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From Waste to Resource: Optimizing Phosphorus and Methane Recovery from Cattle Manure

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Motivation

Phosphorus (P) is typically sourced from non-renewable phosphate rock, and its uncontrolled release causes environmental issues like eutrophication. Animal manure is the largest secondary source of P which can be recovered and reused.[1] The Netherlands produces 74 million tons of animal manure annually, of which 61.2 million tons come from cattle as represented in Fig. 1.[2]

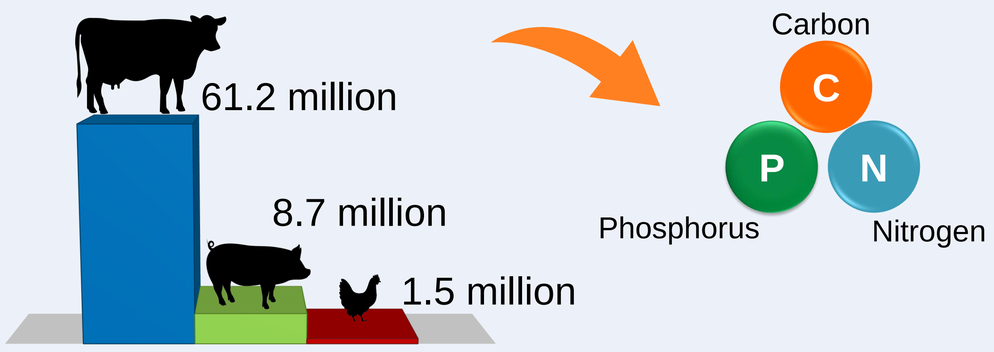

Fig. 1. Manure production in the Netherlands (tons per year) [2]

Therefore, it is crucial to focus on the recovery of P from sources such as cattle manure to prevent the depletion of natural reserves. This project aims to develop a technology that simultaneously recovers calcium phosphate (CaP) and methane (CH_4) within the same reactor. The recovered CaP can be used as fertilizer, while the CH_4 can be an energy source on the farm. The goal is to design a sustainable system that reuses the resources in the manure for on-farm use by using natural principles and the microorganisms already present in cattle manure (Fig. 2).

Technological challenge

Recovering phosphorus (P) from manure presents several interconnected challenges. Limited reactive P availability and high inorganic carbon levels hinder calcium phosphate (CaP) formation, as calcium binds with carbonates to form $CaCO_3$ instead.[3] Additionally, the high solids content in manure complicates mixing, disrupting the distribution of P and C needed for effective recovery of both P and CH_4. The requirement for external calcium further adds complexity, posing practical limitations for scaling the process. Addressing these challenges requires integrated strategies that optimize recovery efficiency while ensuring compliance with regulatory standards for the recovered products.

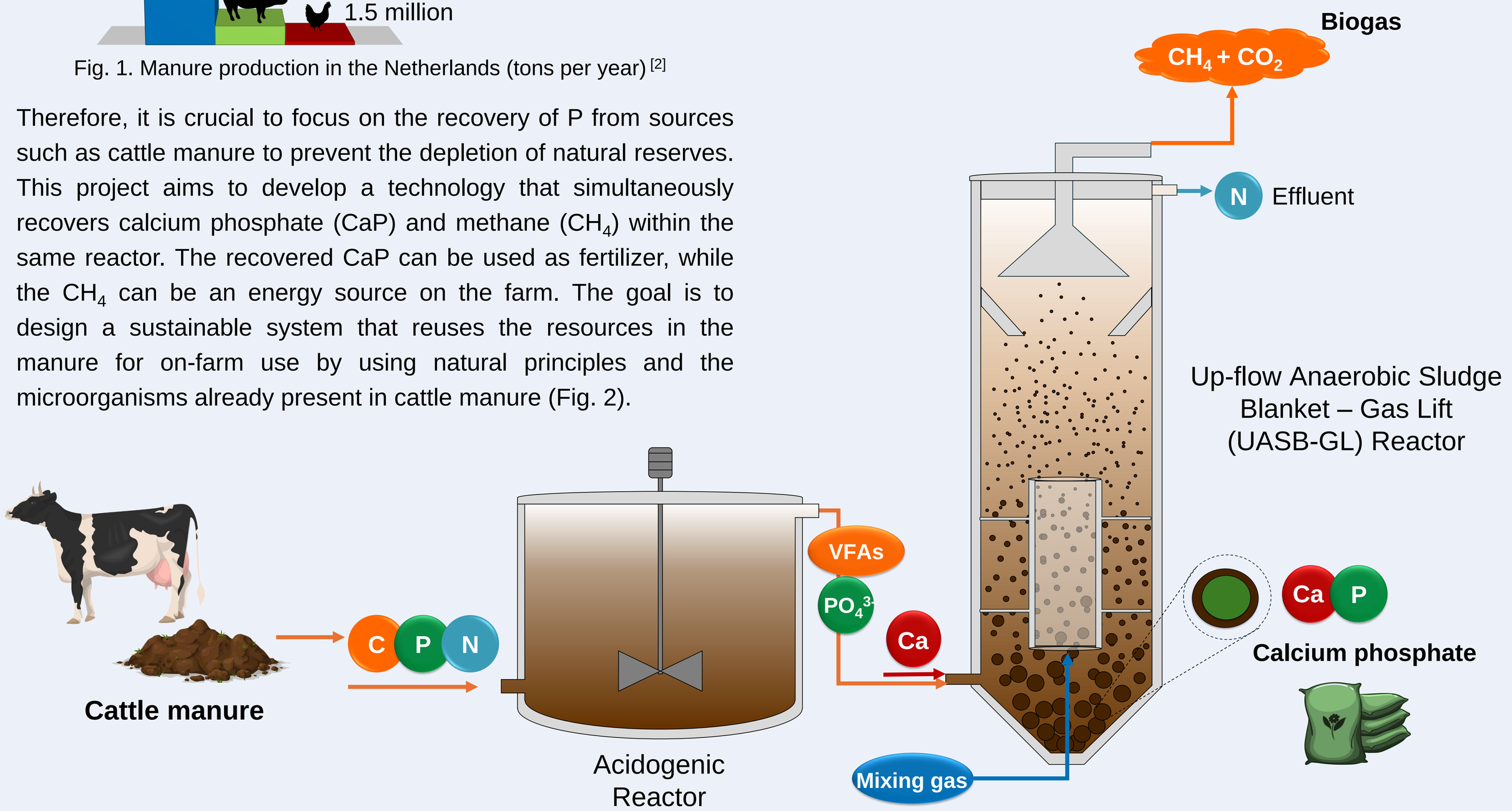

Fig. 2. Proposed phosphorus and methane recovery system

Research goals

- Enhancing technology for efficient P and CH_4 recovery from cattle manure by using natural principles and the microorganisms already present in cattle manure.
- Developing strategies to tackle limited P availability and high inorganic carbon simultaneously.
- Boosting the efficiency and sustainability of manure management through advanced recovery technologies, contributing to better nutrient recycling and waste treatment practices.

References

[1] D. Cordell, and S. White,, Agronomy 3(1) (2013) 86-116. CBS
[2] Statline, Livestock on agricultural holdings, (2023).
[3] C. Schott. et al., Chemical Engineering Journal 460 (2023)

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