Collaboration and biomass circularity at landscape scale potentially lowers greenhouse gas emissions and nitrogen losses

- An example on the coupling of biogas and biorefineries in Denmark

Introduction

Farms and farming systems in North and Western Europe are generally highly specialised, with little integration between crop and livestock production within farms and between farms within a region. Yet, improved integration, be it at farm or landscape level, offers substantial potential for enhanced circularity of utilization of biomass, especially for co-products (e.g. residues, manure, waste). The main objective of this research project is to co-design locally improved, innovative circular crop and livestock systems in North and Western Europe. To reach this objective, MI BICYCLE assesses alternative utility options of biomass and co-products in integrated crop-livestock systems at field, farm and landscape levels.

The MI BICYCLE Project

Increased circularity of agricultural co-products includes improved interactions between specialized arable and livestock production systems and innovative technologies through exchange of e.g. manure, fodder, and land use, to achieve ambitious greenhouse gas (GHG) and nitrogen (N) reduction targets. This implementation of new technologies, such as biogas plants (Figure 1), biorefineries (Figure 2), biochar, etc. can support the transition towards environmentally and climate friendly production systems, which is one focus area of the Danish regional study in the MI BICYCLE (ERA-NET) project.

Figure 1: Biogas plant – Photo: Lundsby - Vinkel Bioenergi

Figure 2: Green biorefinery – Photo: Aarhus University, AU-Viborg

Production of renewable green energy to substitute fossil fuels is currently a prominent actor of the green transition in Denmark, including investments in biogas plants based on manure, plant residues, wastewater, and other organic products. The coupling of biogas plants with other innovative technologies such as biorefineries enables expansion of typical system boundaries to include more actors and larger parts of the landscape.

In the biorefinery, grass is pressed producing a green juice and a fiber fraction. From the green juice, protein is extracted through heating or steaming and can be fed directly to monastic animals - thereby replacing the less sustainable soya feed. The fiber fraction can be fed to ruminants (e.g. cattle), or distributed to the biogas plant. In addition, the biogas plant also receives manure and other co-products from the field, and the energy produced here can be transferred to run the biorefinery. The biogas remnants, including potentially produced biochar, finally is recycled back to the local fields as fertilizer and/or to promote carbon storage in the soil, thereby contributing to circularity of the system. Hence, strengthened collaborations and circularity at the landscape scale with maximum reuse of co-products may help to reduce the overall loss of GHG and nutrients. In the project we develop frameworks to analyse the conversion to such systems, and scenarios for the implementation and related land use changes in the central Limfjorden catchment in Jutland. This includes effects of improved collaboration and matter flow cycles within the catchment, and a better targeting of biofertiliser and land use measures.

The Danish case study is one of the four that feature within the MI-BICYCLE project, which also includes case regions in Southern France, Scotland and the Netherlands.

Relevant links:

- Dalgaard et al. (2021) ***Changed crop type and crop rotation as a measure to increase N use efficiency and achieve reduction targets for N leaching*.** https://ini2021.com/changed-crop-type-and-crop-rotation-as-a-measure-to-increase-n-use-efficiency/. Abstract for The International Nitrogen Conference.
- Dalgaard et al. (2021) ***Geographical targeted landscape management for reduced N pollution from agriculture*.** https://ini2021.com/geographical-targeted-landscape-management-for-reduced-n-pollution-from-agriculture/. Abstract for The International Nitrogen Conference.

Videos:

- Visit at the Biogas plant in Foulum: https://youtu.be/NNBPfL4aTf8
- Biorefinery and harvest of green biomass at Aarhus University, Foulum: https://www.youtube.com/watch?v=iT5EjFv4nJA

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