

Recovery of phosphorus from animal manure



Chris Schott

chris.schott@wetsus.nl

Motivation

Phosphorus (P) is essential for life on earth due to its various functions in growth and energy mechanisms of fauna and flora. However, the natural reserves of P are diminishing in quality and quantity. To ensure future food security, P needs to be recovered from waste streams [1].

In The Netherlands, 71 million kg of P are annually generated mainly as cattle and pig manure. To prevent run off and consequent eutrophication, the agricultural applicability of animal manure is limited. Therefore, its surplus is incinerated or transported at high economic and environmental costs to other countries [2,3].

This project aims to design a sustainable biotechnological process which enables the recovery of phosphorus as concentrated calcium phosphate granules (Figure 1) from thin manure. The separation of nutrients allows more nutrient specific and predictable crop fertilization than spreading raw animal manure. This approach increases the value of animal manure and stimulates circular agriculture.

Technological challenge

In animal manure, P is barely abundant as soluble PO_4^{3-} and the concentration of solids and organic matter is high. Therefore, calcium phosphate granulation is not occurring by simply adding calcium as previously demonstrated for black water treatment [4].

Releasing P into solution requires an understanding of how P occurs in animal manure. The phase in which P is present in cow and pig manure as well as various pre treatments to release P into solution will be investigated so that in the main reactor calcium phosphate may granulate.

After enabling calcium phosphate granulation, the collection from the reactor requires optimization. The recovered products need to be suitable for direct use in agriculture or for processing in the fertilizer industry.

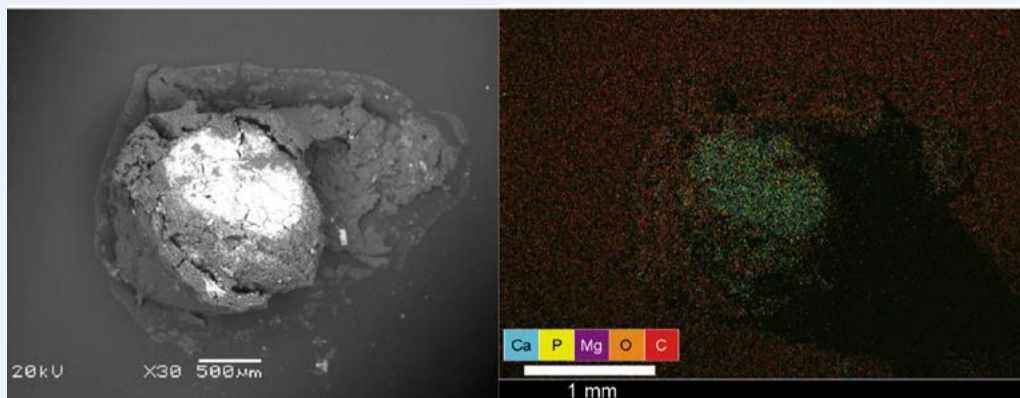
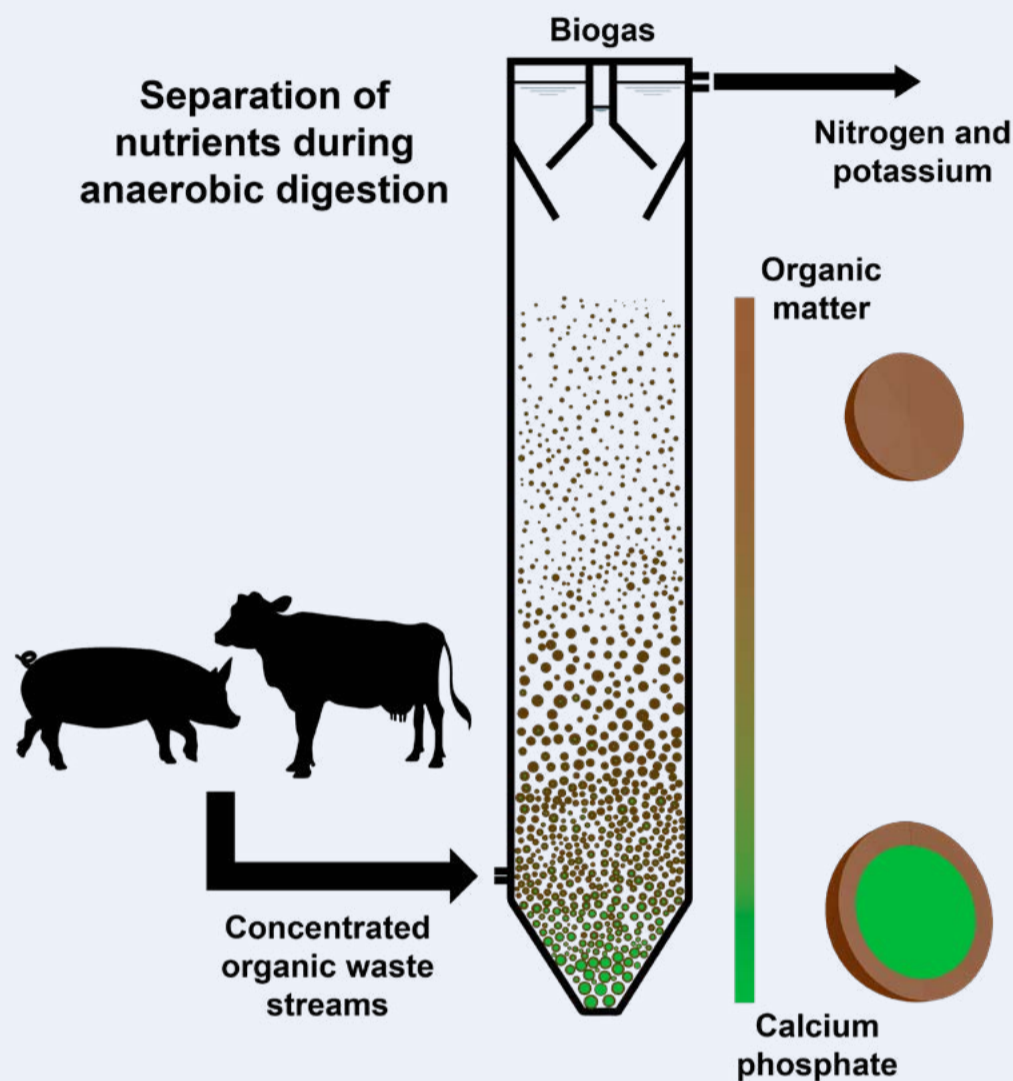


Fig 1. Scanning electron microscope (SEM, left) and electron dispersive x-ray (EDX, right) image of a calcium phosphate granule with an inorganic core consisting of calcium phosphate (EDX green) [4].



Research goals

- Characterizing cow and pig manure and specifically the P speciation
- Stimulating calcium phosphate granulation by increasing the ionic activity of PO_4^{3-}
- Optimizing bioreactor design for recovery of calcium phosphate granules
- Characterizing the products based on their composition, fertilizing performance and applicability

References

- [1] Cordell et al. (2009). "The story of phosphorus: Global food security and food for thought." *Global Environmental Change*, 19(2): 292-305.
- [2] Sommer et al. (2013), "Animal manure recycling; Treatment and management", Wiley
- [3] Wageningen UR Livestock Research (2014), "Manure – A valuable resource"
- [4] Cunha et al. (2018), "Calcium addition to increase the production of phosphate granules in anaerobic treatment of black water.", *Water Research*, 130: 333-42