AARHUS UNIVERSITY

soil effects

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EFFECTS OF APPLYING ANAEROBICALLY DIGESTED SLURRY ON SOIL AVAILABLE ORGANIC C AND MICROBIOTA

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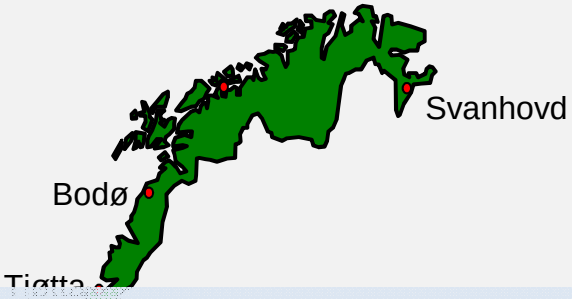
Outline of talk

- The SoilEffects project
- Aim and setup of field plot in Tingvoll, Norway
- Sampling and analyses
- Results
- Conclusions

Full project title: Effects of anaerobically digested manure on soil fertility - establishment of a long-term study under Norwegian conditions



Full project title: Effects of anaerobically digested manure on soil fertility - establishment of a long term study unit

Bioforsk Organic and Farm Tingvoll

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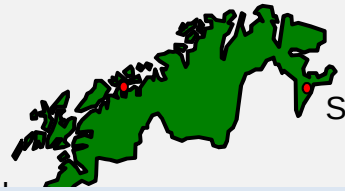
Anaerobic digestion may be a feasible way for organic farmers to:

- ❖ Produce sustainable bioenery and fertilizers for crops.
- ❖ Recycle animal slurries and plant residues on the farm.



Full project title: Effects of

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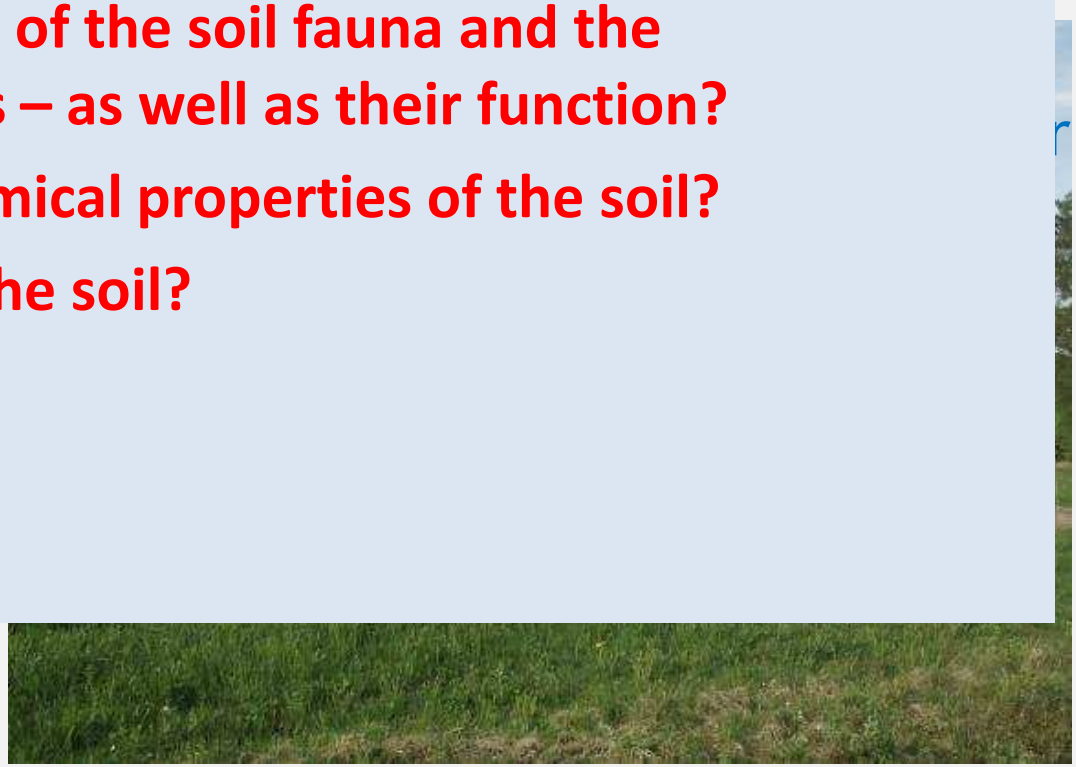
Main questions and concerns

Do the residues from anaerobic digestion impact

- **the biodiversity of the soil fauna and the microorganisms – as well as their function?**
- **the physicochemical properties of the soil?**
- **the fertility of the soil?**

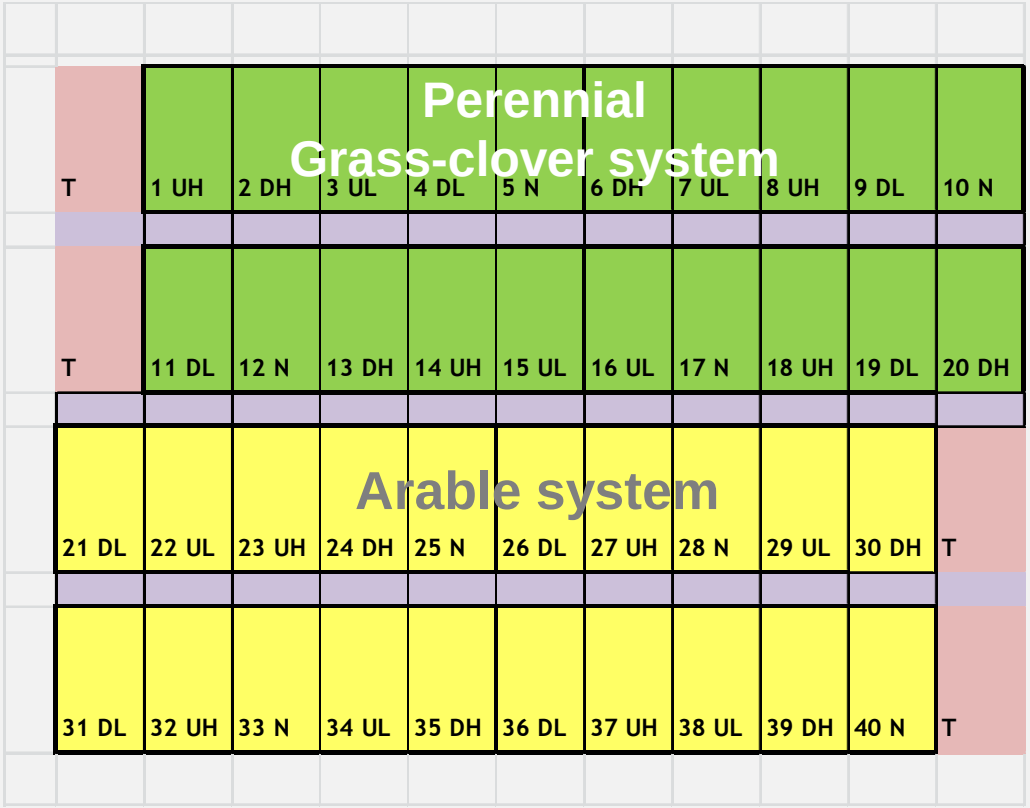


The main aim of the SoilEffects project is to establish a field experiment to compare long-term effects of anaerobically digested vs. non-digested manure (slurry) on crucial soil physical, chemical and biological characteristics.

Secondary aims are to:

- Establish a long-term field experiment within Tingvoll research farm and conduct the initial site characterization.
- Observe effects of the early transition period (3Y) on soil fauna (earthworms and other key-fauna organisms).
- Observe effects of the early transition period on soil physical, chemical and microbiological conditions (soil density; soil pH, nutrients, organic matter content and quality; accumulated soil respiration, microbial community diversity).
- Measure the effect of digested manure on the local Tingvoll earthworm population by in vitro pot experiments.
- Characterize the activity of microorganisms and important members of soil fauna (springtails).

The experimental plots were numbered 1-40 (3mx8m), and the five treatments were randomly assigned between the plots in each of four blocks.



Manure treatments:

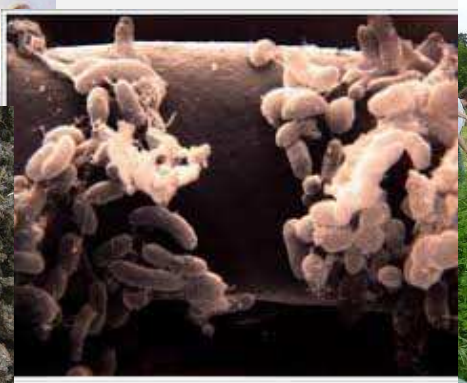
Control treatment with no manure = N
Undigested slurry, low level = UL
Undigested slurry, high level = UH
Digested slurry, low level = DL
Digested slurry, high level = DH

Manure application per year
Arable L/H: 85/170 kg N/ha
Perennial L/H: 110/220 kg N/ha

Analyses and tests

Soil physical/chemical parmeters
Plant nutrients
Crop yelds
Weeds
Manures/digestate characteristisc
Soil content of available organic carbon

Biological parameters
Earth worm species and abundance
Collembola species and abundance
Microbial community - diversity and size (PLFA)



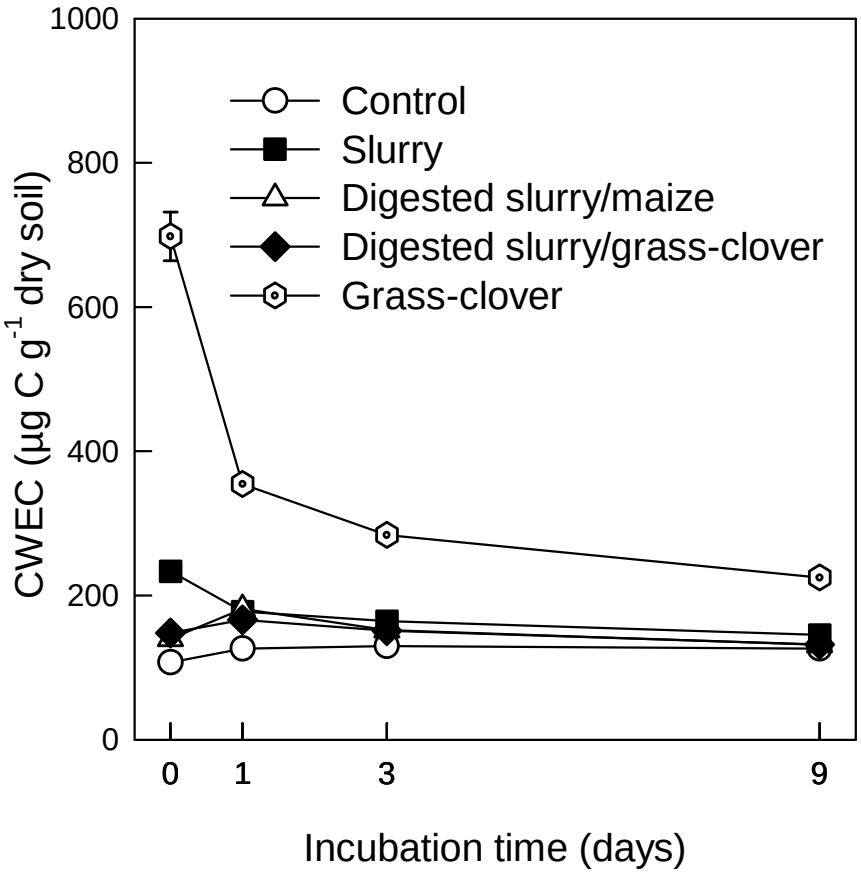
We measure soil available organic C – because it governs the response of the microbial community.

Available org. C =
cold-water extractable C (CWEC)

Grass-clover contains most available org. carbon

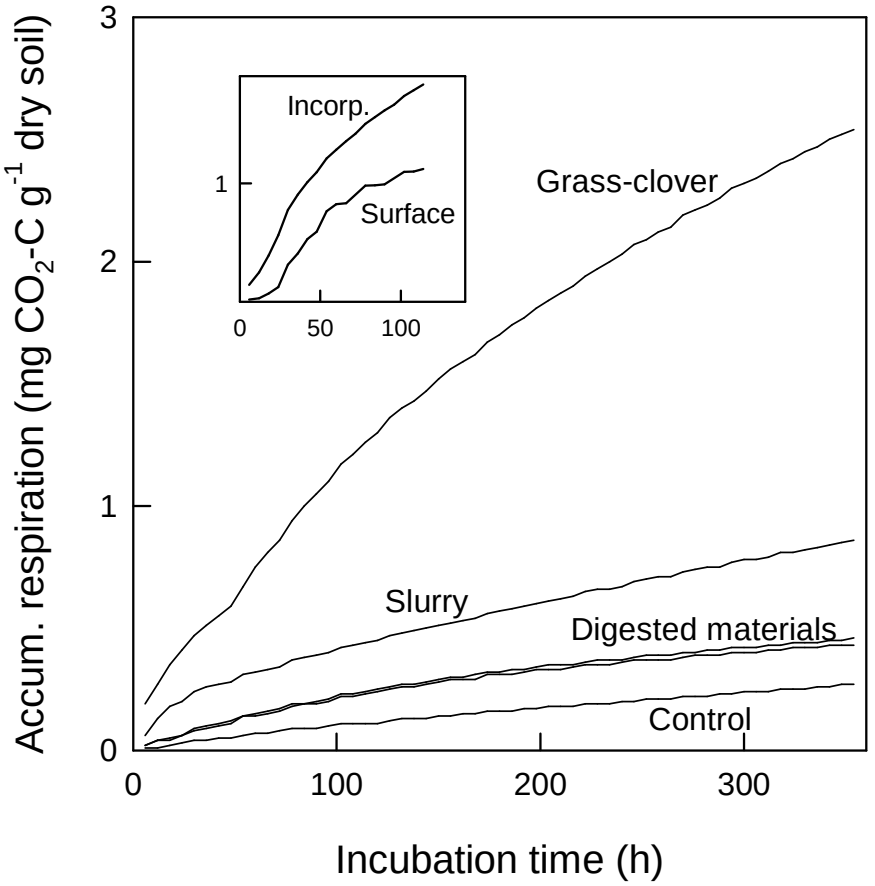
Raw slurry contains slightly more org. carbon than digested materials

Expt #1



Carbon respired by microorganisms after addition of digested materials to soil (respirometer)

Expt #2

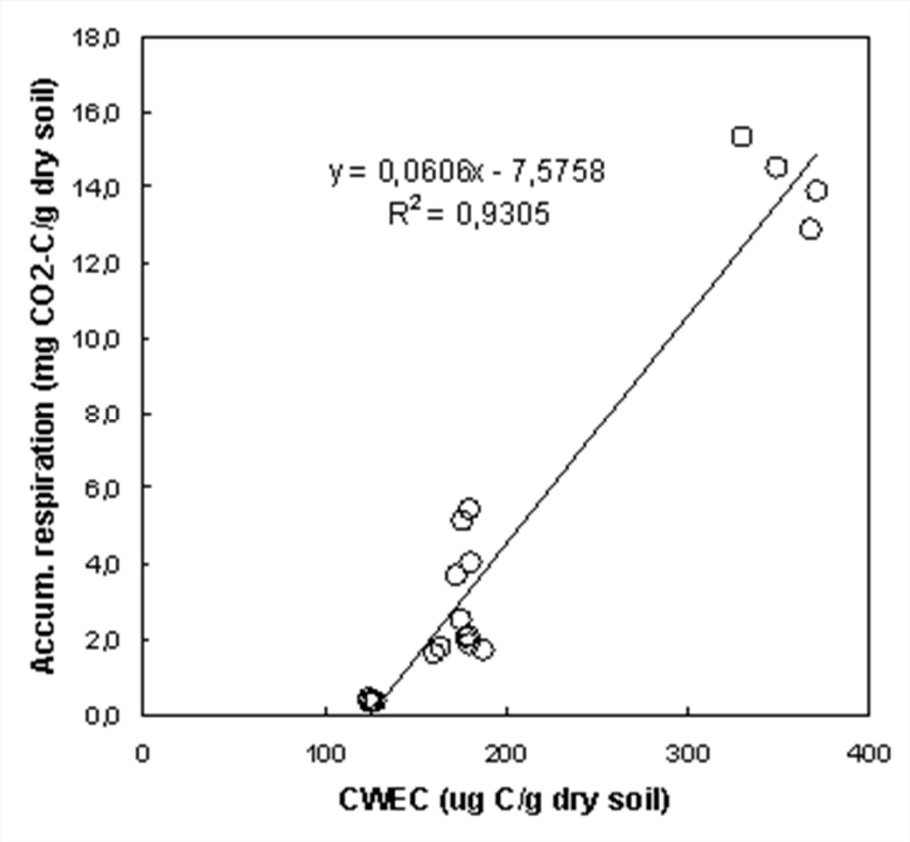


The materials containing most available org. C are turned over most quickly - and emit most CO_2

Tight relationship between the available carbon (CWEC) pool and the microbial respiration.

There is a close relationship between soil respiration and the CWEC applied with the residual materials.

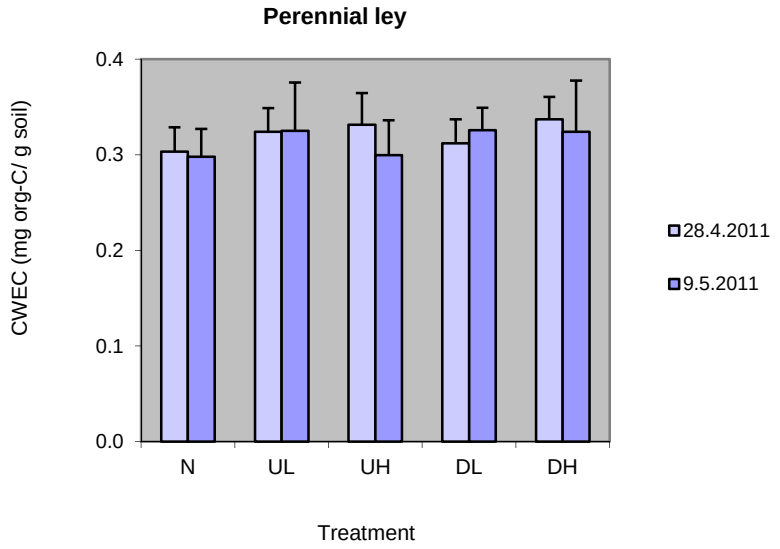
So the content of this type of C in the slurries is important for the microbial community!

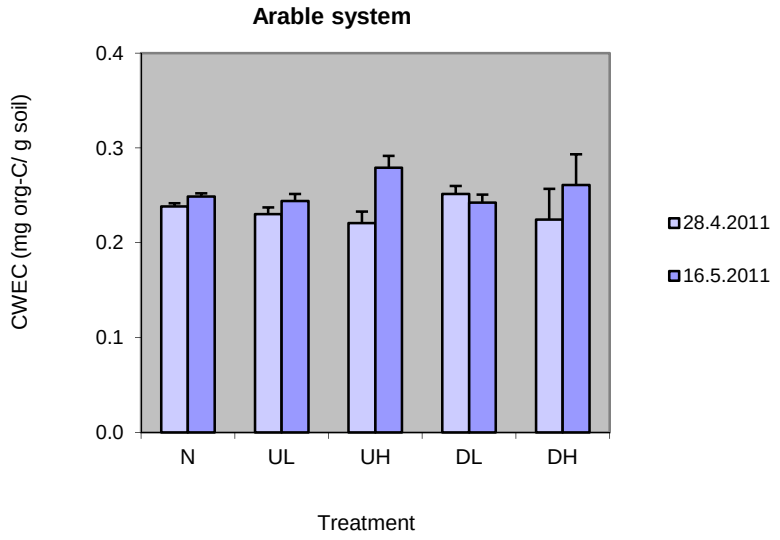


SoilEffects
Cold-water extractable organic C (CWEC) in spring 2011

The soil was sampled before fertilization and five days after fertilization

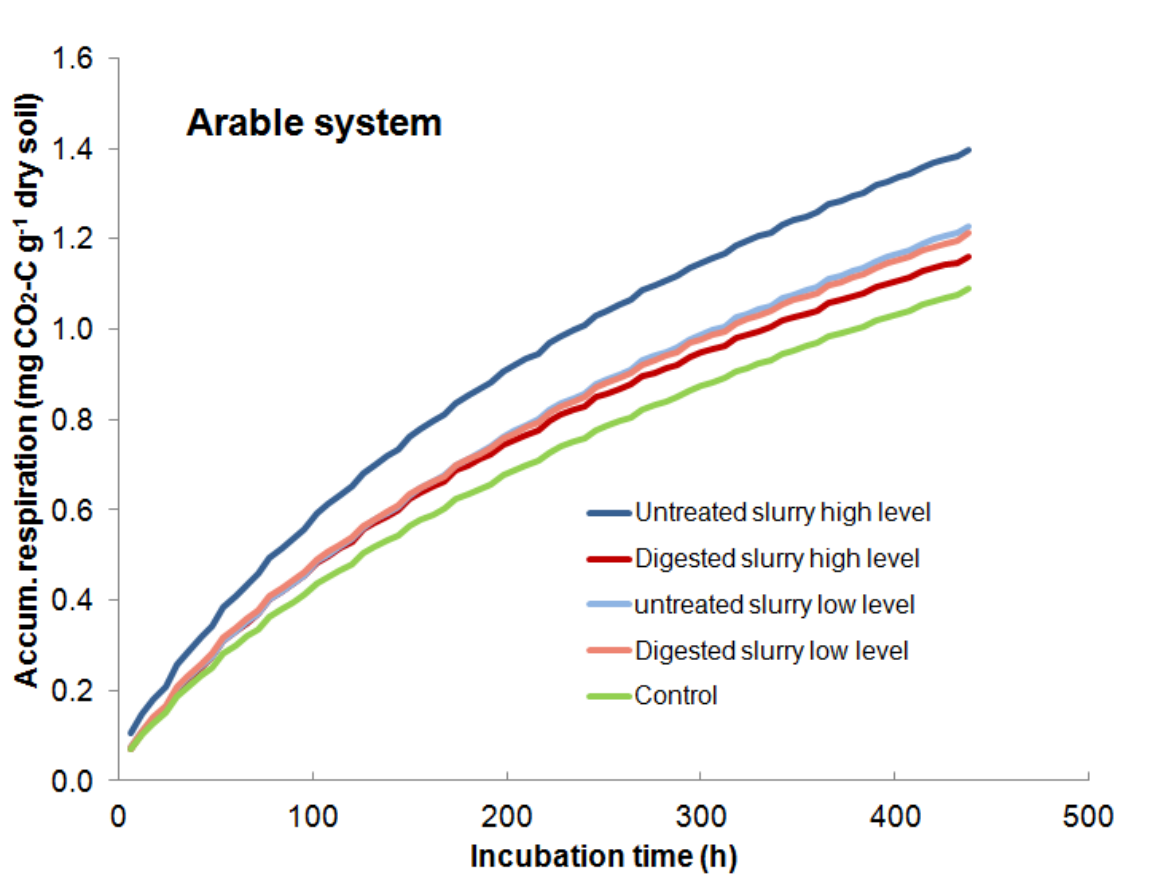
The CWEC was not much different among treatments but higher in perennial than in arable system





SoilEffects
Accumulated respiration from soil sampled in arable system in spring 2011

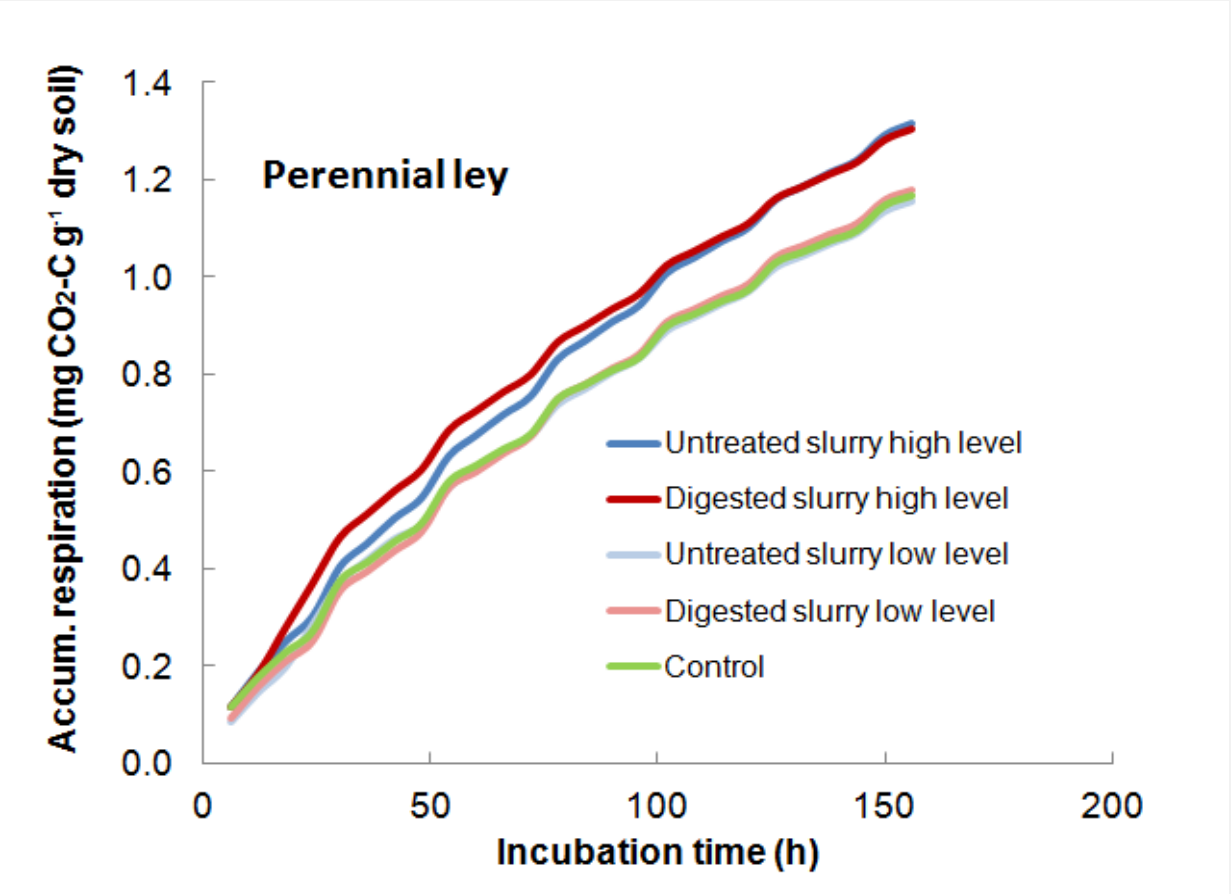
Untreated slurry at high level respires most – controls respires the least



SoilEffects

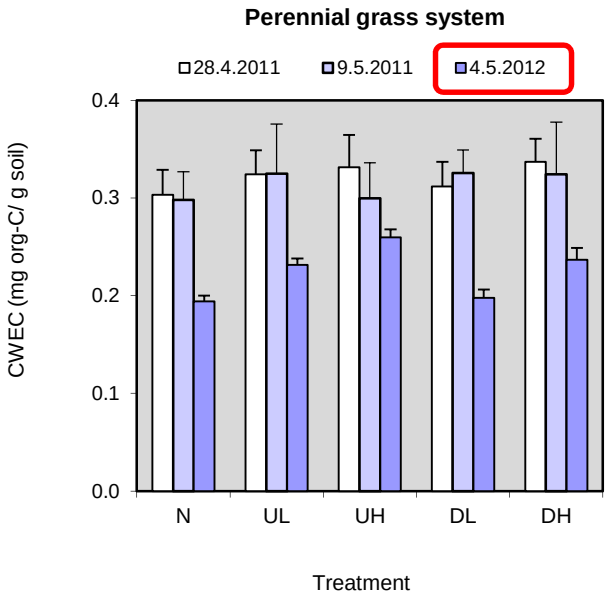
Accumulated respiration from soil sampled in perennial system in spring 2011

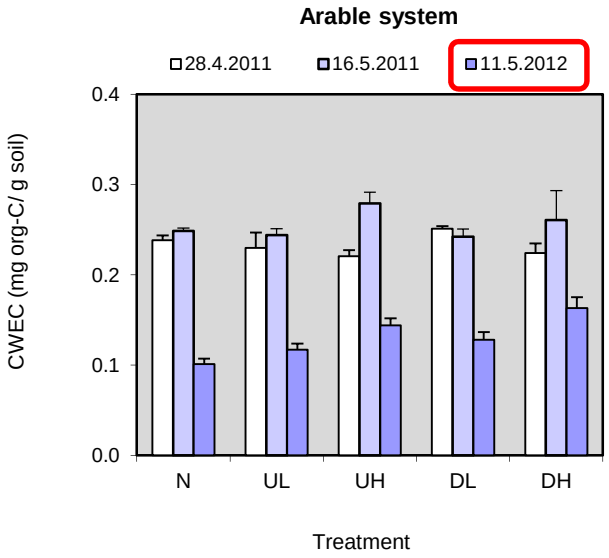
Untreated/digested slurry at high level respires most



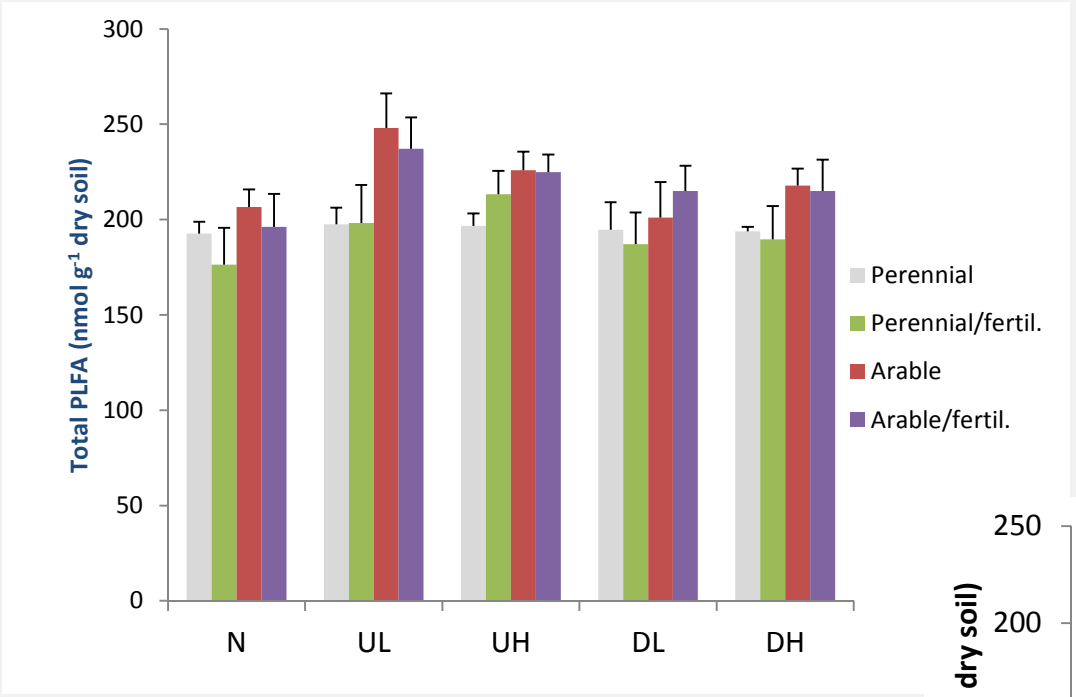
SoilEffects
CWEC somewhat lover in 2012 that in 2011, but follows the amount of manure applied

The difference between 2011 and 2012 maybe reflects differences in microbial biomass (can vary a lot between years) and with factors like crop type, precipitation, temperature etc.

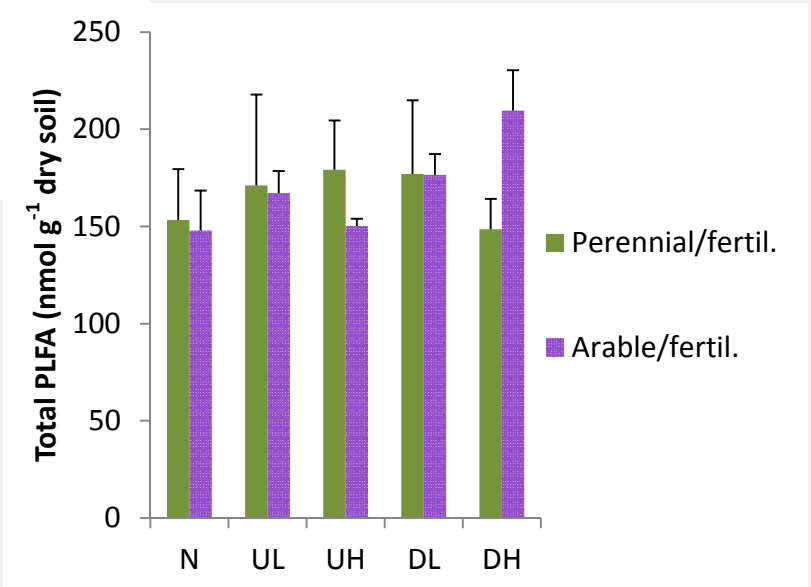




Soil microbial biomas as indicated by total PLFA (2011)



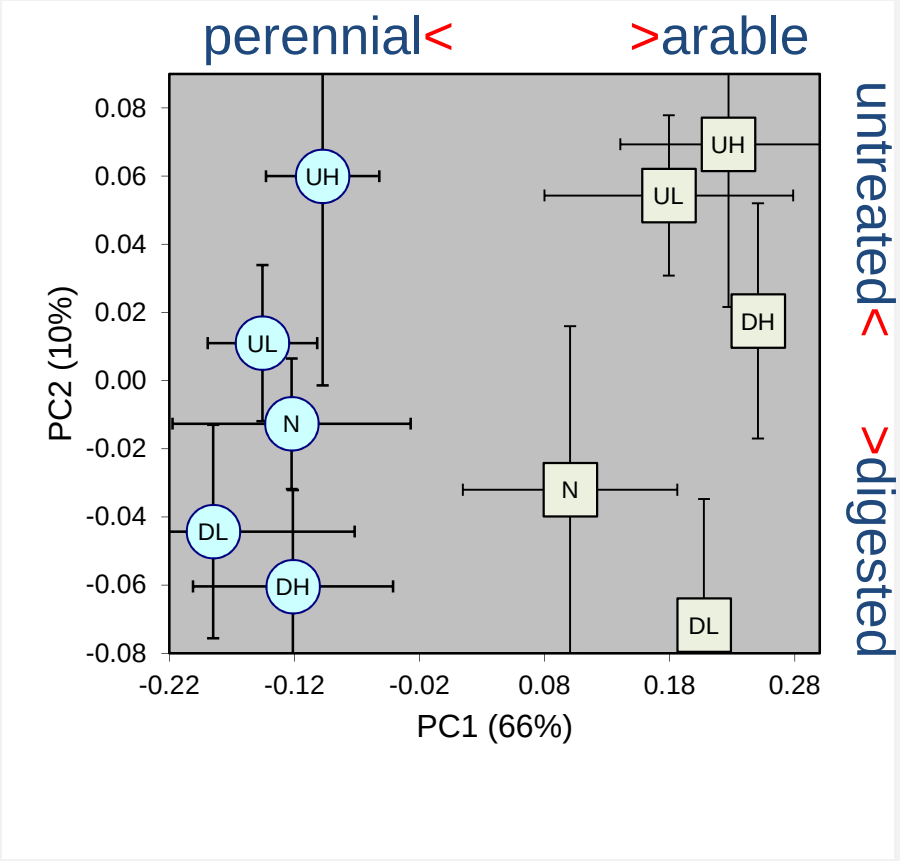
and - in 2013



PLFA: phospholipid fatty acid analysis
Indicates microbial biomass and community structure

Score plot from a principal component analysis of 26 PLFAs from soil sampled in the arable (squares) and perennial (circles) crop systems; five days after application of slurries in 2011.

The type of cropping system has more impact on the microbial community than the type and amount of material applied to the soil.



Conclusions

- The type of the cropping system seem to have more impact on the soil microbial community than the type of the applied manures.
- A substantial proportion of the organic C in the pristine slurry may be respired quickly after application – not contributing to the more resistant pool of organic C in the soil.
- The microbial community seems not impacted by the use of digested slurries compared to pristine slurry.
- A long-term experiments (20-30Y) is needed (and intended) to measure the effects of repeated application in many years – obviously.

How does all this fit into an “innovative strategy for sustainable plant nutrition”?

Anaerobic digestion may:

- Improve recycling of organic matter on farm.
- Improve possibility for utilizing organic matter from off-farm sources through anaerobic digestion to replenish most of the nutrients (N, P, K etc.).
- In this way may free some of the field areas otherwise used for nitrogen fixation so that they can be utilized for other purposes.

(SoilEffects was granted by the Research Council of Norway and the Agricultural Agreement Fund)