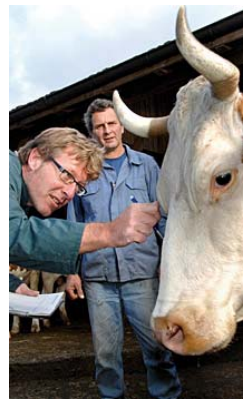
FiBL
EXCELLENCE FOR SUSTAINABILITY

Research Institute of Organic Agriculture
Forschungsinstitut für biologischen Landbau
Institut de recherche de l'agriculture biologique








State-of-the-art concerning carbon sequestration in organic agriculture versus emission of GHG and potential for climate mitigation compensation

Andreas Gattinger
(andreas.gattinger@fibl.org)

Round Table on Organic Agriculture and Climate Change

Contents

- Organic farming and soil carbon sequestration – state of the art
- Organic farming and GHG emissions from soils – state of the art
- Potential for compensation of climate change mitigation
- Conclusions

Contents

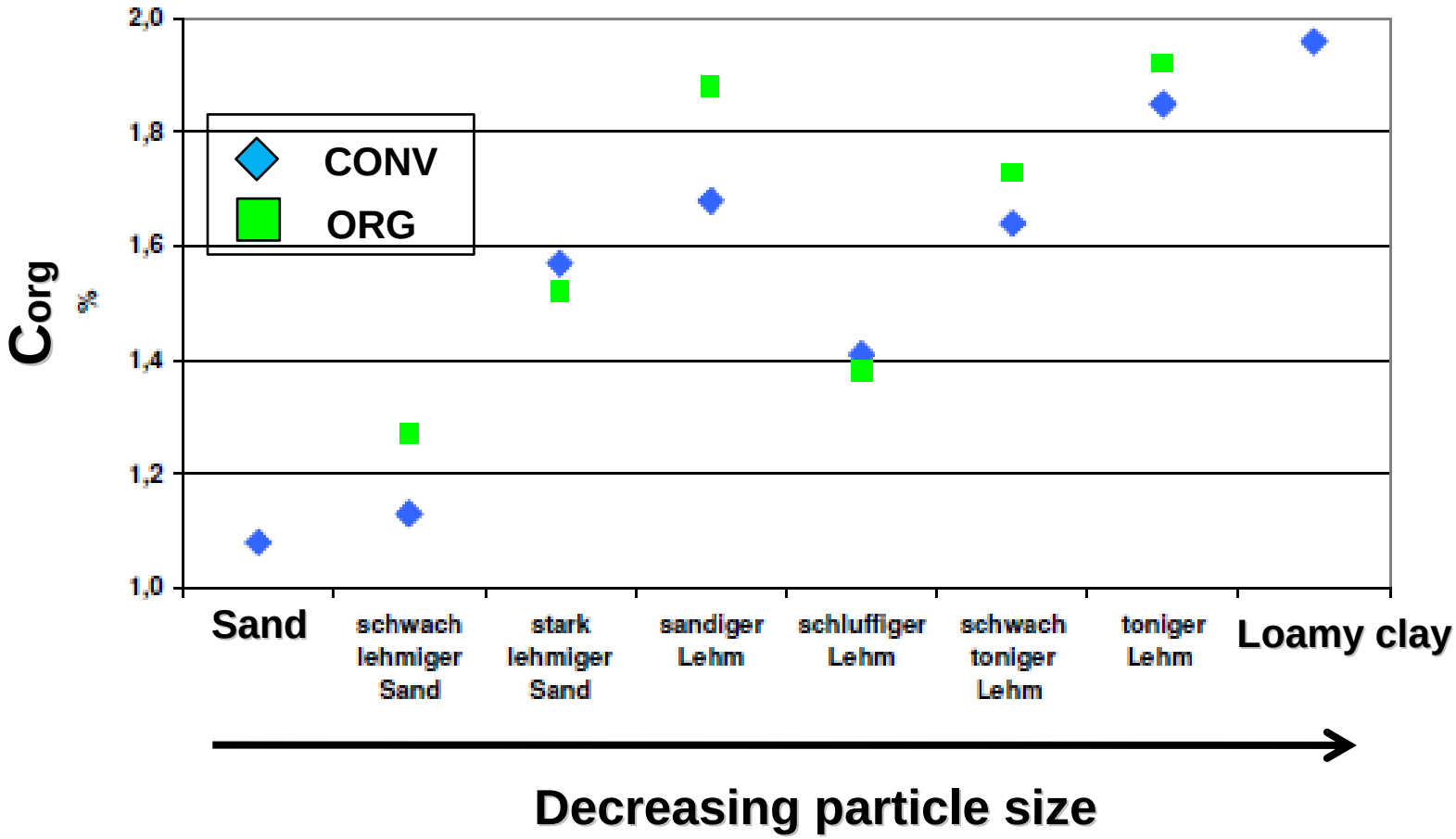
- Organic farming and soil carbon sequestration – state of the art
- Organic farming and GHG emissions from soils – state of the art
- Potential for compensation of climate change mitigation
- Conclusions

Soil organic matter and organic farming

- Increasing and maintaining soil organic matter (SOM) is a core principle in organic farming
- It is essential for plant nutrition and soil fertility built-up in organic (= low external input) farming systems
- Diverse and legume containing crop rations and organic manuring are integral measures in OF
- Hence SOM (= soil carbon sequestration) levels are higher under OF practices?

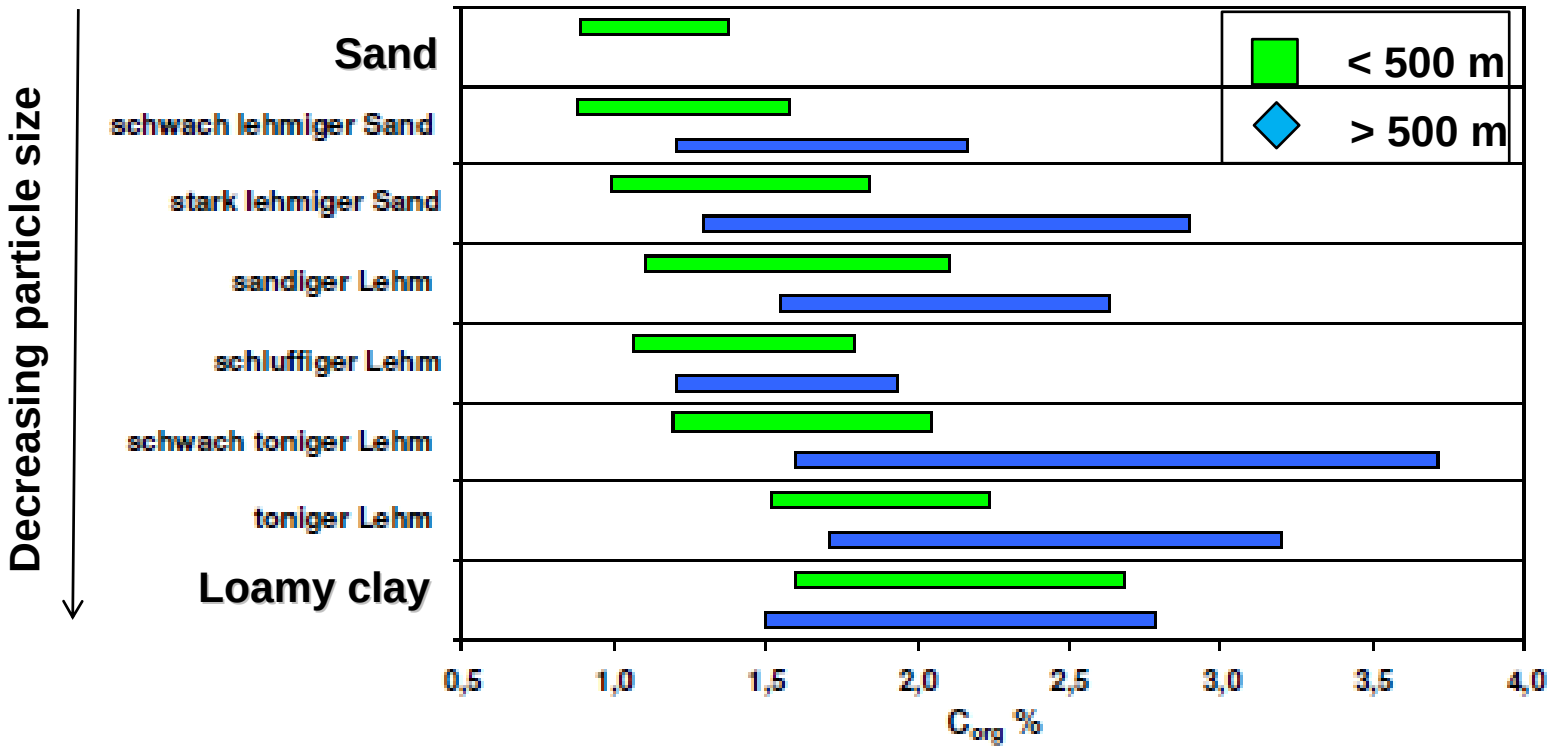
Influence of soil texture on organic matter contents in soil under “ORG” and “CONV” management

(Soil monitoring on practical farms, Bavaria)



(n = 1542: conv. = 1232; org. = 310) Capriel, 2006

Influence of climate (i.e. altitude) on organic matter contents in soil



(n = 1542) Capriel, 2006

(I) Carbon sequestration in long term experiments

(Niggli et al. 2009; non peer-reviewed: 7 studies; 5 comparisons)

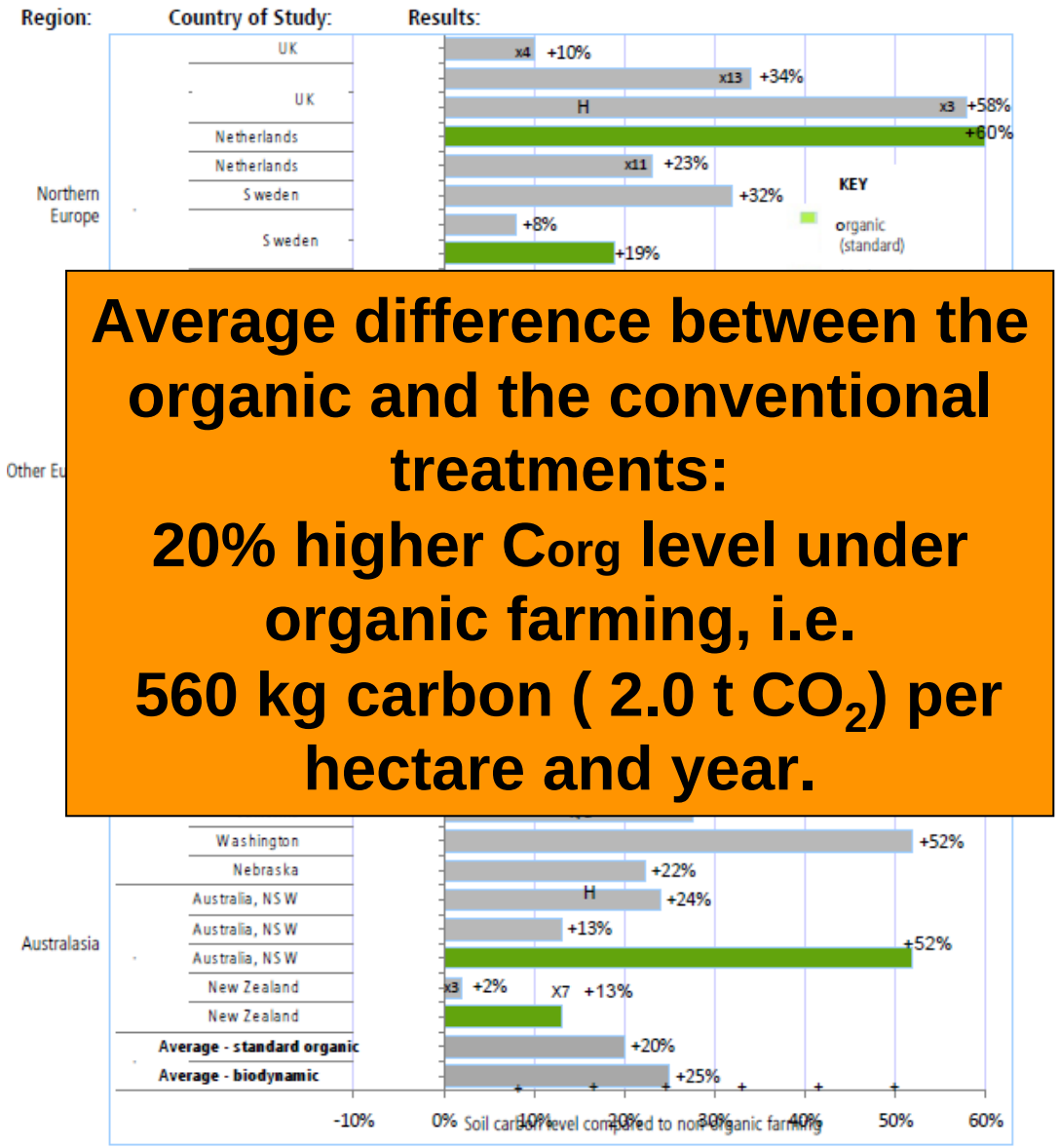
Field trial	Components compared	Carbon gains (+) or losses (-) kg ha^{-1} yr^{-1}
DOK experiment, CH (Mäder, et al. 2002; Fliessbach et al., 2007) Running since 1977	Organic, FYM composted	+ 42
	Organic, FYM fresh	-123
	IP, FYM, mineral fertilizer	-84
	IP, mineral fertilizer	-207
SADP, USA, (Teasda		+ 810 resp + 1783
2007), 1994 to 2002		0
Rodale FST, USA, (H		1218
al., 2006; Pimentel, et		857
Running since 1981		217
Scheyern Experiment		+ 180
(Rühling, et al. 2005)		- 120
Frick reduced tillage e		0
(Berner, et al., 2008), since 2002	Organic, reduced tillage	879

Average difference between the best organic and the conventional treatments: 590 kg carbon (2.2 t CO_2) per hectare and year.

Niggli, U., *Fließbach*, A., Hepperly, P. and *Scialabba*, N., 2009. *ftp://ftp.fao.org/docrep/fao/010/ai781e/ai781e.pdf*

(II) Carbon sequestration in long term experiments

(Soil Association 2009; non peer-reviewed: 39 studies, more than 100 comparisons)



Average difference between the organic and the conventional treatments:
20% higher C_{org} level under organic farming, i.e.
560 kg carbon (2.0 t CO_2) per hectare and year.

(III) Carbon sequestration under organic farming

(Leifeld & Fuhrer 2010; peer-reviewed: 32 studies; 68 comparisons)

Table 2 Overview of key data for the comparison of organic versus conventional farming including relative SOC change rates per year

Experiment setup (from-to)[a]	Duration (years)[d]	Depth (cm)[e]	Annual change[f] (percent)					N[h]
			Total	Experiment type[g]		SOC measure		
				Plot	Farm	Concentration	Mass	
con–con	12, 13.1 (3–27)	20, 20 (7.5–30)	−0.16 (0.45)	−0.16 (0.45)	–	−0.21 (0.64)	−0.03 (0.19)	14
con–org								20
								34

- **2.2% annual C_{org} increase under organic, no increase under conventional farming**
- **differences due to often disproportionate application of organic fertiliser**
- **No data from developing country included**

[a] con–con c… …ith either (b) change r… …s without reference to…

[b] Relative t…

[c] Relative t…

[d] Median, r…

[e] Median, mean (min and max)

[f] Mean carbon change rate per year (percentage of reference) relative to starting value or conventional control, 1 SE in parenthesis

[g] *Plot* controlled field experiment, *Farm* comparison of adjacent farms

[h] Number of data sets for three experimental set-ups

(IV) Carbon sequestration under organic farming

(Gattinger et al., in preparation)

- Until now 60 peer-reviewed studies were collected
- Review will be based on meta-analysis and multiple analysis of variance

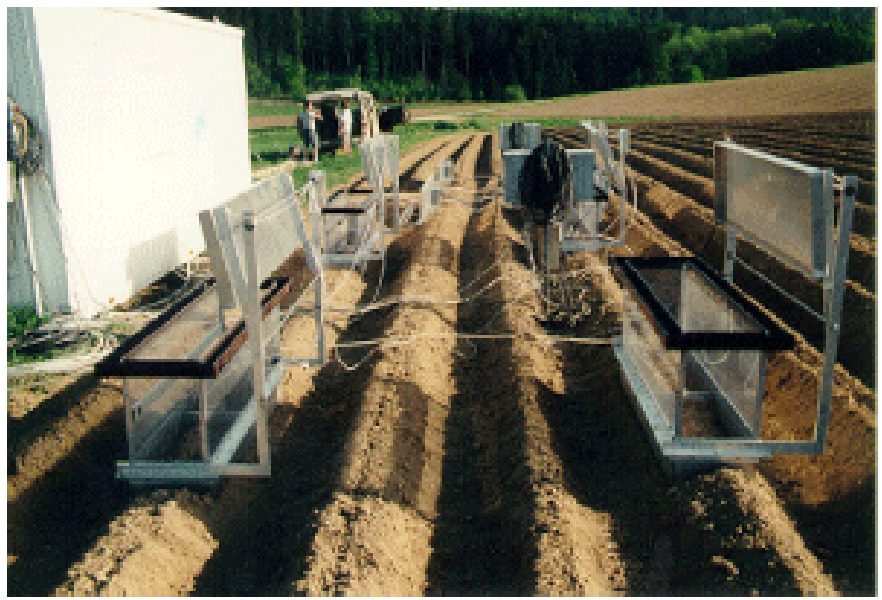
•No results yet!
•Until now only 4 studies from developing countries. No African study at all.
•Request for further reliable data sets!!!

Contents

- Organic farming and soil carbon sequestration – state of the art
- Organic farming and GHG emissions from soils – state of the art
- Potential for compensation of climate change mitigation
- Conclusions

GHG emissions and organic farming

- Nitrogen fixing legumes, green and organic manuring are key elements in organic crop rotation and bear the potential of N_2O losses when incorporated/applied to the soil.
- Easily available synthetic N fertiliser can be applied according to the plant nutrient status.
- But far more less (non easily availabe organic) N fertiliser are applied in organic farming.
- Hence GHG emission rates (esp. N_2O) are lower under OF practices?



GHG emission from soils under conventional and organic management

- Very poor data base
- Only very few system comparisons based on field measurements

•No evidence-based review yet
•Data only for northern countries
•Request for further field measurements and reliable data sets!!!

GHG emission from soils under conventional and organic management (preliminary compilation)

	Type of study	CON > ORG	CON = ORG	CON < ORG
Petersen, 2006: A, DK, FIN, I, GB	Field measurement	x		
Chirinda, 2010: DK	Field measurement		x	
Küstermann, 2008: D	Modelling	x		
Flessa, 2002: D	Field measurement	x*		
Sehy, 2003: D	Field measurement	x*		
Lynch, 2008: Canada	Field measurement	x		
Nemecek, 2005: CH	Life cycle assessment	x**		
Hansen, 2008: N	Field measurement	x		

* no difference when related to unit of yield
** lower GHGE in ORG when related to unit of yield

Contents

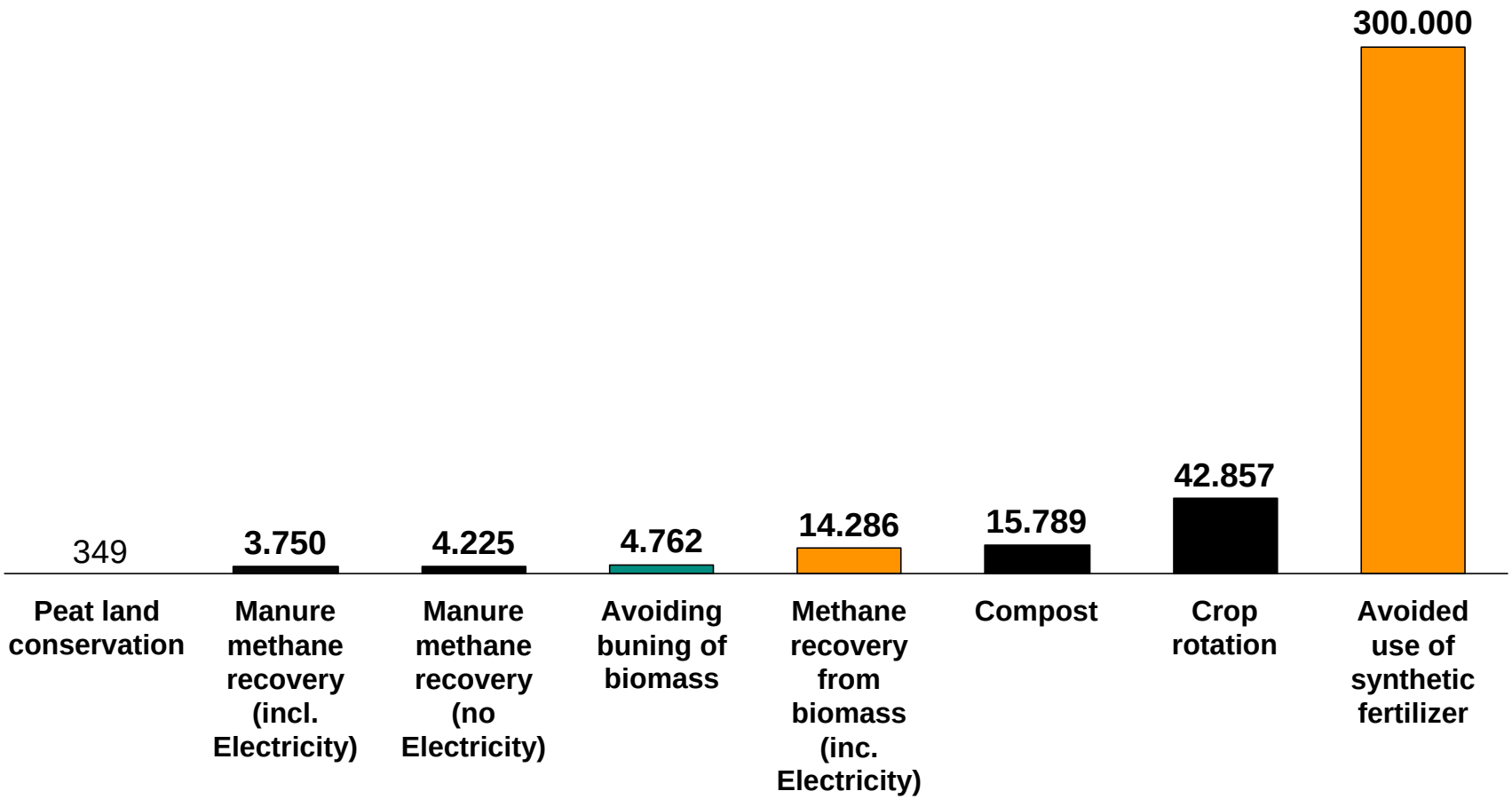
- Organic farming and soil carbon sequestration – state of the art
- Organic farming and GHG emissions from soils – state of the art
- Potential for compensation of climate change mitigation
- Conclusions

Mitigation practices/methodologies typical for sustainable farming practices

- Fertilizer replacement
- Composting
- Soil Carbon Sequestration (no approved methodology yet)
- Methane recovery from manure
- Avoided biomass burning
- Agroforestry
- Biogas electricity
- Crop rotation with legumes (no approved methodology yet)

Most agricultural projects need to be big to achieve critical size

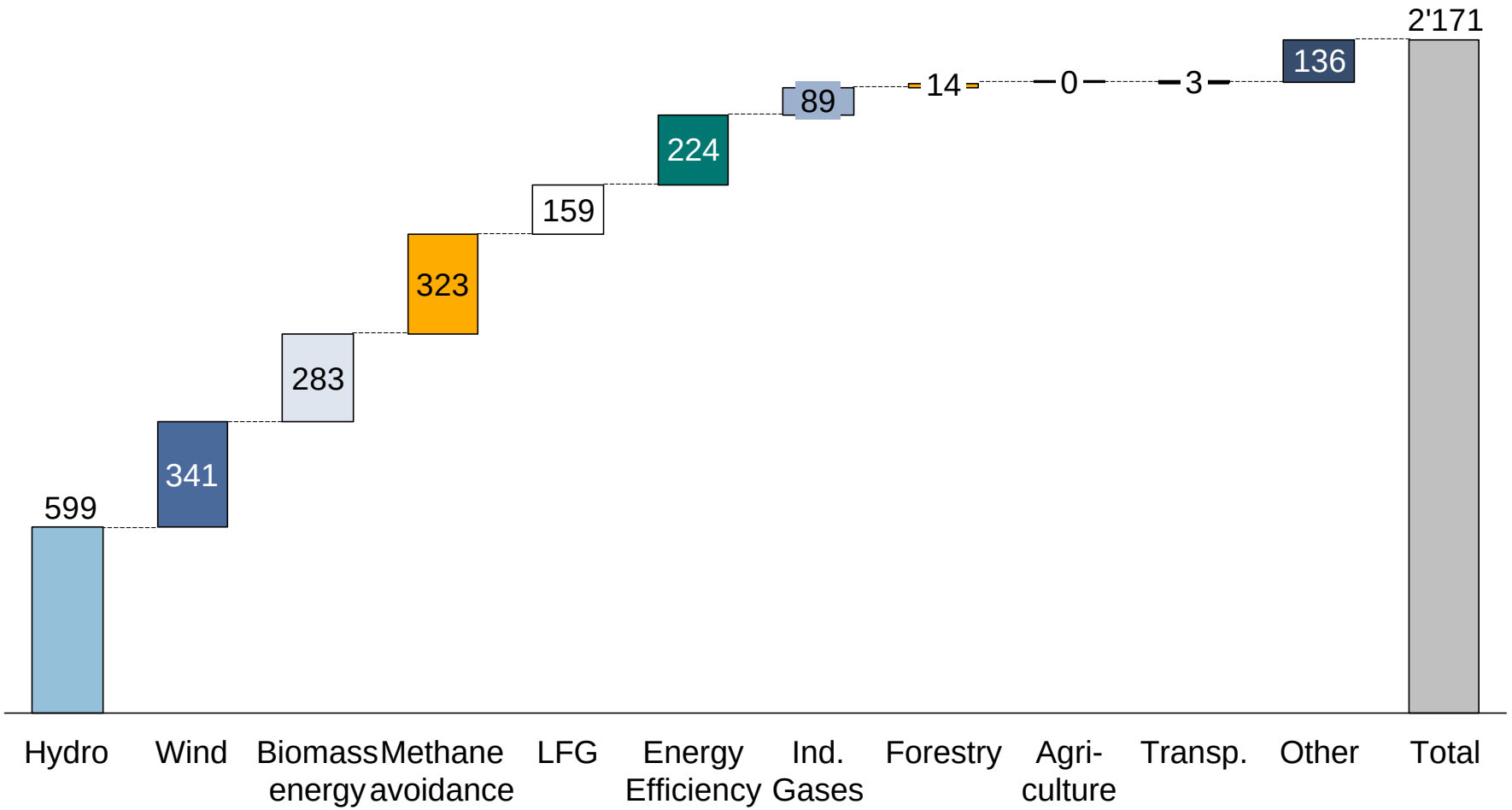
Project size in ha to achieve 30‘000t CO2e/a



(Source: Elaboration of new methodologies for organic farming greenhouse gases mitigation projects, South Pole 2010)

…. and only few project types

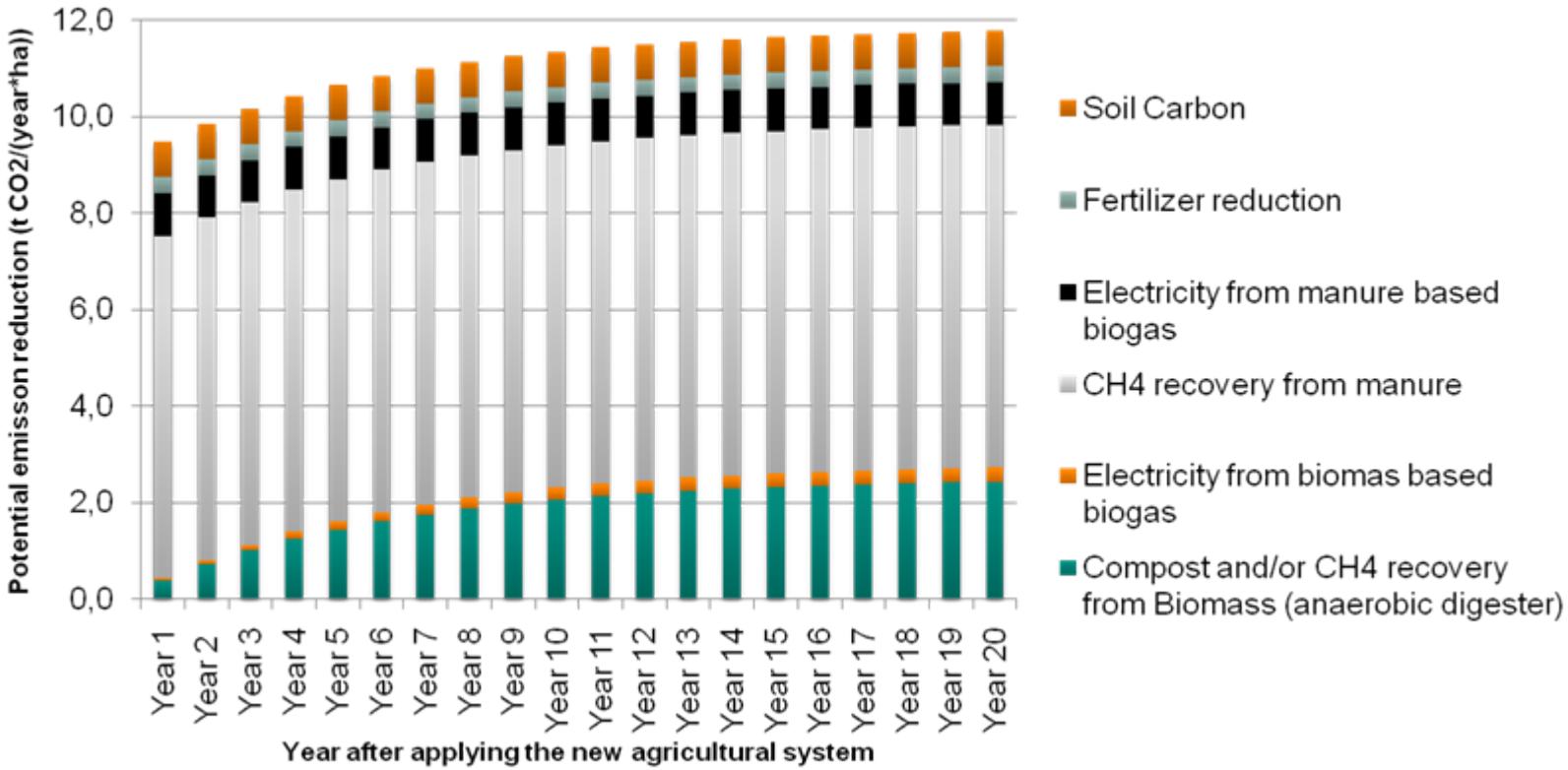
Number of CDM projects per sector* (Status 1 May 2010)



* Source: UNEP Risoe CDM pipeline, 01.05.2010

Combination of methodologies in the context of organic farming

Estimation based on an optimised crop rotation including optimized manure handling



(very rough and preliminary numbers!!!)

…an even higher potential when mitigation practices are combined with co-benefits of OF

The generation of co-benefits for mitigation projects in developing countries as a result of the carbon credit trading. These are:

- **Positive environmental impacts: soil fertility, biodiversity, resource conservation**
- **Contribution to food security: yield increase and yield security**
- **A new income opportunity for small holders: empowerment, food security**

Many different voluntary standards exist, of which the most important are the Gold Standard...

Aims

Quality label which guarantees**:**

- Effective emission reductions
- Direct contributions to sustainable developement

Founded by WWF & other NGOs

Requirements

- Increased **consultation of local stakeholders**
- Limited **to ER and EE project**
- Verification of **sustainable development indicators**

Characteristics

- Sell at **higher prices**
- **Greater post-2012 security**
- **Simplified approval procedure** for micro projects (ER<5000pa)

South Pole Specializes in Gold Standard projects

http://www.cdmgoldstandard.org/

Contents

- Organic farming and soil carbon sequestration – state of the art
- Organic farming and GHG emissions from soils – state of the art
- Potential for compensation of climate change mitigation
- Conclusions

Conclusions

- No consolidated data available yet on carbon sequestration and GHG fluxes under organic farming practices
- Pairwise field/farm trials are necessary (esp. GHG fluxes) combined with process models for further upscaling
- Organic farming practices offer potential for compensation of climate change mitigation


Thank you very much for your attention!