. 100˚C. The dried sludge is discharged to a storage silo and then to storage boxes.

Biobased fertilising products recovered

Quality requirements of GRANBIAL fertiliser by decision of the Minister of Agriculture and Rural Development

- total nitrogen content (N) - 2.5% (m/m),
- phosphorus content expressed as P2O5 - 3.8% (m/m),
- organic matter content in dry matter - 40.0% (m/m),
- Form - solid, granulated (2 - 6 mm).

Existing LCA analyses

A number of studies using physical, physicochemical and chemical tests were carried out at the Institute of Soil Science and Plant Cultivation in Puławy. Dr. Eng. Tamara Jadczyszyn supervised the entire research process and confirmed the reported nutrient content, physical, physicochemical and chemical parameters, as well as compliance with minimum quality standards and permissible levels of contaminants. The fertiliser has also undergone agricultural tests, which resulted in an opinion stating that Granbial is an effective source of nitrogen and phosphorus for plants. After applying the fertiliser, a positive effect on plant growth, nitrogen and phosphorus nutrition and yield was found. Moreover, the Institute of Horticulture in Skierniewice under the supervision of Dr. Eng. Jacek Nowak noticed that plants using Granbial fertiliser achieved optimal performance during 3 months of soil cultivation. It is worth noting that the application of the fertiliser is convenient and simple, and an additional advantage is the long-term release of its ingredients into the soil. The use of sludge fertilisers is a significant problem due to their sanitary condition and the microbiological threat they pose to humans and the environment. In order to confirm the sanitary condition of organic fertilisers, the National Veterinary Institute - National Research Institute in Puławy (Department of Microbiology and Department of Parasitology and Invasive Diseases) conducts biological tests. These tests check for the presence of intestinal parasite eggs and Salmonella bacteria. Opinions were collected from various institutions on the impact of fertiliser on human health (the Witold Chodźko Institute of Rural Health in Lublin), animals (State Veterinary Institute in Puławy) and the environment (Institute of Environmental Protection in Warsaw - National Research Institute in Warsaw), and all opinions were positive. The final form of the fertiliser, i.e. granules, is obtained by drying it on heating trays, which ensures full hygienisation of the fertiliser. The accredited Białystok Waterworks laboratory ensures continuous quality control of the fertiliser. Sediment fertiliser can be used on all types of soil (recommended especially on weak and mineral ones), in the cultivation of agricultural plants (cereals, corn, rapeseed, industrial plants), for establishing lawns, fertilising trees, shrubs and ornamental plants grown in the ground.

Poland

OMEGA SA

Name: OMEGA SA
Location: Plac Konstytucji 3 Maja 1, 67-200 Głogów, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Wacław Pawłowski, Piotr Michalak, Marian Pasierbek

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

OMEGA SA has patented the technology for producing Oskar organic-mineral fertiliser using sewage sludge. The Oskar fertiliser production method makes it possible to produce a high-quality fertiliser used in agriculture and forestry.

Oskar is an organic-mineral fertiliser produced by OMEGA SA in Głogów. It is a product made from sewage sludge. The production process is carried out in such a way that the magnesium sulfate formed as a result of the reaction of acid and magnesite is not completely saturated with water, which allows its granulation.
Main waste type treated: sewage sludge

Technical dimension

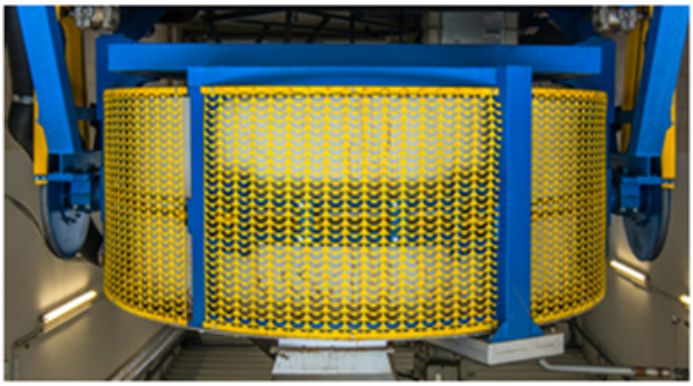
The reactor is where magnesite is introduced into the optimal amount of sludge, which is usually about 50% of the total mixture. Then, a concentrated 96% sulfuric acid solution is slowly added to the previously prepared portion. This process triggers an exothermic reaction that neutralizes both the magnesite and the acid, leading to an increase in temperature that brings the reactor contents to just above 100˚C. High temperature plays a key role in the complete decontamination of the sludge, causing the denaturation and elimination of all biological substances. The ongoing mixing processes allow for a significant reduction in the concentration of heavy metals present in the dry matter of the sludge, which is as much as eight times lower than before.

Biobased fertilising products recovered

Oskar organic-mineral fertiliser contains magnesium sulphate with 16% MgO, sulfur with 29%, SO3 and organic compounds of natural origin with 18%, a valuable source of organic carbon with properties that stimulate plant vitality.

Existing LCA analyses

For the fertiliser produced with this technology, on February 16, 2012, the Ministry of Agriculture and Rural Development issued decision No. 289/12 (amended by decision No. 289a/12 of June 19, 2012) allowing the applicant to place the organic-mineral fertiliser on the market. In accordance with the provisions of the annex to the above-mentioned decision, the organic-mineral fertiliser can be used on all types of soil, for field crops and for fertilizing soil intended for afforestation, as well as for use in forest crops, including: for revitalising soil in forest nurseries and for fertilizing seed stands and seed plantations, as a source of magnesium and sulfur.
The soils found in Poland are usually low in humus and sulfur. However, the use of Oskar fertiliser can significantly improve the quality of the soil by regularly supplying it with sulfur and magnesium. This, in turn, leads to an improvement in the structural composition of the soil, an increase in its sorption capacity and better water retention, which results in improved soil and plant moisture. As a result, the use of our product can improve the quality and yield of crops. In addition, the OSKAR fertiliser production process ensures that the sludge used in production is fully hygienic and partially decomposed, making it easily accessible to plants.



Poland

Municipal Repair and Service Company Ltd.

Name: Municipal Repair and Service Company Ltd. in Sławki (Gminne Przedsiębiorstwo Remontowo – Usługowe Sp. z o.o. w Sławkach)
Location: Sławki 1a, 83-314 Somonino, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Maria Ludwika Piotrowiak

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

The main goal of the project was to develop a fertiliser that would ensure the appropriate level of soil abundance in digestible and available nutrients, which would enable the cultivated plants to meet their nutritional needs.

AGRO SLUDGE is a fertiliser improving soil properties produced by Municipal Repair and Service Company Ltd. in Sławki is recommended for use in field crops of agricultural plants not intended for direct human consumption or for the production of feed. Used for post-harvest or pre-sowing crops. The agent helps to improve soil properties. The granules DE acidify the soil, thus replacing lime used in agriculture. Proper dosing is facilitated by the granulated form of the product. Distribution and dosing of fertiliser into the soil is possible, among others, using a disc fertiliser spreader.

Main waste type treated: sewage sludge

Technical dimension

The product improving soil properties AGRO SLUDGE is created as a result of the granulation process of sewage sludge with quicklime (CaO). During the process, the sludge dewatered on the belt press is subjected to the reaction of lime with intersludge water in a granulation device. Typically, for dewatered sludge with a dry matter content between 15% and 18%, 3 to 3.5 kg of CaO per kg of dry matter is used.
During the slaking reaction of lime with intersludge water, a high temperature is generated (from 90 to 100 C), causing intensive evaporation of water from the sludge and its complete hygienization. Intensive mixing using specially designed mixer blades in the granulator results in optimal granulation to a particle size of 1-2 mm.

This product has a high temperature when it comes out of the device and reaches its final form in the pile after approximately 12 hours after the reaction. After this time, the granulate is dry (dry matter approx. 65%), completely stabilized and ready for transport. Apart from sewage sludge and quicklime, no other raw materials are used to produce AGRO SLUDGE granules.

Biobased fertilising products recovered

Content of main ingredients

- N – 8,2 %
- P2o5 – 1,1%
- Mg – 0,2 %
- K2O – 0,54%
- SO3 – 0,29%
- CaO – 37,8 %
- pH – 12,5

Organic matter – 65% (d.m.):

Existing LCA analyses

It contains a large amount of calcium as well as other ingredients, such as Nitrogen, Phosphorus, Potassium, Magnesium, which support plant growth. Can be used on all types of soil. It combines the organic properties of sewage sludge with the properties of lime, supporting soil DE acidification. The temperature used eliminates all undesirable compounds. Based on tests of the quality of the soil conditioner, the Ministry of Agriculture and Rural Development agreed to introduce the organic-mineral soil conditioner AGRO SLUDGE to the market.

Poland

MERAL Ltd.

Name: MERAL Ltd.
Location: Grodzie 5, 14-500 Braniewo, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Radosław Jechna

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

In 2016, the MERAL company started the implementation of a new project - launching the innovative production of unique fertiliser granulates using horse manure. Thanks to its use, the earth receives all the minerals necessary for the proper growth of plants.

Horse fimus is a natural organic fertiliser based on horse manure. The product is in the form of granules, which facilitate application and contribute to the gradual and even release of nutrients in the soil. Fimus based on horse manure is universal, so it is suitable for the care of fields, vegetable gardens, orchards and for growing ornamental plants.

- Main waste type treated: manure

Technical dimension

Fimus "horse" manure is subjected to a drying and forming process, thanks to which it contains all the ingredients of traditional manure. The supplied natural manure is ground and dehydrated. In this way, the resulting mass is granulated. The material prepared in this way is packed into packages. Tight closure and storage in appropriate conditions ensure that the product remains fresh and useful for a very long time after production.

Available on the market (TRL 9)

Biobased fertilising products recovered

Chemical composition of Fimus fertiliser (per ton):

- N - 22,8 kg
- P2O5 - 22,9 kg
- K2O - 20,9 kg
- CaO - 26,9 kg
- MgO - 16,3 kg

Existing LCA analyses

Based on tests of the quality and suitability of fertiliser in agriculture at The Institute of Soil Science and Plant Cultivation (IUNIG) in Puławy, decision 576a/20 of 2020-12-08 was issued to qualify horse manure fertiliser for use in agriculture. The fertiliser has a non-intrusive smell and can be used to fertiliser almost all plants: field crops, vegetable growing, fruit growing, horticulture, field crops and ornamental plants (including potted plants). Horse manure is recommended primarily for crops and crops under cover. The fertiliser has a non-intrusive smell and can be used to fertiliser almost all plants: field crops, vegetable growing, fruit growing, horticulture, field crops and ornamental plants (including potted plants). Horse manure is recommended primarily for crops and crops under cover.

Poland

Bio-Med Ltd.

Name: Bio-Med Ltd.
Location: Szczukowskie Górki 1a, 26-065 Szczukowskie Górki, Poland
Type of system: Industry, Farmer
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Stefan Sikora

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

IGRAMED mineral-organic fertiliser was soil protection, abundance and high quality of crops. GRAMED fertiliser ensuring the implementation of Good Agricultural Practice on all farms. Thanks to its unique properties, Gramed fertiliser alleviates the side effects of excessive mineral fertilisation or mineral deficiency in the soil.

GRAMED fertiliser combines the advantages of mineral fertiliser and manure. It is produced, among others, from processed sewage sludge. In order to develop the best quality of action of this fertiliser, it is used on an experimental farm and its effects are checked. The research is conducted on a 230-hectare farm dealing mainly with the cultivation of cereals and corn. Research and analyzes are carried out in cooperation with scientific units such as the University of Agriculture in Krakow and the Kielce University of Technology. Then, conclusions are drawn and the fertiliser is improved. The fertiliser production volume is approximately 8000 Mg/year.

Main waste type treated: sewage sludge

Technical dimension

Initial preparation of sewage sludge involves partial dewatering and inoculation with a biopreparation at the treatment plant. The biopreparation contains selected cultures of microorganisms after dewatering the sludge (60%, after 2-3 months), the sludge is delivered using a loader or forklift with a bucket-dipper to the basket (initial hopper) of the GRAMED fertiliser production line, which is located in a covered production silo.

Biobased fertilising products recovered

Content of main ingredients:

- nitrogen (N) – 8% (m/m)
- phosphorus (P_2O_5) – 4% (m/m)
- potassium (K_2O) – 9% (m/m)
- calcium (CaO) – 12% (m/m)
- organic matter in dry matter – 50% (m/m)
- form: granules, loose

The organic substance contained in the fertiliser allows water to be retained in the soil and released during periods of deficiency, as well as more effective use of minerals by plants.

Existing LCA analyses

The company has collected relevant documents, including: a positive opinion on the suitability of this fertiliser developed in 2009-2011 by the Institute of Soil Science and Plant Cultivation (IUNIG) in Puławy; positive opinion of the Institute of Environmental Protection on the environmental impact of GRAMED fertiliser; opinion of the National Veterinary Research Institute in Puławy on the impact of fertiliser on animal health; opinion of the Institute of Rural Health in Lublin regarding the impact of fertiliser on human health, and consequently obtaining Decision No. 280/11 of June 21, 2011. Minister of Agriculture and Rural Development authorizing the introduction of fertiliser to the market.
As a result of numerous fertiliser tests conducted since 2009, the company obtained Decision No. 280/11 issued on June 21, 2011, by the Minister of Agriculture and Rural Development for the introduction of an organic-mineral fertiliser under the name "GRAMED". Research conducted by IUNG in Puławy shows that the fertiliser contains less heavy metals than permitted by standards. The manufacturer also emphasizes that it does not contain pathogens harmful to plants.
The ecological justification for the production of GRAMED fertiliser is to significantly reduce the negative impact on the environment of sewage sludge accumulated over many years in various types of landfills and to use the produced fertiliser to fertilise barren soils and to cultivate devastated areas, which is beneficial for the environment.

Poland

DMG Sp. z.o.o.

Name: DMG Sp. z.o.o.
Location: Koczergi 56, 21-200 Parczew, Poland
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Mariusz Gołacki

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

The main goal of the project was to create an organic fertiliser from digestate produced in an agricultural biogas plant in the process of sophilic fermentation of corn and organic waste from the processing of agricultural raw materials.

Bio-Eko2 fertiliser is produced by the DMG Sp. z o.o. biogas plant in Korczegi. The main substrates are corn silage, waste from fruit and vegetable processing (apple pomace, potato pulp) and distillery stock. The biogas plant does not use animal waste. The fertiliser is stored in concrete tanks with a total capacity of over 14,000 m3. Bio-Eko2 can be used on arable land for all field crops, i.e. cereals, corn, rapeseed, fodder and industrial plants as a nitrogen-potassium fertiliser.

- Main waste type treated: digestate

Technical dimension

The digestate is separated into solid and liquid fractions, with part of the liquid fraction being returned as process liquid to the digester. It is produced in mesophilic fermentation processes, which are carried out in closed fermentation chambers at a temperature of approximately 30–40° C. The fermentation process lasts approximately 30 days.

Organic fertiliser in liquid form is spread on the fields, both on the farm, which also supplies substrates and on the fields of nearby farmers.
Available on the market (TRL 9)

Biobased fertilising products recovered

Content of main ingredients:

- N – 0,26%,
- N-NH4 – 0,13%,
- K2O – 0,38%,
- organic matter content – 53,4%
- form - liquid, suspension

In 10 tons (m3), the fertiliser contains at least: 15 kg of nitrogen (N) and 25 kg of potassium (K2O).

Existing LCA analyses

The soils in the region where the biogas plant operates are of lower quality classes, therefore the use of the Bio-Eko2 fertiliser will, together with the digestate, add nutrients directly available to plants and the organic substance contained in the fertiliser. Appropriate use of digestate ensures a significant increase in yields. The risk of nitrogen emissions and odor nuisance was prevented by the use of the so-called "floating cover" in the form of plastic cubes which, floating on the surface of the digestate, arrange themselves in the shape of a honeycomb and create a fairly tight and at the same time flexible covering of the surface of the stored mass. Thanks to this, the threat of nitrogen and odor emissions was neutralized.
The production of fertiliser minimized the amount of waste from the agri-food industry. The fertiliser is stored in tight tanks and/or lagoons that prevent the fertiliser from entering surface waters.

Decision No. 332/14 of the Minister of Agriculture and Rural Development granted a positive opinion and permission to DMG Sp. z o.o. to market the organic fertiliser titled "Bio-Eko2" produced by the above-mentioned entity.

Inventory of the European NoLLs - FINLAND

Biolan Oy

Finland

Name: Biolan Oy (daughter companies Novarbo Oy and Kiertoravinne Oy selling recycled nutrient based fertilizers to horti- and agriculture)
Location: Eura, Finland
Type of system: Company, production of organic and organomineral fertilizers.
Geographical scale: European and National
Living Lab manager/promoter/coordinator: Hannamaija Fontell

Partners involved in the LL:

- Biolan Oy, Company producing fertilizer, selling to consumers
- Norvabo Oy and Kiertoravinne Oy, Daughter company of Biolan Oy

Overall concept of the activities to be implemented

Biolan Oy was founded 1974 to produce natural fertilizer from broiler manure. Now producing wide range of different consumer and professional fertilizers using different recycled raw materials.

Biolan Oy has an industry scale production facility in Eura, Finland that can be used to produce small batches of sample products (depending on the production capacity needed for the commercial production), the current Biolan Oy fertilizer product range can be used in living lab testing.

Technical dimension

Biolan Oy has an industry scale production. The granulated fertilizers are made in drying, pelletizing and granulating using different raw materials based on the needed nutrient content of the product. Production complies with the European directive of animal side streams (70 degrees C, 1 h).

Biolan Oy is producing liquid natural fertilizer (ammonium lactate) especially for professional horticulture. Production is based on washing ammonia to lactic acid from the compost reactor. Biolan Oy daughter company Biolan Baltic Ou (Estonia) is producing wood based biochar used in Biolan Oy products.

Biobased fertilising products recovered

Biolan Oy, Novarbo oy and Kiertoravinne Oy have a very wide range of bio-based fertilizers from small scale consumer products for different plant types to large scale products for agriculture and horticulture. The product specifications can be obtained if there would be a living lab project to attend.

Existing LCA analyses

There are LCA -analyses done for some of the products. This can be looked into more closely during the planning process of living lab tests.

Finland

Tyynelä farm

Name: Tyynelä farm
Location: Joutseno, Finland
Type of system: Farmer
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Juuso Joona

Partners involved in the LL:

- Tyynelä farm, Local

Overall concept of the activities to be implemented

At the Tyynelä farm fertilization additional to crop rotation and biological N-fixation is based on recycled fertilizers. These are also developed and tested at the farm.

Tyynelä farm is a 140 hectare organic and regenerative crop production farm. In its seven year crop rotation are cereals, pulses and oilseed crops grown. Organic recycled soil improvement materials such as wood industry based ashes and fibres are used. Nutrients are applied with biogas sludges. Farm is developing the most resource efficient practices of fertilisation integrated into the production system.

Technical dimension

Soil improvement fibres are made of the side streams of the pulp industry.
The raw material of the biogas sludge is source separated biowaste

Biobased fertilising products recovered

The fertilizers used are of high quality and has proven to be efficient in improving soil health and developing decent crops.

Existing LCA analyses: N.A.

Finland

Kirmanjärvi catchment

Name: Kirmanjärvi catchment
Location: Maaninka, Finland
Type of system: Farmers/research institute
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Mari Räty

Partners involved in the LL:

- LUKE, Natural Resources Institute Finland

Overall concept of the activities to be implemented

In Finland, the proportion of manure nutrients is about 60% of all P and 33% of all N fertilisation in agriculture. Of the manure generated, the greatest quantities are generated on cattle farms (c. 72%), being mainly used without further processing. In North Savo in east-central Finland, manure is generated in large quantities, being one of the most important dairy and beef production area in Finland. In general, grasslands occupy 45% of agricultural land, but in provinces characterised by grassland-based dairy production the proportion can be 67%. Grasslands are less susceptible to erosion during harvest years, but substantially more prone to DRP losses than arable fields conventional cereal cultivation. In the region, winters (frost and snow) also play an important role in yearly water flow dynamics, affecting agricultural pollution. In North Savo, 22% of lakes and 33% of rivers are not of good ecological water status. Heavily eutrophied lakes are found especially in Iisalmi Route, in which lakes are typically shallow and contain high concentrations of dissolved humic substances. To achieve the water quality targets, the river basin management plans contain significant nutrient load reduction targets especially for agriculture in the new period 2022-2027.

On-farm manures, especially cattle slurries, are an essential component of grass-dominated production systems, but also pose the risk of potential environmental impacts, including gaseous emissions and especially nutrient losses though runoff and leaching. From an agronomic and environmental perspective, the general aim is to enhance sustainable use of manure, maintain soil fertility and enhance carbon sequestration. At the same time, the specific aim is to reduce nutrient losses from grasslands under boreal conditions, in which silage production is based on short-term rotational grass leys (typically renovated every 3-4 years by ploughing).

The small 3.2 km2 agricultural and forested study catchment is situated in the catchment area of Lake Kirmanjärvi (c. 27 km2, 31% fields) in North Savo in east-central Finland, in the eutrophic Iisalmi Route. Lake Kirmanjärvi is agriculturally loaded and associated with high internal P loading. The study catchment is covered by 50% forests, 32% fields and 18% peatlands, in a livestock production area with proportions of grassland, cereal and forest area that are typical for east-central Finland. Over half (52%) the agricultural land have been under grassland (inc. leys and pastures consisting of mainly timothy and meadow fescue), and the other 48% under spring cereals (such as barley and oat).

Technical dimension

At both monitoring sites, the instrument shelters (sea containers) are equipped with main electricity and radiators/air heat pumps to enable year-round operation. In wintertime, several heating cables are used to protect water tubes and measurement culverts in ditches from freezing. The custom-built, eight meters in length plastic culvert structures have been placed in the open ditches, where the flow measurement takes place continuously with Sommer RQ-30 meters. Water sampling with automated programmable samplers (WaterSam WS 312 VAC) and continuous water quality monitoring with YSI EXO2 multiparameter sonde (inc. different sensors) and TriOS OPUS are placed in the self-designed tubular systems in the containers, through which the water is pumped (Verderflex iDura 25 hose pump) into the container and back into the ditch. In addition, the data is produced by a weather station (Vaisala all-in-one WXT536) and soil moisture/temperature/electrical conductivity sensors. The development of the automation system will continue in the near future.

TRL 6 (for the new solution used/tested in agricultural water monitoring)
Funding source for establishment and instrumentation: Natural Resources Institute Finland (Luke), and the projects, which have received its main funding from the European Regional Development Fund (ERDF) through the Regional Council of Pohjois-Savo.
Funding source for water monitoring: Ministry of Agriculture and Forestry of Finland (MMM), and future projects (e.g. different sampling campaign, research questions).

Biobased fertilising products recovered

As fertilizers, on-farm manures are an essential part of grass ley cultivation, and widely used in North Savo and in the study catchment area. In the region, farmers have also been increasingly interested in recycled organic fertilizers and soil amendments, about which information will be shared during the project.

Under a changing climate, information on the effects of livestock production systems and use of manures on water quality is produced at a small catchment scale, representing northern agricultural production.

The empirical data can be utilized e.g. in modelling work. The results can be used e.g. in the development of sustainable use of manure, and in the planning of cost-efficient mitigation measures targeting nutrient losses especially at the regional/national level.

Existing LCA analyses: N.A.

Finland

Pirteä porsas Ltd.

Name: Pirteä porsas Ltd
Location: Vehmaa, Finland
Type of system: Digesting pig slurry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Jyrki Heilä

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

Pirteä Porsas Ltd. digestate about 16000 m3 of pig slurry (1600 sows) annually (capacity for 35000 m3). After anaerobic digestion, slurry is separated into a liquid and solid fraction. Liquid fraction is distributed to the fields through pipelines extending up to 4 km from the digester. Solid fraction of pig slurry, containing most of the phosphorus (P), is distributed to fields requiring P fertilization. This technology ensures that only liquid fraction will be utilized in fields with high P status and will eventually decrease excessive soil P status in these fields and reduce the potential P losses to the surface waters. Technology used for distribution of liquid fraction to fields is innovative in Finland. This reduces trafficking between farm and field as liquid fraction is pumped through pipelines close to the fields and spreading is conducted through hose spreading.

Total of 16000 m3 of pig slurry is digested annually and with the technology used, both nitrogen and phosphorus fractions will be utilized in fields with actual demand for these nutrients. Pirteä Porsas Ltd. digestates pig slurry mainly originating from its own production, but liquid fraction is utilized farmers having fields along the pipeline (length of 4 km). Concentrating P into solid fractions also reduces the cost for transporting solid fraction to fields with demand for this nutrient. This provides means for reducing high soil phosphorus levels and decreasing phosphorus losses to surface waters.

Technical dimension

Mesophilic digestion of pig slurry, followed by separation into liquid and solid fraction, TRL 9

Biobased fertilising products recovered

Liquid fraction is used for nitrogen fertilizer at the field close by and solid fraction can be transported to fields with actual phosphorus demand.

Existing LCA analyses: N.A.

Finland

Toholampi

Name: Toholampi
Location: Toholampi, Finland
Type of system: Research institute
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Riitta Lemola

Partners involved in the LL:

- LUKE, Natural Resources Institute Finland

Overall concept of the activities to be implemented

The Toholampi experimental field was established in 1992 for erosion and nutrient (N, P) leaching studies. The current crop rotations, which mimic organic and conventional crop rotations in hypothetical cereal and dairy farms, were established in 2001. The experimental design is a randomized complete block design with four treatments (rotations) and blocks. Both the dairy farm crop rotations (organic, OMilk and conventional, CMilk) and the organic cereal (OCer) rotation received cow manure (slurry) for fertilization. Application rates and times varied according to the crop rotation. The organic cereal rotation received the least manure and the conventional dairy farm received the most. In addition, the fertilization of the conventional dairy rotation was supplemented with mineral fertilizers within the limits allowed by the agri-environmental scheme. The conventional cereal rotation (CCer) was fertilized only with mineral fertilizers. The crop sequences were designed so that the crops in the organic and conventional rotations (OMilk - CMilk; OCer - CCer) were rather similar, but with typical differences such as the prevalence of legumes. The design was also realistic in terms of practical farming in the Ostrobothnian region.

The experimental field is constructed for nutrient leaching studies and contains 16 plots isolated hydrologically from each other. Surface runoff and sub-surface drainage (depth about 1 m) water from each plot is conducted separately to an observation building to measure the discharge and to collect flow-weighted water samples throughout the year.
The main objective of the study is to monitor the effects of organic and conventional farming on erosion and nutrient loads, as well as on crop quantity and quality. Changes in soil properties are monitored every five years.

This is a field-scale experiment with a total field area of 2.56 ha in 16 separate plots. The size of the plots is 0.16 ha (16 m * 100 m). Fertilization is done with either mineral fertilizer (CCer) or manure (OMilk, OCer) or both (CMilk).
The field trial will provide information on the potential of manures and biological nitrogen fixation of legumes in organic farming to sustain crop growth compared with mineral fertilization or manure fertilization supplemented with mineral fertilizers.

Biobased fertilising products recovered: N.A.

Existing LCA analyses: N.A.

Finland

Yöni

Name: Yöni
Location: Jokioinen, Finland
Type of system: Research institute
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Riitta Lemola

Partners involved in the LL:

- LUKE, Natural Resources Institute Finland

Overall concept of the activities to be implemented

The experimental field was established in the 1990s when current crop rotations in both organic and conventional farming were established. In addition, two plots are meadows with no agricultural interventions (representing background load). The crop rotations have remained unchanged since 1995. Cultivated crops grown are the same in organic and conventional crop rotations [barley, timothy/clover ley (2 cut), timothy/clover ley (1 cut), rye, a mixture of a pea and oats]. Each crop in the crop rotation is grown in at least one plot each year both organically and conventionally.

The organic crop rotation is fertilized only with manure and conventional rotation only with mineral fertilizers.
The amount of manure used is linked to the amount of crop produced. It has been 50 kg/ha of total nitrogen per year. The conventional crop rotation is fertilized within the limits allowed by agri-environmental scheme in force.
Until 2010 used manure was a mixture of peat litter and dairy cow excretion (urine and dung) and later dairy cow slurry.
In six plots, surface run-off and drainage water are conducted into a well where the total run-off is measured and weigh-proportional water samples are collected to determine erosion and nutrient (N and P) losses from the different crop rotations.
The main aim is to monitor the impact of organic and conventional farming on erosion and nutrient loads, as well as on crop quantity and quality. Changes in soil properties are monitored at 5-year intervals.

This is a field scale experiment with a total field area of 7.4 ha in 14 separate plots. Size of the plots are circa 0.5 ha (0.44-0.62). Fertilization is conducted either with mineral fertilizers (conventional farming) or manures (organic farming). Field trial provides information about the potential of manures to sustain crop growth in organic farming.

Biobased fertilising products recovered: N.A.

Existing LCA analyses: N.A.

Finland

The farm of Qvidja

Name: The farm of Qvidja
Location: Parainen, Finland
Type of system: Farmer
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Pekka Heikkinen

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

Qvidja´s farm is utilizing organic residues as a soil improver and bio-based fertilisers. Qvidja' s farm is an organic farm with 180 hectares of arable land, 100 cattle, 30 horses and 40 sheep. Manure is composted and utilized as a fertilizer on their own fields.

Biobased fertilising products recovered

Forest industry mixed sludge (https://soilfood.fi/maatalous/tuotteet/soilfood-kompostoitu-ravinnekuitu-i/) is used as a soil improver (high organic carbon content) to improve soil structure and to provide nutrients for the crops. Also, manure that is produced at the farm is composted and used as fertilizer on farms´s own fields.

Existing LCA analyses: N.A.

Inventory of the European NoLLs - FLANDERS (BE)

Belgium

Inagro

Name: Inagro
Location: Ghent, Rumbeke-Beitem, BELGIUM
Type of system: Research institute
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Sander Vandendriessche

Partners involved in the LL:
- UGhent, University
- European Biogas Association (EBA), Association

Overall concept of the activities to be implemented

Farm-scale anaerobic digestion of agro-residues/pig manure to increase local nutrient cycling & improve nutrient use efficiency.

This small-scale AD plant is a classical CSTR reactor with a total volume of 200 m³ and a nominal volume of 150 m³. The installation has an electrical power of 31 kW and is operated at mesophilic (± 40˚C) or thermophilic (± 50-60˚C) temperatures. The biomass is being mixed by a Peters Fermento Mixer (11 kW), adjustable in height and width. Prior to burning the biogas in a CHP unit, water vapour and sulphur are removed from the biogas by a condensation step and biological desulphurization, respectively. To date, this technology occurs almost exclusively on dairy farms in Flanders, while Inagro digests mainly local agro-residues and/or manure
The AD plant can be visited for demonstration purposes and serves as a pilot scale research facility for anaerobic digestion, pre- and post-treatment, as well as biogas upgrading.

Technical dimension

This demo/pilot is operational at TRL 9 and has been set up through a biogas installation at Inagro with a 31 kW pocket (farm-scale) anaerobic digester, making it directly comparable to other pocket digesters and thus very relevant for farmers. The pocket digester can be fed with different input streams to assess co-digestion conditions for small scale anaerobic digestion, has the possibility to implement pre- or post-treatment techniques and/or biogas upgrading. This demo/pilot solution is linked to Nutri2Cycle EU Project, Biogas-MAMBO SWO and Horizon Europe-project Value4Farm.

Overview of the biogas pilot plant (Pocket digester (31 kWel)) at Inagro: (1) Silage tanks to store and feed liquid pig slurry; (2) Triolliet screw press to feed the faecal fraction of pig manure; (3) Mixing system; (4) Reactor; (5) Air injection for biological desulphurization; (6) CHP; (7) Partially covered trench silos for the storage of the faecal fraction of pig manure.

Biobased fertilising products recovered:

Digestate: the characteristics of the digestate are variable and largely depend on the input stream(s) used, as well as on any pre- and/or post-treatment present.

Existing LCA analyses: N.A.

Belgium

IVACO

Name: IVACO
Location: Gistel-Zevekote
Type of system: pig husbandry farm
Geographical scale: Regional
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

Excessive manure production is a problem in Belgium and above all for Ivaco, a farm that owns 11,000 pigs. Indeed, there are more animals than arable land to dispose on. In 2012 the company decided to install a digester to treat the solid part of the manure and a 150kW biogas plant.

This installation was constructed within the project DIGESMART. It can treat a mixture of liquid fraction pig manure and digestate to strip the ammonia and produce ammonium nitrate in a consecutive scrubber. The installation can treat up to 20 m^3/day of thin fraction and produces an ammonium nitrate solution with a concentration of 18 %N (m/m).

Technical dimension

The electricity generated by cogeneration is used within the company itself and the heat is used for composting process. The product coming from the biogas installation is composted, and the end product of that composting process is a soil enhancer which is then exported to France, where there is a bigger need of nutrient and organic carbon. The distinctive feature of the plant lies in the use of a stripping-scrubbing model, installed as part of the European Union's Digesmart project. The pig manure treated is first separated and the liquid fraction is then treated, so that the ammonium nitrogen can be recovered via the stripping-scrubbing process.
Currently, the pilot has a capacity of 15,000–20,000 tonnes of LF of digestate per year.
This technology ensures that the entire biogas chain is more sustainable.

Biobased fertilising products recovered

Existing LCA analyses: N.A.

Between 50 and 90% of the nitrogen can be extracted and recuperated in the form of ammonium nitrate, with a concentration of about 18% of nitrogen on total fresh weight. It can be used as a mineral fertiliser substitute, to replace fossil energy-based mineral fertilisers.
Finally, the end product of the liquid fraction is further post-treated into water in the facility.

Belgium

NV De Zwanebloem

Name: NV De Zwanebloem
Location: Adinkerke, Belgium
Type of system: diary farm
Geographical scale: Regional
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

Ideally, it would be possible to fertilize fields of fellow farmers with cattle manure just across the border in France. There is a high demand for animal manure, while in Flanders there is a surplus.
It should also be possible to replace the fertilizer currently given to the crops with animal manure, possibly separated without exceeding the maximum amounts of phosphorus and nitrogen.

The farmer has an interest to adopt a thermophilic anaerobic digestion process which would allow the digestate to be considered hygienized, conforming to the EU By-product regulations and thereby opening the possibilities for spreading the resulting digestate just across the border in France where demand for good fertilizers is significantly higher than in (West-) Flanders, BE (which itself is characterized by local overproduction on soil balance).

Technical dimension

Processing 25.000 t/y of cattle manure together with 5.000 t/y of co-substrates.
We milk 1000 cows and have 750 young cattle. Currently, the surplus manure is sold to neighbouring farmers in Flanders and part of it goes to organic manure processing. With the construction of a digester of 30000 tons, we want to process our manure ourselves. We also have a manure separator to dilute the cattle manure and to have an even better valorization of the manure. The digester will be put into operation in November 2023.

Biobased fertilising products recovered

Manure and digestates

Existing LCA analyses: N.A.

Belgium

Waterleau New Energy

Name: Waterleau New Energy
Location: Ieper, Belgium
Type of system: Environmental service company
Geographical scale: Regional
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL: N.A.

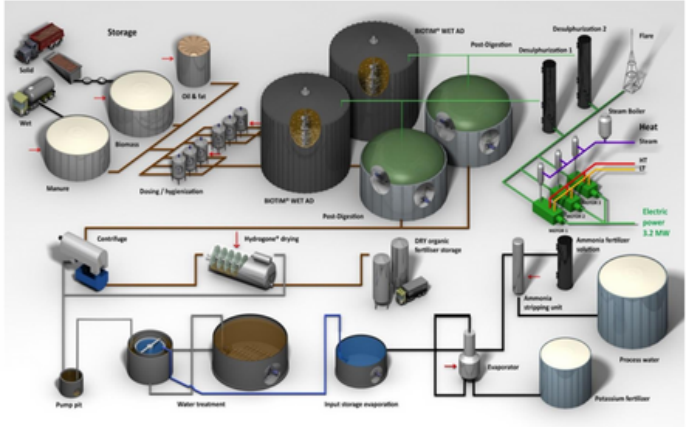
Overall concept of the activities to be implemented

Waterleau is an environmental services company in the fields of water, air and waste treatment as well as in new energy recovery. Waterleau New Energy is their biogas plant in Ieper. It's location in West Flanders is characterized by intensive pig husbandry and therefore has to cope with a manure surplus and stringent local fertilizing legislation.

The biogas plant is codigestion of 45% manure and 55% biological waste streams
Date of construction 2012 Size (MWel) 3,2 Volume (m3) 12.000

Technical dimension

Waterleau NewEnergy had already invested in an advanced digestate treatment line. Digestate is separated into a dried solid fraction. The liquid fraction is further treated by means of an evaporator where ammonium is removed and recovered as condensed ammonia water. Condensed water is purified through reverse osmosis (RO). The remaining concentrate of the evaporator is low in ammonium but contains other macro-nutrients. Other innovations include blending of the dried solid fraction and evaporator concentrate producing tailor-made organic fertiliser products with N-P-K ratios in accordance to farmers demands.



Biobased fertilising products recovered

Dried solid fraction (92% dry matter) can be effectively transported over long distances. It is sold in France as an organic P fertiliser. Condensed ammonia water (93 g N/kg) is a suitable alternative for urea or synthetic ammonia water in DeNoX installations for treatment of flue gasses. However, it is unsuitable as an N fertiliser because of its high pH.
Evaporator concentrate, remaining after evaporation of water and ammonia, is high in K (25 g K/kg), N (11 g N/kg) and S (12 kg S/kg). Concentrate has to compete with disposal of animal manure due a high fraction of N being present in organic form and a rather high P content.
To improve its business case, WNE is now blending dried solid fraction with evaporator concentrate. This blend is a wanted fertilizer is France.

Existing LCA analyses

Biogas is converted into 21,300 MWh of electricity of which 70% is fed to the grid and the remainder used on-site. Thermal heat produced by the combined heat and power (CHP) generator is used on-site to meet the energy demand of the dryer and evaporators.
By means of a decanter, 75% of phosphorus is recovered in the solid fraction which is subsequently dried to solid organic fertiliser with 90% dry matter. The liquid fraction is treated in an evaporator which effectively separates one tonne of liquid fraction into 0.14 tonnes of concentrate, 0.015 tonnes of condensed ammonia water 0.85 tonnes of condensed water. Condensed water needs post-treatment by RO in order to meet criteria for discharge.
Chemicals consumed include polymer for solid/liquid separation and sulphuric acid for nitrogen recovery on the RO.

Belgium

Heirbaut Hoeveproducten

Name: Heirbaut Hoeveproducten
Location: Veldstraat 218-9140 Temse, Belgium
Type of system: Family farm
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Kris Heirbaut

Partners involved in the LL:

- UGent, University
- VITO, Research organisation
- ILVO, Research organisation
- Inagro, Research organisation

Overall concept of the activities to be implemented

The Heirbaut farm allows the cows to graze in the meadow, freely walk and develop their natural herd behavior. In addition, methane emissions are minimized by collecting the cows' manure and fermenting it in a bioreactor to produce green energy. The CO2 released during biomethane combustion is captured and used to cultivate microalgae, the digestate (fermented manure) fertilizes the fields and pastures, and the electricity is supplied to the house, farm, and shop.

Heirbaut ALgriculture is a pioneer in Flanders concerning microalgae production. It cultivates Chlorella, a green freshwater algae with a deep vegetable flavor. Its name means "little green leaf", so the algae are entirely packed with chlorophyll, giving it a characteristic striking green color. Furthermore, Heirbaut promotes carbon farming, i.e., capturing carbon in agricultural soils, as a climate change mitigation strategy for farmers. The carbon increases the soil quality and enhances crop resistance in prolonged drought or intense rainfall. These practices use a home-grown mixture of grasses, clovers, and herbs from eight plant families. It does not require artificial fertilizers or sprays and contains sufficient proteins, minerals, and vitamins for their cows. The farm also tests several agroforestry strategies for carbon capture.

The main waste stram treated is cattle manure

Technical dimension

- Cultivation of microalgae: The CO2 released during the production of green energy is captured and purified. This is then used as a medium for algae cultivation.
- Fresh Algae mass: Once the algae have grown sufficiently, they are harvested fully automatically. The fresh algae mass with digested cell walls then finds its way to the processing industry. Algae can be widely used in a range of products.
- ·Grass 2 Algae: Try to avoid fertilizer. Hence the quest to meet the nitrogen needs of algae species even grow much faster if you feed them with grass juice.
- ·The fermented manure, digestate, is used to fertilize fields and meadow.

Biobased fertilising products recovered

Digestate

Existing LCA analyses:N.A

Belgium

Bio Sterco

Name: Bio Sterco
Location: Grote Stadenstraat 9, 8830 Hooglede, Belgium
Type of system: Company
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Johan D'hondt

Partners involved in the LL:

- UGent, University
- Detricon, Company

Overall concept of the activities to be implemented

The Bio Sterco is a modern manure processing plant that mainly processes sow manure from breeding pigs. The company was looking for a way to treat both the thin fraction of pig manure and the unseparated sow manure, not only on the farm but also to recover valuable nutrients.
The recovery of ammonia nitrogen in the form of ammonium sulphate (40% aqueous solution) via a stripping and scrubbing process, proved to be the right technique for this purpose. This way, biological purification is relieved, oxygen can be saved, emissions reduced and valuable nitrogen recovered.

In addition, in terms of water management, the aim was to further purify the effluent from manure processing with a plant-based system (reed bed) to maximise the use of purified water as drainage water during dry summers, such as water in the air scrubbers to capture nitrogen in the form of ammonia, and cleaning water in the stables if microbiological requirements are met.

The main waste type treated is pig manure

Processing capacity
100-5.000t/y inorganic fertilizer production

Technical dimension

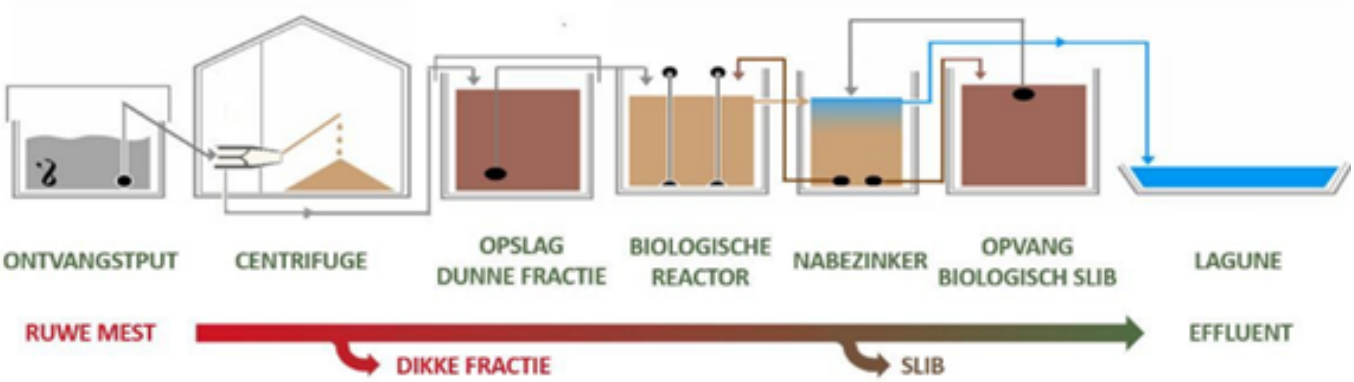
Biological manure treatment is the most common kind of manure treatment on a large scale. Fresh manure is first separated, where after the ammonia nitrogen in the liquid fraction is converted by bacteria in the biological reactor into harmless nitrogen gas. If appropriate, the solid fraction and effluent could be treated too.

- The pig slurry is separated by means of a centrifuge.
- The solid fraction is stored in the shed.
- The thin fraction flows into a reservoir. The ammonia from the thin fraction is processed in biology into Nitrogen gas that is released into the air.
- The remaining liquid is an influent that is rich in Potassium and poor in Nitrogen and Phosphorus.

Biobased fertilising products recovered

The solid fraction is in a form of bio compost and is removed from the company.
Ideal for fertilizing gardens.
Fertilizer Value: 28-12-14 (Nitrogen – Phosphorus – Potassium)

Existing LCA analyses: N.A



Belgium

Aquafin NV

Name: Aquafin NV
Location: Dijkstraat 8, 2630 Aartselaar, Belgium
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Lennert Dockx

Partners involved in the LL:

- UGent, University, Belgium
- University of Southern Denmark, SDU, University, Denmark
- Universidade de Coimbra, University, Portugal

Overall concept of the activities to be implemented

Aquafin was established by the Flemish Region in order to expand, operate and pre-financing the entire wastewater treatment infrastructure in Flanders. The Living Labtreat mainly real municipal and urban wastewater.

Technical dimension

HRAS (High-rate activated sludge)
Adsorption: ion-exchange
Aquafin with with another UGent EU project (Walnut) investigating how nitrogen can be extracted from domestic wastewater via adsorption.
The first stage (HRAS) will mainly focus on the removal of organic matter. Aquafin foresees a sequencing batch reactor (SBR) to explore the potential of HRM treating urban wastewater. The pilot will be able to deal with a discontinuous influent flow of 1300 L/day.

During the second stage (adsorption/ion-exchange) they aim to recover at least 50% of the total nitrogen content from the influent wastewater, in the form of ammonium sulphate (from regeneration of the adsorbent) or as saturated adsorbent. On lab-scale, the type of adsorbent and dimensioning of the pilot are still under investigation. Bed volumes per hour (BV/h) are estimated between 8 and 40.

Biobased fertilising products recovered

Mainly nitrogen; Ammonium sulphate ((NH4)2SO4);
Ammonium nitrate (NH4NO3)
Eventually phosphorus and potassium

Existing LCA analyses: in progress

Inventory of the European NoLLs - ANDALUSIA (SP)

Spain

Axarquía Sostensible

Name: Axarquía Sostensible
Location: La Axarquía, Andalusia, Spain
Type of system: Waste water from agriculture
Geographical scale: Spain
Living Lab manager/promoter/coordinator: Bioazul

Partners involved in the LL:

- Bioazul, S.L., SME (water technology)
- Trops S.A.T. 2803, large company (fruit producer and distributor)
- Comunidad de regantes de Algarrobo, irrigators community
- CSIC-IHSM La Mayora, Research centre

Overall concept of the activities to be implemented

The mission of the Operational Group (GO) "AXARQUÍA SOSTENIBLE" is to promote, through the innovative project, the use of regenerated water in the different areas of action of each of the members of the group and to promote the transfer of knowledge and innovation to the agricultural sector of Axarquía. The aim is to pave the way for regenerated water to be a real alternative that has the trust of water managers, authorities, farmers and consumers. From a multidisciplinary approach, the management of fertigation with regenerated water will be addressed using ICT technologies, in order to achieve better management of water and nutrients, which in turn will reduce the environmental impact of agricultural activity on soils and lower water tables.

The GO arises mainly from the need to guarantee access to water for irrigators of subtropical crops in the region of La Axarquía (Málaga), which represent a large percentage of the total irrigated agricultural area (close to 40%). The state of the waters impounded in the Viñuela reservoir – which supplies water for irrigation to the region – has reached only 47.41 hm3, 28.66% of its capacity (reading of 7/10/2020). 9.7% of its capacity (12/6/2023)

This innovative project is based on the previous work carried out in the project funded by the European Horizon 2020 program, RichWater, during which results were generated on the water treatment and regeneration process and the management of this resource in agricultural irrigation that gave gives rise to a transfer of very useful knowledge for the agricultural sector of our region.

Technical dimension

The proposed solution will be a water reclamation system that guarantees high water quality in accordance with the legal requirements for its reuse in agriculture (RD1620/2007 and EU Regulation 2020/741), and that will be integrated with an adapted irrigation system. for the use of reclaimed water and will have software for the management of nutrients contained in reclaimed water.

Biobased fertilising products recovered

The main product of the AXARQUÍA SOSTENIBLE project is a water regeneration system that guarantees high water quality in accordance with the legal requirements for its reuse in agriculture (RD1620/2007 and EU Regulation 2020/741), the system is integrated with a adapted irrigation system for the use of regenerated water that will have software for the management of nutrients contained in the regenerated water. This product will be validated based on the results of a previous research project funded by the European Commission under the Horizon 2020 programme, the RICHWATER project (contract number: 691402).

Existing LCA analyses: N.A.

Spain

P2GreeN

Name: P2GreeN
Location: Axarquía, Andalusia, Spain
Type of system: Urban wastewater
Geographical scale: Spain
Living Lab manager/promoter/coordinator: Agrathaer GMBH

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

P2GreeN's overall objective is to foster a paradigm shift, from a linearly organised resource and nutrient system within the agri-food supply chain, towards a circular material flow system between urban and rural areas thereby restoring the coupling of the water-agri-food system using a holistic symbiotic resource management approach following the 3R principle "Reduce, Reuse, Recover". To achieve this, P2GreeN will develop new solutions for the circular economy to halt and eliminate nitrogen (N) and phosphorus (P) pollution by connecting blue urban with green rural infrastructure, focussing on circular nutrient flows of nitrogen (N) and phosphorus (P), two important plant nutrients and at the same time water polluters. This objective will be achieved through the implementation and exploration of innovative N & P recovery solutions for the utilisation of human sanitary waste from urban settlements and its conversion into safe bio-based fertilisers for agricultural production in three pilot regions (P2GreeN pilot regions) on a north-south trajectory from the Baltic Sea region via the metropolitan area of Hamburg-Hannover to the region of Axarquia in Southern Spain and by multiplying the impact via four follower regions in Hungary, Italy, France and Greece.

ThePP2GreeN pilot regions will provide an operational environment to develop, adapt and demonstrate innovative circular systems for the utilisation of human sanitary waste from urban settlements and its conversion into safe bio-based fertilisers for agricultural production and thus create innovative governance solutions at the water-agri-food nexus.

Technical dimension

P2GreeN will close nutrient cycles of N & P to foster the transition towards a circular and clean economy (green transition) as well as supporting sustainable food systems from farm to fork offering viable alternatives to reduce the current usage of mineral fertilisers with innovative Green bio-based fertilisers and thus minimise the pressure on the natural resources, specifically water and soil. P2GreeN will further enable policy makers to replicate P2GreeN's sustainable regional circular economy models in all regional settings across Europe.

December 1, 2022 was the starting date for new four-year EU project P2GreeN, which will develop, test and adapt the use of human sanitary waste to produce safe, bio-based fertilizers for agriculture. Consortium of 32 European partners scored well with the Horizon Europe program and have been awarded the contract to implement this unprecedented project.

Biobased fertilising products recovered: N.A.

Existing LCA analyses: N.A.

Spain

Water2REturn

Name: Water2REturn
Location: Salteras, Andalusia, Spain
Type of system: Slaughterhouse wastewater
Geographical scale: Spain
Living Lab manager/promoter/coordinator: Bioazul

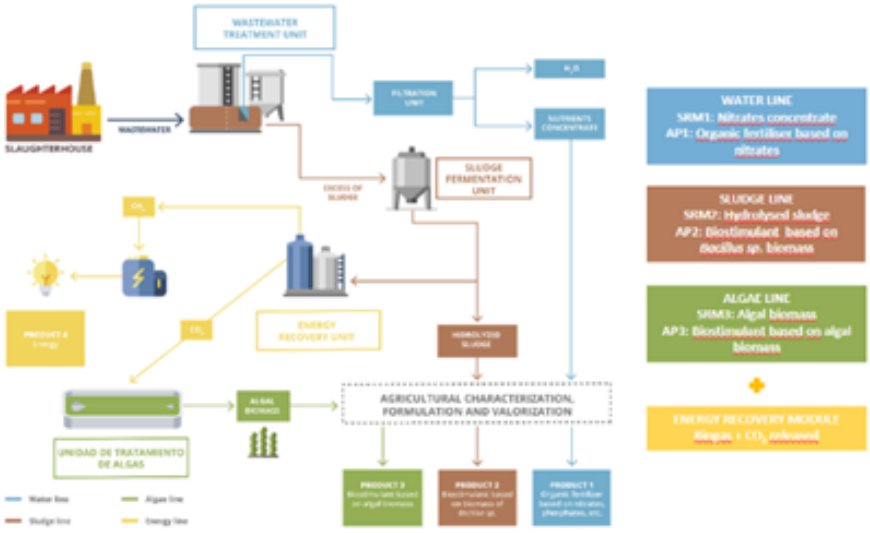
Partners involved in the LL: N.A

Overall concept of the activities to be implemented

Water2REturn proposes an integrated solution for slaughterhouse wastewater treatment, as well as for the recovery of nutrients with high market value in the agricultural sector. This Circular Economy approach turns wastewater treatment facilities into "bio-refineries".

Water2REturn proposes a full-scale demonstration process for integrated nutrient recovery from wastewater in the slaughtering industry using biochemical and physical technologies implemented in a real case study, the slaughterhouse 'Matadero del Sur' located in Salteras, Spain. Most of these technologies are widely known, but the novelty of the Water2REturn system lies in their innovative combination in cascade, allowing that all processes occur in the same place, being in this case the end user's facilities, thus eliminating intermediate transport processes. In addition, the sludge line has an innovative pre-treatment system endorsed by the EU Environmental Technology Verification (ETV), which is the official tool of the European Commission to verify the performance of innovative technologies with an environmental nature.

The main aim of the ETV is to facilitate the market entry of new innovative technologies that have an environmental benefit compared to existing technologies and to confirm their green credentials.



Technical dimension

All technologies are grouped in four treatment lines within Water2REturn system, called water line, sludge line, energy line and algae line.

The wastewater from the slaughterhouse enters the water line, which consists of a wastewater treatment system and a nutrient recovery module. The wastewater reaches a Sequential Batch Reactor (SBR) able to treat 50m3 of wastewater per day, and the treated water then goes through a nutrient recovery module consisting of a filtration unit, where a filtration process takes place (microfiltration, ultrafiltration and reverse osmosis). The resulting subproduct is a nutrients concentrate, which constitutes the secondary raw material that will serve as a basis to produce the first agronomic product: an alternative fertiliser.

In addition to the nutrients concentrate, there is a second subproduct generated in the water line: the sludge resulting from wastewater treatment. This sludge enters the sludge line, where it goes through a first pre-treatment process where pathogenic microorganisms are eliminated and sanitisation is achieved. Subsequently, it goes to the fermentation unit, a bioreactor where the sludge is fermented with Bacillus spp. As a result, a hydrolysed sludge with high availability of organic matter is obtained, and it can be used in other biological processes such as anaerobic digestion in the energy line, producing biogas. The hydrolysed sludge constitutes the secondary raw material that will serve as a basis to produce the second agronomic product: a biostimulant.

As mentioned, the hydrolysed sludge is upgraded in the energy line, where it goes through an anaerobic digestion process, in which organic matter is transformed into biogas, composed mainly of methane and CO2. The biogas is further turned into energy in a cogeneration unit. The energy generated can be used to either power the slaughterhouse or the system itself.

Part of the hydrolysed sludge and the resulting digestate from the energy line contribute to the growth of algal biomass in the algae line. In this line, where an algae treatment process takes place, the AlgaBioGas (AGB) technology is used, which is based on a system of algae ponds that allows controlling and measuring the input and output parameters of the water. The subproduct obtained after this treatment is an algal biomass that constitutes the secondary raw material that will serve as a basis to produce the third agronomic product: a biostimulant.

Water2REturn is an Innovation Action co-funded by the European Commission under its Horizon 2020 (H2020) programme. It is coordinated by BIOAZUL company (Malaga, Spain) and is focused on the recovery and recycling of nutrients from slaughterhouse wastewater in the framework of a Circular Economy model. Nutrients recovered are turned into value added products for the agro-chemical industry and, consequently, for the agricultural sector.

Biobased fertilising products recovered:N.A.

Product of water line: The resulting concentrate will be rich in nutrients, and it will constitute the first secondary raw material to further manufacture an organic fertiliser.

Product of sludge line: The sludge, that initially had a dry matter of approximately 20g/L, was concentrated to 49.4 ±0.84 g/L. The concentration of Bacillus in the product is relatively high, which makes this hydrolysed sludge a potential agronomic product with PGPB (Plant Growth Promoting Bacteria) properties.
A biostimulant was formulated and produced from this hydrolysed sludge. The recommended rate was 5 L/ha (both for irrigation and soil spraying application), being preferably applied on a regular basis, anticipating critical moments of the crop when the elements are blocked due to low temperatures or under stress conditions.

Product of algae line: The produced biomass will be processed by the partner Kimitec before starting agricultural trials. The biostimulative effects of algal biomass have already been evident from the laboratory and pot agricultural tests done by the partners from University of Ljubljana. In the meantime, algal growth on the digestate and biostimulants' production is being further optimised and tested in the Algae Park in Slovenia by the Slovene partners Algen and University of Ljubljana.

Existing LCA analyses: Water2REtrun Layman's report

Spain

RichWater

Name: RichWater
Location: Algarrobo, Andalusia, Spain
Type of system: Urban wastewater
Geographical scale: Andalusia, Spain
Living Lab manager/promoter/coordinator: BioAzul

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

RichWater solution is based on a new groundbreaking technology combining low-cost and energy efficient MBR treatment, a module for mixing the optimal combination of clear and reclaimed water, and an advanced monitoring /control module including soil sensors to guarantee demand-driven and pathogen-free fertigation. RichWater approach is a highly promising method which permits to save freshwater and fertilizers in agriculture.

A low energy MBR has been designed for the wastewater treatment module in a way that the contained nutrients (mainly nitrogen and phosphorus) remain after the treatment whilst pathogens are removed.
The mixing station mixes the appropriate proportion of freshwater and the treated wastewater coming from the MBR, which is then fed into the fertigation module (drip irrigation). The appropriate mixing level is determined by monitoring the level of nutrient content in the soil via sensors; this information is sent by remote control to the monitoring unit, which converts the signals to be read by the control unit. The control unit automatically adjusts the mixture inside the mixing module via valves according to the crop's demand.

WWTPOs will have the possibility to offer a new product (nutrient- rich/pathogen-free irrigation water) to potential customers. Farmers will have access to a guaranteed and constant source of irrigation water, which is a huge benefit in arid regions.

Technical dimension

Business plan show that RichWater® solution requires a high investment of approximately 200 – 250m € for treating and reuse urban wastewater from 1,000 inhabitants. Benefits obtained for using the water in irrigation (estimated at 0.30€/m3) result in a pay-back period of 5.33 years when adding reuse to conventional wastewater treatment.
The RichWater project is an initiative funded by the European Union in the framework of the Fast Track To Innovation Programme (Horizon 2020).

Demonstrated in relevant environment (TRL6)

Biobased fertilising products recovered

The effluent produced is free of pathogens and rich in nutrients, showing 99.99% of E.Coli removal, 69% of total N recovery, 80% of total P recovery and 94% of K recovery.
The average content of N in RichWater® effluent was about 36.4 mg/L.
RichWater® technology obtained in 2020 the Environmental Technology Verification (ETV), which is a guarantee on the technology performance. ETV has been conducted by an external and independent verification body, the Institute for Ecology of Industrial Areas (IETU) located in Poland, which certified that RichWater® is able to treat urban wastewater up to the necessary quality standards required for irrigation.

Existing LCA analyses: N.A.

ALGAENATUS

Name: Algaenatus
Location: Almeria, Andalusia, Spain
Type of system: Wastewater, Pig Manure, Seawater
Geographical scale: Andalusia, Spain
Living Lab manager/promoter/coordinator: Biorizon biotech

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

The proposed ALGAENAUTS innovation project aims at developing a new line of sustainable and eco-friendly bio pesticides line of products for agriculture from microalgae biomass cultivated recovering nutrients from wastewater and pig manure and with seawater. ALGAENAUTS has been designed from a circular bio economy approach. ALGAENAUTS will contribute to the strategy of Biorizon by enhancing and increasing its position as worldwide leader in microalgae-based agricultural products with a new line of bio pesticides and firming up the bio stimulants/bio-fertilisers portfolio with new products based on new strains, obtaining these new bio stimulants/bio-fertilisers with by-products from bio pesticides production process. Biorizon estimates increasing its revenues in 600%, with the new line of microalgae-based bio pesticides and new line of bio stimulants/bio-fertilisers, within the next 3 years after project.

Five selected strains with proven antifungal, antibacterial and bio stimulant activity will be cultivated using wastewater. Culture conditions and operational aspects of microalgae production will be optimized, and the yield and efficiency of large-scale production systems. The optimization of harvesting and downstream process is mandatory in order to ensure the most efficient operation cost. Marine water and wastes (sewage and pig manure) will be used to achieve sustainable processes.

Microalgae systems optimized will be capable of operate in continuous mode for six months without collapses, at productivities higher than 70 t/ha per year, with power consumptions lower than 5 /m3, and recovering more than 90% of nutrients contained into wastes. Up to 10 t /ha per year and 2 tP/ha per year will be recovered at biomass production cost below 1.0 €/kg.

Technical dimension

The harvesting process will allow recovering more than 95% of produced biomass, with power consumptions below 0.1 kWh/m3. Mild processing technologies will be used to extract up to 80% of high-value products from the microalgae biomass, without damaging the residual biomass for its latter utilization to produce bio fertilizers. Only wet processes will be used to enhance the sustainability of the process, the utilization of non-safe solvents being disregarded.

Demonstrated in operational environment (TRL 7)

Biobased fertilising products recovered

Final products formulated (bio pesticides and bio-fertilisers) will be validated through field trials at real crop conditions. Field trials will be developed in an Experimental Center with fully monitored conditions in horticultural and fruits crops. Additionally, target products will be evaluated and validated with end-users such as distributors and farmers. Also, market, social and sustainability aspects such as social and market acceptance, environmental impact and the carbon and water footprint mitigation will be evaluated. The legal framework of bio pesticides and bio-fertilisers produced will be studied for the registration assessment, according with the EU legislation, additionally to the legal framework of other key third countries for the interest of Biorizon´s external market.

Existing LCA analyses: N.A.

Business plan for the ALGAENAUTS process is the start point of the project.
Developed business plan demonstrate the viability of producing target products under defined conditions and allows identifying the boundary conditions on which the technology will be optimized.
Based on a business plan a techno-economic analysis will be performed which will take the lead on the necessary decisions for the successful of the project.
Other work packages will continuously provide information to the techno-economic analysis to assist in the decision-making, in order to steer the whole project towards a successful development.
As any other biomass-based process, the cultivation, harvesting and transformation of algae come with a number of potential environmental and social impacts, which this work package tries to evaluate and mitigate.
Thus, studies on the topic should be conducted, in an effort to understand and mitigate impacts.
The sustainability of large-scale process proposed will be analysed based on nutrient recovery and efficiency, energy balance, air emission and water quality exhausting the process.
Market opportunity and performance will lie at the core of the project.
To this end, the project will build upon a comprehensive market analysis of the products to be generated within the project, their market uptake potential, main end-markets, market value and legal framework.

Spain

SABANA

Name: Sabana
Location: Almeria, Andalusia, Spain
Type of system: Wastewater (sewage, centrate and pig manure), marine water
Geographical scale: Andalusia, Spain
Living Lab manager/promoter/coordinator: University of Almeria

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

SABANA aims at developing a large-scale integrated microalgae-based bio refinery for the production of bio stimulants, bio pesticides and feed additives, in addition to bio fertilizers and aqua feed, using only marine water and nutrients from wastewaters (sewage, centrate and pig manure). The objective is to achieve a zero-waste process at a demonstration scales up to 5 ha sustainable both environmentally and economically. A Demonstration Centre of this bio refinery will be operated to demonstrate the technology, assess the operating characteristics of the system, evaluate environment impacts and collaborate with potential customers for use.

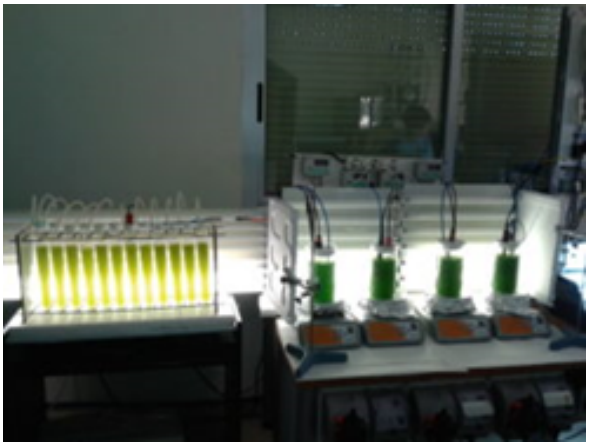
Wastewater-based algae bio refinery (WWAB). Up to 1.7, ha of raceway and tubular reactors located inside, a greenhouse was installed to produce biomass for agriculture and aquaculture related applications.
Using marine water and wastewater the plant is managing up to 2.000 m3 of microalgae cultures.

Technical dimension

The SABANA project is aimed to develop a new integrated bio refinery concept, not only restricting to the utilization of biomass as raw material, but also considering the whole process from the recovery of nutrients from wastewater (C, N, P) to the final products, as valuable compounds or the whole microalgae biomass, suitable to be applied in agriculture and aquaculture. As example, up to 1 kg of microalgae biomass can be produced per m3 of sewage, up to 10 kg can be produced per m3 of centrate from anaerobic digestion of activated sludge, or up to 100 kg can be produced per m3 of pig manure from livestock. Produced biomass must be adequately harvested ensuring the quality of clean water remaining, in addition to the recovery of the produced biomass (>95%). SABANA project was approved by the European Union's Horizon 2020 Research and Innovation program, under the topic H2020-BG-2016-2017 Blue Growth: Demonstrating an ocean of opportunities. As Innovation Action, it received funding from the under the Grant Agreement No. 727874 and started on December 1st of 2016. During four years, research and innovation activities will be performed to achieve the final goal: to build and operate a demonstration facility for producing bio fertilizers/bio pesticides and aqua feed at 5 ha scale.

Validated in relevant environment (TRL 5).

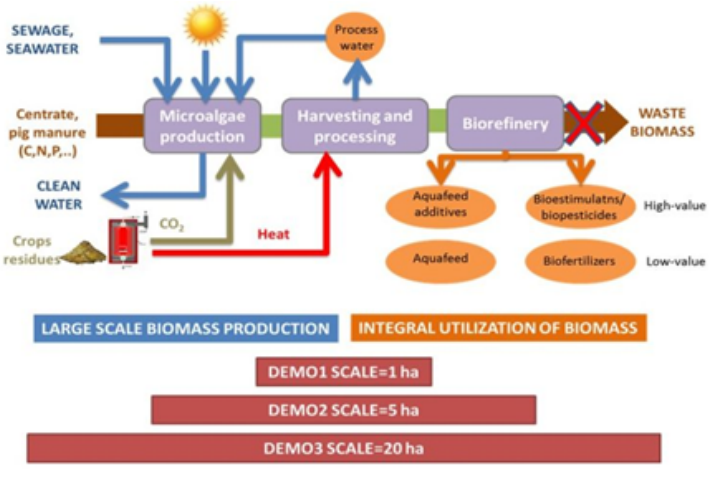
Biobased fertilising products recovered



Produced biomass contains valuable compounds as proteins, carbohydrates and lipids, in addition to specific valuable biomolecules with recognized applications as bio stimulants and bio pesticides in agriculture, and feed additives in aquaculture, both as extracts/pure chemicals or including in adequately processed whole biomass. The objective of SABANA is to develop the necessary knowledge and technology to complete this process and to demonstrate it at commercial scale, verifying the obtained products.

Existing LCA analyses

A Demonstration Centre of this bio refinery will be operated to demonstrate the technology, assess the operating characteristics of the system, evaluate environment impacts and collaborate with potential customers for use.



Spain

REUTIVAR

Name: Reutivar
Location: Montilla, Andalusia, Spain
Type of system: Urban wastewater
Geographical scale: Andalusia, Spain
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

Optimisation of the reclamation treatment for the specific use of the olive grove based on a settling pond, a storage basin with ultrasonic treatment and a ring filtration system. The wastewater treated at Montilla WWTP, by means of a prolonged low-load aeration process and subsequent secondary decantation, is sent to a decantation pond in sector I of the CR TINTIN. This pond has a useful capacity of 9,143.45 m3, being used for irrigating a surface of 650.53 hectares.

Technical dimension

The water coming from the settling pond accumulates in the storage pond, with a useful capacity of 222,604 m3, being used for irrigating a surface of 150 hectares.
Two ultrasound units are installed in the storage pond for the elimination of microalgae.
The water from the storage pond, taken via a floating water intake, is filtered by means of rings, consisting of several units of automatic filters of 130 microns, self-cleaning by opening the package of rings.

Demonstrated in relevant environment (TRL 6)

Biobased fertilising products recovered

Enriched reclaimed water
The minimum requirements for the water reuse established in the majority of existing regulations, like RD 1620/2007 and the new Regulation (EU) 2020/741, must be applied as long as reclaimed water from municipal sewage treatment plants is used for irrigation in agriculture, in accordance with Directive 91/271/EEC.
The quality of the reclaimed water complies with the quality criteria established in annex I.A, Quality 2.3 of RD 1620/2007, related to eggs of intestinal nematodes, E. coli and solids in suspension, which guarantees that said water can be used with security for agricultural irrigation of the olive grove, also ensuring a level of environmental protection, human health and animal health.

Existing LCA analyses: N.A.

Spain

ENRICH

Name: Enrich
Location: Murcia, Spain
Type of system: Urban wastewater
Geographical scale: Andalusia, Spain
Living Lab manager/promoter/coordinator: Cetaqua, Water Technology Centre

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

LIFE ENRICH will bring this objective to the practice by developing an innovative treatment train integrating leading-edge technologies that will enable an efficient recovery of both Nitrogen and Phosphorus contained in the wastewater, as ammonium salts and struvite, respectively. The products obtained will be blended in order to obtain suitable fertilizers for the target crops.

In parallel to the technical development, a business model for the entire nutrient recycling value chain will be defined, thus promoting the replicability and transferability of project results in other EU regions.

The LIFE ENRICH project proposes a solution that allows the recovery of nutrients from wastewater and their use as fertilizers. The recovered nutrients have been analyzed in detail and mixed to obtain optimum products for their use in certain crops, thus promoting a circular economy model.

Different technologies for N & P recovery are integrated in the existing Murcia Este WWTP. First, an elutriation process full-scale wa implemented, in a reversible configuration, to extract and concentrate phosphates before they enter anaerobic digestion, were uncontrolled P precipitation starts causing operational problems. Phosphates concentrate in the supernatant of primary thickeners can feed the P recovery unit for struvite production.

Technical dimension

Depending on the configuration of the WWTP, phosphate can accumulate in centrates or in the supernatant from primary thickeners, so both streams were fed to the P recovery unit, where ammonium accumulates in higher concentrations, allowing struvite production. N recovery was assessed in centrates stream, since it accumulates ammonium in high concentrations allowing high N recovery rates. Altogether, LIFE ENRICH integrated P&N recovery solution enables a flexible and robust process that maximises nutrient recovery.

The LIFE ENRICH project started in September 2017 and ended in November 2021. The total budget for the project was 2.7M€, from where around the 60 % of the budget was co-funded by the LIFE programme of the European Commission. Cetaqua (Water Technology Centre) led the project and counted with EMUASA, UPC, UPV, IRTA and ASG as partners.

Biobased fertilising products recovered

The recovered struvite and ammonium nitrate were characterised to accomplish the legislative requirements for new fertilising materials (EU 2019/1009)

Existing LCA analyses

The technical efficiency, the environmental impact and the economic feasibility of the LIFE ENRICH value chain (nutrients recovery and valorization in agriculture) were assessed for a full-scale process implementation in Murcia Este WWTP and through the LCA (Life Cycle Analysis) and LCC (Life Cycle Cost) methodologies. A comparison between the current situation (conventional scenario) and LIFE ENRICH scenario (P&N recovery) was performed within a defined framework that involves WWTP operation, not only nutrient recovery but the whole installation, and field fertilization, considering recovered nutrients P and N and also K and Ca macronutrients present in most used conventional fertilizers.

Spain

INCOVER

Name: Incover
Location: El Torno WWTP, Chiclana de la Frontera, Andalusia
Type of system: Urban wastewater
Geographical scale: Andalusia, Spain
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL: N.A

Overall concept of the activities to be implemented

Taking into account the current global water scarcity and the expensive operation and maintenance cost of wastewater treatment, INCOVER concept has been designed to move wastewater treatment from being primarily a sanitation technology towards a bio-product recovery industry and a recycled water supplier.
Three added-value plants treating wastewater (municipalities, farms and food and beverage industries) at three demonstration sites will be implemented, assessed and optimised concurrently. INCOVER plants will be implemented at demonstration scale in order to achieve Technology Readiness Level (TRL) of 7-8 to ensure straightforward up scaling to 100,000 population equivalents (PE).

Wastewater is treated by a 3000 m2 High Rate Algae Pond (HRAP) and tertiary treatment composed of 250 m2 planted filter with natural material for enhancing phosphorous recovery. Irrigation water is finally obtained and reused with a solar anodic oxidation disinfection and smart irrigation system. The biomass obtained is anaerobically digested and biomethane is produced by an innovative biogas upgrading system.

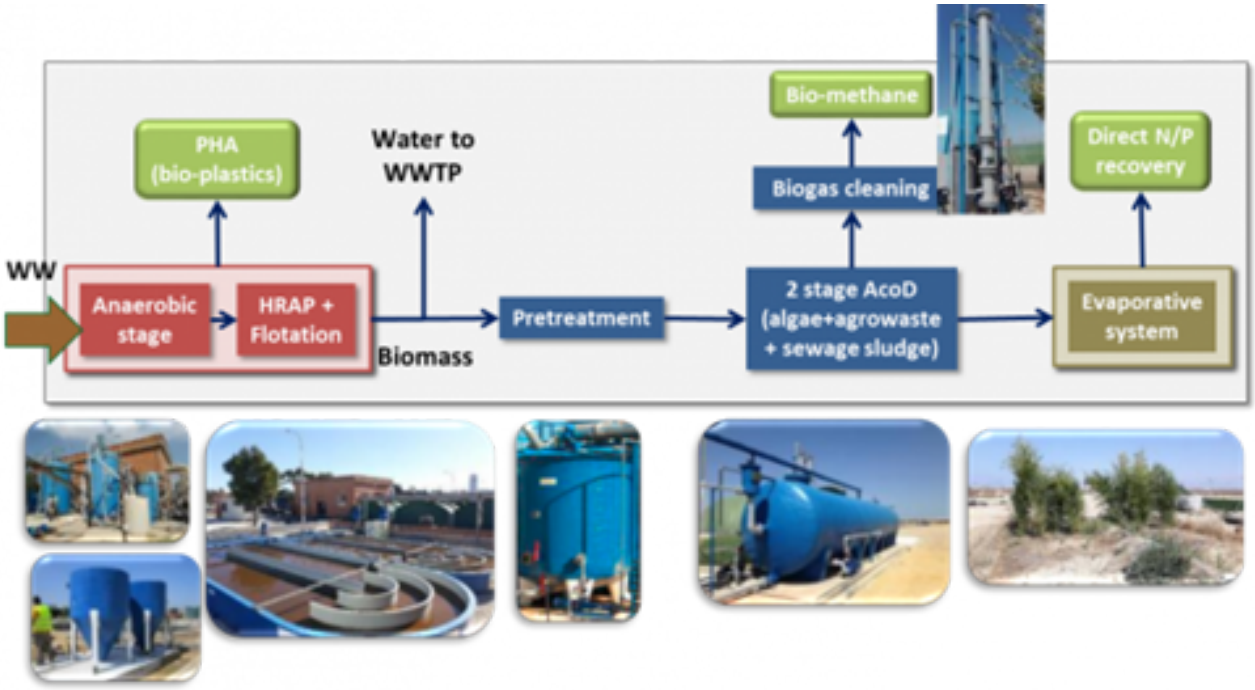
Technical dimension

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 689242.

Demonstrated in relevant environment (TRL 6)

Biobased fertilising products recovered: N.A.

Existing LCA analyses: N.A.



Inventory of the European NoLLs - CATALONIA -Aragon (SP)

Spain

Deseuras S.L.

Name: Deseuras S.L.
Location: Calle la Puntia, 4 - Pol Industrial Beguda, 17857, Sant Joan Les Fonts (Girona) , Spain
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Anotni Deseuras /Ana Robles

Partners involved in the LL:
- Deseuras, Company
- BETA, Technological Center

Overall concept of the activities to be implemented

Deseuras is a pig farm. They have a slurry and other organic waste treatment plant with the generation of electrical energy and the valorization of the by-products obtained in this process.

Type of waste: pig manure.
Selection Deseuras S.L. has a plant located in Sant Bartomeu del Grau, in the county of Osona. In this plant and do co-digestion of different waste organic Livestock excrement and industrial sludge are mainly treated there food industry (slaughterhouses) and other organic waste. The latter can vary depending on their punctual availability.

Thanks to technology and experience, they have managed to adjust a robust and flexible digestion process that it allows to cope with this temporal variability of the input materials. The biogas generated is transformed into electrical and thermal energy in two engines cogeneration.
The electrical energy is sold to the grid and the thermal energy used on the farm, the anaerobic digester and drying. On the other hand, one of the aspects that must be highlighted of this plant is that it has been maintaining exemplary digestate treatment for years. The process consists of a mechanical phase separation (centrifugation). The fraction liquid passes through a flotation unit followed by a membrane system (ultrafiltration and reverse osmosis). The water is used for irrigation and the concentrate for formulate the organic fertilizer. The solid fraction is dried, pelletized, formulated a request and sold as quality organic fertilizer (adoba®).

Technical dimension

- Anaerobic digestion
- Membrane system

Existing LCA analyses: N.A.

Bio-based fertilising products recovered:

- Water
- Organic fertiliser (adoba®)

Noguera Renovables

Name: Torre Santa Maria
Location: Balaguer
Type of system: Industry
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Beatriz Corzo/Sebas Farré Riba/ Ana Robles

Partners involved in the LL:

- Torre Santamaría, Farm
- BETA, technological center
- Noguera Renovables, S.L., company
- Sorigue', Company
- Axpo, Company

Overall concept of the activities to be implemented

Noguera Renovables is a dairy farm that together with Noguera Renovables SL, a company that offers comprehensive solutions to waste management, has included composting and fertilizer manufacturing on the farm, and recently it has incorporated an anaerobic digestion system.

Promoted by the Axpo-Sorigué-Torre Santamaria consortium, Noguera Renovables SL is a company that offers comprehensive solutions to waste management- Specifically, since 2016, he has been involved in the activity of composting and fertilizer manufacturing, to which the activity has recently been incorporated of anaerobic digestion.
This plant start operating in 2022. It is characterized by being located next to the Torre Santamaria dairy farm, since most of organic matter that enters the digester is the livestock excrement of these animals. Other materials are also included, such as leftovers from the same food cows as well as fruit pulp from a nearby industry. This way, with local organic resources, they generate a biogas that subsequently it is purified to obtain bio methane, which is injected into the gas network. In addition, it does efficient management of slurry generating digestate, an organic amendment.

More homogeneous, with a greater amount of mineralized ammoniacal nitrate (more available to plants) and neutralizing odors. This plant, located in Balaguer, is the first in Spain located on a farm, which injects the biomethane generated from livestock waste into the network.
Treatment:
Solid-liquid separation + composting • Destination:
Field application of both fraction is currently in development an extension to manage 300,000 Tn of waste year (mainly livestock farmers) and produce 115 Gw/year + improve digestate treatment Liquid fraction (ultrafiltration, reverse osmosis and stripping) + Fraction solid (composting). This new treatment will improve the quality of the products obtained with the aim that they can be sold as organic fertilisers.

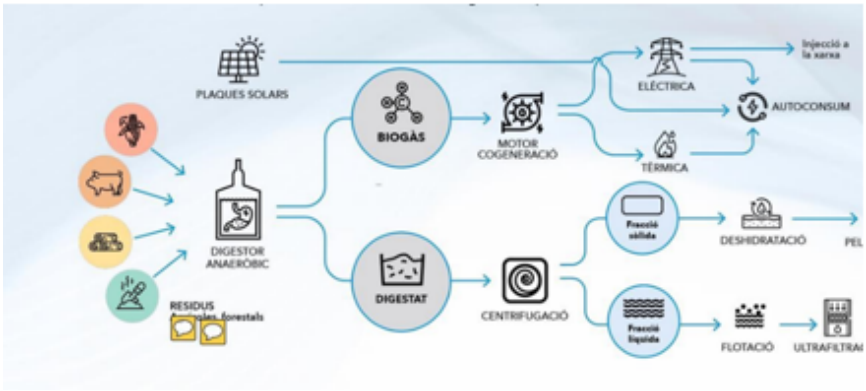
Technical dimension

- Anaerobic digestion
- Ultrafiltration
- Reverse osmosis
- Stripping

Biobased fertilising products recovered

- Water
- Organic fertilizer
- Nitrogen concentrate fertilizer

Existing LCA analyses: N.A.



Spain

Alcarràs Bioproductors

Name: Alcarràs Bioproductors
Location: Polígon 11 parcel·la 62-64, 25180 Alcarràs, Lleida, Catalonia, Spain
Type of system: Farmer cooperative
Geographical scale: Local
Living Lab manager/promoter/coordinator: Jordi Jove and Eugenia Requena

Partners involved in the LL:

- EcoFertiBio, Farm
- Genia Bioenergy, biogas production
- BETA, technological center

Overall concept of the activities to be implemented

The Alcarràs Bioproducers Union is a local initiative between the associations of bovine and pig producers to seek a solution to the problem of excess livestock manure in the region. Thanks to the concerted efforts of the Association, a composting plant with a capacity to treat 54,000 tons of livestock manure and 10,000 tons of vegetable fraction has been successfully developed. The Association is also working towards setting up a biogas plant production soon, which will further advance the cause of sustainable agriculture and waste management.

The Association comprises of 150 families from the region who have acquired a property to set up the composting plant. The plant has the capacity to treat 80,000 t/a of slurry or plant waste in two digesters of 3,617 m3 capacity. The proposed strategy for managing the by-products generated from the plant includes 1) obtaining biogas and producing electrical energy through co-generation, and 2) generating digestate and ammonium sulfate for sale and application in the agricultural fields of the region.

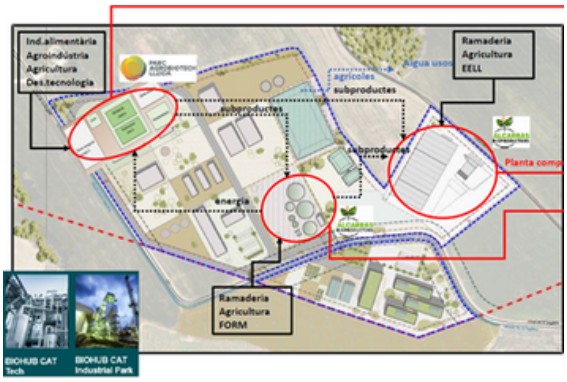
Technical dimension

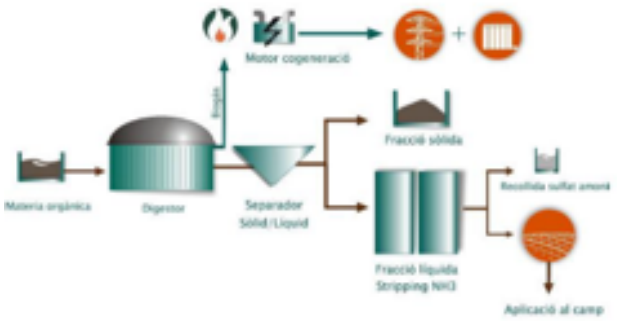
- Composting plant
- Biogas generation: 1.786.442 Nm3
- 50% of the generation to auto consume and sell it on the network of Electric distribution.
- Transformation biogas to biomethane

Biobased fertilising products recovered

- Digestate
- Ammonium sulfate

Existing LCA analyses: N.A.





Spain

Consortium Genia and EcoFertibio (ammoneva)

Name: Consortium Genia Bioenergy + EcoFertibio (Ammoneva)
Location: Carretera Berga 13, Navas, Catalonia, Spain
Type of system: Industry
Geographical scale: National
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL:

- EcoFertiBio, Farm
- Genia Bioenergy, biogas production
- BETA, technological center

Overall concept of the activities to be implemented

The Ammoneva system is a new comprehensive method for the treatment of livestock manure in the certification process capable of extracting between 60-70% of the ammoniacal nitrogen NH3 from the liquid fraction of manure, avoiding the volatilization of the liquid fraction of CO2; CO; H2S and VFA (volatile fatty acids) and can precipitate calcium phosphate.

The system promoted by the consortium Genia Bioenergy + EcoFertibio to treat livestock manure is based on the filling and emptying sequence carried out simultaneously in separate tanks. The sequential stages in the reactors consist of three: the filling stage, the reaction stage, and the emptying stage. The separate regulation of these stages in each reactor allows for the evaporation and absorption of the components according to the required objectives.

The system was originally developed in 2015, and it underwent significant enhancements in 2019, coinciding with the commencement of by-product certification. In mid-2019, an important milestone was achieved when a commercial agreement was established between UPB GENETIC WORLD SL and BIOAMMONEVA SLSL to build the Industrial scaling of the AMMONEVA System. Finally, in 2020, a 6.4 m3 system was launched for the treatment of pig manure in the intensive sow farm that UPB owns in Viver I Serrateix - Barcelona.

The slurry is separated into solid and liquid fractions by the system. The liquid fraction is then utilized for the precipitation of apatite and organic matter. After that, in the reactor, the gases from the liquid fraction of the slurry (NH3, H2S, CO, CO2, VOC, H2O) are evaporated to extract and concentrate NH3 and other gases, organic compounds, and water. Once extracted, the remaining fraction is sent to a reactor that allows the nucleation, growth, and precipitation of phosphorus, potassium, nitrogen, and other organic-inorganic compounds in the form of struvite, k-struvite, and organic matter. These are then marketed as slow-release fertilizers.

Technical dimension

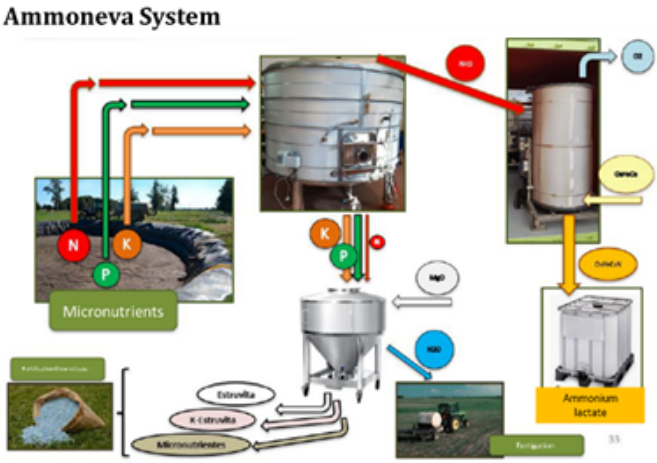
Raw material: Livestock manure and vegetal material

- Vacuum evaporation of ammonia
- NH3 bubblers

Biobased fertilising products recovered

- Ammonium lactate: Organic nitrogenous root stimulant
- Apatite
- Estruvite + k-Estruvite + organic matter
- Solid fraction (organic amendment)

Existing LCA analyses: N.A.



Spain

Biofertiplus

Name: Biofertiplus
Location: Can Barrina, Santa Cecilía de Voltrega, Spain
Type of system: Farmer
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Màrius Simon Monrós de la Federació de Cooperatives Agraries de Catalunya Agrària Plana de Vic i secciò de Credit/ BETA technological Center

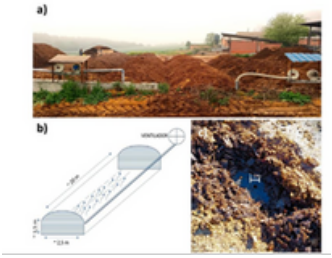
Partners involved in the LL:

- Federació de Cooperatives Agraries de Catalunya, Farmers organisation
- Girona Fruit, Farmers organisation
- Agrària Plana de Vic i secciò de Credit
- Covides, Farmers organisation
- C.T. BETA, technological center

Overall concept of the activities to be implemented

BIOFERTIPLUS makes Tailor-Made Fertilisers (TMF) from a compost which the original waste source are 450 cows. This compost is mixed with a few additives and pelletized. TMFs is oriented to fertilise ecologic and non-ecologic fields of apples and vineyards.

- Type of waste: Animal manure (cows)
- Products: TMFs
- LCA will be performed by BETA in a regional research project.



Technical dimension

- ·Cow excreta is composted. Then, from the chemical analyses of the soil and crops the TMFs are designed for covering the NPK demands as well as other micronutrients (such as potassium). Few additives are mixed to complement the original chemical values of the compost and obtain the properties desired.

The final mix is pelletized. This allows an easy cost-efficient spreading system for the target fields.

Funding source: Government of CatalunyaTRL: 5-6

Biobased fertilising products recovered

TMFs are pellet with variable composition. Composition varies depending on the needs of the crop needs, and soil properties. However, it mainly contains an organic amendment with adequate level of NPK. Moreover, it contains micronutrients such as calcium or potassium.

Existing LCA analyses: ·
To be started soon by BETA

Spain

Fertinagro

Name: Fertinagro Biotech
Location: c/ Los Enebros, 74. 44002 Teruel, (España)
Type of system: Industry
Geographical scale: National-International
Living Lab manager/promoter/coordinator: Ignasi salaet/ Ana Robles

Partners involved in the LL:

- Fertinagro, Company
- BETA, technological center

Overall concept of the activities to be implemented

Development of innovative technologies to recover nutrients from livestock manure and include them in their commercial fertilizer production chain.

Fertinagro Biotech is the head of the Plant Nutrition Division of Grupo Térvalis, a business group dependent on the Inversalia Patrimonio holding, which operates in the agri-food and renewable sectors. For almost 40 years, they have been working to achieve a more competitive, valuable and sustainable agriculture, with a dynamic growth policy and a strong commitment to research, which has allowed them to adapt to the new needs of farmers and markets. Organia also belongs to the Tervalis group, and it's the branch dedicated to the design, production and marketing of organic fertilisers since 1986. They are pioneers in using different types of raw materials to produce fertilisers, transforming them into products of high agronomic value. The whole group produces 1,800,000 tonnes of all types of technological and sustainable fertiliser marketed worldwide.

Type of waste: Organic materials of animal and plant origin (animal manure, animal by-products, plant waste etc.)
Biogas reactor and development of new nutrient recovery technologies, including composting or hydrothermal conversion (TRL 6-7)
Fertinagro was already the pilot for the project Fertimanure, where they produced on-farm tailor-made fertiliser (TMF) with a combination of pig slurry, synthetic mineral fertilisers, biostimulants, and humic acids and applied them to a potato field trial in Spain (TRL 7)
They are also involved in the development of R&D testing centralised at the C.I.B.A located in Utrillas, Teruel, where we have a physical-chemical analysis laboratory and a molecular biology laboratory where our latest acquisitions represent an important revolution in the field of biotechnology. In it we carry out metagenomic studies with which we are able to sequence the genome of the different microorganisms present in the soil and, therefore, see the characteristics of their microbiological composition.





Technical dimension

- Anaerobic digestion
- Solid-State Fermentation
- Vacuum evaporation
- Hydrothermal conversion
- Composting

Biobased fertilising products recovered

- Nutrient-rich organic amendments
- Biostimulants
- Liquid nutrient-rich concentrates
- Tailor Made Fertilizers

Existing LCA analyses: N.A.

Spain

GAP Cooperativa – TRACJUSA SA

Name: GAP Cooperativa – TRACJUSA SA
Location: Cami de Juneda a Arbeca s/n°, 25430 Juneda, Lleida, Spain
Type of system: Industry
Geographical scale: National
Living Lab manager/promoter/coordinator: Mònica Jiménez i/o Jordi Armengol/Ana Robles

Partners involved in the LL:

- GAP Cooperativa, Farmers organisation
- TRACJUSA SA, Biogas company
- C.T. BETA, technological center

Overall concept of the activities to be implemented

Treatment of a large volume of pig manure (from more than 100 farms) through anaerobic digestion. Digestate is further treated by centrifugation, acidification, evaporation and drying. By this process a solid nitrogen fertilitzer is generated.

Type of waste: pig manure
Biogas reactor and digestate treatment fully operational. The company is in the process of certification of the fertilizer. CE certification is recommended. An eminent LCA study has been ordered to BETA
*On the future they are willing to increase the volume of the plant and incorporate codigestion of other organic residues.
https://gapcooperativa.com/es/inicio/
https://www.youtube.com/watch?v=zmVirHagXmc

GAP Cooperativa, as a farmers organization, had to deal with the excess of nitrogen present on theirs pigs manure. Their solution was to gather together and invest on the construction of a biogas plant, owned by the then created TRACJUSA SA. They built this 100.000 Tn/year treatment capacity plant which has been running since its creation.

Technical dimension

- Anaerobic digestion
- Digestate treatment
  - Centrifugation
  - Acidification
  - Evaporation
  - Drying

Biobased fertilising products recovered

- Nitrogen Rich Solid Fertiliser

Existing LCA analyses: to be started

Inventory of other European NoLLs - SPAIN

Spain

ITACyL

Name: ITACyL
Location: Valladolid, Castilla y León, Spain
Type of system: Research institute
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Livestock department

Partners involved in the LL:

- Research group of Processes and Technologies for livestock and agrofood waste treatment and valorization, Regional Research Center

Overall concept of the activities to be implemented

The group are developing a fertilising product in the framework of the project LIFE Green Ammonia, and it would like to contribute with insights about the technology and the difficulties they have seen.
In general, they are an applied research centre collaborating closely with farmers in the region. The group is now testing a pilot prototype that is placed in a swine farm for the recovery of nitrogen from manure.

Technical dimension

- Life Ammonia trapping: http://ammoniatrapping.com/ à In this project they worked with gas-permeable membrane technology to extract ammonia from digestate and slurry. They treat if to get ammonium sulphate. Originally their intention was not to produce fertilisers but to recover and avoid emissions in areas with high density of farms exceeding the emissions levels allowed. Then they identified the potential as nutrient source and started doing some studies on the fertilising potential. TRL: 5/6
- Life Green Ammonia: https://www.lifegreenammonia.eu/ Ongoing. Optimization of technology to bring the technology to a commercial level. Scaleup and concentration of the final product. TRL: 8/9.
- Walnut project. https://walnutproject.eu/ (Also UGENT). Ongoing. Several pilots under development regarding the obtention of fertilising products from wastewater, brine etc. Each pilot works with different side streams. TRL: n/a. The role of the group in this project was to transfer the knowledge gained during the Project to the farmers and to To elaborate a White paper recommendations and Benefit from farmers to use BBFs from wastewater.

Biobased fertilising products recovered

The fertilizer product was an ammonium salt in liquid from, initially with a nitrogen concentration of 2-3%. The nitrogen concentration of this solution to 21% will be studied. In addition, biostimulant effect of this solution has been demonstrated in plot assays due to the presence of trace of organic compounds.

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Existing LCA analyses

An LCA analyse was performed in the framework of the Life Ammonia Trapping Project and as an overall, the gas-permeable system-based treatment is more environmentally sustainable compared to the conventional scenario of manure management (storage and field application) thus making this an attractive option for environmental management systems, especially in areas with low water quality or high nutrient imbalance.

Reference: González-García, I., Riaño, B., Cuéllar-Franca, R.M., Molinuevo-Salces, B., García-González, M.C. (2022). Environmental sustainability of a membrane-based technology for livestock wastewater with nutrient recovery. Journal of Environmental Chemical Engineering, 10, 107426.

Inventory of the European NoLLs - CROATIA

Croatia

OPG Marija Mesić Tuškanec

Name: OPG Marija Mesić Tuškanec
Location: Savska ulica 15, Galdovo, Sisak, Croatia
Type of system: Farmer
Geographical scale: Local
Living Lab manager/promoter/coordinator: Marija Mesić Tuškanec

Partners involved in the LL:N.A.

Overall concept of the activities to be implemented

OPG has been in existence since 2003, and since 2015, it has been operating under the name "OPG Marija Mesić Tuškanec." The motivation for engaging in ecological farming is to contribute to environmental protection and increase the potential for food production security in the future. The OPG's operations are entirely ecological and cover an area of 48 hectares.

Since 2008, the OPG has been registered in the Registry of Producers in Ecological Production of Agricultural and Food Products. Certified ecological livestock production includes the breeding of native breeds of cows, sheep, and donkeys. Plant production focuses on meadows and permanent pastures, as well as the cultivation of clover-grass mixtures used for animal feed. All agricultural production is under the ecological supervision of authorized control authorities. The OPG has modernized and improved its working processes and gradually increased production capacities. This was achieved by using EU measures to purchase new equipment and to manage and utilize animal manure in order to reduce its harmful environmental impact. In the future, the goal is to improve production by introducing new technologies that would facilitate and simplify the production process. An innovative approach on the OPG involves the use of Californian earthworms to address the excess of animal manure through bio-based fertilizing products.

The ecological production covers an area of 48 hectares, and it involves the use of animal manure (pure animal manure with bedding).

Technical dimension

The technology used for applying animal manure was a manure spreader trailer for distribution on the meadows. However, due to certain norms within the eco-scheme, this method is no longer applied. Further investment in technology and process modernization will contribute to better preparation of animal feed and environmental.
TRL1-TRL2: Foundational research has been conducted to identify new methods of applying animal manure, based on theoretical data and potential benefits, and expected process barriers. Enhanced knowledge of these technologies has been gained, and a qualitative description of the interactions between production technologies and animal manure application is in progress.

Biobased fertilising products recovered

Below is an analysis of aged sheep manure. The first analysis pertains to manure that has aged for 4 years, while the second analysis relates to manure that has aged for 10 years. The following values were obtained from these analyses:

Analysis I:

Parameter	Specification
Total organic carbon %	6.98
Total potassium (K) %	1.15
Total nitrogen %	0.43
Total phosphorus (P) %	0.57
Dry matter %	22.10
pH	9.30
Humidity	77.90

Analysis II:

Parameter	Specification
Total organic carbon %	8.95
Total potassium (K) %	1.54
Total nitrogen %	0.23
Total phosphorus (P) %	0.26
Dry matter %	66.42
pH	7.08
Humidity	33.58

Existing LCA analyses: N.A.

Croatia

OPG Dario Cenger

Name: OPG Dario Cenger (Bioel d.o.o. – Ecodig)
Location: M. A. Relkovića 61a, 43290 Grubišno Polje, Croatia
Type of system: Industry/farmer
Geographical scale: Regional
Living Lab manager/promoter/coordinator: Dario Cenger, Marijan Cenger

Partners involved in the LL:N.A.

Overall concept of the activities to be implemented

OPG Dario Cenger started in 2005. It encompasses five thriving business entities under the umbrella of Grupa Cenger. Each company within the group has a unique specialised task but all of them have common objective – contribution to the development of ecological agriculture in Croatia.
Bioel d.o.o. provides green energy with its 1MW Biogas power plant, while PZ Zrno organises cooperation and transportation. Biodem takes care of distribution and sales, while OPG Jerko Cenger works intensively in the sector of ecological livestock farming, crop production and medicinal plant cultivation, and OPG Dario Cenger produces high-quality Ecodig organic fertilizer.
Ecodig fertilizer feature a well balanced nutrient composition devoid of any animal-based residues.
All business entities within Cenger Group operate on a group model, where the initial founder and producer of Ecodig, OPG Dario Cenger, plays a central role. This interconnectedness of the group companies enables the creation of the innovative solutions for the agricultural sector.
Long-term goal is to create a circular economy in which production and distribution of organic fertilizers is integrated into local community.

The data for the BIOEL facility for the year 2021 is as follows:

- The produced electrical energy (Eu) amounts to 9,238.500 MWh (33,258,600 MJ).
- The useful thermal energy (Hk) amounts to 4,040.552 MWh (14,545,987 MJ).
- The primary fuel energy (Q) amounts to 22,010.472 MWh (79,237,699 MJ).

Main waste type treated are plant materials and manure from livestock production.

Technical dimension

Ecodig fertilizers are created by anaerobic digestion of plant materials and manure from livestock production with the addition of a mineral component.
In the process of anaerobic digestion, during the breakdown of complex organic substances (e.g., carbohydrates, fats, and proteins), simpler compounds such as methane (CH_4) and carbon dioxide (CO_2) are produced. The final products of anaerobic digestion are biogas - a renewable source of energy used for electricity production, and digestate - the residue from biogas production used as fertilizer. Considering the diversity of substrates added to the plant, there are two main types of digestion:

1. Monodigestion - a process in which only one feedstock is used for biogas production (e.g., energy crops).
2. Codigestion - a process in which more than two feedstocks are used for biogas production (e.g., energy crops and manure or other types of organic waste).

Biobased fertilising products recovered

Fertilizers fully meet all standards of ecological production according to EU Council Regulation (EC) no. 2018/848, which is confirmed by the EASY-CERT services certifier. The production process is controlled by the HACCP system.

NPK 2:7:11 (S-10)
The product contains a high proportion of organic matter and at the same time a high proportion of organic carbon, which greatly improves water-air relations and the absorption of nutrients in the soil. Due to its good supply of macroelements and neutral pH value, it is a high-quality organic-mineral ecological fertilizer.

Parameter	Specification
Total organic nitrogen %	2
Total phosphorus (P_2O_5) %	7
Total potassium (K_2O) %	11
Total sulfur (SO_3) %	10
Organic carbon (C) %	27
Total organic matter %	60
Dry matter %	90
pH	7
Calcium (Ca) %	4
Magnesium (Mg) %	0.94
Calcium oxide (CaO) %	5.9

NPK 2:5:8 (S-8)
The product is richly supplied with macroelements, and due to its high content of organic matter, it promotes the formation of humus, the airiness of the soil and the even absorption of nutrients in the soil. It is an extremely suitable fertilizer for acidic soils because its composition is pH neutral and has excellent solubility.

Parameter	Specification
Total organic nitrogen %	2
Total phosphorus (P_2O_5) %	5
Total potassium (K_2O) %	8
Total sulfur (SO_3) %	8
Organic carbon (C) %	33
Total organic matter %	78
Dry matter %	85
pH	7
Calcium (Ca) %	1.07
Magnesium (Mg) %	0.58
Calcium oxide (CaO) %	2.04

Existing LCA analyses: N.A.

Croatia

VINKA PLUS d.o.o

Name: VINKA PLUS d.o.o
Location: Jarminačka cesta 1, Vinkovci, Croatia
Type of system: Industry – processing company
Geographical scale: National
Living Lab manager/promoter/coordinator: N.A.

Partners involved in the LL: N.A.

Overall concept of the activities to be implemented

OVinka was established in 1967, and its business is based on two important segments - the Borinci orchard spanning 900 hectares and a factory for processing vegetables and fruits into frozen products. The company organizes the production, storage of fruits and vegetables for processing, and packaging of frozen products for industrial customers, the HORECA channel, and retail. Vinka has a total of 14 production lines that meet all modern technological requirements for product quality, as well as three types of technologically advanced warehouses - for root vegetables, for fruits and vegetables, and for frozen products.
In short, Vinka is a fruit and vegetable processing company from Croatia, which has started an investment in planting 7,56 ha of raspberry orchard using different types of fertilizers – including digestate from locally based biogas installation. In the phase of soil preparation, the company applied the combination of Ca (OH)2, thick fraction of digestate and cattle manure.

Main waste type treated: different agro residues from agricultural production (cattle and pig manure/slurry, corn silage, soy molasses).

Technical dimension

The company used digestate that was produced in the near proximity of the orchard meaning that closing of nutrient cycles on a local level is supported as well as dependence on nutrients (due to geopolitical situation across the globe) is being reduced. The digestate applied was produced in a biogas plant Energy Gradec d.o.o. using mostly different agro residues from agricultural production (cattle and pig manure/slurry, corn silage, soy molasses). At the moment, the plant is not using agro streams generated at the processing line of Vinka (peas stems, sweet corn husks/piston/stems, pepper seeds loge, carrots and potatoes epidermis, onion peels, cauliflower flowers, cherries juice and pulp) but an intention of the company is to prepare an analysis of the biogas potential of these streams and if financially sustainable process it in the biogas plant (digestate).
In the phase of soil preparation, the company technologists decided to implement the combination of Ca (OH)2 in concentration of 1,00 t/ha, thick fraction of digestate in concentration of 50,00 t/ha and cattle manure in concentration of 33,00 t/ha. Next to organic fertilizers, 30 grams/plant of mineral fertilizer (NPK 7-20-30) was also applied. The digestate was applied using Strautmann fertilizer spreader. The foreseen scale of operation is one-time application of digestate while for the further management of the orchard, one will use fertigation system and combination of mineral fertilizers Novalon (NPK 20-20-20) and Vital Power Phos (NPK 7-21-0).
TRL8-TRL9: Application of digestate in large scale orchards may have been applied across EU already, but it is an innovative management solution in Croatia. When investigating existing research databases, there were no specific research found on application of digestate in raspberry plantation. Since this solution refers to existing technology, TRL is high. It is strongly believed that further scientific research could create new market value in Croatia and surrounding countries.

Biobased fertilising products recovered

Laboratory analysis was conducted on the digestate applied and it had the following content:

Parameter	Specification
Total organic nitrogen %	0.35
Total phosphorus (P) %	0.80
Total potassium (K) %	7.5
Dry matter %	4.04
pH (H2O)	7.91
Calcium (Ca) %	1.49
Magnesium (Mg) %	0.65

Existing LCA analyses: N.A.

3. Selection of LH demonstrations

From the list of NoLLs identified above one per region is selected as a LH demonstration as identified with the LH symbol. LH demonstrations will serve as the basis for WP4 activities and more information regarding the LH demonstration selection process can be found in D1.4 selection of lighthouse demonstrations.

Novafert

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