ANIMAL MANURE FOR BIOGAS PRODUCTION – WHAT HAPPENS TO THE SOIL?

Bioforsk

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Summary: Utilizing animal slurry to produce biogas may reduce fossil fuel usage and emissions of greenhouse gases. However, there is limited information on how the recycling of digested slurry as a fertilizer impacts soil fertility in the long run. This is of concern because organic matter in the slurry is converted to methane, which escapes the on-farm carbon cycle. In 2010, a study of this question was initiated on the organic research farm in Tingvoll, Norway. So far, a biogas plant has been built, producing anaerobically digested slurry to be compared with undigested slurry in perennial ley and arable crops. Effects on crop yields, soil fauna, microbial communities, soil structure, organic matter and nutrient concentrations are measured.

Background

On-farm biogas production converts various organic substrates to energy, and help to reduce dependency on fossil fuels and emission of greenhouse gases. However, especially organic farmers are concerned about the resulting reduced input of organic matter to the soil after digestion. What happens to soil life when we reduce the input of organic carbon?

Figure 1. Spreading manure, mixed 50% with water. on the research field.

Experimental details

On Tingvoll research farm, a biogas plant was recently built to digest the slurry from 25 dairy cows. The digested slurry (D) is compared with undigested slurry (U) in two cropping systems; arable crops and perennial ley, at low and high fertilization levels. Two plot experiments with four replicates are located next to each other in the field (Fig. 2), using ignition loss to find the plots with most even soil conditions. The soil is an imperfectly drained silty sand, from marine deposits, with 2.8-4.8 % organic matter in the arable plots and 3.9-9.6 % in the ley plots. Plot size = 3 m x 8 m.

Manure characteristics

In 2011, we had to purchase U and D from the Norwegian University of Life Sciences. The D had less dry matter, and more mineral N (Table 1).

Table 1. Chemical analyses of manure used 2011	*Undigested slurry, U*	*Digested slurry, D*
Dry matter, %	6,8	5,2
Total N (Kjeldahl), kg tonne^{-1}	2,7	2,8
Phosphorus, kg tonne^{-1}	0,50	0,46
Potassium, kg tonne^{-1}	3,3	3,0
Ammonium-N, kg tonne^{-1}	1,6	2,0
Calcium, kg tonne^{-1}	0,82	0,65
Magnesium, kg tonne^{-1}	0,46	0,39
pH	6,8	7,8

During storage, sawdust had precipitated in U. The analysis is from the liquid part. No sediment was found in the D tanks. The U was yellowish brown and had a strong smell. D was greenish grey, had a softer smell reminding of soil, and lower viscosity.

The digestion impacted the N concentration and dry matter content (Table 1). In ley, 21/42 tonnes ha^{-1} of U, and 20/40 tonnes ha^{-1} of D were applied on May 4. Half of these amounts will be applied after the first cut. To cereals, 23/46 tonnes ha^{-1} of U or D were applied on May 11. Animal slurry is heterogeneous and difficult to handle, and to sample and spread evenly. We mixed it with water (1:1) to facilitate even spreading. The high levels were close to the limit of what could be infiltrated in the soil.

Figure 2. Seed planting on cereal plots, May 20, 2011. In the background, the ley plots are visible.

Initial measurements

To reveal time-dependent changes, earthworms and spring tails have been sampled (Fig. 3).

Figure 3, above. Blue-grey earthworm (*Octolasion cyaneum*) is found in the field, together with the common species *A. caliginosa*. Figure 3, below. Springtails and mites (red) comprise a significant, but so far little studied group of species in the agricultural soil fauna.

Soil mineral N, water extractable C, accumulated respiration, microbial biomass, and shifts in microbial community structure described by phospholipid fatty acid technique are measured before and after slurry application. Soil physics and nutrients are also characterized.

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