

ESNI-NERM

28-29 April 2026 Brussels & hybrid

HARVREST-GREENHOOD WORKSHOP

The Flagship Event on
Nutrient Recycling

DAY 2



HarvREST
Greener Farming with RES



Funded by
the European Union

www.harvrest.eu

On-Farm Biogas Production and Environmental Sustainability Enhancement Through the Treatment and Utilization of Digestate



From Research to Innovation

HarvRESt → Assesses baseline conditions impacts of digestate use

Soil quality, crop performance, emissions, leaching

GREENHOOD → Advances with **enhanced nutrient recovery technologies**

Optimising nutrient flows and circularity

What This Workshop Will Show

A **progression of knowledge:**

Field-scale evaluation of RES-derived inputs

Transition to **technology-driven solutions**

Insights into **sustainable nutrient management strategies**



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WHY THIS WORKSHOP?

Growing need to decarbonise agriculture while maintaining productivity

Opportunity to valorise biogas by-products as fertilisers

Challenge: ensuring efficient, safe, and circular nutrient use

SHARED DEMONSTRATION CONTEXT

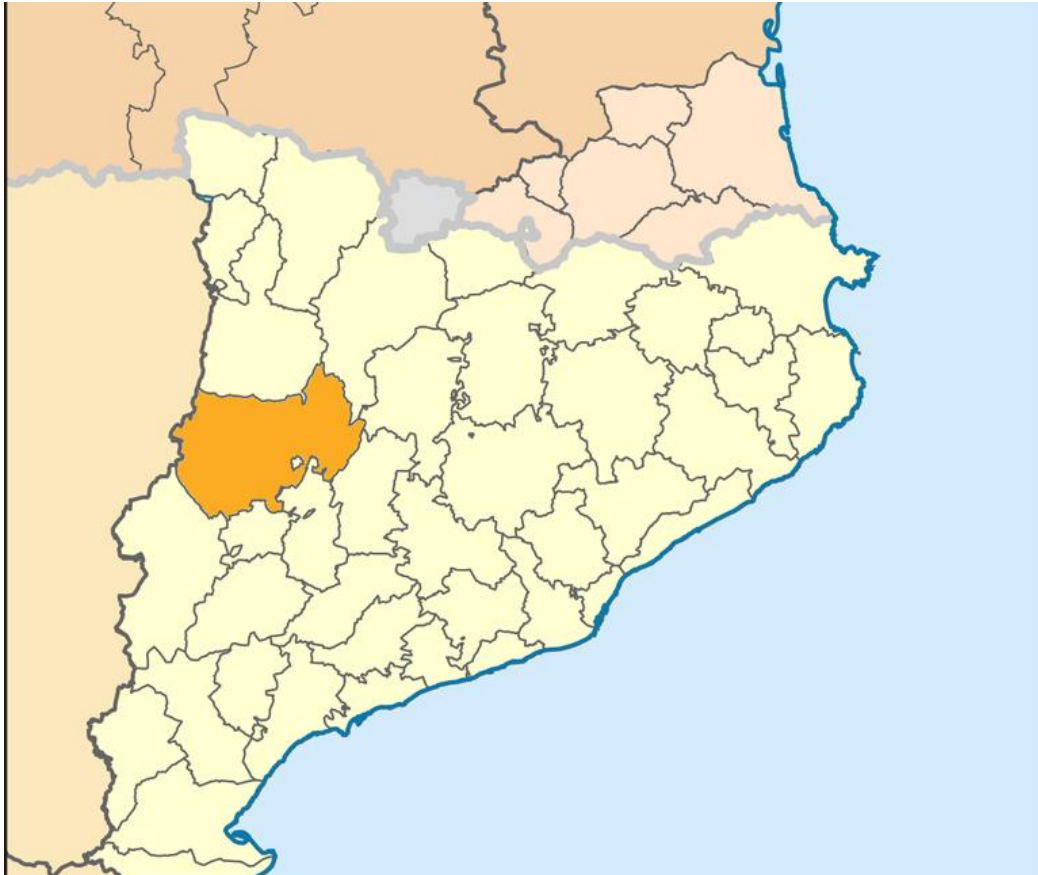
Real-farm setting in Balaguer (Spain) with an on-site biogas plant

Unique platform to test RES–agriculture integration under practical conditions



TERRITORIAL CONTEXT

Area of high livestock production



- High generation of slurry and manure
- Limitations on agricultural application
- Environmental and regulatory pressure
- Opportunity for energy valorization
- Territorial management tool



COLLABORATION MODEL

Integration of different profiles

- Livestock farm: supply the raw materials and provide the agronomic perspective
- Engineering: plant design
- Plant operator: day-to-day management
- Energy operator: gas management / certification process



Reception and Management of Substrates: the basis of biological balance

SUBSTRATE TYPES

- Slurry
- Manure
- Straw
- Animal feed Waste

KEY TECHNICAL ASPECTS

- Prior homogenization
- Dry matter control
- Organic loading rate control
- Seasonal variability
- Continuous daily feeding
- Maximizing methanogenic potential



ANAEROBIC DIGESTION

BIOGAS CHARACTERISTICS

- Aprox 55% CH₄
- CO₂ as the main remaining component
- H₂S minimized



Upgrading

CH₄ pure



UPGRADING

- H₂S removal
- Moisture removal
- VOC removal
- CO₂ separation: membrane technology
- Continuous quality control
- Grid injection



DIGESTATE

- Solid/liquid separation
- Liquid fraction: agricultural application / treatment
- Solid fraction: composting and sale as a finished product



**NOGUERA
RENOVABLES**

soriguè

oxpo



UVIC

UNIVERSITAT DE VIC
UNIVERSITAT CENTRAL DE CATALUNYA

HarvRESt

Harnessing the vast potential of RES for sustainable farming



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Greener Farming with RES



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Why HarvRESt?

About 30% of the world's energy is consumed within agri-food systems and about a quarter of the total energy is consumed during the production stage, being responsible for a third of agri-food systems' emissions of greenhouse gases.

The HarvRESt project has been launched to address the need of enhancing the use of Renewable Energy Sources (RES) along with sustainable farming methods, aiming to **help the agricultural and food industry reduce carbon emissions.**



The main goal of HarvRESt is to work on **improving the existing knowledge** on alternatives for farms decarbonisation, maximising synergies between agricultural and energy sectors.



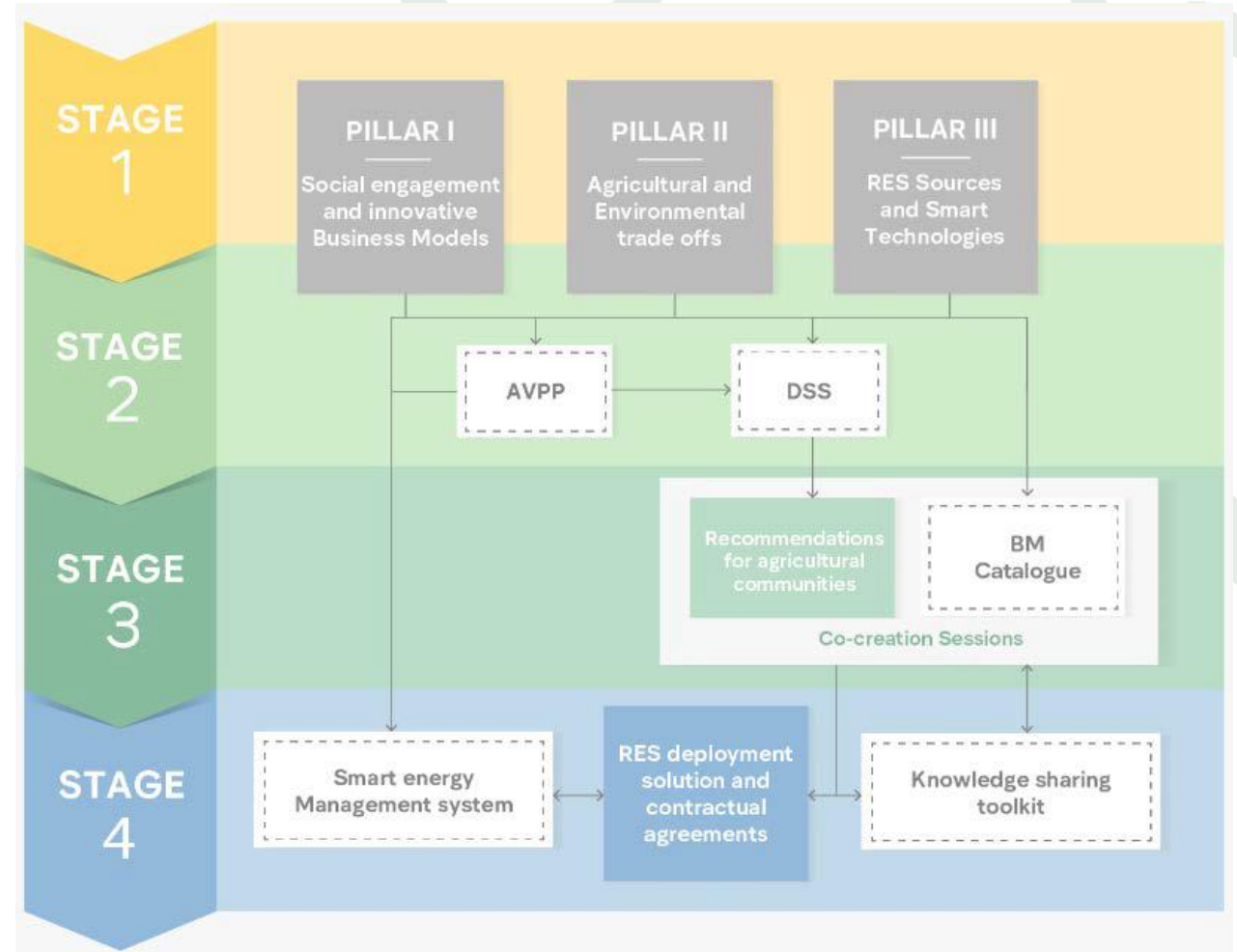
Understanding agro communities to develop innovative business models that consider combined agricultural and RES production

Addressing the impact of RES technologies on agricultural production, potential trade-offs and synergies of the alternatives to be explored

Addresses the modelling and design of the technological alternatives required to support the uptake and upscaling of RES production

The main goal of HarvRESt is to work on **improving the existing knowledge** on alternatives for farms decarbonisation, maximising synergies between agricultural and energy sectors.

The integration of the pillars will be materialized in the creation of an **Agricultural Virtual Power Plant (AVPP)** that combined with **Multi Criteria Decision Analysis (MCDA)** will provide the necessary information for **HarvRESt Decision Support System (DSS)** to make recommendations of the best RES integration solutions and operation procedures.





	ITALY	DENMARK	SPAIN	NORWAY
TECHNOLOGIES	PV	Biogas	PV, biogas, storage, electrolyzers, biomass	PV, thermal storage, batteries, biogas, hydro, wind
ACTIVITY	Agro-industrial, farmers	Large scale biogas plants	Winery and dairy products	Livestock farming
KEY OBJECTIVE	Explore joint models for promoting RES in agro communities and along the food value chain	Enhance biogas planning tool for Danish farms, evaluating GHG emissions, nutrient balances, and leveraging big data.	Enhance the production management: <ol style="list-style-type: none"> Digital management of a winery to optimise RES assets and the consideration of the impact of RES on crops. Biogas production modelling from agro-residues 	Development of an intelligent energy system for total GGE decarbonization
PARTNERS	EnG, CONFAGRI, FSDC, ICA	CT, FBCD	VdV, VRT, SORIGUÉ, BETA & CIRCE	GGE, NORCE



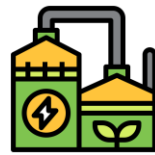
Biogas production unit consisting of 4 digesters that valorise agro-residues and produce digestates in the process



To collect data from the biorefinery to model and optimise biogas production from agro-residues



To assess the fertiliser potential of the nutrients recovered from the the digestate



Crude digestate



Solid fraction



Liquid fraction



Solid fraction



Different experimental activities will be carried out on an experimental campaign to achieve the objectives of the Catalan UC:



1. **Agronomic assays** will be performed under natural conditions in the **field** and controlled conditions in the **laboratory** through **pot-tests** using representative soil to analyse the capacity of the digestate for improving nutrient management, soil quality and **crop yield** and replace current mineral fertilizers in crops.

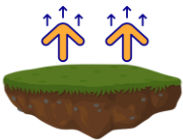


2. **N release dynamics** of the digestate will be assessed and compared with other similar fertilizers by **soil incubation assays** to determinate whether the product can be deemed as worthy substitute of current products in the market.



3. **Nutrient losses** will be evaluated through two approaches:

- Nitrate residues & leaching risk will be assessed by the determination of NO₃-N residue in the simulated soil profile (0 – 90 cm) in the post-harvest period.
- Gaseous emissions from digestate will be evaluated by calculating the emission of ammonia (NH₃) and greenhouse gases (N₂O, NO, and CO₂).





GREENHOOD

Nutrient management strategies for regional ecosystems across Europe

Nutrient balance and resource optimisation in regional ecosystems
through holistic, sustainable and zero-pollution solution

GREENHOOD



Funded by
the European Union


Nutrient balance and resource optimisation in regional ecosystems through holistic, sustainable and zero-pollution solution – GREENHOOD


- ◆ Call topic: HORIZON-CL6-2024-ZEROPOLLUTION-01-1
- ◆ Project Budget: 9.6 M€ (EU Contribution: 9 M€)
- ◆ Project duration: 01/01/2025 – 31/12/2028

Consortium of 31 Partners from 10 countries




Disrupted nutrient flows need to be solved → need for integrated management plans



Balance N & P emissions
Region-specific practices




Bio-based fertilizers
Innovative practices & technologies



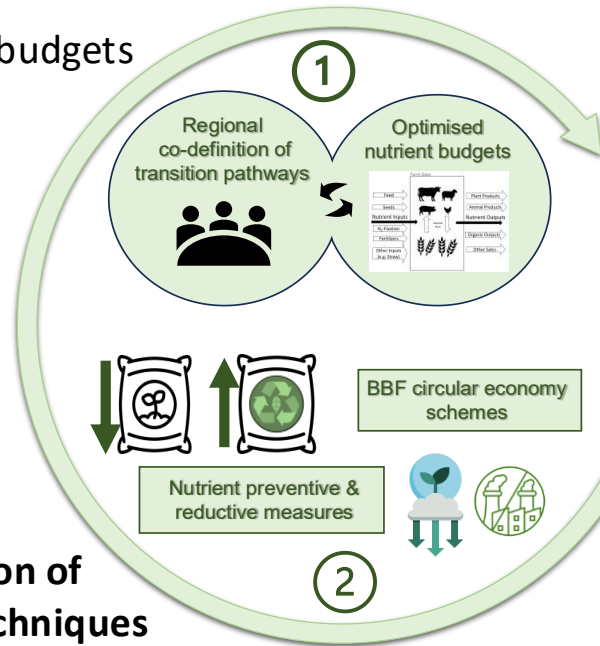

Governance models
In line with nutrient management strategies



To demonstrate an effective and sustainable approach to **re-balance nutrient flows and reduce N/P emissions.**

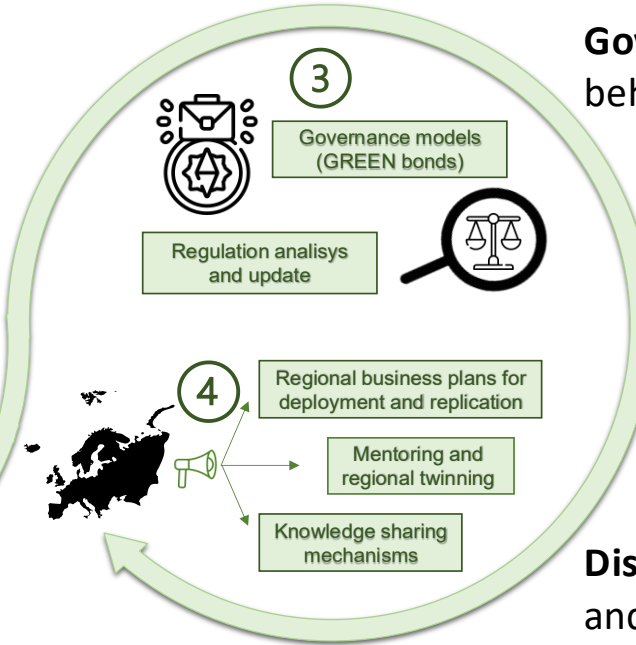
- Targeted efforts in regional hotspots and robust nutrient budgeting methodologies
- Collaborative testing of diverse innovations (TRL5/6 to 7/8) with regional stakeholders

Region-specific nutrient budgets & stakeholders' policies



Practical **demonstration of nutrient balancing techniques**

Governance, regulatory and behavioural aspects



Dissemination, communication and exploitation

The potential of innovative nutrient management strategies will be showcased in the following unbalanced regions:


- ◆ Ebro River Basin, Spain
- ◆ Rhine, Meuse & Scheldt Basins, Belgium and the Netherlands
- ◆ Archipelago Sea Basin, Finland
- ◆ Trondheim Fjord Basin, Norway

**A regionally tailored, cross-sectoral approach
to balance nutrients**

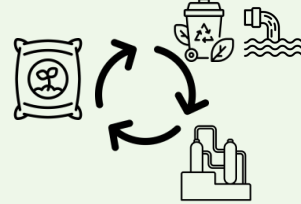




Balance N & P emissions




Bio-based fertilizers

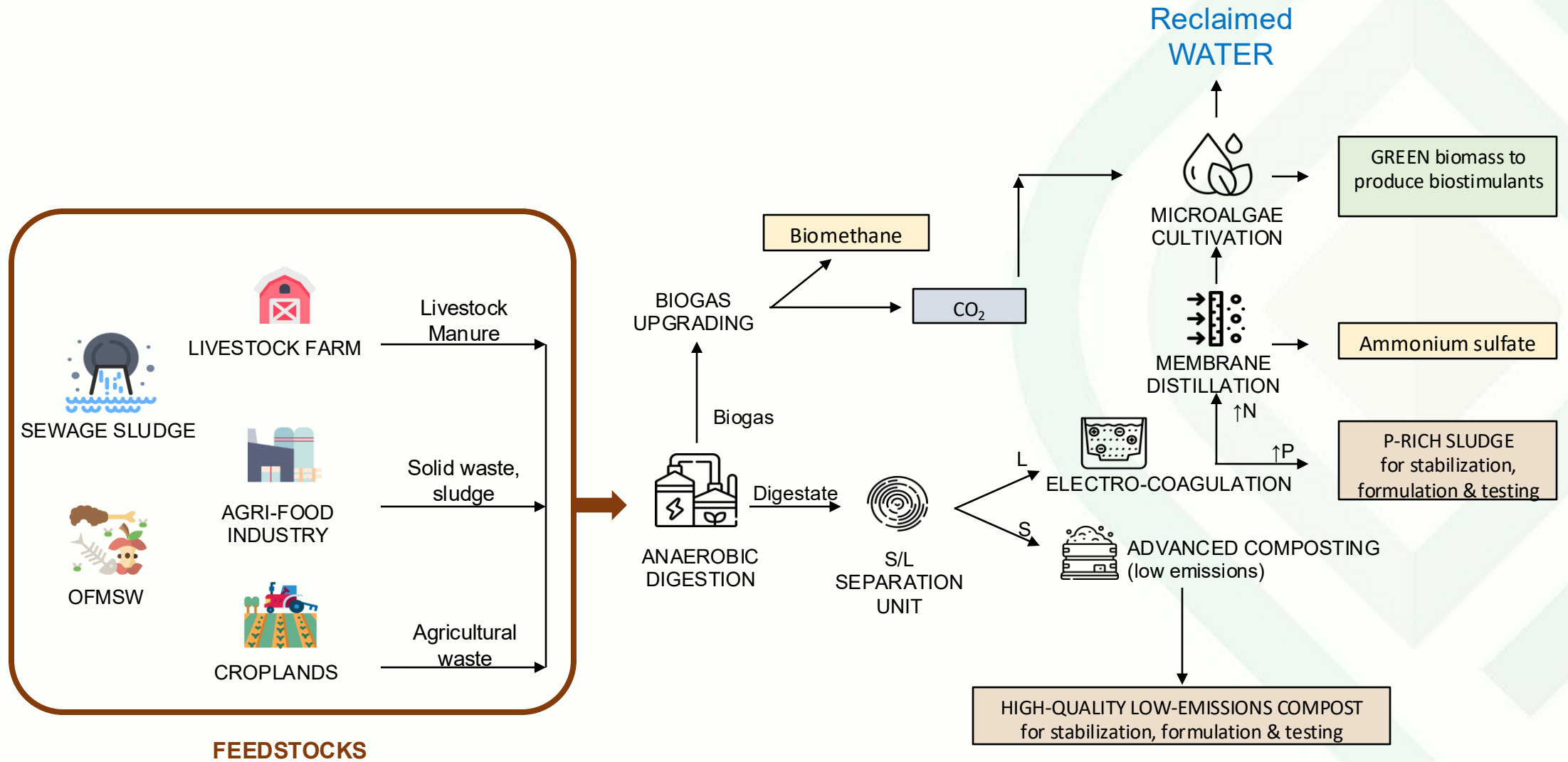


Governance models

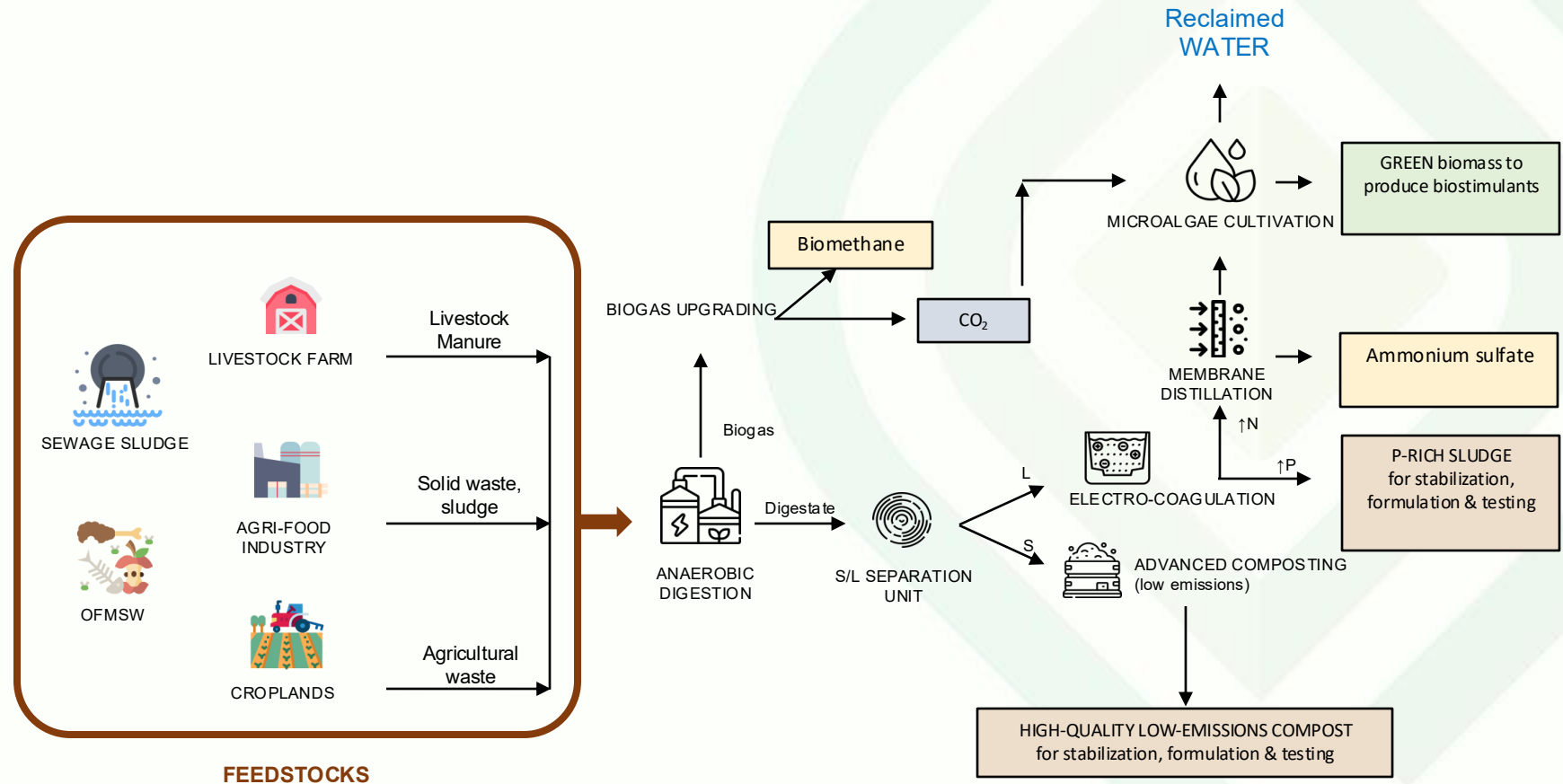


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- **Optimised Regional Nutrient Budgets**
 - Regional stocktaking analysis, pathways for implementation, optimised Nutrient Models
 - **Nutrient Balancing Practices targeting different sectors**
 - Technical solutions to recover nutrients, reduce losses & produce biobased fertilizers
 - Sustainability assessment of the proposed solutions
 - **Governance and business models**
 - Region-specific policy recommendations, solution feasibility & economic analysis, upscaling plans, financial strategy

DESCRIPTION OF THE SOLUTION



- Selective recovery of nutrients for further BBF formulation
- Initial TRL: 5-6
- Final TRL expected: 8
- Core technologies:
 - Anaerobic digestion
 - Solid/liquid separation
 - Electrocoagulation
 - Membrane distillation
 - Microalgae cultivation
 - Low-emission composting

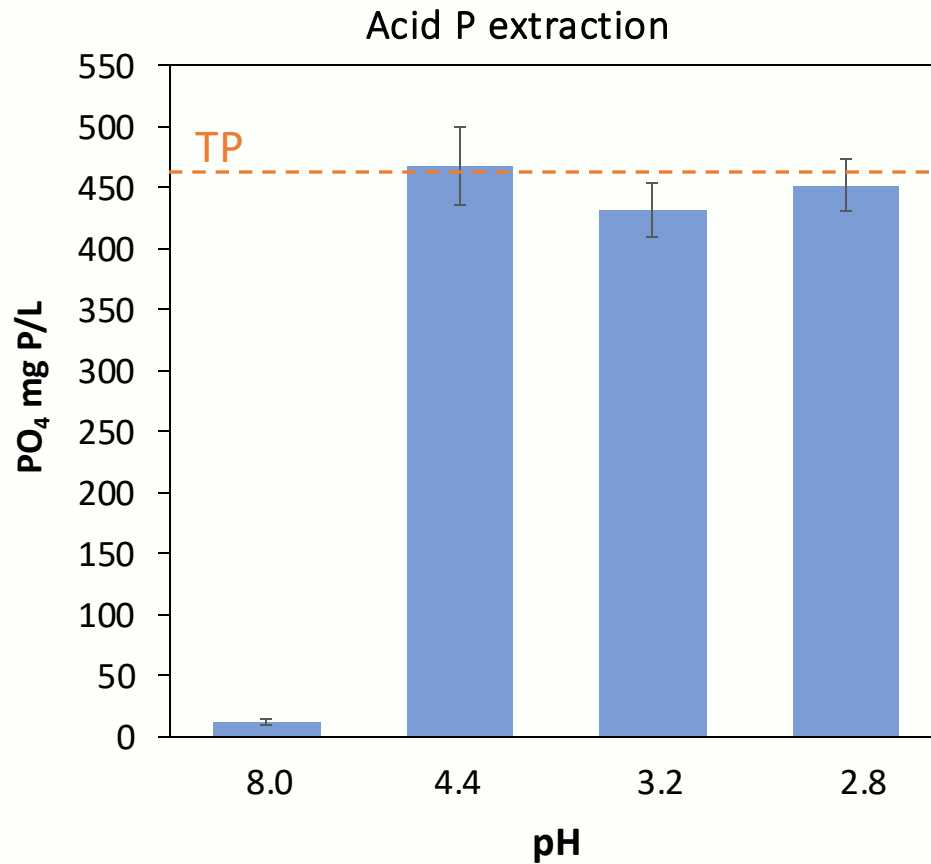
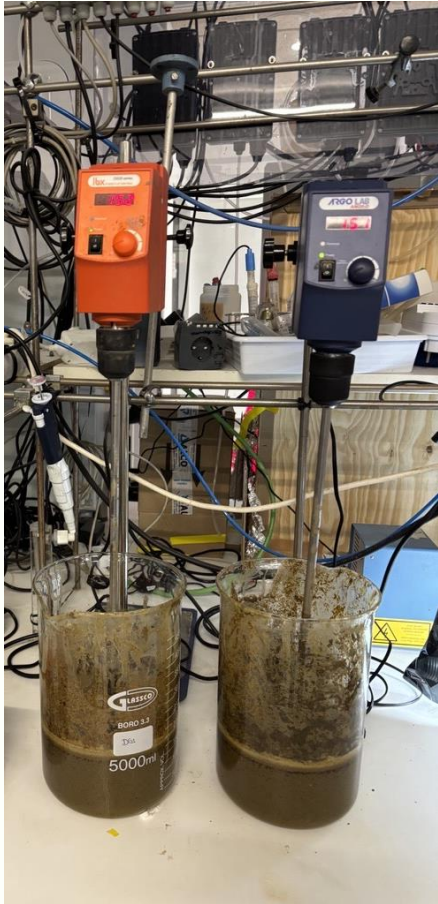


Digestate and liquid fraction of the digestate characterized for nutrients recovery potential

Parameter	Digestate liquid fraction	Digestate (no S/L separation)
pH	7,82 ± 0,00	8,03 ± 0,00
TS (g/kg)	9,21 ± 0,00	46,05 ± 0,30
NH ₄ ⁺ (g NH ₄ ⁺ -N/L)	1,10 ± 0,03	1,75 ± 0,06
Total P (mg P/L)	63,81 ± 0,83	443,42 ± 35
Soluble P (mg P/L)	9,43 ± 0,70	11,99 ± 2,81

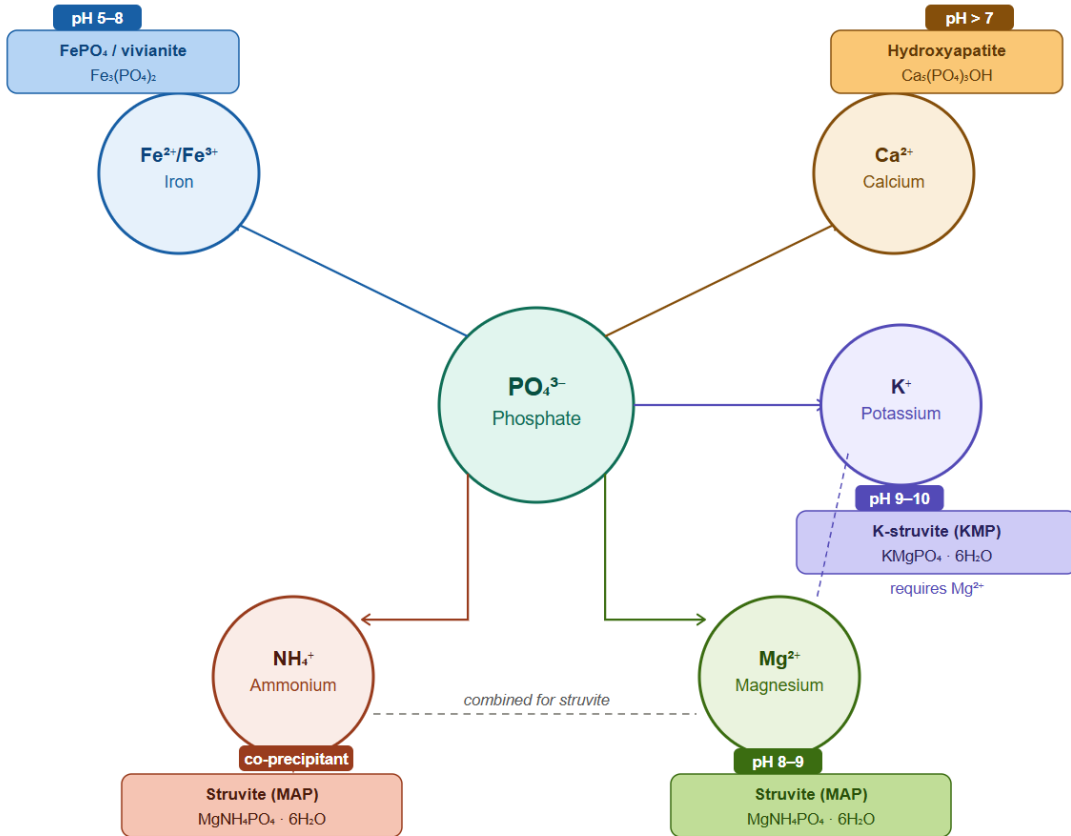
- ◆ Low P concentration in the liquid fraction – limited recovery feasibility
- ◆ Higher P concentrations in the digestate, but requires extraction prior to recovery
- ◆ Digestate selected for further recovery

P extraction assessed through lab-scale experiments under acid and alkaline conditions



- ◆ High extraction yields under acid conditions (>95%)
- ◆ No significant changes in NH_4^+ concentrations
- ◆ Negligible P extraction under alkaline conditions

Assessment of ion interactions on P precipitation and recovery



- ◆ Lab-scale precipitation experiments ongoing
- ◆ Evaluation of influence of effluent cations on P precipitates formation
- ◆ Characterisation of precipitates mineralogy and morphology
- ◆ Assessment of P recovery efficiency and precipitate agronomic quality as slow-release fertiliser



FORMULATION AND TESTING OF BBF, TMFS AND NOVEL FERTIGATION TECHNIQUES



CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERGÉTICOS



Biodiversitat, Ecologia, Tecnologia Ambiental i Alimentària



Biostimulation fertilizer concentrated gel



Field testing in maize and cereal crops



Liquid fraction of the digestate & recovered products



- ◆ Treatments to be tested:
 - ◆ Digestate, Liquid + solid fraction of digestate, TMF1, TMF2, and negative control
- ◆ 2-year field trials
- ◆ Different irrigation methods and fertilisation levels
- ◆ Pot tests for products available in limited quantities



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THANK YOU