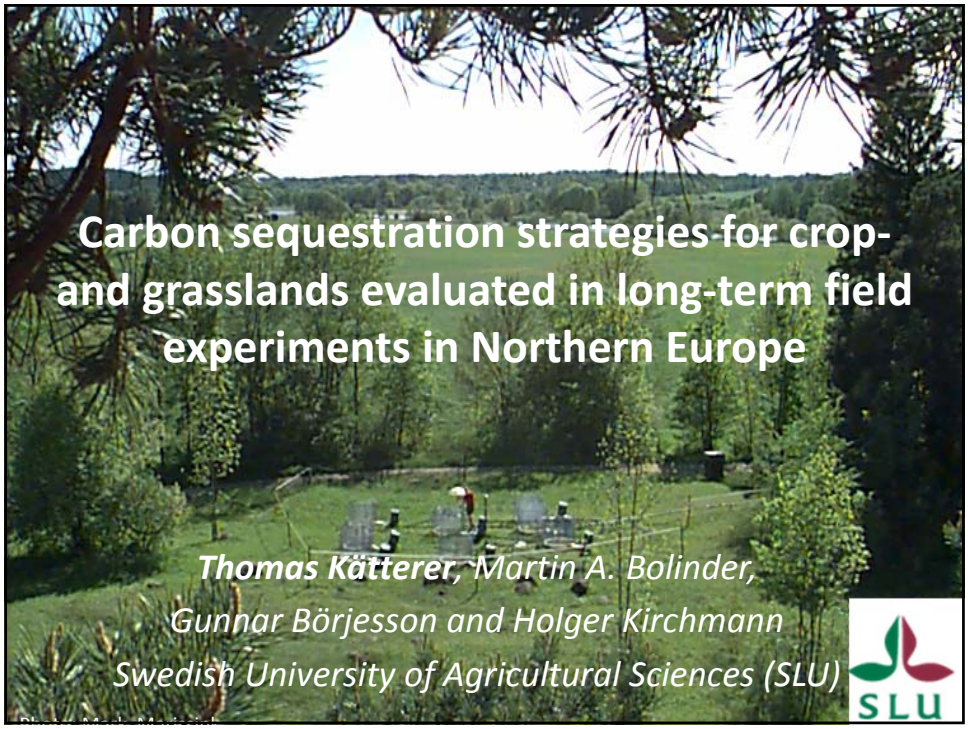

Carbon sequestration strategies for crop- and grasslands evaluated in long-term field experiments in Northern Europe

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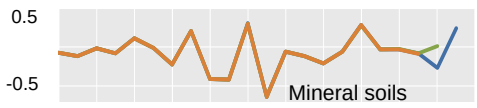
Swedish University of Agricultural Sciences (SLU)

SOC changes are slow – long-term experiments are valuable for model calibration, e.g. for national GHG reporting

- Meteorological data
- Agricultural statistics
- Soil monitoring
- Soil hyraulic properties database
- Long-term field exp. (calibration)

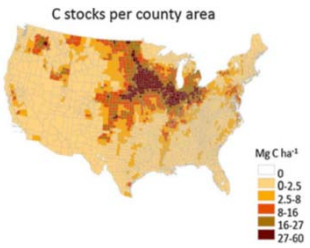
ICBM_region model



Tg CO_2

1990 2000 2012

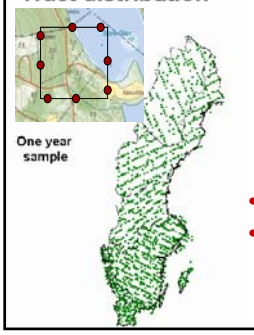
ICBM applications



Andrén & Kätterer 2008 Nutr. Cycl. Agroecosys. 81:129–144
Lokupitiya et al. 2012 Biogeochem. 107:207–225
Borgen et al., 2012 GHG Meas. Managem. 2:1, 5-21

Do Nordic grasslands sequester carbon under present management?

Tract distribution



National land use monitoring, Sweden

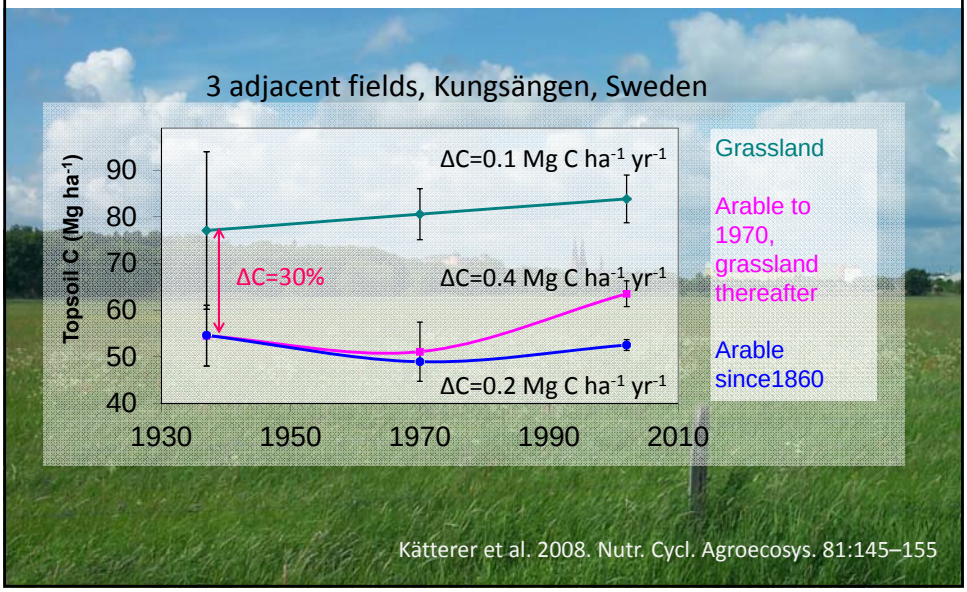
30 000 permanent plots
383 plots on grassland
10-year cycles for soil sampling
C sequestration 1990-2006 (Karltun et al., 2010)

30 kg C ha^{-1} yr^{-1}

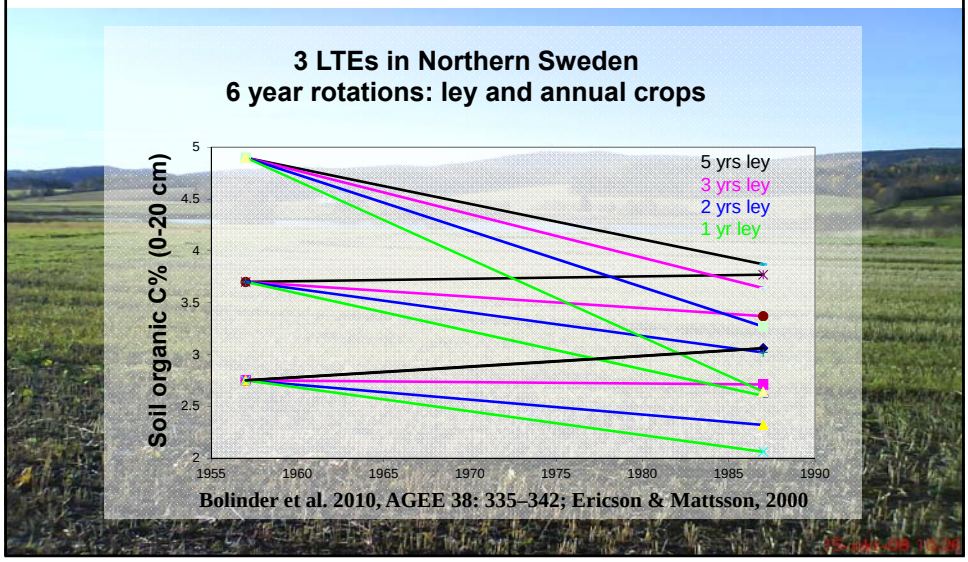
- Insignificant C sequestration in permanent grasslands
- Higher intensity (e.g. N fert.) would increase C stocks – but negative effects on biodiversity

SLU

Case study: Land use change - effects on soil C

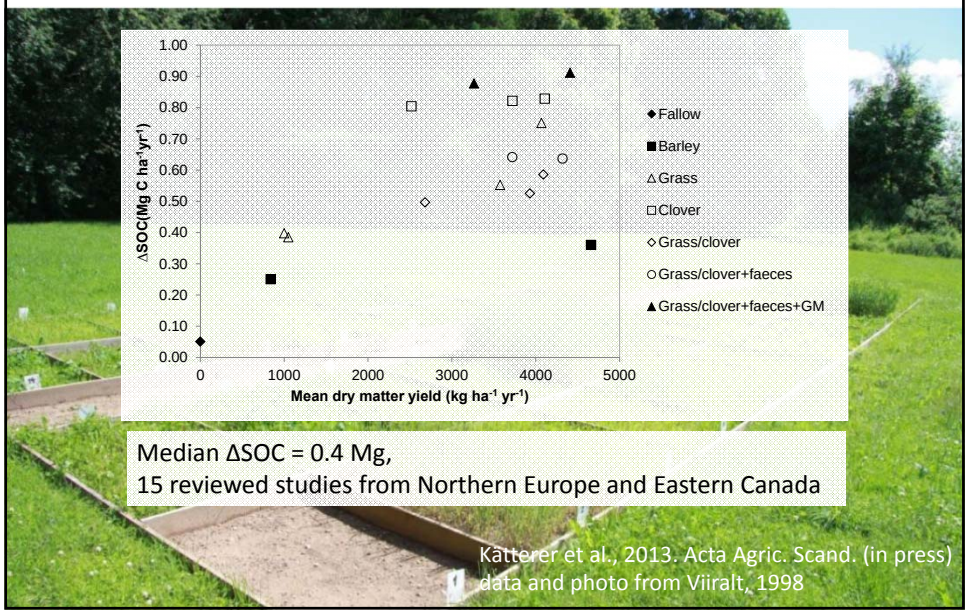


Temporal grassland: Frequency of annual vs. perennial crops affecting the soil C balance



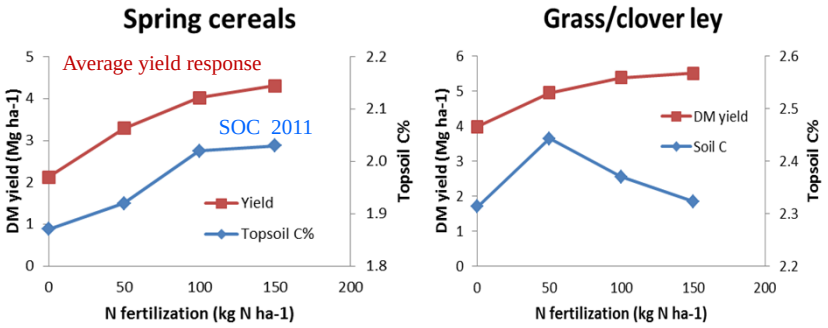
Annuals vs. Perennials and fertilization

LTE in Estonia 1965-1997



N fertilization and SOC

4 Swedish long-term field experiments >30 years



Effect of production on soil C

Proportional to production

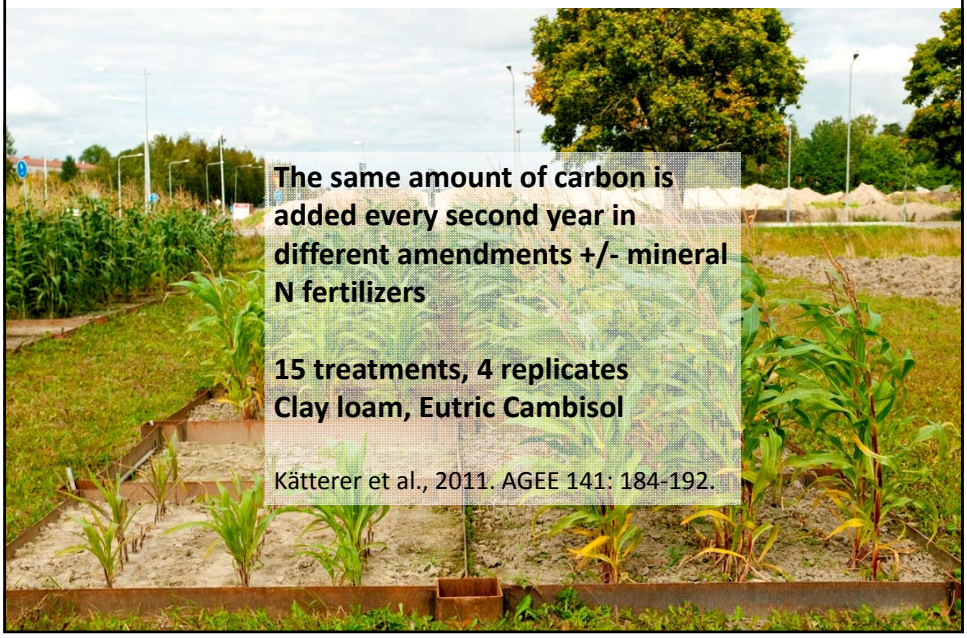
Not proportional to production

Annual cropping mimicking perennial systems

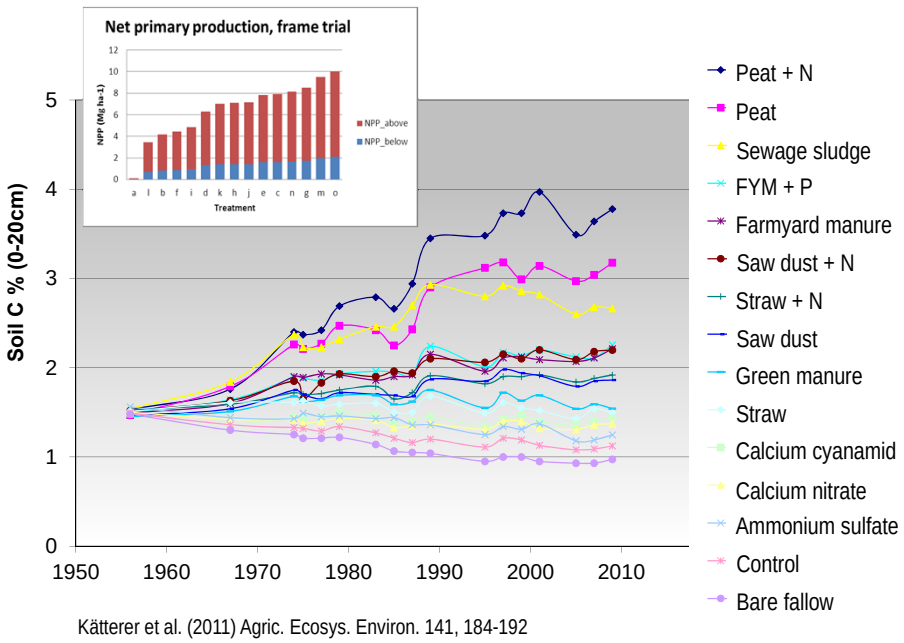
Catch crops and shelterbelts for C sequestration, also reducing leaching and erosion

Photo: Gunnar Torstensson. Timothy and English Ryegrass

Cropland managment: Ultuna frame trial

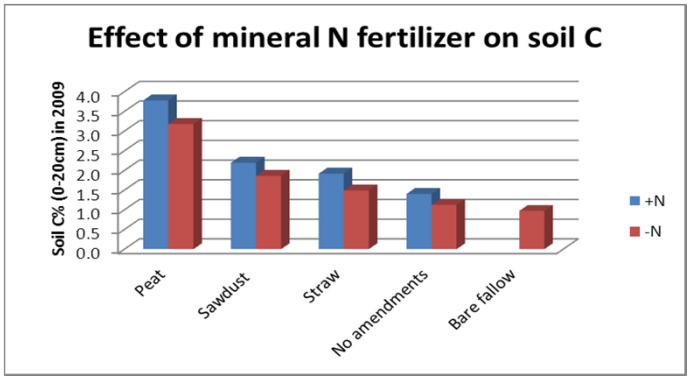


Changes in topsoil C over time in the Ultuna frame trial



Kätterer et al. (2011) Agric. Ecosys. Environ. 141, 184-192

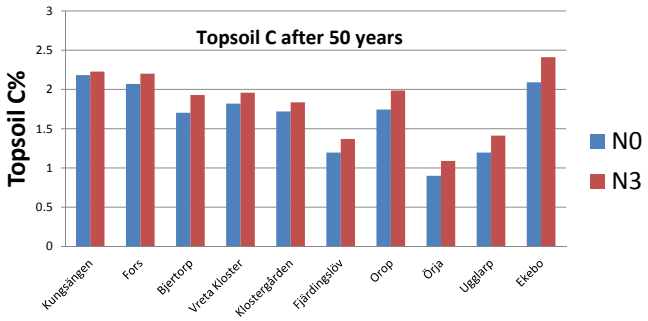
The effect of organic amendments and increased C input from roots due to N fertilization on soil C

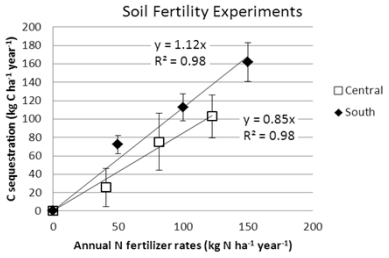


- **N fertilization results in higher root production and higher soil C stocks (1.6 -2.1 kg C kg^{-1} N applied)**

Kätterer et al., 2013. Acta Agric. Scand. (in press)

SOC in Swedish soil fertility experiments



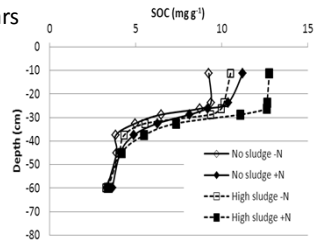


SOC stocks increase 1 kg C for each kg N applied

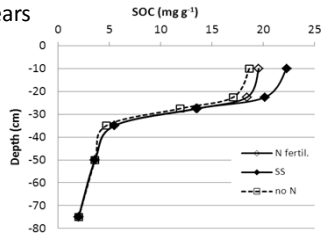
Kätterer et al., 2013. Acta Agric. Scand. (in press)

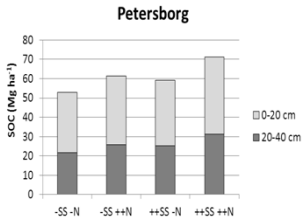
Significant SOC changes in upper subsoil after 13 or 30 years of repeated sewage sludge application

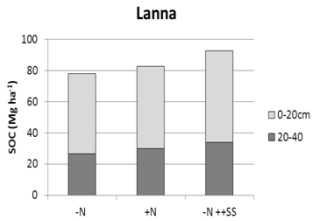
30 years



13 years



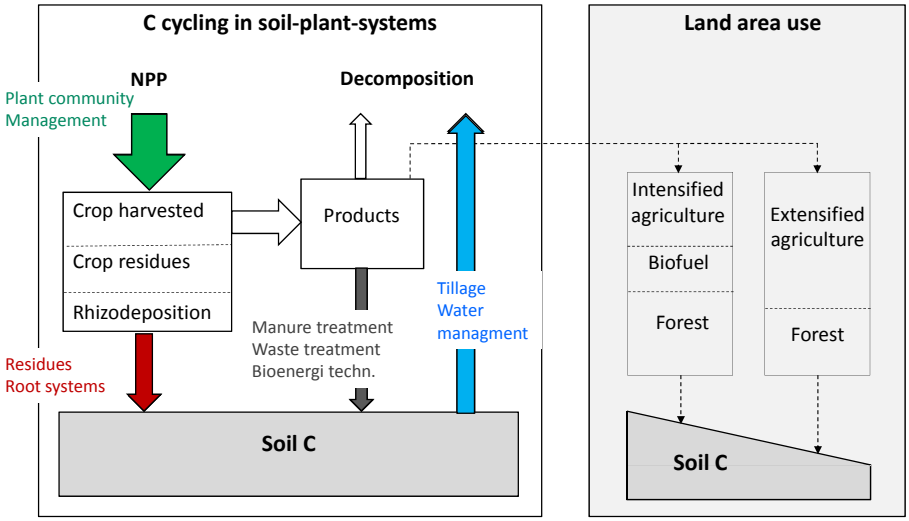




About 30% of SOC changes occurred below ploughing depth

Kätterer et al., unpublished

Carbon cycling in agricultural systems is driven by management decisions



Kätterer et al., 2013. Acta Agric. Scand. (in press)

Conclusions: Strategies for C sequestration

- Sustainable intensification, closing yield gaps

  1 kg N results in at least 1 kg extra SOC when N use efficiency is high
- Perennials instead of annuals (e.g. leys instead of fodder maize)
- Increased intercropping, catch crops, shelterbelts
- 30% of SOC changes may occur below the plough layer
- Recycling of waste products that are not recycled today
- Extensification of production will lower SOC and lead to land use change