Anaerobic digestion of cow manure – long-term implications for soil fertility and crop yield

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Background

Anaerobic digestion of animal manure can help farmers to produce renewable energy and reduce greenhouse gas emissions. Compared to non-digested slurry, digested slurry has a reduced content of organic matter, which may affect the soil fertility and crop productivity in the long-term. Hence, a field experiment with two slurry-application levels was established in 2011 to study how application of anaerobic digested slurry versus untreated dairy cattle slurry affects soil characteristics and crop yields. The field experiment was established in a grass-clover ley and comprised two fertilizer treatments applied at two rates of total N compared with a non-fertilised control.

Fig.1. *Slurry application and harvest of the grass-clover ley.*

Materials and Methods

Untreated **S**lurry (**US**)

Anaerobically **D**igestated **S**lurry (**ADS**)

Long-term field experiment (2011-)

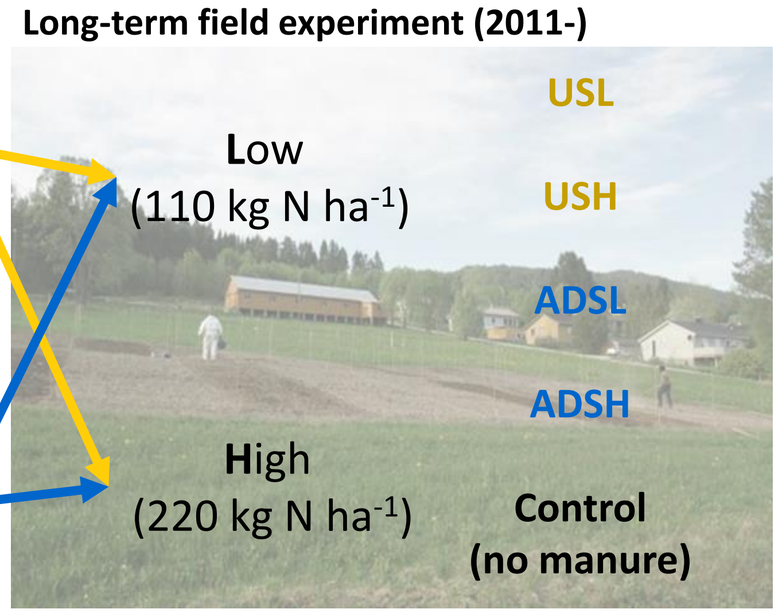

Fig.2. *Treatments of the SoilEffects long-term field experiment.*

Results

Tab.1. *Average values (2011-2021) of the chemical composition of non-digested slurry (US) and anaerobically digested slurry (ADS)*

Chemical composition	US	ADS
Dry matter (%)	5.3	3.4
Loss ignition (%)	1.2	0.9
Tot-N (g kg DM^{-1})	50.0	71.0
NH_4-N (g kg DM^{-1})	31.7	42.1
NH_4-N (% of total N)	60.6	65.2
pH	7.4	7.7
P (g kg DM^{-1})	9.4	10.9
Ca (g kg DM^{-1})	30.6	35.5
Mg (g kg DM^{-1})	8.5	10.3
S (g kg DM^{-1})	5.1	5.5
K (g kg DM^{-1})	63.6	81.4

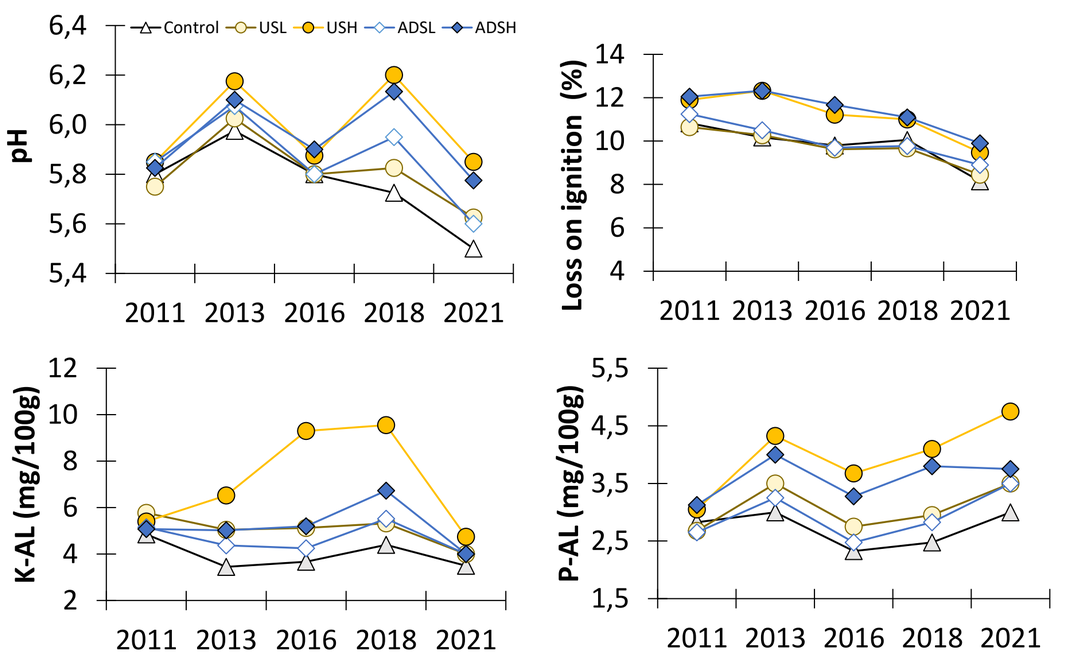

Fig.3 *Changes in soil pH, organic matter (LOI) and P-AL and K-AL in the SoilEffects long-term field experiment, spring samples. Non-digested slurry (US) and anaerobically digested slurry (ADS).*

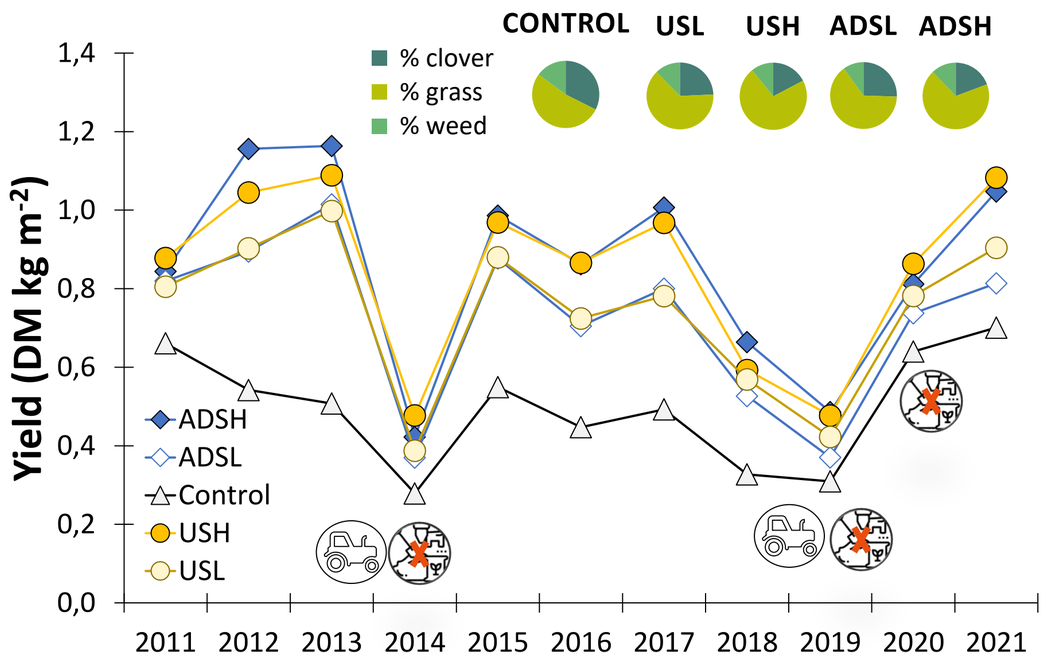

Fig.4*. Summarized mean DM yields (sum of 1st and 2nd cuts) of grass-clover ley in a field experiment 2011-2021. Inserted graphic is the average in percentage of clover, grass and weed in each treatment over the years. = re-establishment of the ley with green fodder; no manure application. Non-digested slurry (US) and anaerobically digested slurry (ADS).*

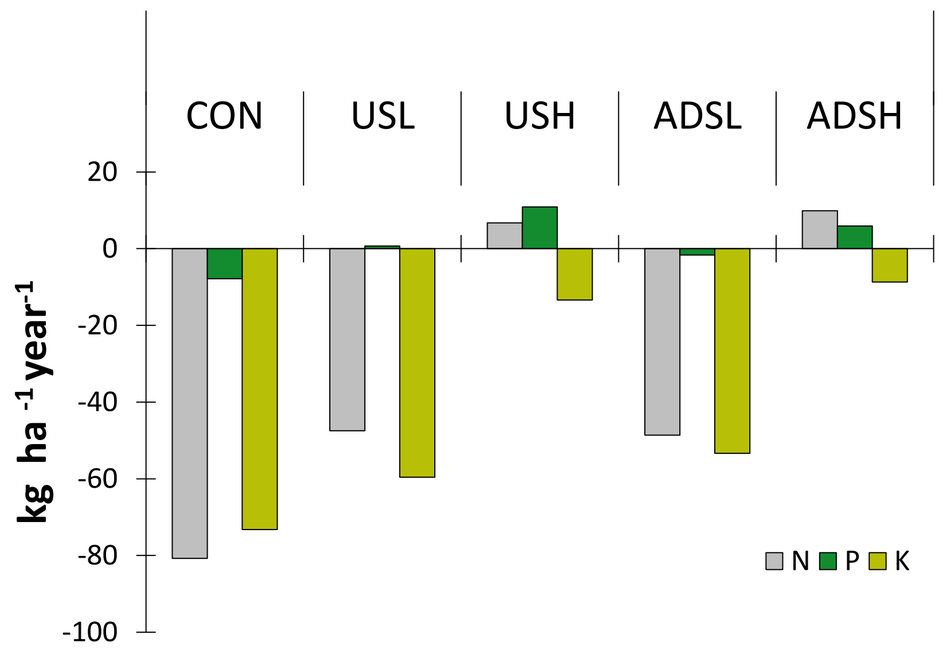

Fig.5. *Nutrient (NPK) budgets (manure minus yields, kg ha^{-1} $year^{-1}$) in the SoilEffects long-field experiment. Non-digested slurry (US) and anaerobically digested slurry (ADS).*

Conclusions

This study confirmed that anaerobically digested slurry has a low content of organic matter. The long-term effect of application of ADS vs. US to soil did not affect SOM, soil fertility or crop yields. Surprisingly, we found that the application of organic fertilizers did not increase SOM, and a decline in SOM was observed in all treatments. This may be due to the high initial content of SOM and soil drainage. As expected, higher rates of manure reduced the proportion of clover. Higher manure application resulted in slight surpluses of N and P in nutrient budgets. Even in the treatments with low application rate, the total P deficit was minimal. For N and K, low rates of manure application led to significant deficit of these nutrients. Under the given conditions, we found that the benefits of extracting energy from the slurry by AD will not compromise grassland productivity or soil quality in the long run.

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