



Nutrient recycling by combining renewable energy production and biorefinery on a farm scale

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Research Question

How is nutrient recycling improved by combining agricultural farming with small scale biorefinery units?

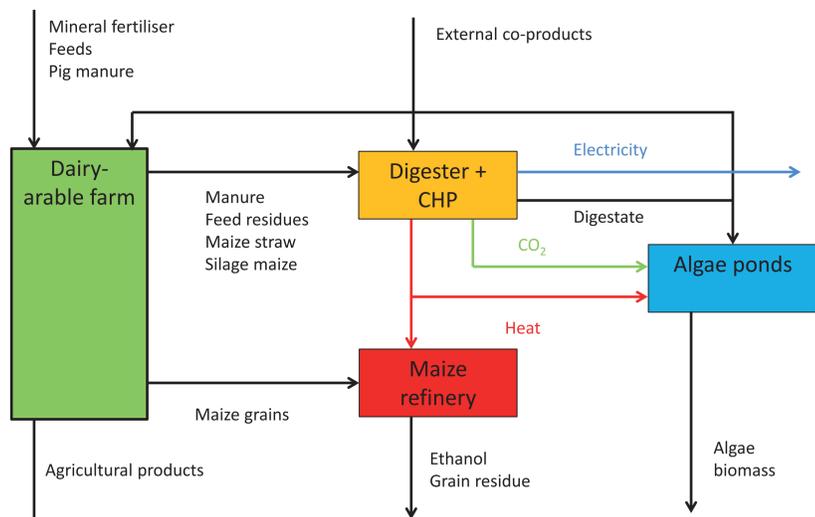
Approach

Modelstudy to support current pilot in Lelystad (The Netherlands) started in 2010.

Description pilot Lelystad:

- Mixed dairy-arable farm + Biorefinery units: Co-digester, Maize refinery plant, Algae ponds
- Basis principle:
 - Maximum utilization waste streams (heat, CO₂, manure, crop residues)
 - Farm scale processing of biomass

Figure 1: System setup biorefinery pilot Lelystad



In the modelstudy three scenarios with biorefinery were compared with a reference situation without biorefinery.

Scenario	Farm	Digester + CHP	Algae ponds	Maize refinery
REF	+			
ALG	+	+	+	
MAI	+	+		+
ALG+MAI	+	+	+	+

System size

- Dairy-arable farm with 200 cows and 330 ha agricultural land
- All produced manure is digested (50% manure + 50% co-substrates)
- Size of maize refinery and algae ponds depends on available heat from CHP

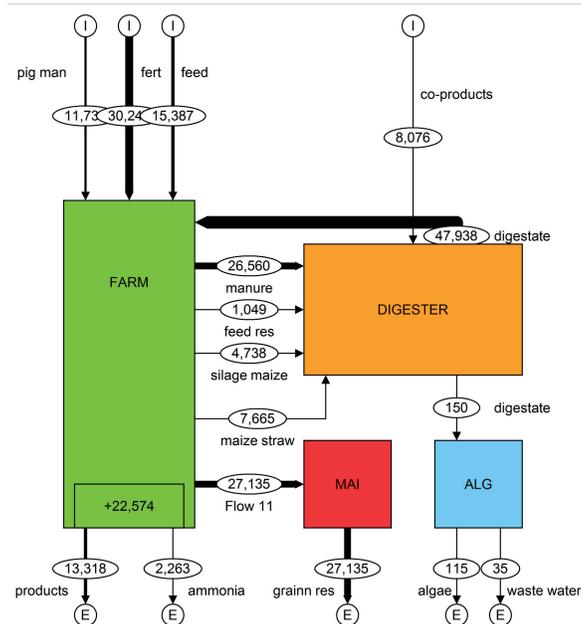
Table 1: Scale level of the different scenarios

Scenario:	ALG	MAI	ALG + MAI
Milking cows, number	200	200	200
Agricultural land, ha	330	330	330
Digester, ton/year			
Manure	6070	6070	6070
Co-products	6070	6070	6070
Algae ponds, m²	2000		1000
Maize refinery, m³ Ethanol-60/year	0	935	935

Results

- Only a small fraction of the digestate is necessary to meet nutrient demand of the algae ponds
- Nitrogen balance:
 - No difference in surplus between biorefinery scenarios but considerable differences between inputs and outputs
 - N surplus: Biorefinery < REF (-10 kg N/ha)
 - N fertiliser demand: Biorefinery < REF (-25-50 kg N/ha)

Figure 2: Nitrogen flows (kg) scenario ALG+MAI



Scenario:	ALG	MAI	ALG + MAI	REF
Surplus, kg N/ha	76	75	75	86
Mineral fertiliser, kg N/ha	119	91	92	143

Conclusion

Introduction of biorefinery on a farm scale level can have varying effects on nutrient management, but can be designed to improve nutrient recycling.