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Climate effects of recycled fertilizers and biochar: emissions of nitrous oxide, methane and ammonia in a field experiment

Background

Nitrogen (N) fertilizers are essential for crop production. Farmyard manure and slurry traditionally constitute about half of the total N inputs into crop production in Switzerland [1]. Recycled fertilizers such as biogas slurry, liquid digestates and compost enable simultaneous energy production and closing of nutrient cycles (fig.1). There is evidence that recycled fertilizers can help to increase N use efficiencies and to improve N supply in organic farming [2]. Biochar amendment has shown a potential to mitigate soil greenhouse gas (GHG) emissions, in particular nitrous oxide (N_2O) emissions [3]. Here, we combine one of the liquid recycled fertilizer treatments with biochar. In a 2.5-years on-farm experiment, we quantify GHG emissions and further gaseous N-losses via ammonia (NH_3) emissions.

Fertilizer recycling

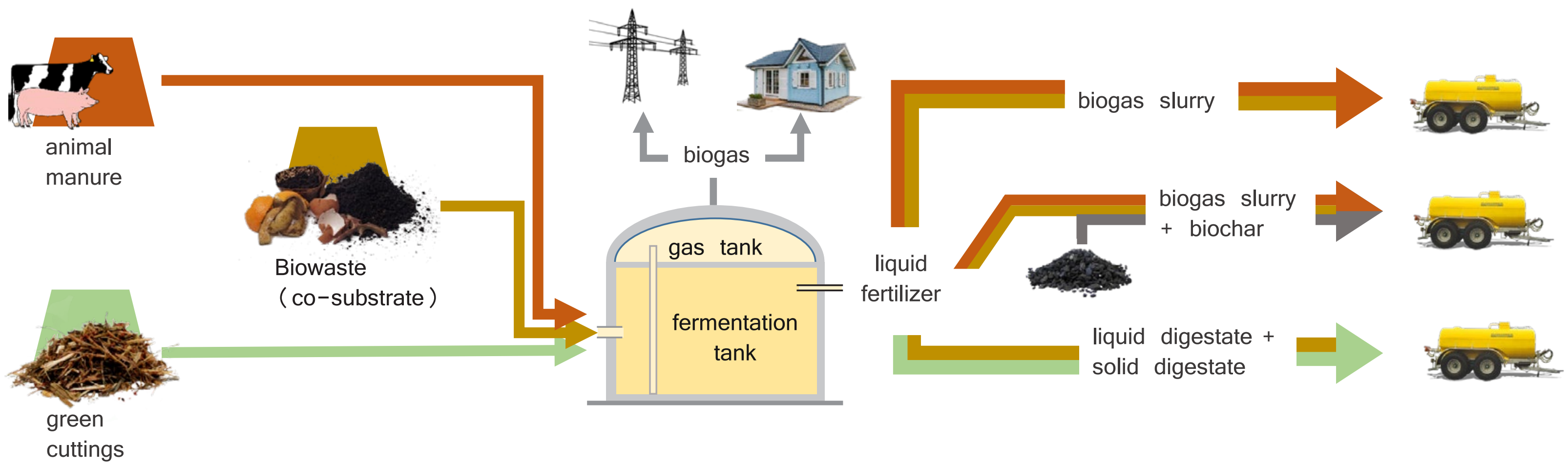

Fig.1. Schematic display of a biogas plant. Besides biogas, an agricultural facility produces biogas slurry (animal manure + biowaste) and an industrial facility liquid and solid digestate (green cuttings + biowaste), both under anaerobic conditions.

Project aims

Evaluate the effects of recycled fertilizers on

- GHG emissions
- gaseous N-losses
- Soil quality
- Soil microbial community

Treatments

Liquid organic fertilizers (140 kg N/ha/year)

Biogas slurry	anaerobic, from an agricultural biogas plant
Biogas slurry + biochar	amended with pyrolyzed (500–600 °C) tree and shrub cuttings
Liquid digestate	aerobic, from a commercial biogas plant
Cow slurry	

Controls

Unfertilized (0-control)

Mineral fertilizer (positive control)

Methods

GHGs: N_2O, CH_4 and CO_2

- Measured with closed static chambers [4]
- weekly and event-based measurement
- Two chambers per plot/treatment, four replicates (n=48)
- Analysis via gas chromatography

Fig.2 GHG sample collection.

Further gaseous N-losses: NH_3

- Captured via acid traps in a micrometeorological setup
- Complemented by wind dispersal modelling [5]

Fig.3 Quantification of NH3-emissions via automatized "Low cost impinger system (LOCI)". [5]

Associated soil analyses at 0–20 cm depth: Nmin, pH, microbial DNA

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