

## Cost-benefit analysis of the use of recycled nutrients

This is a three-part analysis of the costs and benefits associated with recycling nutrients in agriculture and aquaculture in Norway. The analyses will be done as a part of the research project “Nutrients in a circular Bioeconomy: Barriers & opportunities for MINeral Phosphorus INdependence in Norway (MIND-P)”, led by Programme of Industrial Ecology at NTNU. The project starts up in October 2017 and ends in October 2020.

MIND-P aims to analyze pathways towards independence from mineral P fertilizer use through improved recycling with a focus on manure and fish sludge. However, there may be both economic barriers and opportunities associated with such recycling, and the analyses outlined here will look into this.

Secondary P products need to be cost-competitive with primary products. Technologies for secondary resource collection, treatment, and handling result in investment and operation costs that need to be balanced with the benefits of increased value creation. The potential secondary products should be able to replace primary products already in the market. However, secondary products may introduce added value as well as disadvantages compared to the conventional primary products (e.g., a manure based secondary fertilizer product may contain valuable organic carbon in addition to nutrients that the farmer cannot get through primary mineral fertilizer, but a secondary product may also contain heavy metals, which are perceived negatively).

The cost-benefit analyses will be conducted of i) fish sludge as secondary fertilizer, ii) manure as secondary fertilizer, and iii) IMTA<sup>1</sup>. The analyses should include transportation costs, capital investments and operations costs to compare with benefits and determine which alternative products have an acceptable return:

- i) Conduct a cost-benefit analysis for collecting, treating, transporting, and applying fish sludge as secondary fertilizer: Lerøy will advise and provide data on costs.
- ii) Conduct a cost-benefit analysis for collecting, treating, transporting, and applying manure as a secondary fertilizer: Promising technologies identified by literature will be analyzed in dialogue with Foss Gård, Norsk Naturgjødsel, and Landbruksdirektoratet.
- iii) Conduct a cost-benefit analysis of IMTA systems based on findings from other parts of the project, in collaboration with NTNU Biology and DTU (Technical University of Denmark).

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<sup>1</sup> Integrated multitrophic aquaculture production