NUTRI•KNOW

WEBINAR Nº5

Fertiliser Production

5th November 2024

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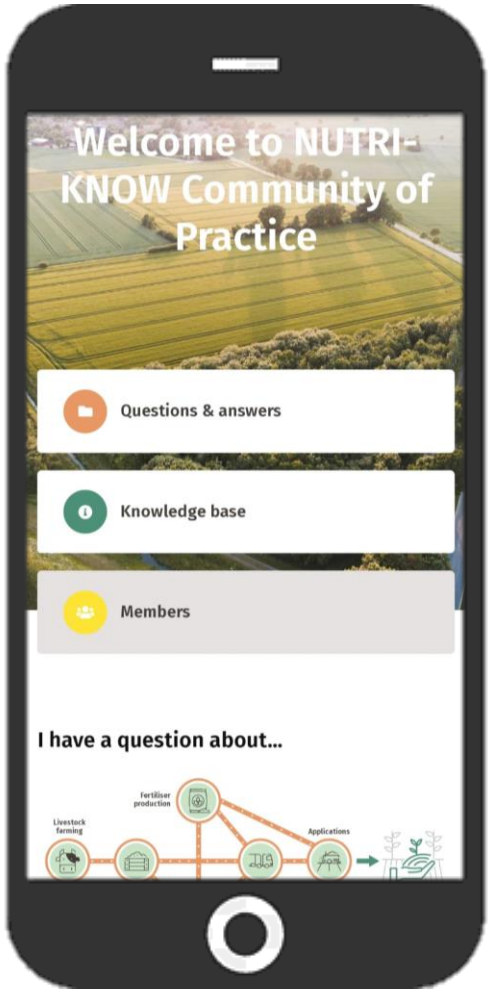

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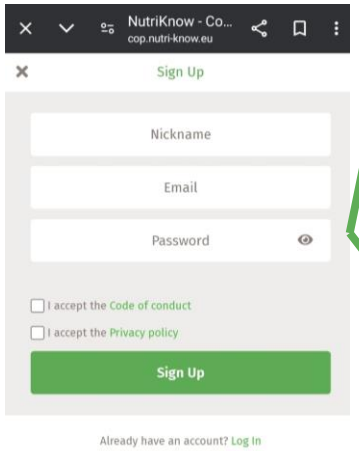

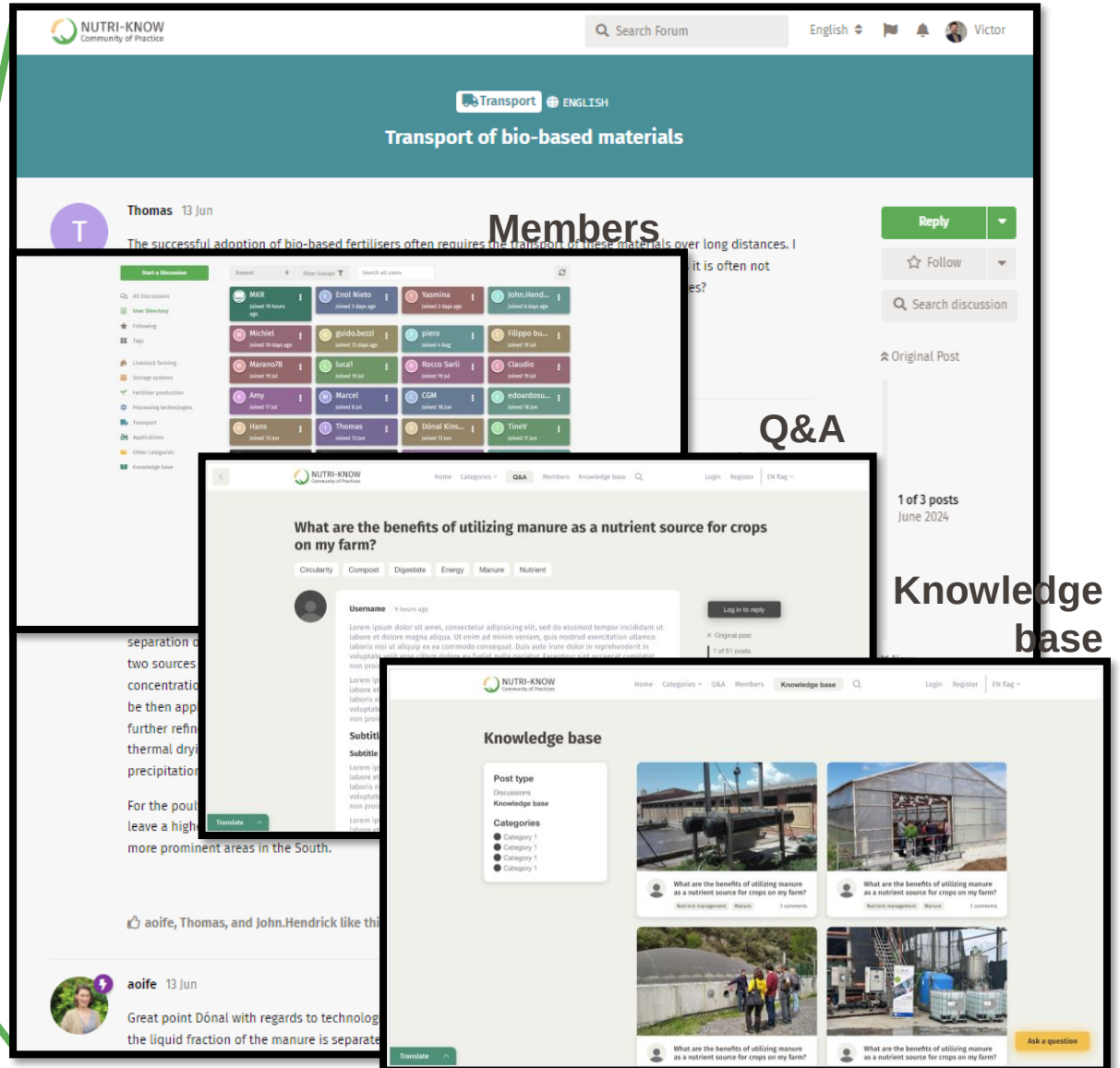

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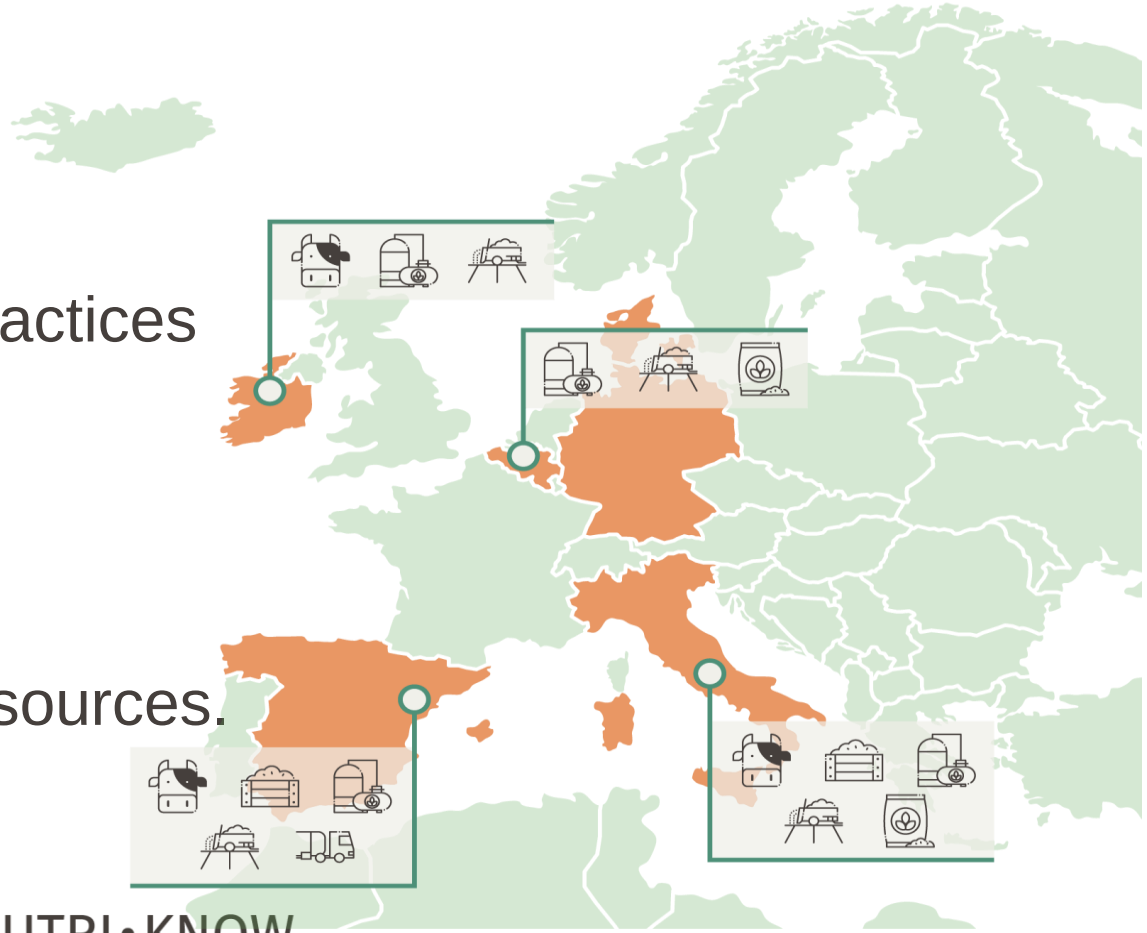
NUTRI-KNOW – Broadening the Impact of EIP-AGRI OGs in the Field of Nutrient Management

Aims and Objectives

- Improve nutrient management practices
- Sharing knowledge
- Reduce dependence on finite resources.



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Why?

- Production challenges
- Sustainability.
- Finite resources.
- Recycling and reusing nutrient-rich by-streams

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Innovation in Agriculture.

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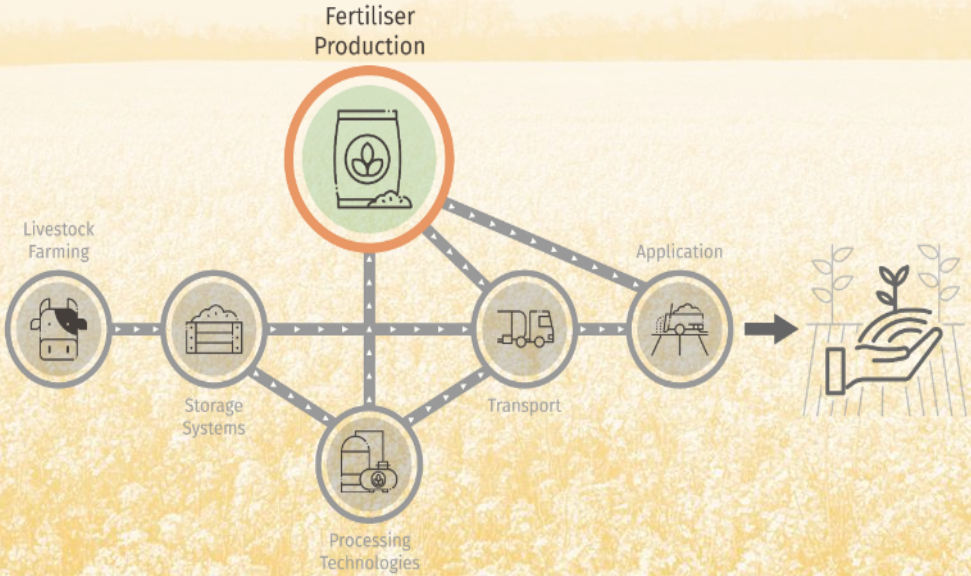
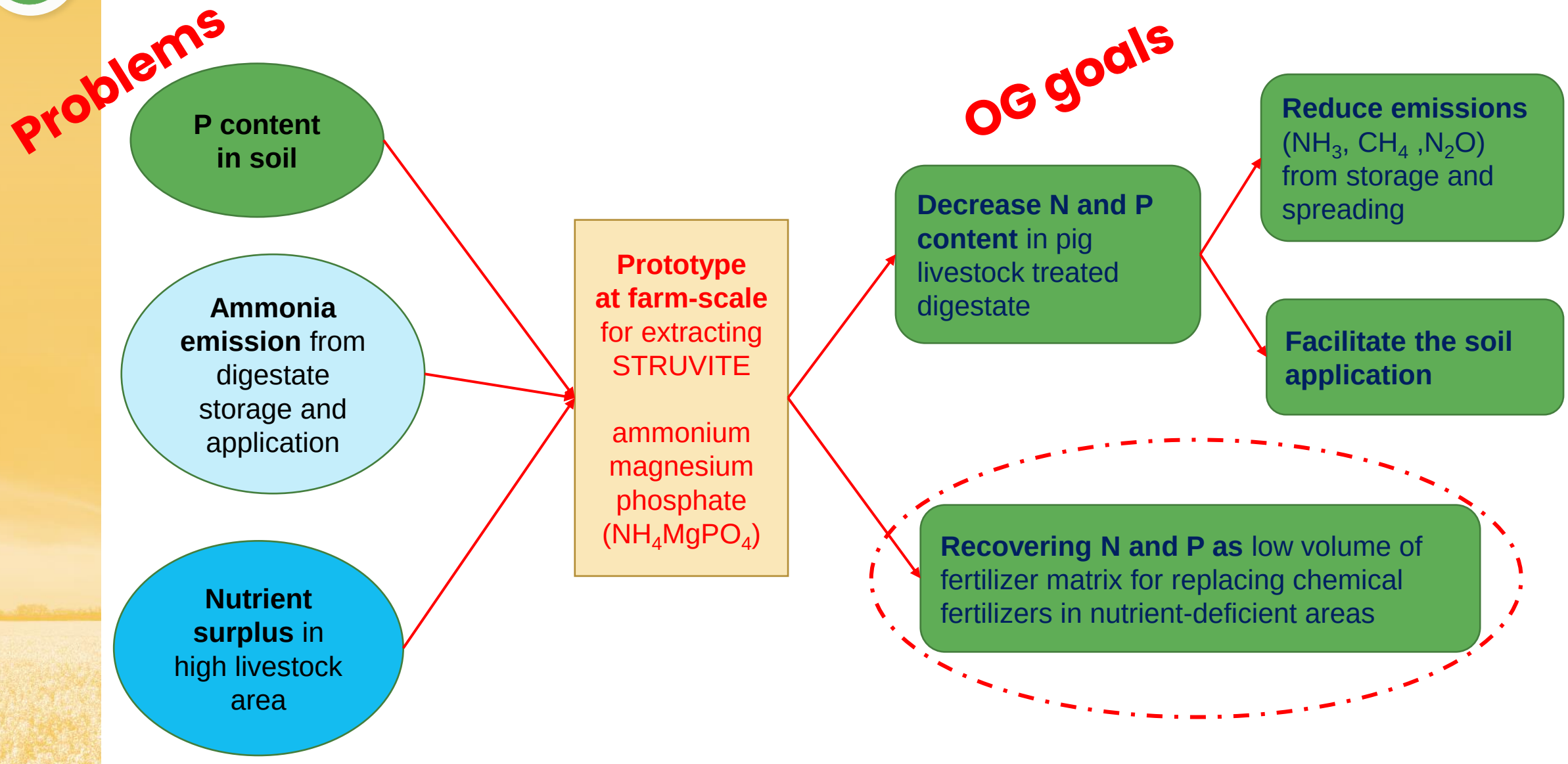


Production of Struvite Fertiliser from Manure and Digestate.

OG Struvite Production of Struvite Fertiliser from Digestate



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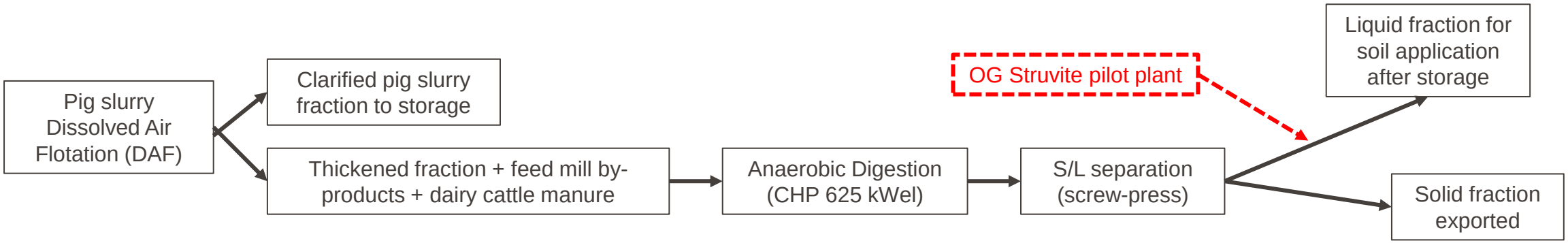
Colombaro pig farm: Modena, Emilia Romagna (IT)

Main pig livestock data

- 15000 animal place
- Growing and fattening pig phase: 30 – 170 kg/pig
- Parma ham PDO suppley chain



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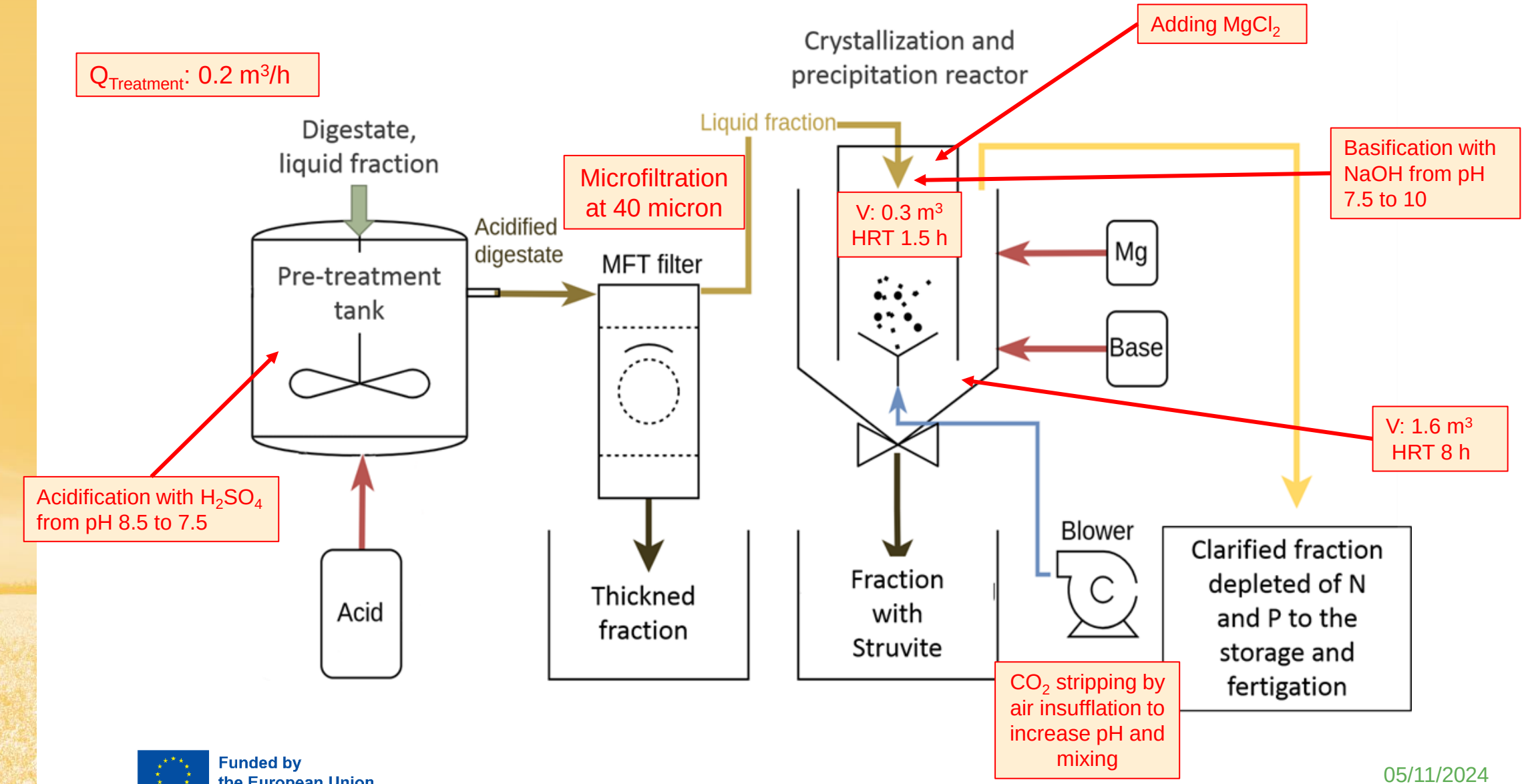
Layout of the treatment



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Struvite prototype

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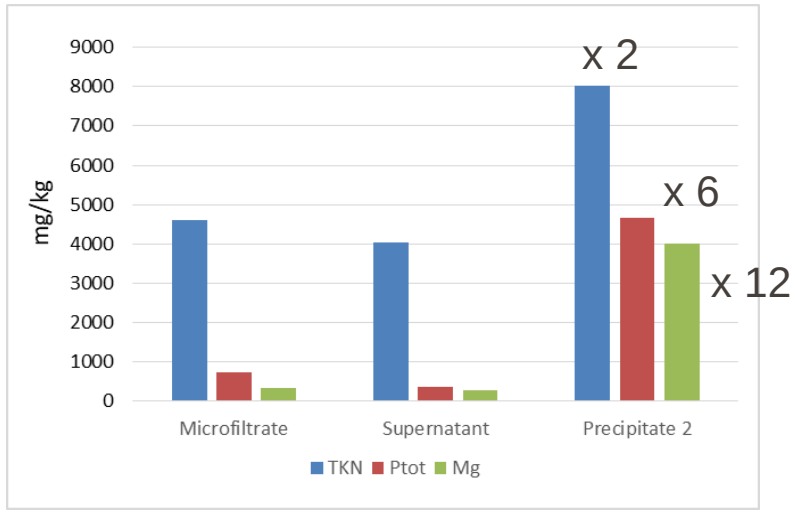
OG Struvite: treatment efficiency

Chemical characterisation of the input and treated flows

	Q mass flow	pH	TS	TKN		TP		Mg		P recovery efficiency
	%	[-]	g/kg	mg/kg	%TS	mg/kg	%TS	mg/kg	%TS	% input P
Input (clarified digestate)	100	8.3	51	**5074**	9.9	**1370**	2.7	**785**	1.5	
Thickened fraction	29	7.5	67	**5293**	7.9	**1756**	2.6	**1098**	1.6	37
Microfiltrate	*71*	7.5	42	**4621**	11.0	**725**	1.7	**335**	0.8	
Supernatant	64	9.1	36	**4040**	11.3	**367**	1.0	**272**	0.8	
Struvite Precipitate	7	10	123	**8035**	6.6	**4657**	3.8	**4001**	3.3	24 (61) - 63

Nutrient concentration by struvite reactor



		Struvite Precipitate	EU Regulation 2019/1009
TOC	% in weight	3.7	3%
P tot	P_2O_5 % weight	1-2%	16%
Ni	mg/kg d.m.	8.7	100
Cu	mg/kg d.m.	282	600
Zn	mg/kg d.m.	1058	500
Cd	mg/kg d.m.	<0.2	3
Hg	mg/kg d.m.	<0.2	1
Pb	mg/kg d.m.	3.9	120
Escherichia Coli	UFC/g	<10	<1000
Salmonella	/25 g	Absent	Absent

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Conclusions

- STRUVITE system to recover phosphorus and nitrogen from digestate are technically feasible …. but this treatment has still to be further more efficient;
- Precipitate containing struvite should be used as “raw material” for the production of phosphate fertilizers to replace phosphate minerals rocks;
- Fertilizer producers should collect the raw precipitate from several agro-livestock farms installations, refine and use it in their productions;
- Producing commercial struvite compliant with the regulation (EU 2019/1009) in the agricultural context could be problematic;
- The high concentration of solids in the digestate, even if subjected to S/L separation and microfiltration, is a critical issue.

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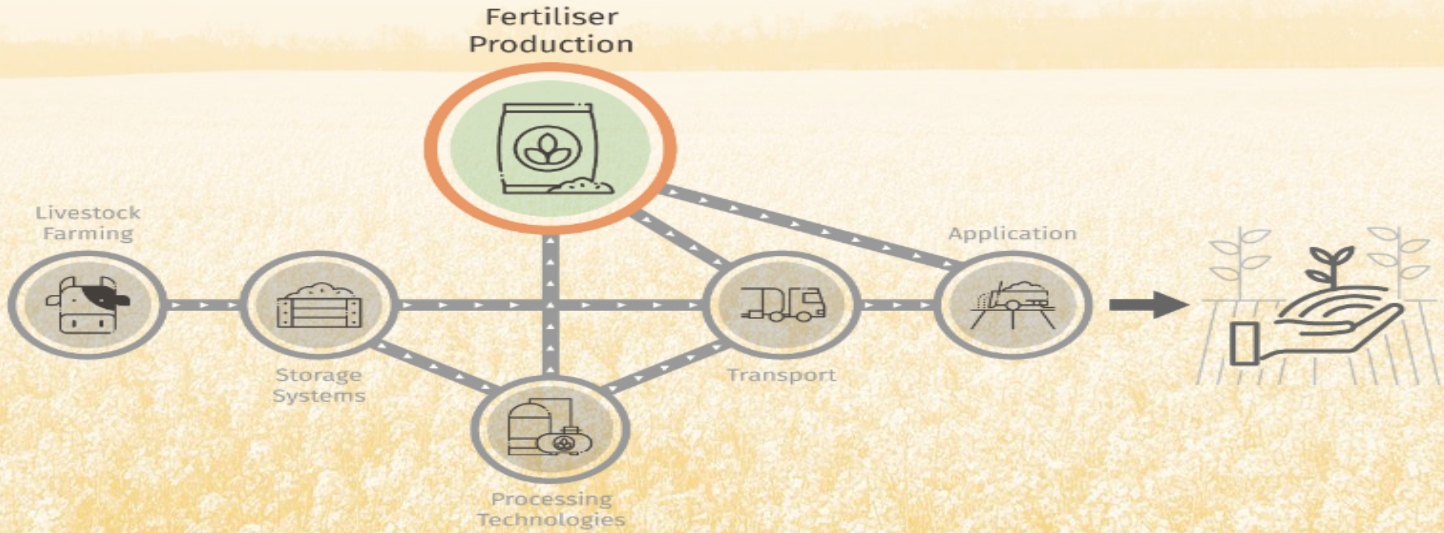

Nitrogen Fertiliser from Animal By-products.

Challenge of manure application

Animal manure

Compost

Digestate

Solid pellets

Concentrated liquid fraction

Ammonium salts

Nitrates Directive

In Nitrate vulnerable zones, < 170 kg N ha^{-1} yr^{-1}

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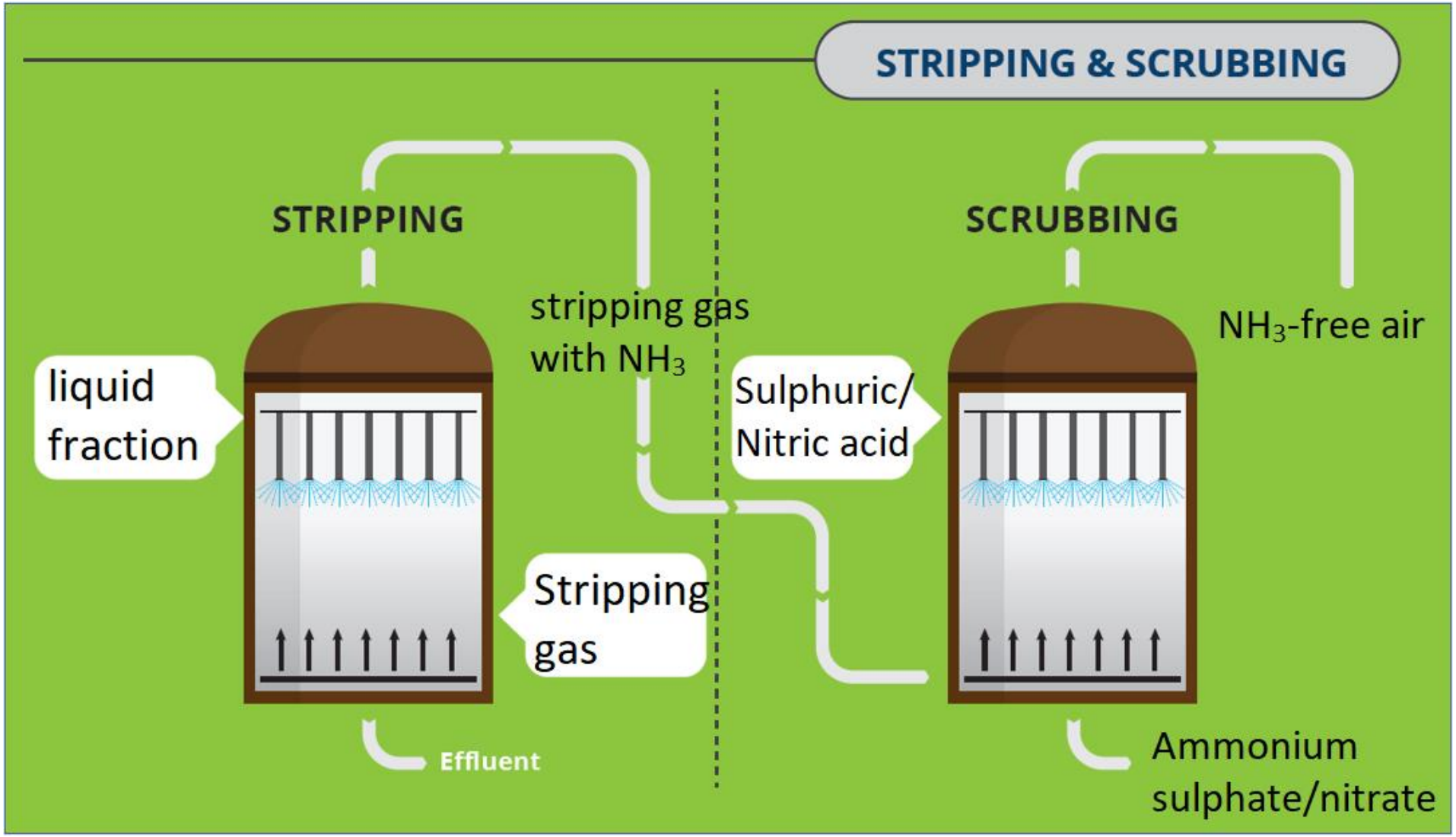
Opportunity with Stripping and scrubbing process



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Ammonium salts as alternative fertilisers

	Ammonium sulphate	Ammonium nitrate
pH	5-7 (slightly acidic)	
Nitrogen %	8%	10-15% (50/50 ammonium/nitrate ratio)
Sulphur %	9 (of 23% SO_3)	0
Density (ton/m^3)	1.15-1.2 (pure minerals no organic particles)	

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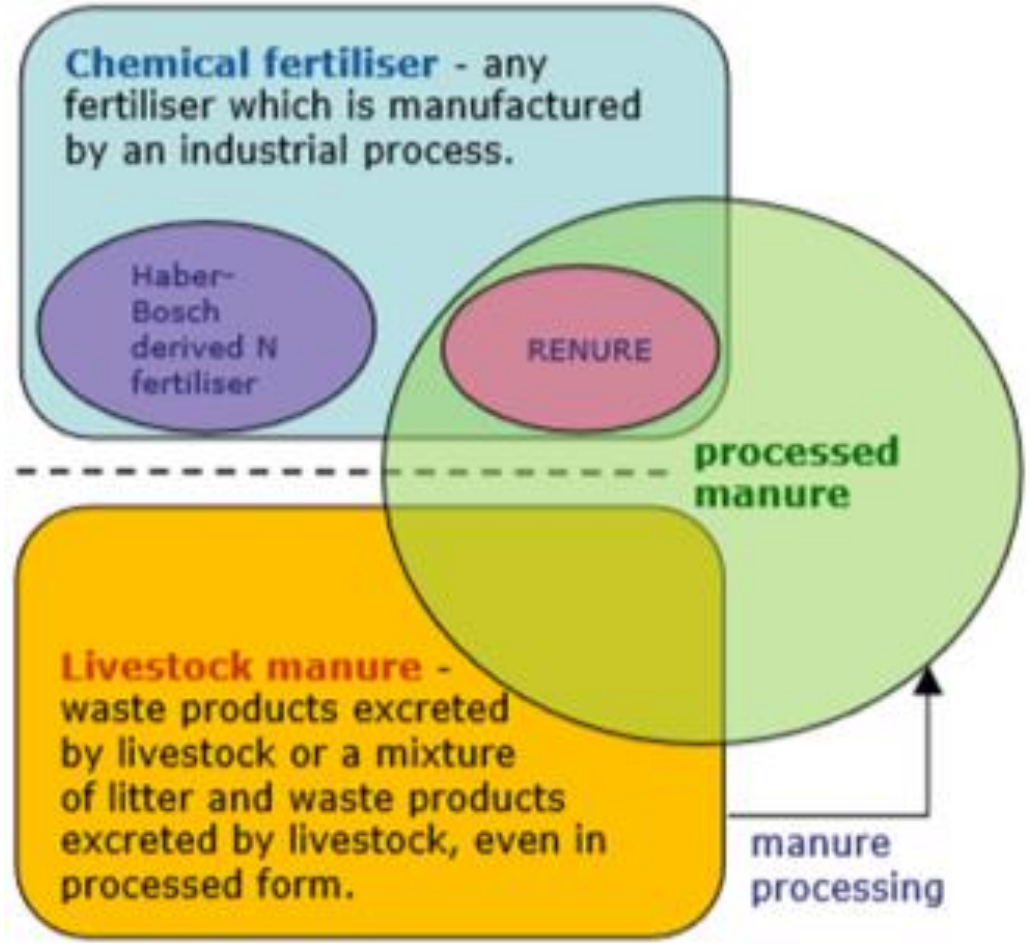
RENURE: recovered nitrogen from manure



RENURE criteria proposed by Joint Research Center (JRC):

- Minerale N /total N ratio > 90%

OR organic C /total N ratio < 3

- Zinc < 300 mg/kg dw,
- Copper < 800 mg/kg dw
- Limiting nutrient losses and ammonia emissions during storage and application steps.

Current status:

Intake of RENURE in EU regulations under discussion

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Injection of ammonium salts to reduce ammonia emissions during application

Five field trials were conducted in 2022 and 2023 with potato, maize and winter wheat.
Results indicated that the **ammonium nitrate recovered from animal manure performs as well as artificial fertilizers (urea and calcium ammonium nitrate) in terms of effectiveness and fertilizing value.**

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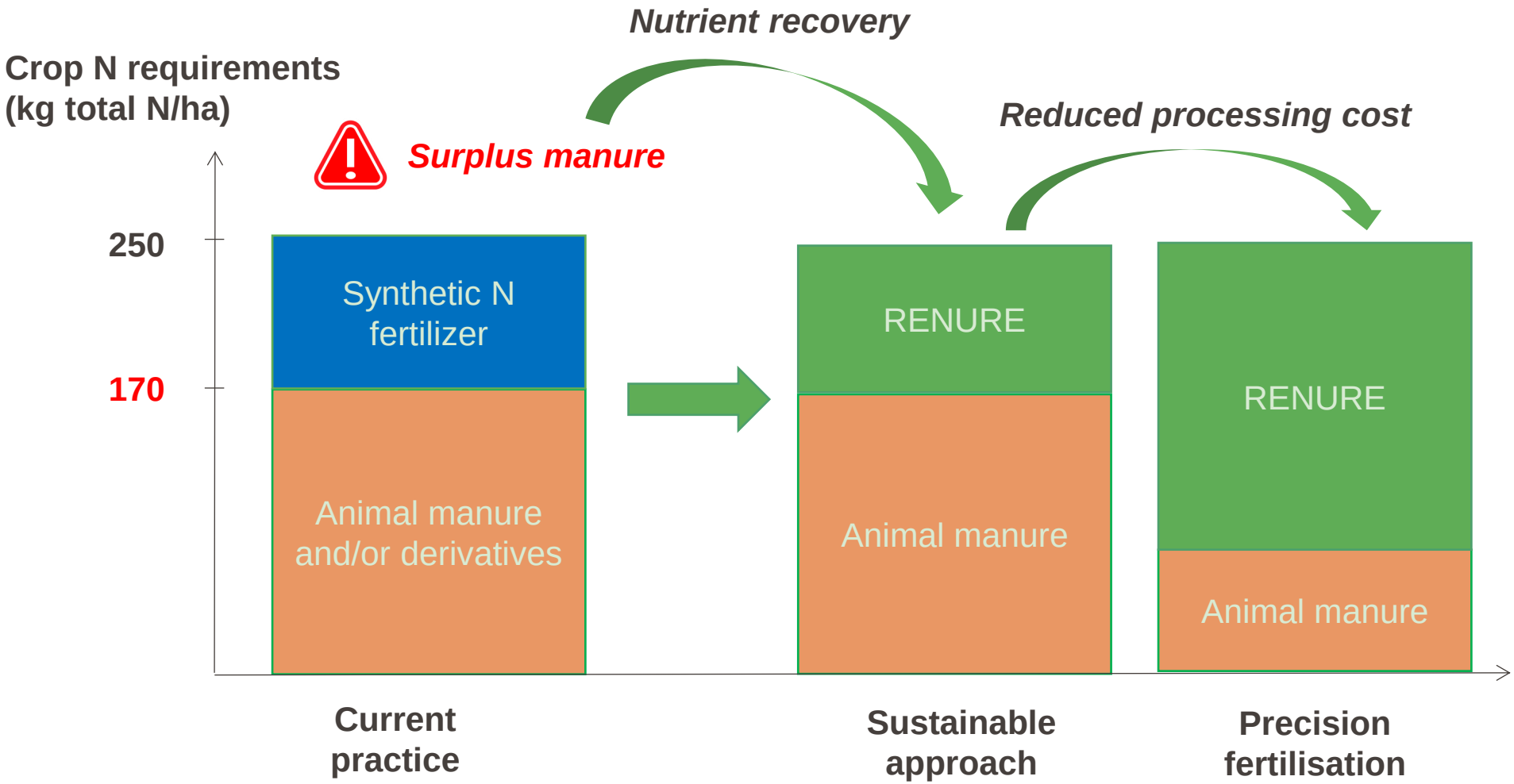
Ammonium salts as alternative fertilisers



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OG Gas Loop: an air washing system that removes ammonia from pig stables

GAS LOOP

Ammonia emissions: from a problem to a fertilizer resource

Gas Loop Goals:

- To **develop a pilot** able to clean the air and to recover ammonia from pig livestock (TRL8)
- To **reduce ammonia emissions**
- **To produce a recovered fertilizer** (ammonium sulphate solution)
- To **increase the animal and human operator welfare and productivity** due to better air quality inside the pig housing

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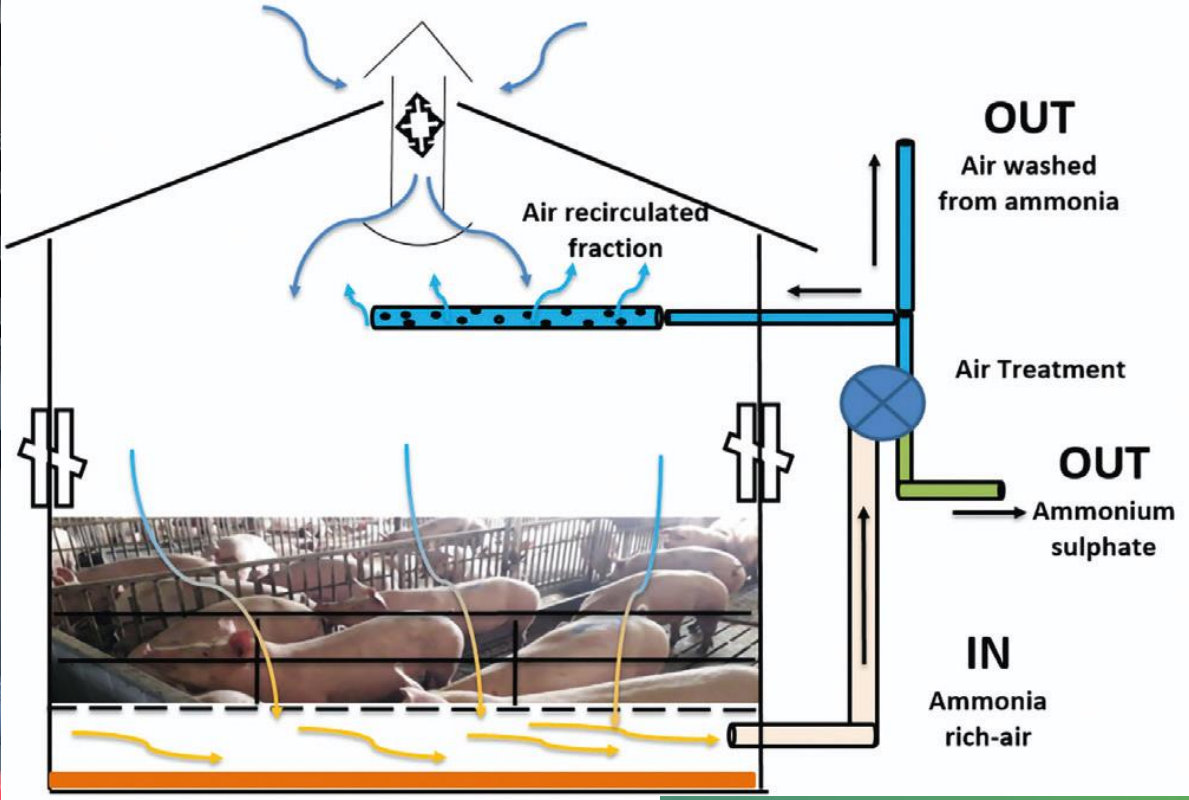
Air washing system

GAS LOOP

Fattening pig rooms for Parma Ham DPO
from 45 to 175 kg of pig weight (heavy pig)

- ✓ Air flow treated: 1800 – 2000 Nm^3/h
- ✓ process pH: 4.5
- ✓ washing acid solution of sulphuric acid (H_2SO_4)



Ammonia Washing Machine layout

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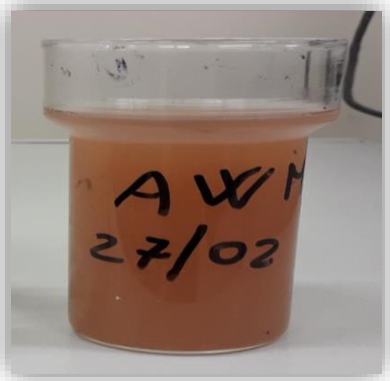
Nitrogen recovered – Ammonia emissions avoided

GAS LOOP

N recovered	14.5	Kg N/year per t live weight
Ammonia emissions avoided	17.6	Kg NH_3/year per t live weight



ammonium sulphate solution produced could complain with the European Regulation on Fertilisers (EU Regulation 2019/1009) as liquid inorganic fertiliser based on macro-nutrients N - category PFC 1(C)(I)(b)(i) as defined in Annex 1, Part II.

Chemical characterisation of ammonium sulphate solution produced		
pH	-	4.0
TKN – Total Kjeldahl Nitrogen	*% in weight*	***6.4%***
NH_4^+-N – Ammonia nitrogen form	*%TKN*	*99%*
TOC – Total Organic Carbon	*% in weight*	*1.3*
Ammonium sulphate production	*Litres/year per ton of live weight*	230
GHG reduction due to replacement of N industrial fertilizers (*)	*kg CO_2eq/year per ton of live weight*	66

(*) JRC: Giuntoli J, Agostini A, Edwards R, Marelli L, Solid and gaseous bioenergy pathways: input values and GHG emissions. Calculated according to the methodology set in COM(2016) 767, EUR 27215 EN, doi:10.2790/27486, 2017)

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Conclusions

GAS LOOP

- Air treatment with ammonia recovery as fertilizer was **technically feasible,** the system has been up to a technological maturity level equal to 8;
- In pig farm with a total live weight of 1155 t results **recoverable 16.8 t N/year**;
- N recovered in the ammonium sulphate solution could be valorized as a mineral **N fertilizer** in the pig farm or in an external trading **(Nutrient Recovery and Reuse)**;

but

The **impact on the pig production costs:**

cost increase of 7.3% for kg of meat produced (0.15-0.17 €/meat kg of live weight heavy pigs for the DPO Parma Ham chain)

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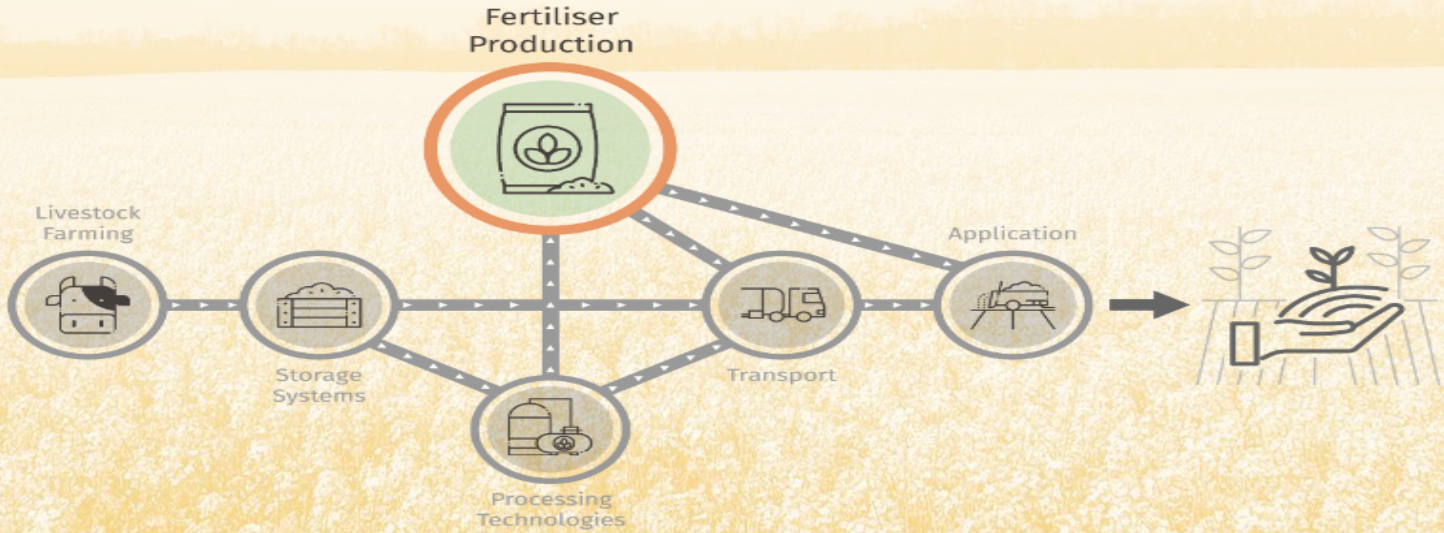
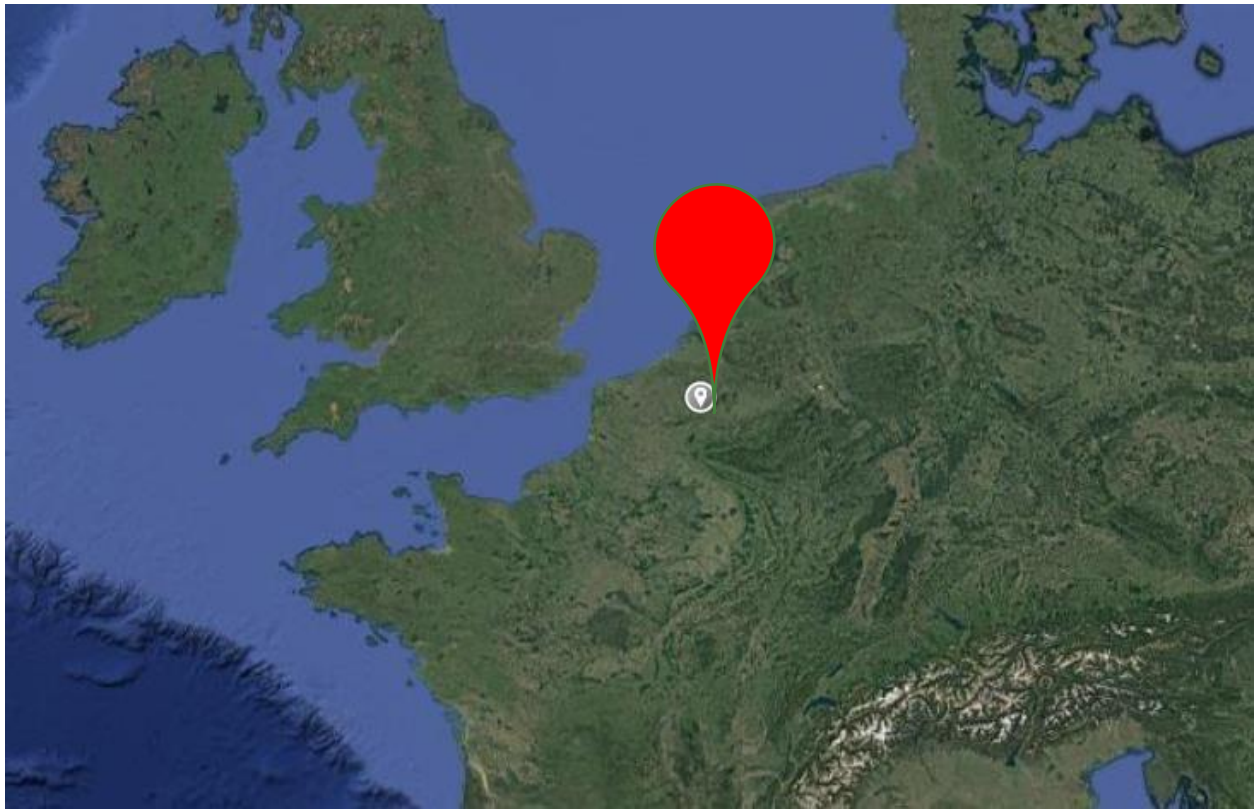


Biobased Fertiliser from Grass Juice.

Grass2Algae

- Operation group (OG) 9
- Flanders, Belgium.
- Pilot scale.



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Grass2Algae

- Low-quality grass; processing an unused resource.
- Grass juice produced is 40-60% of grass weight.
- Microalgae cultivation.
- New potential income source for farmers.

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Grass2Algae - Grass Valorisation Technology

Roadside verges

Green spaces

Field edges

Low-quality grass

40-60% of the raw weight

Separation by sedimentation and coarse filtration

Fiber fraction

Grass juice rich in nutrients

Microalgae cultivation

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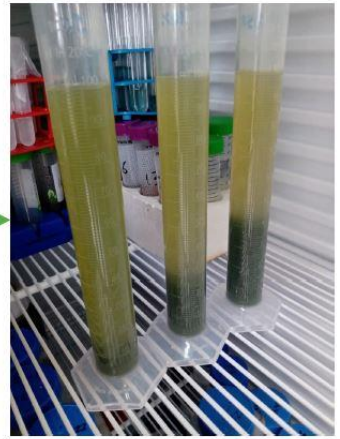
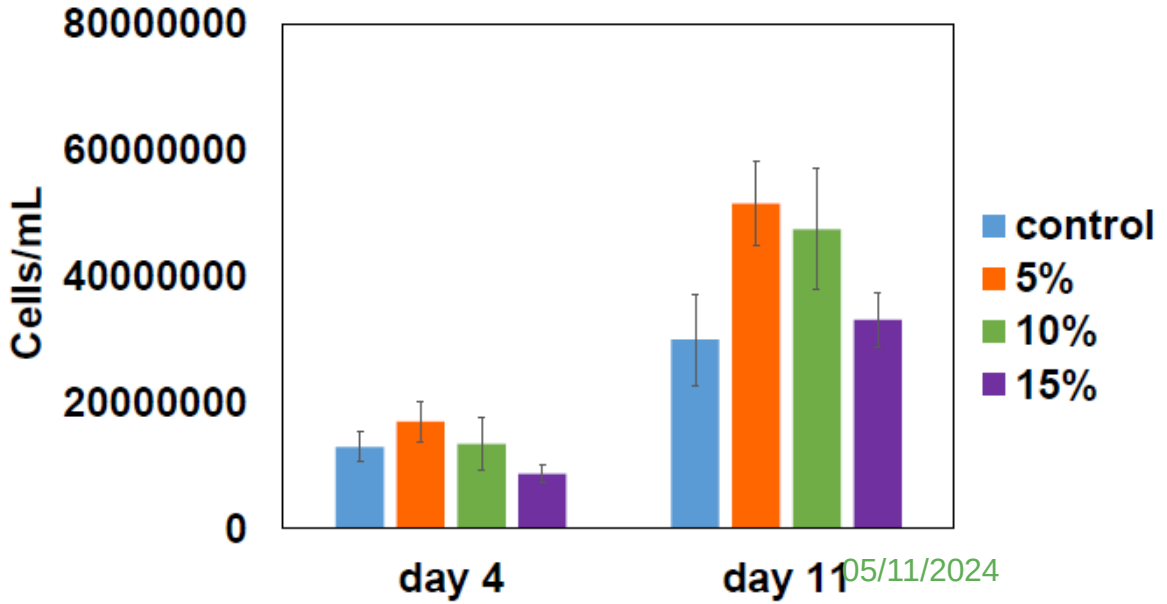
Grass2Algae - Grass Valorisation Technology

Dilution (5, 10, 15%)
+
Sedimentation
+
pH adjustment to 7



- Increased light penetration properties;
- Reduced microbial contaminants;
- Promoted good algal growth

Microalgae species *Chlorella sorokiniana* grew better on grass juice after dilution to 5 or 10% as compared to the control (mineral medium).



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Grass juice; a Biobased Fertiliser.

Lab scale

- Grass juice is rich in macro and micronutrients
- Bio based fertiliser for algae production.
- Algae quality is up to specifications for animal & human food application.
- Algae biomass contains 41% protein.
- New income source for farmers.

Pilot scale

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Biorefinery Glas

- Operation group (OG) 10
- South West Ireland.
- Pilot scale.

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Biorefinery Glas

BIOREFINERY GLAS

- Processes grass into four products.
- Refines unused protein.
- 50% into press cake.

- + 40% usable Pr/Ha.
- N and P losses -25%.

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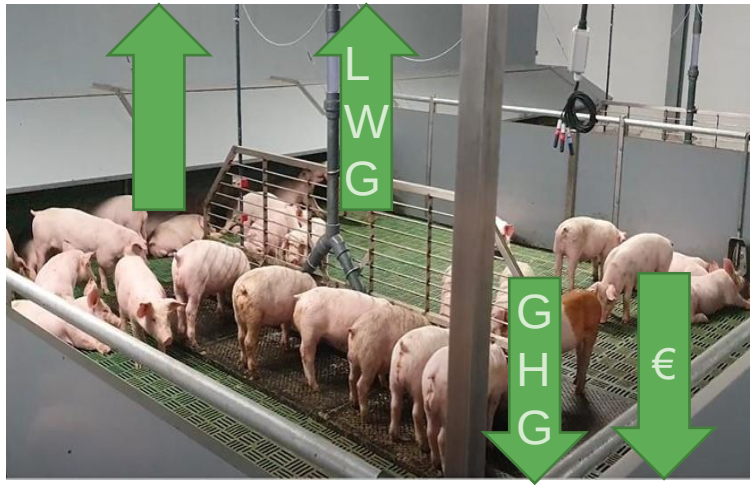
BIOREFINERY
GLAS



Product Streams

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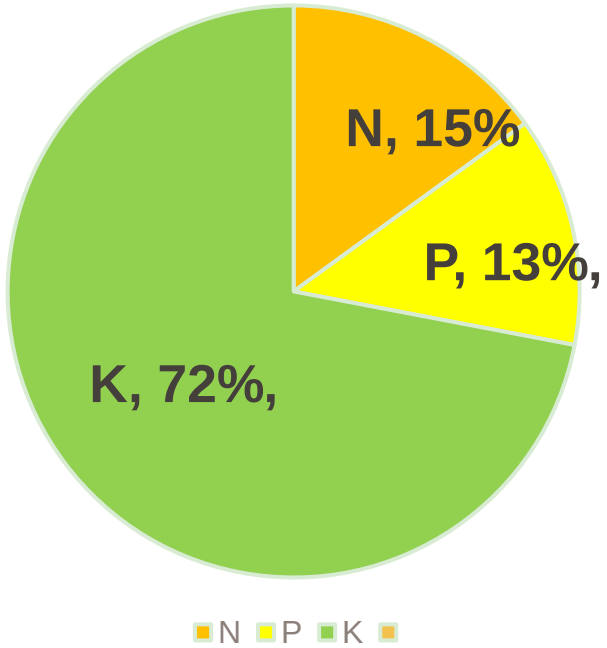
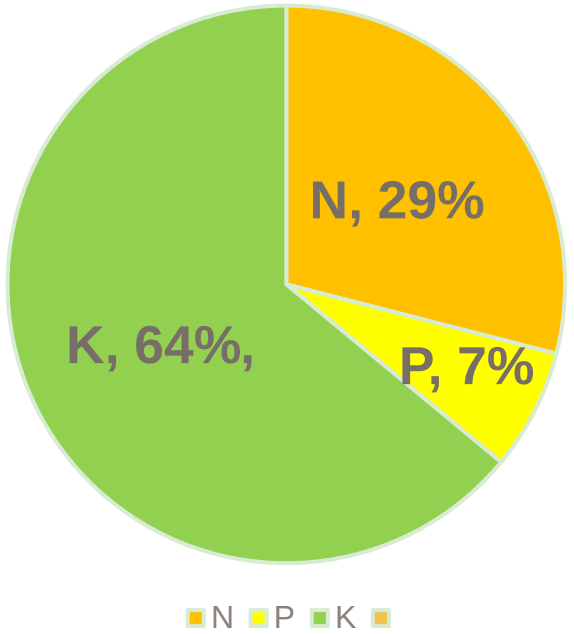
Grass Whey; a Biobased Fertiliser.

Slurry



Grass Whey.



Nutrient content Kg/M^3 (Units/1000 Gallons)

	N	P	K
Slurry	0.7 (6.5)	0.6 (5)	3.3 (30)
Grass Whey	1.8 (16)	0.45 (4.05)	4.05 (36.45)

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Grass2ALgae & Biorefinery Glas

- Scale.
- ROI? 3 vs 7 years.
- Employment potential HA * 10%
- Importance of high value streams.

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Q&A

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November 19: Storage Systems