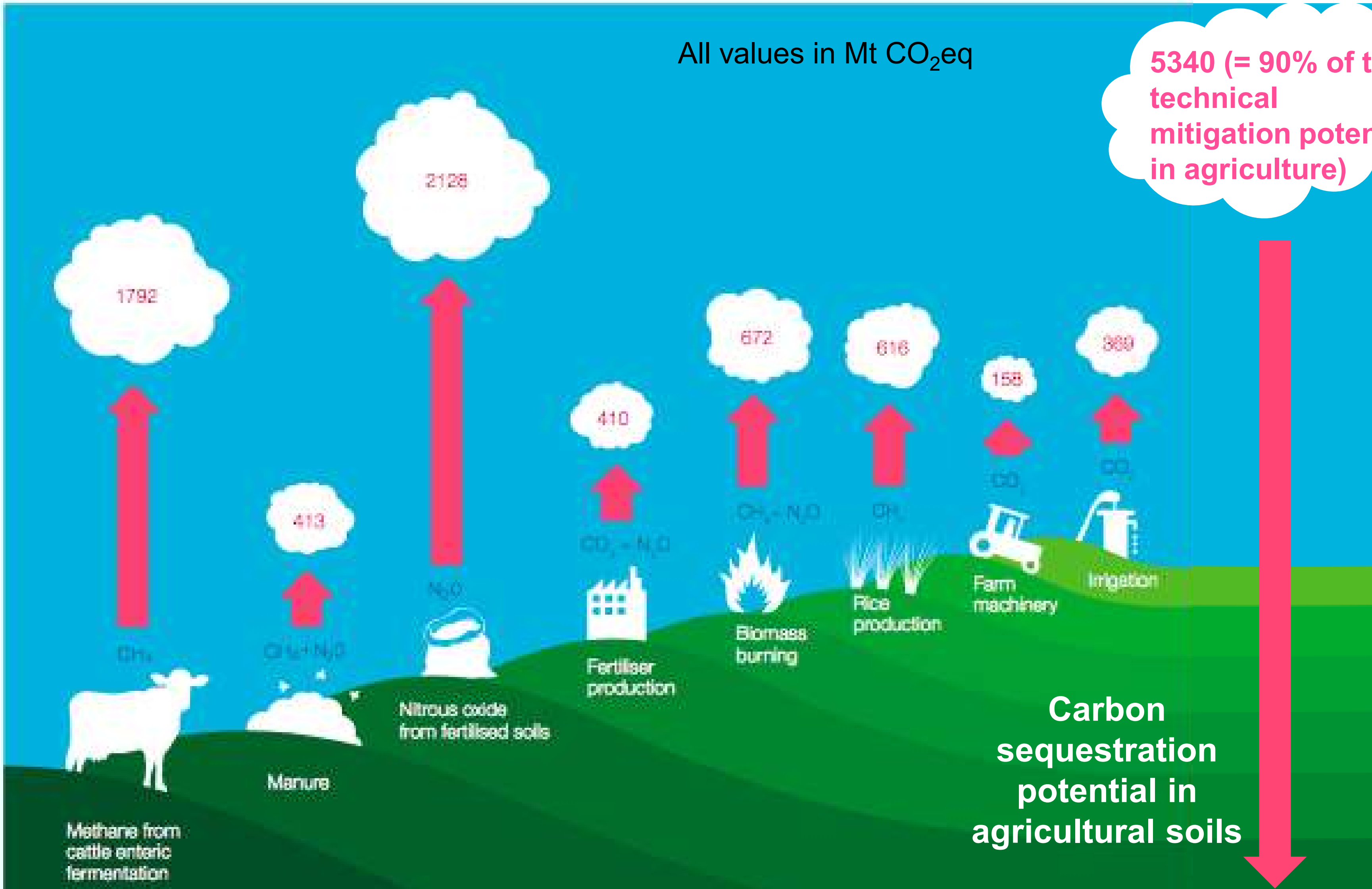
Supported by the LIFE program of the European Union

How can (organic) farming practices reduce greenhouse gas emissions?

Andreas Gattinger

Background: GHG Emissions in Agriculture



Adapted from “Cool Farming”, Bellarby et al. 2008

Mitigation of GHG emissions in agriculture

1. Conversion from conventional to organic farming
2. Implementation of climate-friendly farming practices (SOLMACC)
3. Climate change mitigation <u>and</u> adaption within a systems approach

- Summary and conclusions

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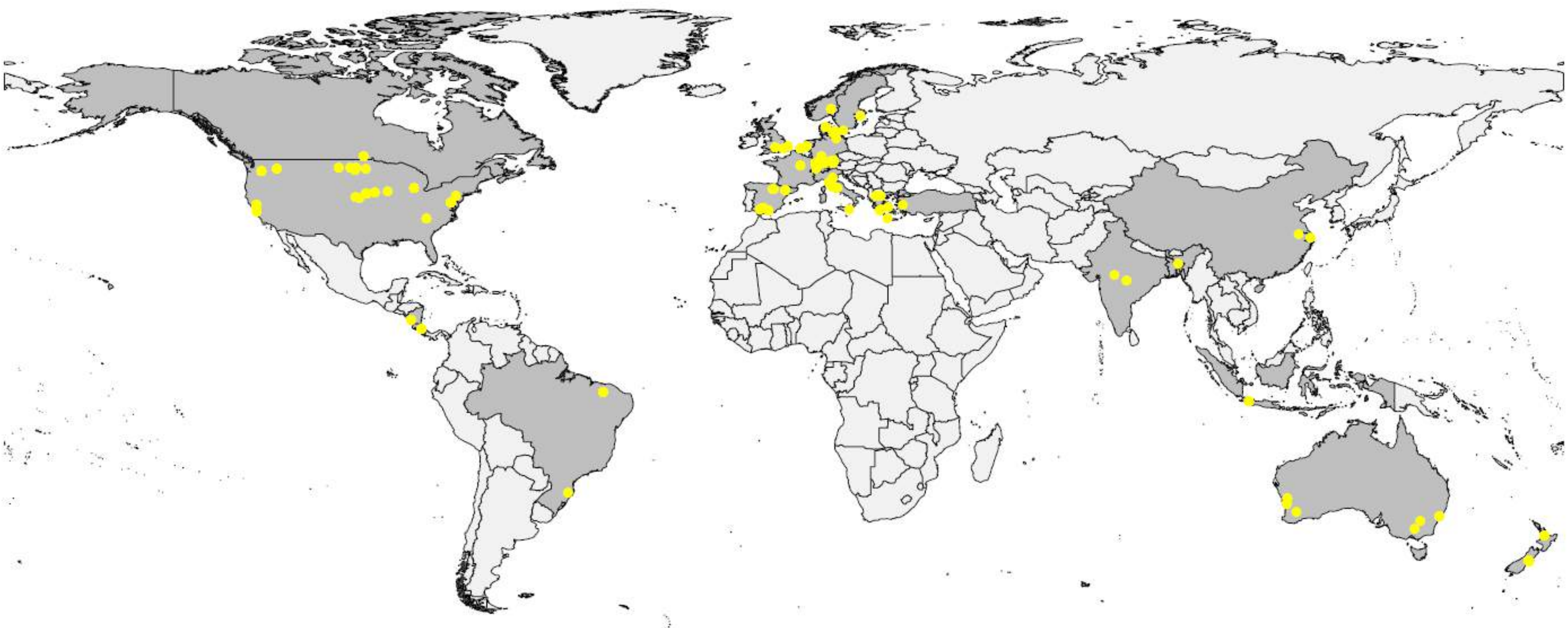
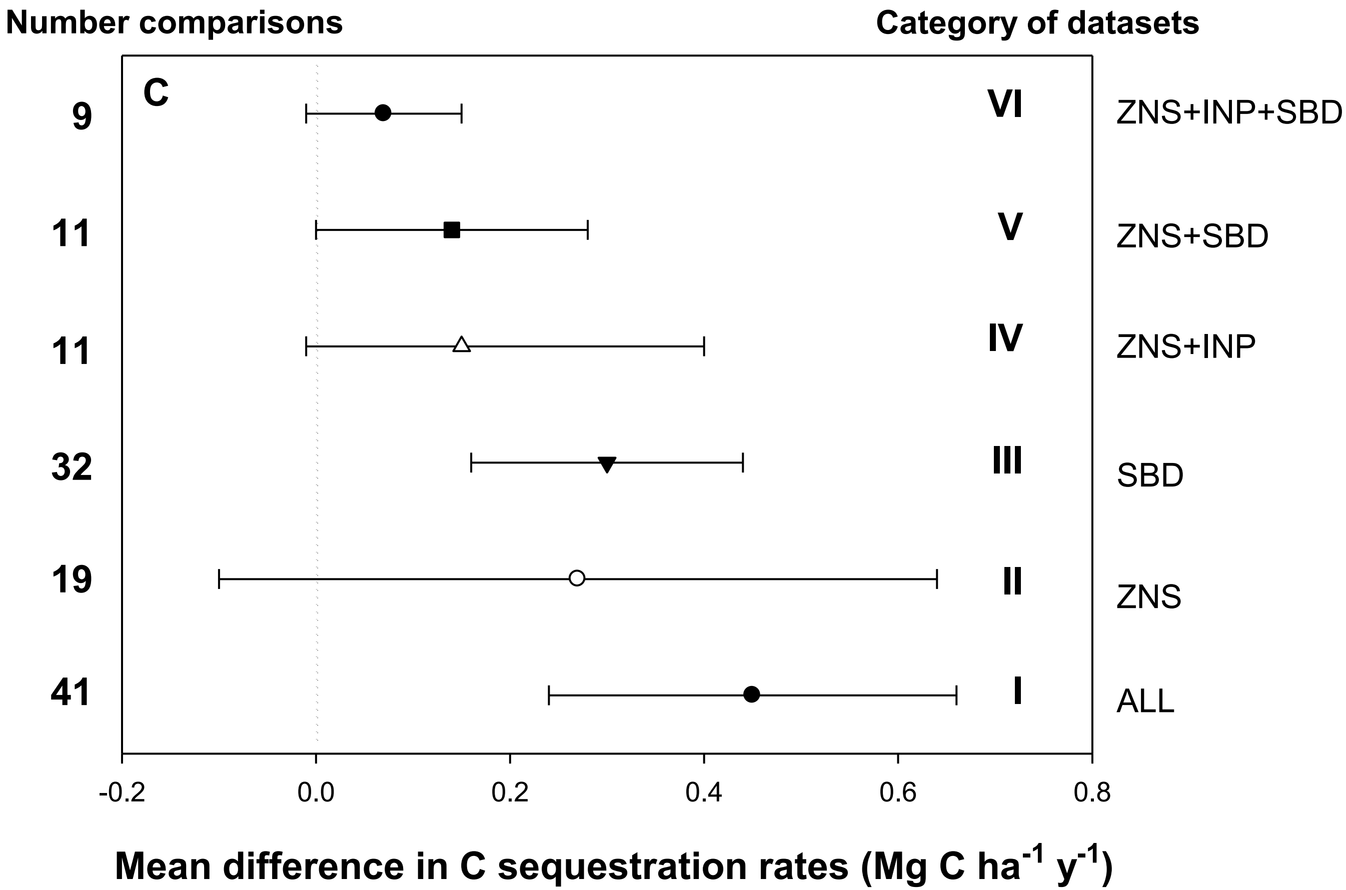
Enhanced C sequestration in organically managed soils?



74 system comparison studies, 211 comparative pairs

Gattinger et al., PNAS, 2012

Carbon sequestration in organically managed soils?



Yes. Net sequestration of 450 kg C ha^{-1} y^{-1} for all organic systems (= ; the potential is lower for for zero net input systems (< 1.O ELU ha^{-1}): 70 – 270 kg C ha^{-1} y^{-1}.

Gattinger et al., PNAS, 2012

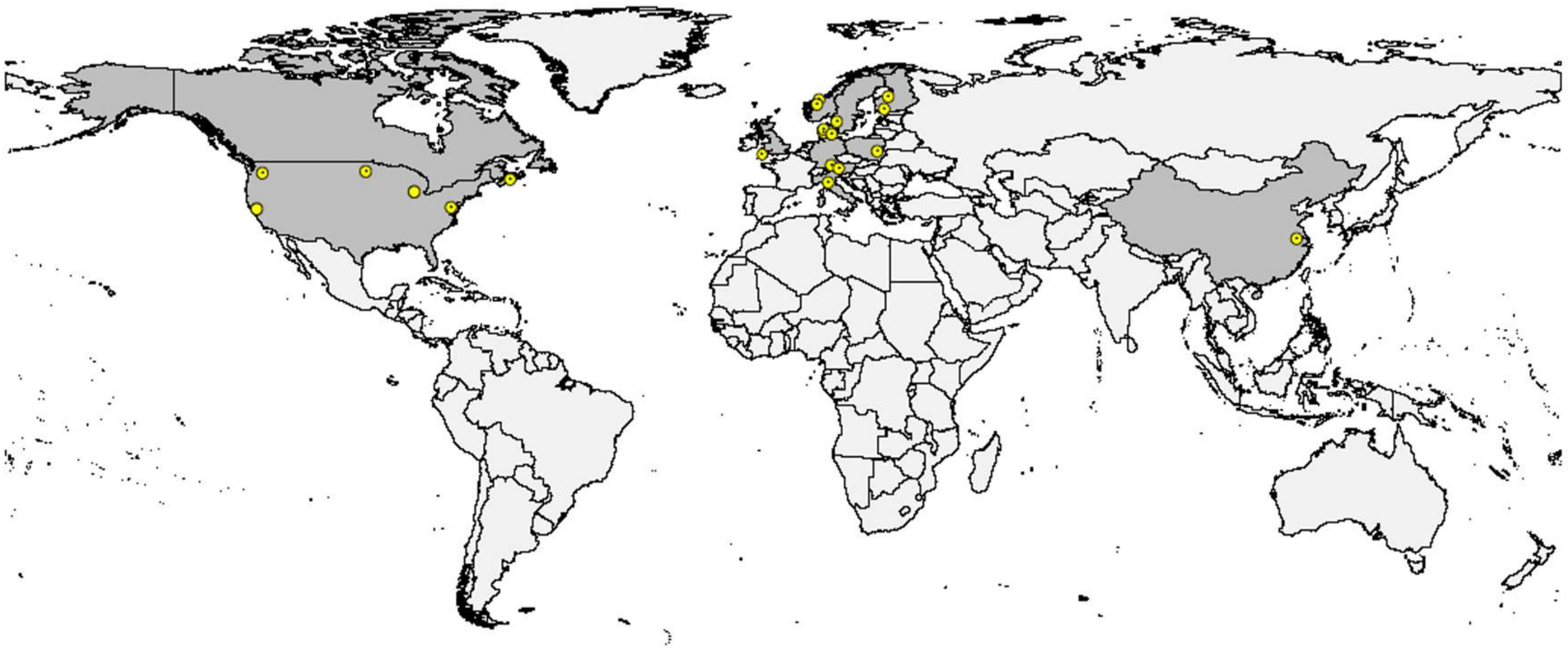
What influences differences in soil carbon?

Based on meta-regression, no significant drivers could be identified, only tendencies:

- Management effects are stronger than site factors (temperature, precipitation, clay content in soil).
- Higher inputs of external C inputs (= organic fertiliser) in organic systems (1.20 vs. 0.29 Mg C ha^{-1} y^{-1})
- Higher frequency of cropping of deep rooting forage legume in organic systems.

= typical for mixed farms

Less N_2O emissions from organically managed soils?



18 system comparison studies, 98 comparative pairs

Skinner, Gattinger et al., STOTEN, 2014

Mean differences (MD) in N_2O emissions: area-scaled

	Area-scaled GWP[d] N_2O emissions ($kg\ CO_2$ eq. $ha^{-1}\ a^{-1}$)				
land-use	MD	CI[b]	p	studies	comp.[c]
all (annual)[f]	-492	160	0.00	12	70
arable	-497	162	0.00	11	67
grassland	-1091	2531	0.40	2	3
rice-paddies	-646	1040	0.22	1	3

[b] ± 95%confidence interval (CI), [c] comparisons,
[d] Greenhouse Warming Potential (GWP)
[f] all annual measurements excl. rice

ca. 500 kg $ha^{-1}\ yr^{-1}$ <u>less</u> CO_2 eq. from organically managed soils.

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Strategies for Organic- and Low-input-farming to Mitigate and Adapt to Climate Change (SOLMACC LIFE)

- **PROJECT LOCATION: DE, IT, SE, Brussels**

- **DURATION: Start: 01/09/2013 - End: 30/09/2018**
- **PROJECT'S IMPLEMENTORS:**
  - **Coordinating Beneficiary: Ekologiska Lantbrukarna, SE**
  - **Associated Beneficiaries: IFOAM EU Group (Day-to-day Coordinator), Brussels;**
  - **AIAB (IT); Bioland Beratung GmbH (DE); FiBL Deutschland e.V. (DE)**

MAIN ACTIVITIES OF SOLMACC

- **Setting up a demonstration farm network with 12 organic farms in DE, IT and SE**

- **Training the farmers to integrate 4 climate-friendly practices into their farming system:**
  - **optimised on-farm nutrient recycling**
  - **optimised crop rotations with legume-grass leys**
  - **optimised tillage system**
  - **Agroforestry**

- **Demonstrating the practices to local farmers and stakeholders**

- **Monitoring the impact of the new practices on climate change mitigation and adaptation, economic viability and technical feasibility**

Practices on different farms in different countries: Sweden

Farm	Hånsta Ö.gärde	Trägsta Gård	Sötåsens N.gymnasium	Körslätts Gård
Improved on-farm nutrient management	On-site, mobile livestock systems	Anaerobic treatment (biogas) of liquid and solid manure	Anaerobic treatment (biogas) of liquid and solid manure	Controlled storage of on-farm residues
Optimised crop rotations with legumes	Maintenance of existing forage legumes	Extending usage of forage legume leys by 1 year	Maintenance of existing grain and forage legumes	Maintenance of existing grain and forage legumes
Optimised tillage systems	Reduced tillage through combined planting of winter and spring cereals and perennial wheat cropping	Reduced tillage through extending usage of forage legume leys	Reduced tillage and undersown crops	Reduced tillage
Agroforestry	Hedgerows and tree strips along agricultural fields	Silvopastoral system	Hedgerows and tree strips along agricultural fields	Hedgerows and tree strips along agricultural fields

Practices on different farms in different countries: Germany

Farm	Kreppold (south)	Pfänder GbR (south)	Gut Krauscha (east)	Kornkammer (west)
Improved on-farm nutrient management	Forage-manure cooperation and composting of on-farm residues	Composting of on-farm residues	Composting of on-farm residues	Anaerobic treatment (biogas) of on-farm residues
Optimised crop rotations with legumes	Introduction of grain legumes and maintenance of existing forage legumes	Maintenance of existing grain legumes as well as summer and winter green manure lay with legume grasses	Maintenance of existing grain and forage legumes	Maintenance of existing grain and forage legumes
Optimised tillage systems	Reduced tillage and undersown crops	Reduced tillage and undersown crops	Reduced tillage	Reduced tillage
Agroforestry	Hedgerows and tree strips along agricultural fields	Hedgerows and tree strips along agricultural fields	Hedgerows and tree strips along agricultural fields	Hedgerows and tree strips along agricultural fields

Practices on different farms in different countries: Italy

Farm	Azienda agricola Fontanabona	Azienda agricola Caramadre	Azienda agricola Mannucci Droandi	Azienda agricola Tamburello
Improved on-farm nutrient management	Improved composting of on-farm residues	Forage-manure cooperation and composting of on-farm residues	Improved composting of on-farm residues	Composting of on-farm residues
Optimised crop rotations with legumes	Increasing proportion of forage legumes	Increasing proportion of forage legumes	Increasing proportion of forage legumes	Increasing proportion of forage legumes
Optimised tillage systems	Reduced tillage	Minimum tillage	Minimum tillage	Minimum tillage
Agroforestry	Hedgerows and tree strips along agricultural fields	Hedgerows and tree strips along agricultural fields	Diversifying the usage of existing tree crops	Diversifying the usage of existing tree crops

"Through participating in the SOLMACC-Project I hope to find a better adapted management in my plant production. Moreover, the measurements and assessments of the climate relevance of my farm are also exiting."

Dirk Liedmann

“Thanks to the SOLMACC practices, I will play a role in the fight against the climate change!”

Claudio Caramadre

"Agricultural challenges are that we now must repair the life supporting systems such as a stable climate and beyond producing more food for more people. We want to take part in the implementation of these two tasks."
Ylva and Kjell Sjelin

Climate change mitigation potential of the different climate friendly practices in comparison to the baseline situation as determined for Farm 3 Germany (350 ha in total),

Climate friendly practice	GHG savings[1)] [t CO_2-eq./ha*year⁻
Improved on-farm nutrient management *(Removal of alfalfa instead of mulching)*	-0.90
Optimised crop rotations with legumes *(Baseline: cereals instead of broad beans, forage legumes)*	+1.01
Optimised tillage systems *(Baseline: ploughing is performed prior to all cropping phases)*	-0.085
Agroforestry (tree biomass: 5,74 t[2)]; soil: 1,67 t/ha*year) *(Baseline: no hedgerows and buffer strips, fossil energy use for heating)*	-7.41

In average: -0.37 t CO_2 eq./ha

[1)] Savings refer to one hectare of the area the practice is applied on.

[2)] CO_2 storage in the trees refer to an annual wood extraction of 20% of the area.

Climate change mitigation potential of the different climate friendly practices in comparison to the baseline situation as determined for Farm 4 (Kornkammer), Germany

Climate friendly practice	GHG savings[1)] [t CO_2-eq./ha*year-
Improved on-farm nutrient management	-2.40
Optimised crop rotations with legumes	-1.55
Optimised tillage systems	-0.57
Agroforestry (tree biomass: 3.723 kg[2)]; soil: 1668 kg/ha*year)	-4.18

In average: -0.94 t CO_2 eq./ha

[1)] Savings refer to one hectare of the area the practice is applied on.
[2)] CO_2 storage in the trees refer to an annual wood extraction of 20% of the area.

Climate change mitigation potential of the practice 2 in comparison to the baseline situation as determined for Farm 2 (Trägsta Gard), Sweden

Climate friendly practice	GHG savings[1)] [t CO_2-eq./ha*year$^-$
Optimised crop rotations with legumes	-0.11

In total: -5,2 t CO_2 eq./farm

[1)] Savings refer to one hectare of the area the practice is applied on.
[2)] CO_2 storage in the trees refer to an annual wood extraction of 20% of the area.

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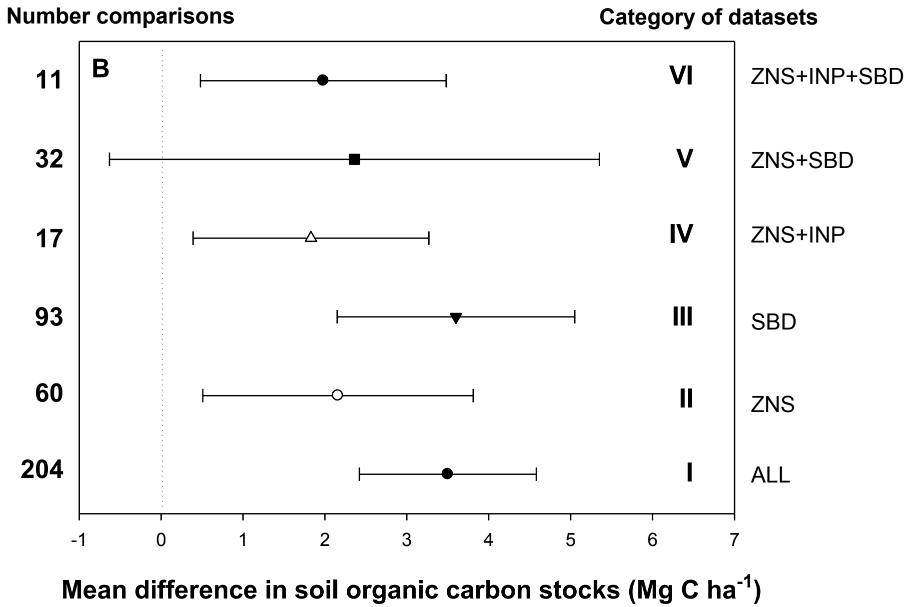
Soil fertility – an important driver for climate change adaptation

Foto: Alföldi, FiBL

More soil organic matter under organic farming?



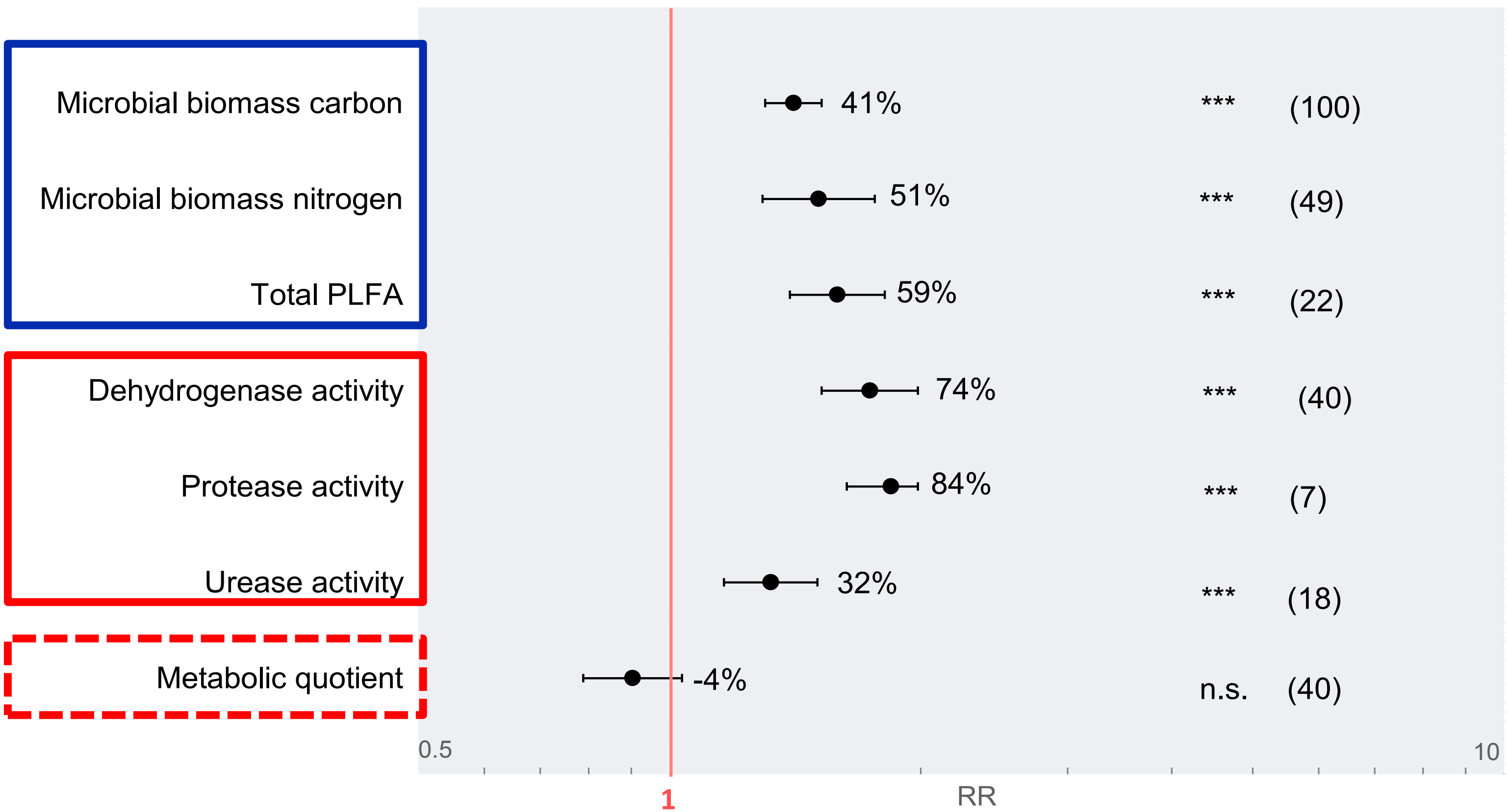
Yes. Higher SOC stocks (3.50±1.08 Mg C ha^{-1})
in topsoils (0-20 cm) under organic farming management.

Gattinger et al., PNAS, 2012

Consequences of more soil organic matter...

- **Higher soil aggregate stability** (Gerhardt, 1997; Siegrist et al., 1998; Brown et al., 2000; Maeder *et al.*, 2002; Pulleman et al., 2003; Williams & Petticrew, 2009).
- **Higher water holding capacities and more soil water** (Brown et al., 2000; Lotter et al., 2003; Pimentel et al., 2005)
- **Enhanced water infiltration** (Lotter et al., 2003; Pimentel et al., 2005; Zeiger & Fohrer, 2009).

….and more (microbial) soil life



Ecoserve Project: Lori et al., in prep.

Soil structure after 21 years

Bio-dynamic farming

Integrierted production (IP), without livestock

Mäder et al. 2002, Science

…after heavy rain

Bio-dynamic farming

Integrierted production (IP), without livestock

Fotos: Fliessbach, Nov. 2002

Summary and conclusions

- **Enhanced C sequestration and reduced in N_2O emissions in organically managed soils**
- **Results from SOLMACC (on-farm trials) suggest that all farms are able to reduce their GHG emissions by 15%**
- **Because of the systems-approach also other impact categories are addressed in climate-friendly organic farming practices**

SOL MACC
ORGANIC FARMERS COUNTERING CLIMATE CHANGE

Life

http://solmacc.eu/