Nutrient recovery at large scale demoplants

NBV Webinar Towards agricultural circularity for nitrogen

10 July 2020, Inge Regelink (Inge.Regelink@wur.nl)

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Content

- Intro: Nutrient balances, manure surplus
- Nutrient recovery technologies at demonstration plants
- Life Cycle Assesment and Environmental Impact

Circular Agriculture

Goal:

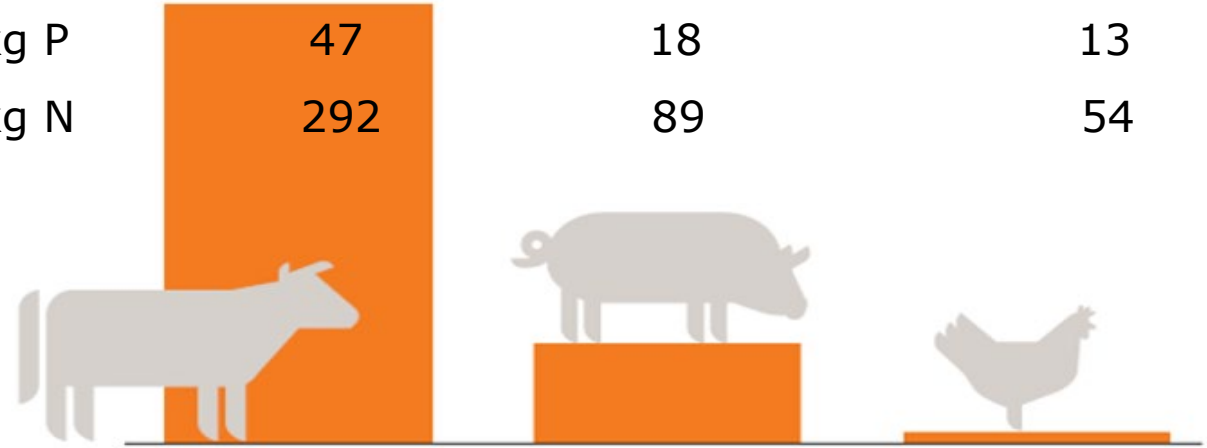
- Lower emissions to soil, water and atmosphere

Measures:

- Reduce the use of non-renewable fertilizers (P) and fertilizers produced by means of fossil energy (N, Haber Bosch proces)
- Manure and other organic waste streams as fertilizer

Manure surplus in The Netherlands

Production	Cattle	Pigs	Poultry
Million kg P	47	18	13
Million kg N	292	89	54



Surplus			
% obv P	6%	37%	100%

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Unexploited sources of nutrients

Use of synthetic fertiliser: 230 million kg N and 5 million kg P

Surplus pig manure
N: 18 million kg
P_2O_5: 12 million kg
Export

Waste water
N: 94 million kg
P_2O_5: 31 million kg
(18 kg N in sewage sludge)

Nitrification/denitrification, incineration of sludge.

Poultry manure
N: 47 million kg
P_2O_5: 26 million kg
Export and incineration

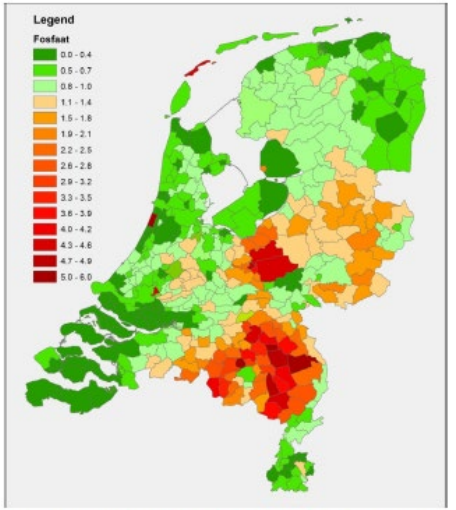
Organic waste
N: 90 million kg
P_2O_5: 30 million kg
Ends up in residual waste and is incinerated

Application rate limits

- Limit for total P
- Limit for N from animal manure (170 or 230/250 kg N/ha)
- Limit for N (effective N from manure and other fertilizer)

Separation of N-NH4, N-org and P (and OC, K, S)

Nutrient ratio in biobased fertilisers should be adjusted to meet crop demand



Figuur 12 Illustratie van de druk op de mestmarkt op gemeenteniveau i

Nutrient recovery in practice: Demoplants

- BENAS (Germany) : Recovery of ammonium sulphate
- Groot Zevert (Netherlands): Recovery of NK concentrate
- AmPower (Belgium): Solid and liquid NPK fertiliser

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Circular solutions for biowaste

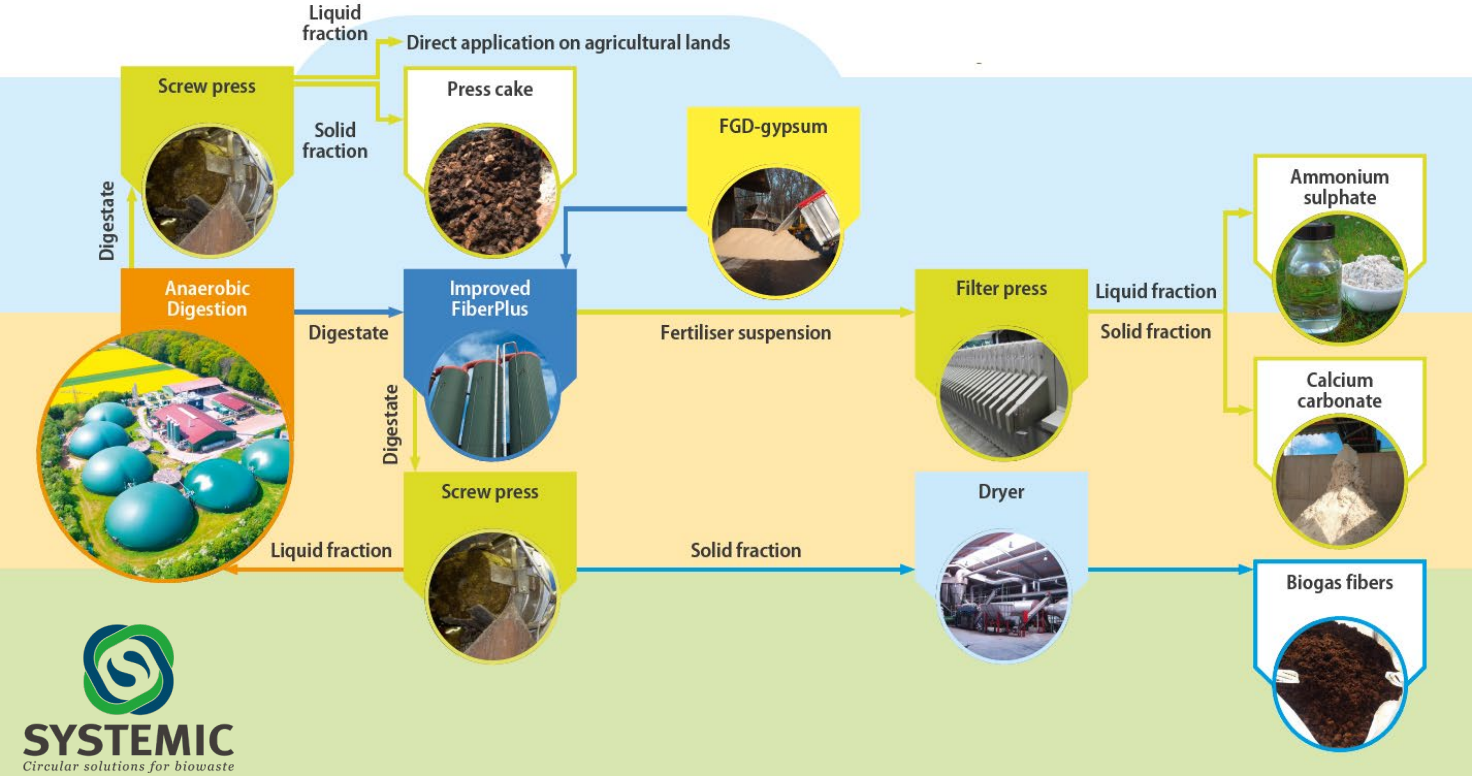
www.systemicproject.eu
2017 til Nov-2021

BENAS (DE): N stripping

Feedstock: Maize sillage and poultry manure

Energy: Biogas is converted in electricity.

Residual heat is used on-site in the N stirpper



Products:

- Ammonium-sulphate
- Low-N digestate
- Low-N fibres

€€ 10% more biogas, sell of AmS, less transport liquid digestate

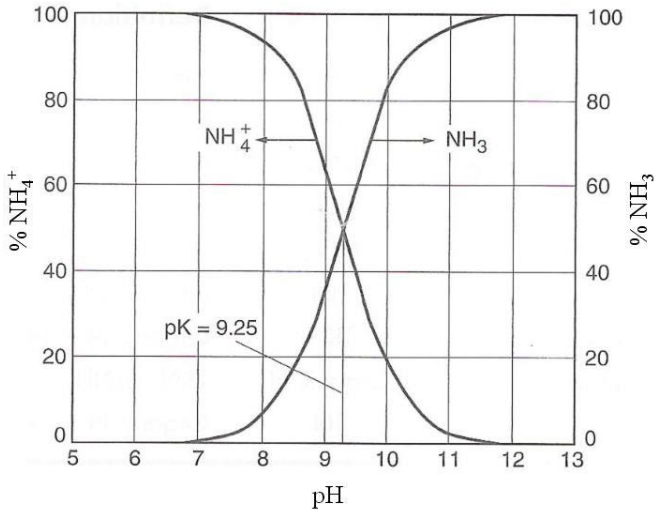
SYSTEMIC
Circular solutions for biowaste

N stripping and recovery as AmS

- Residual heat to increase temperature to speed up ammonia volatilization
- NH_3 – CO_2 equilibrium controls pH
- Usually, ammonia is recovered by sulphuric acid

$NH_4 \rightarrow NH_3 + H^+$

$HCO_3 + H^+ \rightarrow CO_2 + H_2O$



N stripping and recovery as AmS

- Temperature increase to speed up ammonia volatilization
- NH_3 – CO_2 equilibrium controls pH
- BENAS implemented new proces to recovery ammonia with gypsum (waste product from industry)

$2NH_3 + CO_2 + H_2O + CaSO_4 \rightarrow NH_4SO_4\ (l) + CaCO_3\ (s)$

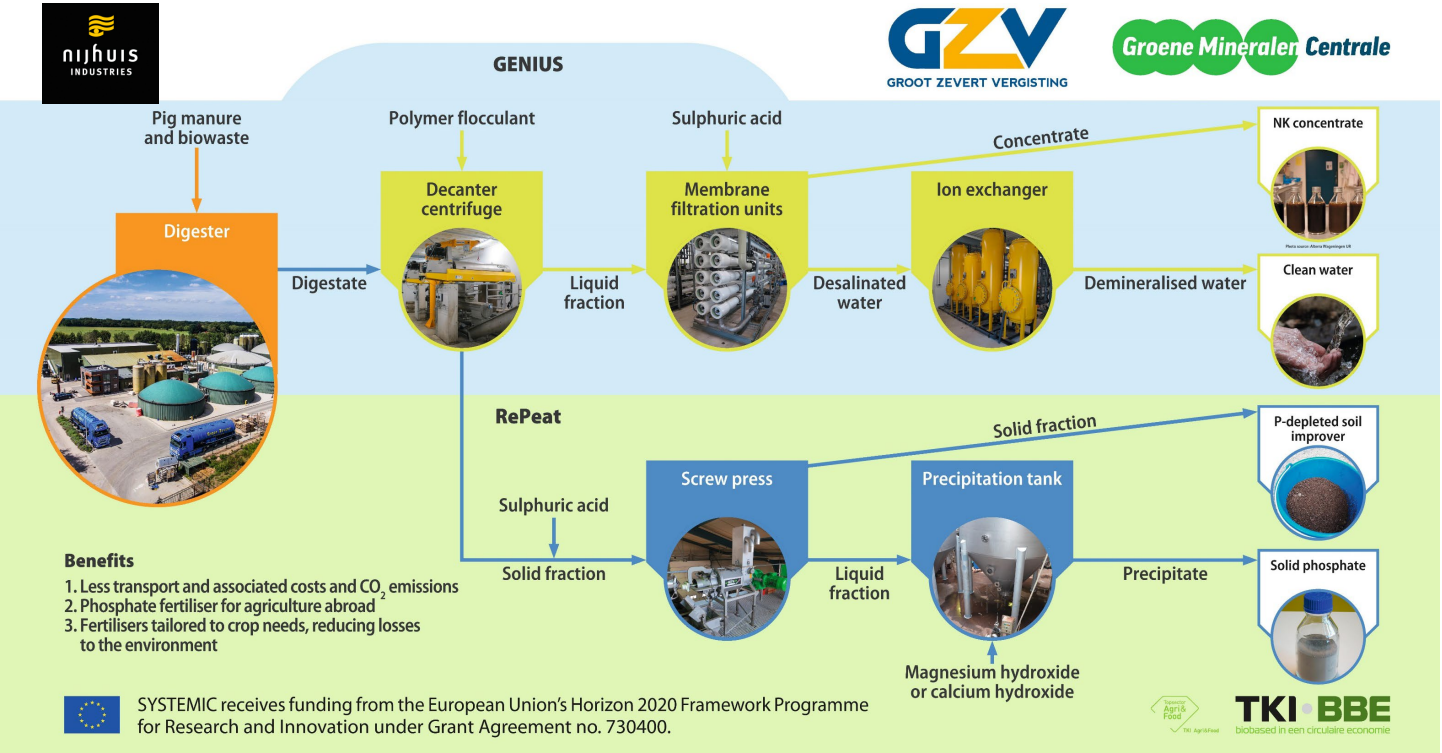
Products: Liquid Ammoniumsulphate and solid calcium carbonate

Time for a five-minute break!

Groot Zevert Vergisting, Netherlands

Feedstock: Pig manure and co-products

Energy: Biogas to nearby dairy factory



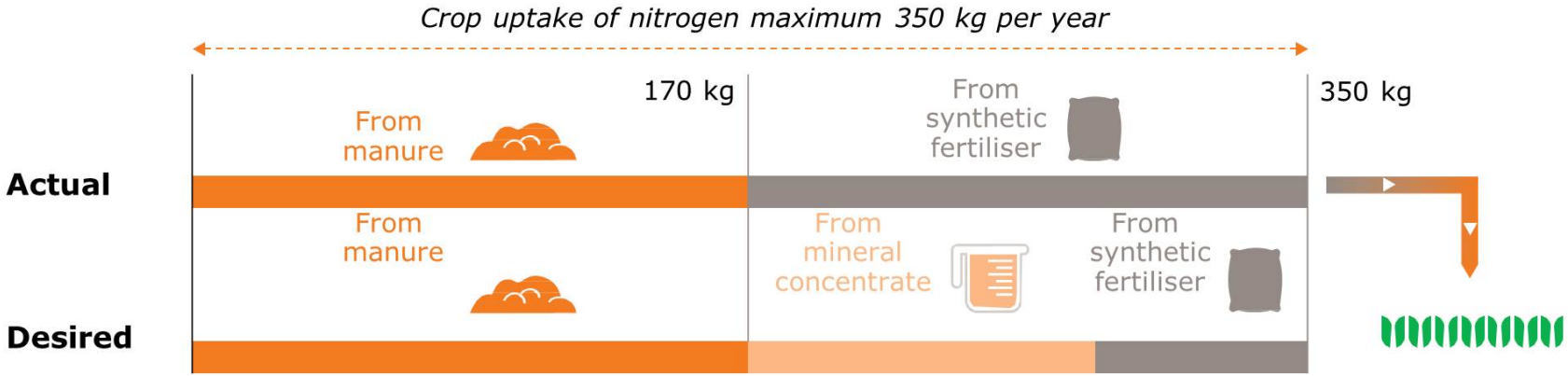
Products:

- NK concentrate
- Solid fraction
- P-fertiliser
- Low-P organic matter
- Water

- NK fertiliser as alternative for synthetic N
- Less transport, lower costs

RENURE products

Desired utilisation of nitrogen by source in kg N/ha, per year



JRC advice End-of-Manure status for recovered products with >90% N-NH_4/N

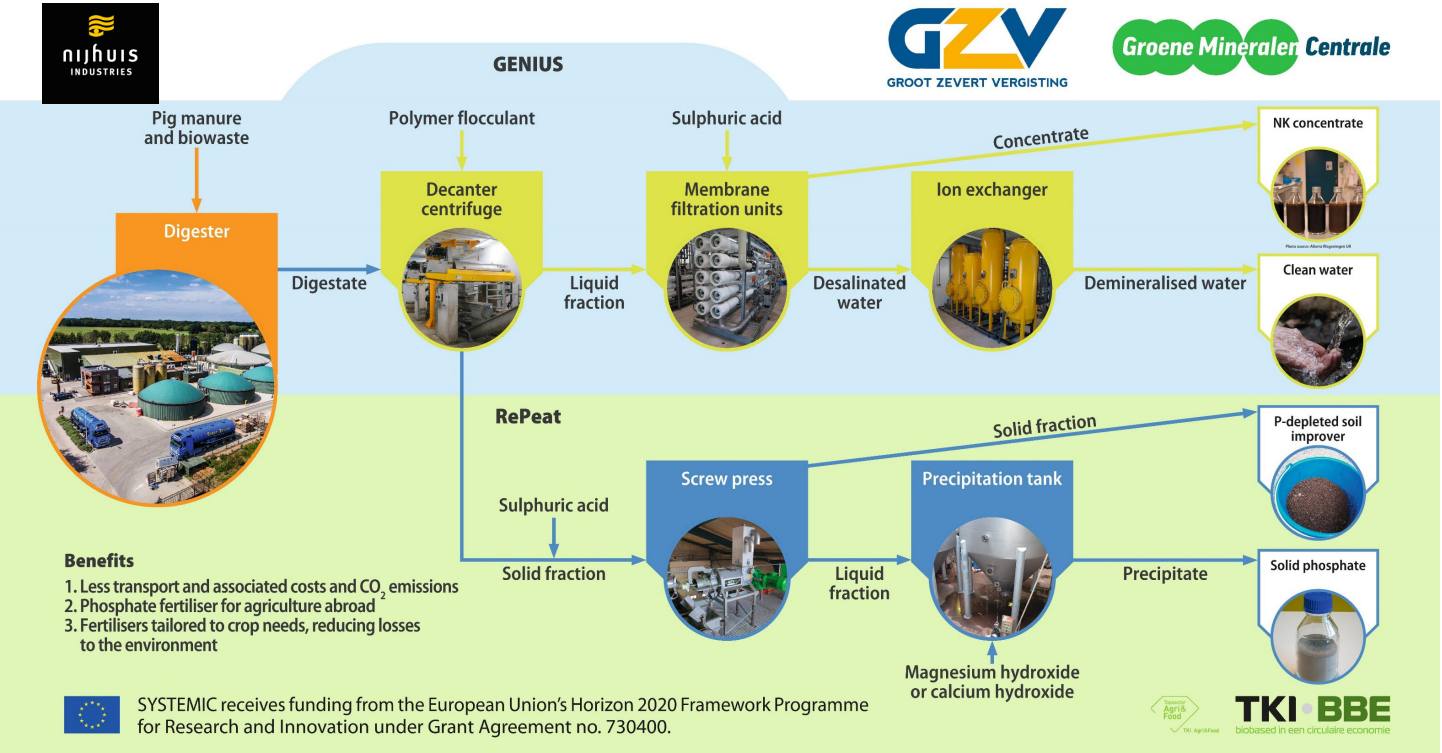
Demo trials

- Biobased Fertilisers Achterhoek:
  - Blends of NK concentrate with ammonium sulphate and urea,
  - low-emission injection to reduce emissions
  - Monitoring of crop uptake and nitrate leaching

Groot Zevert Vergisting, Netherlands

Feedstock: Pig manure and co-products

Energy: Biogas to nearby dairy factory



Products:

- NK concentrate
- Solid fraction
- P-fertiliser
- Low-P organic matter
- Water

- NK fertiliser as alternative for synthetic N
- Less transport, lower costs

Separation of phosphorus and organic matter

- Export of P-rich solid fraction expensive
- Now treated with sulphuric acid to leach out phosphate (>80% removed)
- Phosphate recovery with calciumhydroxide
- Low-P soil improver or peat replacer

Development of new markets for end products

- Low-nutrient organic fibres as alternative for peat in potting soil (GZV and Benas)
- Sustainable alternatives for excavation of peat
- Criteria on structure, smell, pH, salt, stability, nutrients, contaminants,.. Etc
- Additional leaching required to reduce salt (EC)
- High market value

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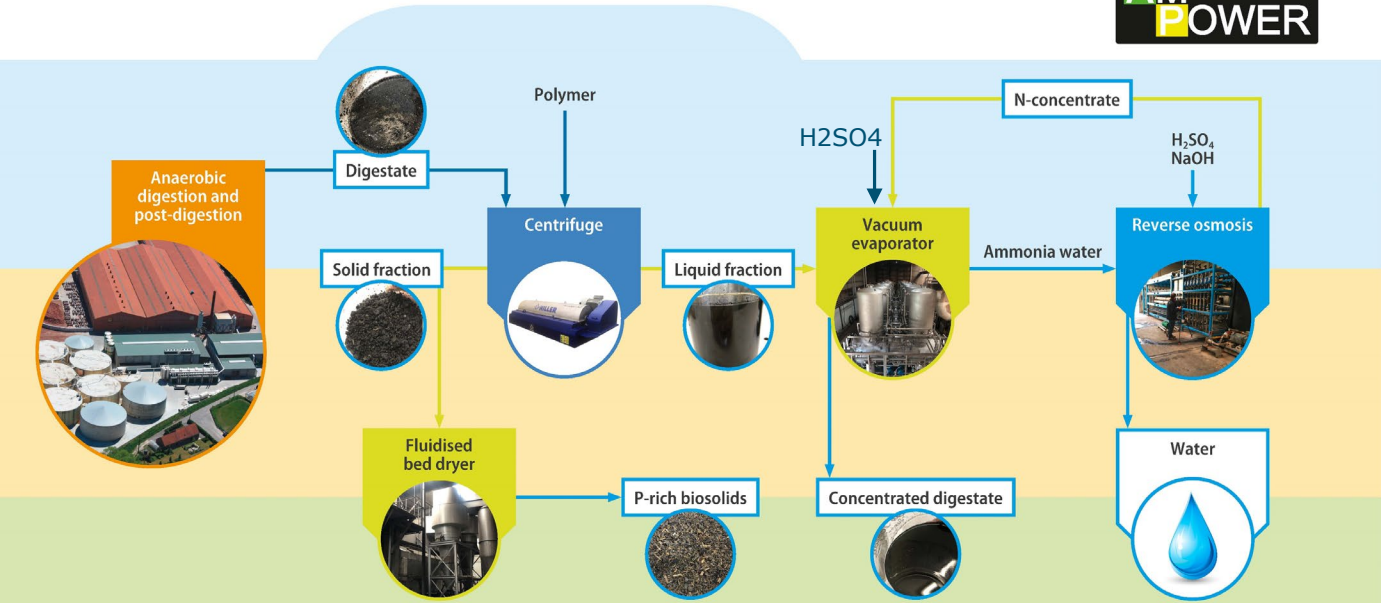
AmPower: Biogas and organic fertiliser from biowaste

Feedstock: Organic residues agri-industry and households (no manure)

Energy: Biogas converted into electricity. Waste heat used in dryer and evaporator



Products:

- Dried organic fertiliser
- Concentrated liquid NPK fertilizer

Business case: Reduce volume and hence costs for long-distance transport

SYSTEMIC receives funding from the European Union's Horizon 2020 Framework Programme for Research and Innovation under Grant Agreement no. 730400.

Environmental Impact Assesment

- Agronomic efficiency (P availability, N mineralisation, NUE)
- Determine emissions of NH_4 and N_2O from biobased N fertiliser
- Heavy metals, 'emerging' pollutants

		EF (% mineral N)
Manure	Shallow injection grassland	16
Ammonium sulphate		11
KAS (calcium ammonium nitrate)		2.4
DAP (diammonium phosphate)		7.4

Source: National emission model for agriculture (NEMA) - 2019

Pot experiment with struvite and DAP

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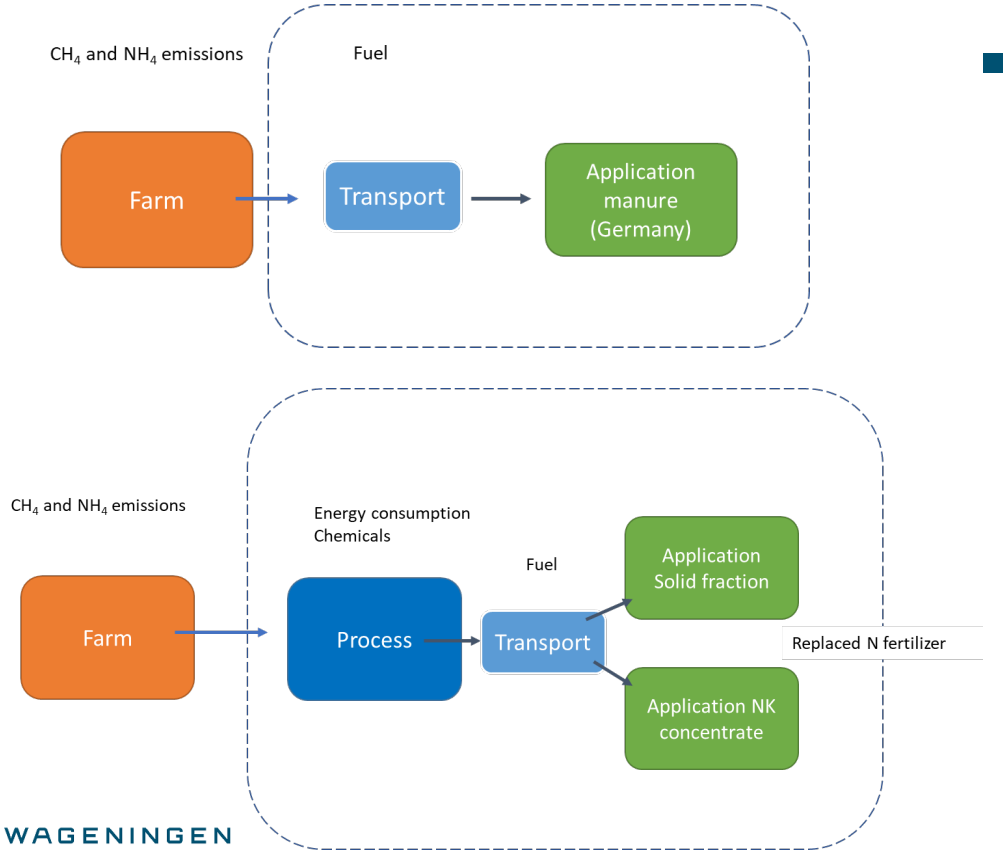
Life Cycle Analysis (LCA)

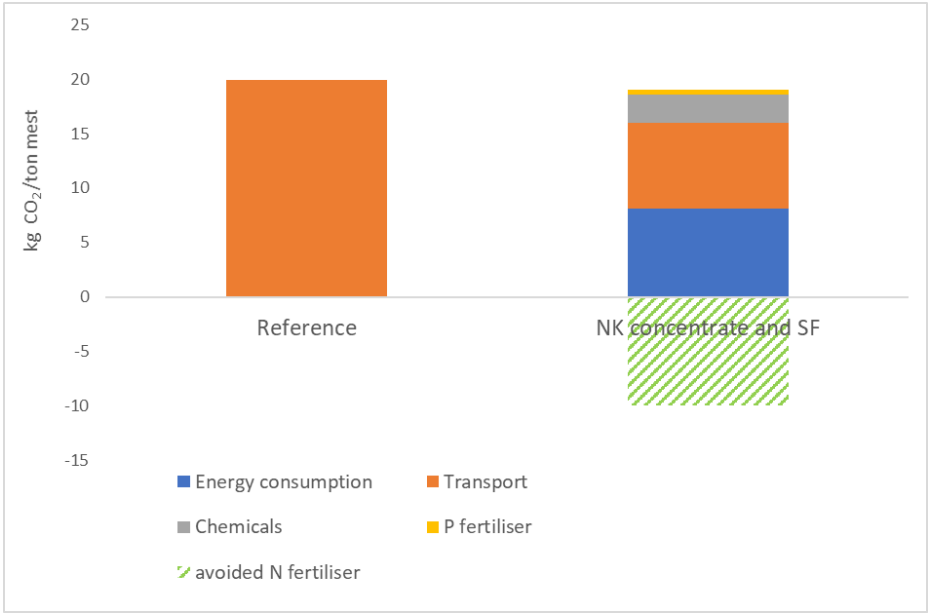
- Overall effect on greenhouse gas emissions (CO_2, N_2O, CH_4)
- Phosphorus is non-renewable
- Nitrogen is abudantly available: GHG emissions of recovery process should be lower than Haber-Bosch process
- Nutrient recovery compared with a reference scenario

Life Cycle Analysis



- Example LCA for NK concentrates from pig manure (no digestion)

Example LCA: NK concentrate from pig manure



- Example NK production from pig manure (no anaerobic digestion)
- Electricity consumption outweights reduction in transport
- But, methane emissions from manure storage on farm (not included) exceed overall emissions of treatment
- Prevention of CH_4 emissions from manure/products should have priority

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- Sources of nutrients: Manure, waste water and organic waste
- Upscaling of nutrient recovery requires positive business case
- Assessment of environmental impact and effects on GHG emissions

More Info

www.systemicproject.eu

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