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

Carbon sequestration and greenhouse gas emissions in organically managed soils – results from the CaLas project

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Aims of the CaLas project (I)

The project “Carbon credits for sustainable land use systems (CaLas)” aims at quantifying the particular climate relevance of organic farming systems regarding:

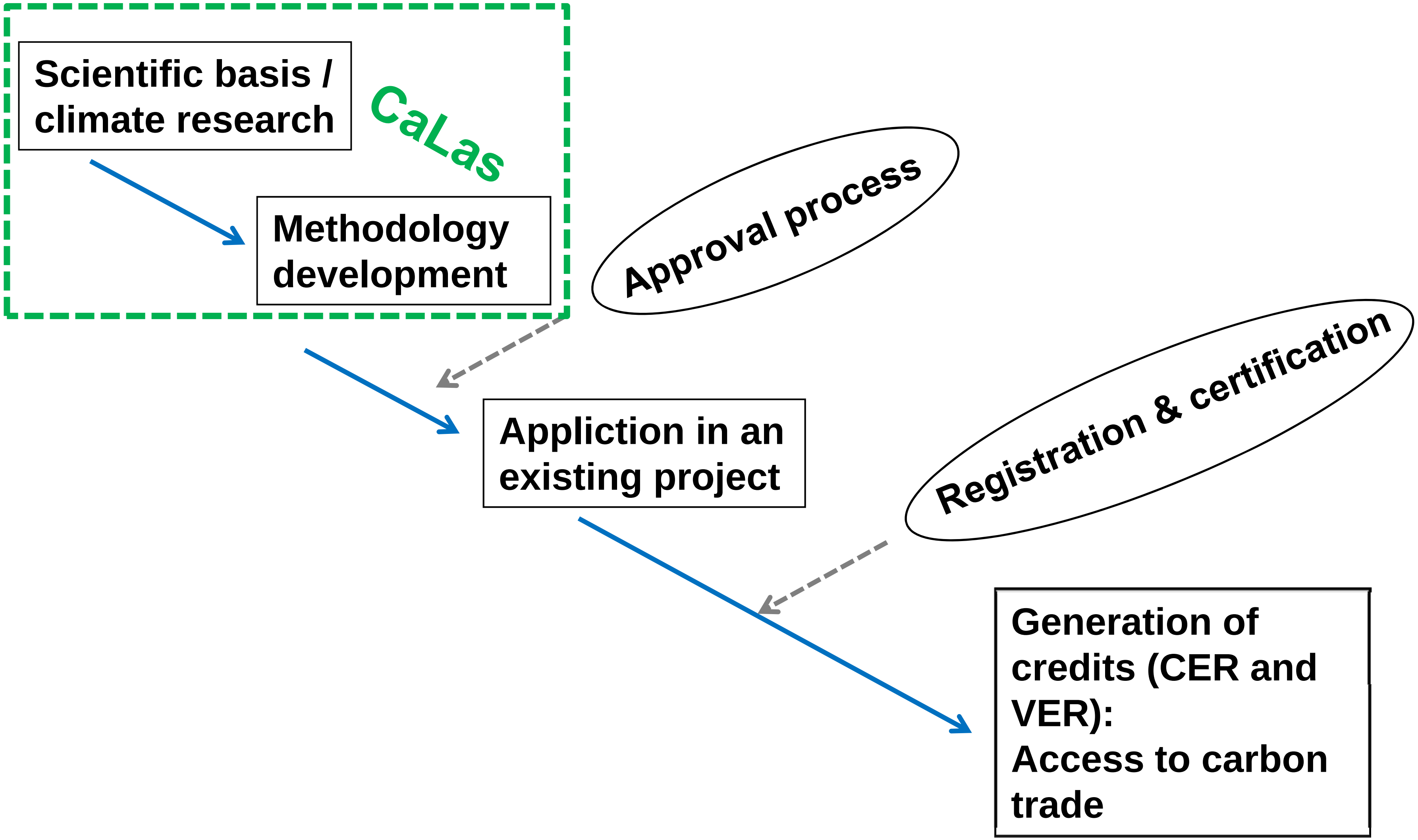
- carbon sequestration
- nitrous oxide and methane emissions from soils
- Based on this knowledge carbon-offset methodologies are developed/improved to enable the participation in the trade of carbon credits from sustainable (= organic) land use systems.

Aims of the CaLas project (II)

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

Organic Agriculture and Carbon Offset:
From Research to Carbon Trade



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Carbon levels in agricultural soils under organic and non-organic management – a meta analysis

A. Gattinger, M. Häni, A. Muller, C. Skinner, A. Fließbach, N. Buchmann, P. Mäder, M. Stolze, N. El-Hage Scialabba, U. Niggli

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Aims of the meta study

- Quantifying differences in 1) soil organic carbon concentrations, 2) stocks and 3) sequestration rates in soils under organic and non-organic management

- Analysing factors influencing observed soil carbon differences between organic and non-organic management:
  - Land use (arable, grassland, etc.)
  - pedo-climatic properties (temperature, precipitation, clay content)
  - mangement factors: organic fertilisation, crop rotation

Approach

1. Literature search
2. Literature review/evaluation
3. If positive: integration into data matrix and parametrisation
4. Meta analysis with *Comprehensive Meta Analysis* software.
   Effect sizes (= target variables): soil organic carbon (SOC) concentration, SOC stocks, SOC sequestration

Qualifying criteria for eligible publications

- Only reviewed papers: a) peer-reviewed scientific journals b) conference proceedings/book chapters/dissertations reporting measured soil organic carbon data

- Only experiments were included where the relevant organic farming principles were applied for at least three consecutive years.

- Only studies based on pairwise comparisons (under similar site conditions) for organic and non-organic (i.e. conventional, integrated) farming practices are considered

Overview of the obtained „soil carbon“ publications for meta-analysis

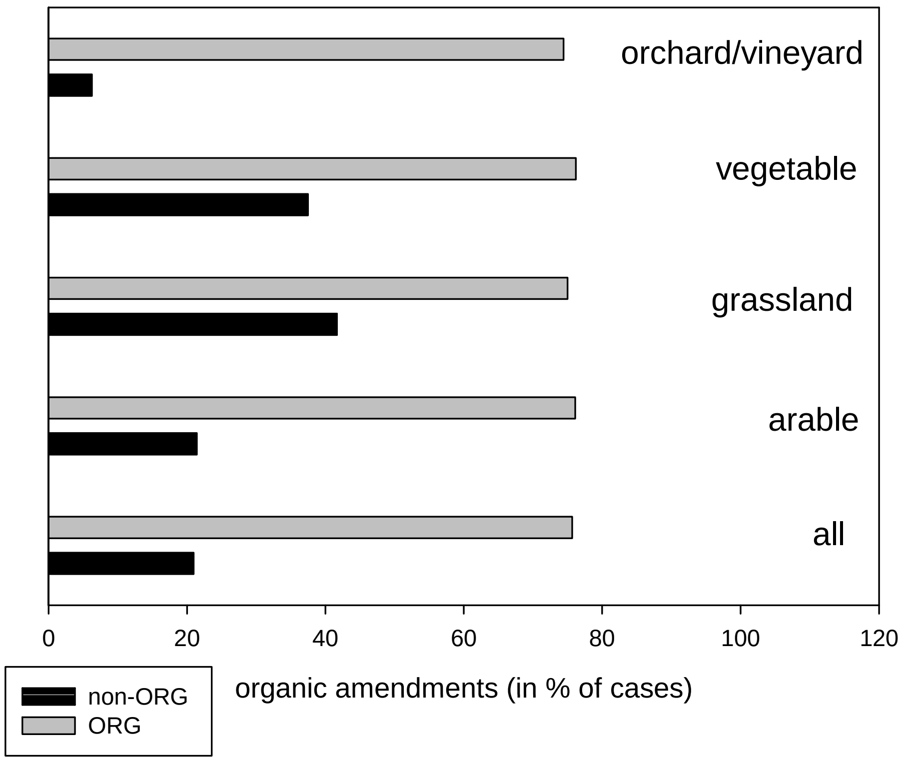
Criterion	SOC concentration (%)	SOC stocks (Mg C/ha)	SOC sequestration (Mg C/ha*yr)
Type of publications			
Scientific journals	71	32*	18**
Dissertations/book chapters/proceedings	4	7*	3**
Type of comparisons			
plot scale	26	23	20
farm scale	48	16	1
Coverage of landuse types:	full coverage	full coverage	only arable and vegetables
Coverage of climatic zones	6 from 8 (except boreal and arid)	5 from 8	5 from 8
Coverage of regions	except Africa	except Africa	except Africa
Average sampling depth	1.9 - 18.9 cm	2.2 - 19.6 cm	0.7 - 22.6 cm
Average farming system comparison	13.1 years	15.0 years	12.4 years

*29 out of 39 studies report measured bulk densities, for the other 10 these were estimated

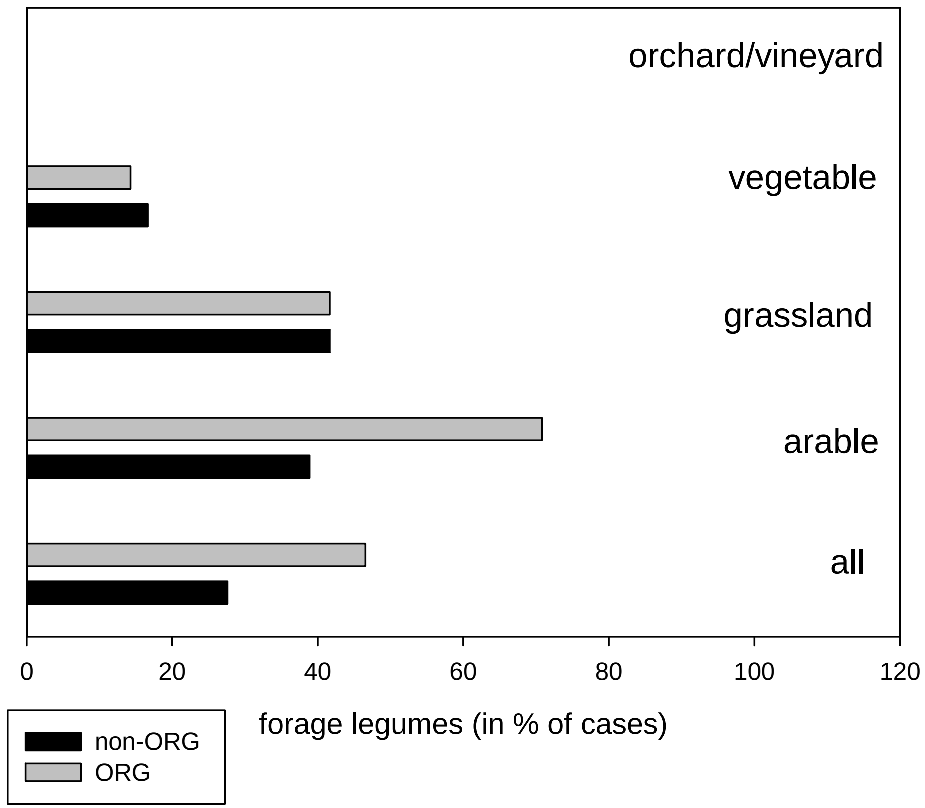
**11 out of 21 studies report measured bulk densities, for the other 10 these were estimated

Management characteristics I

external annual organic amendments

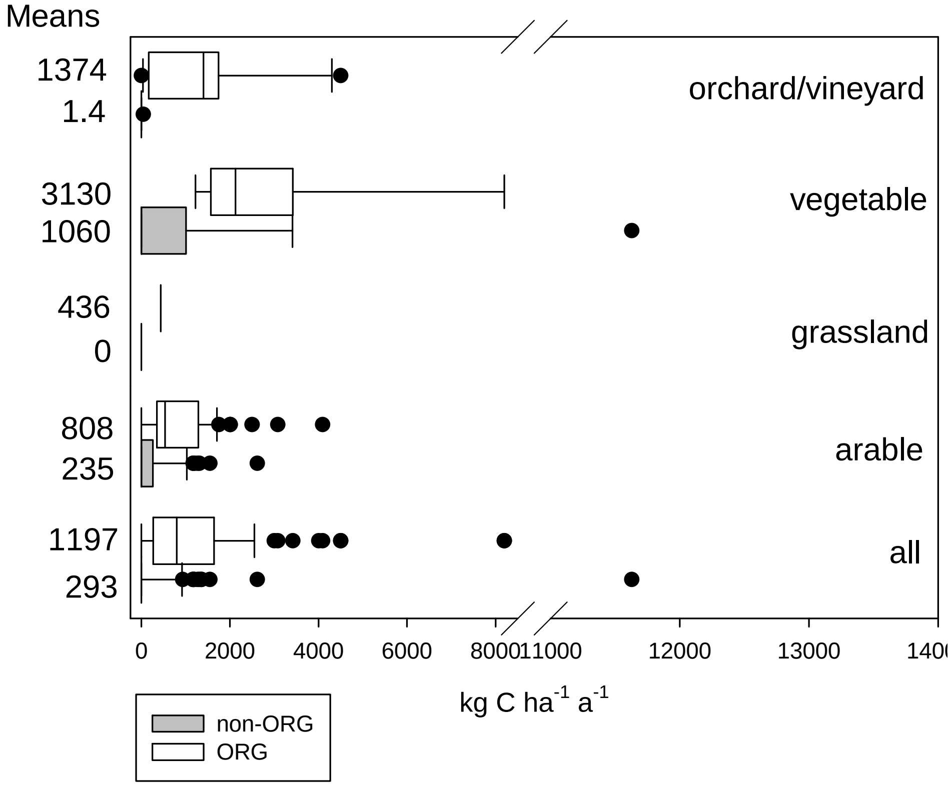


forage legumes included

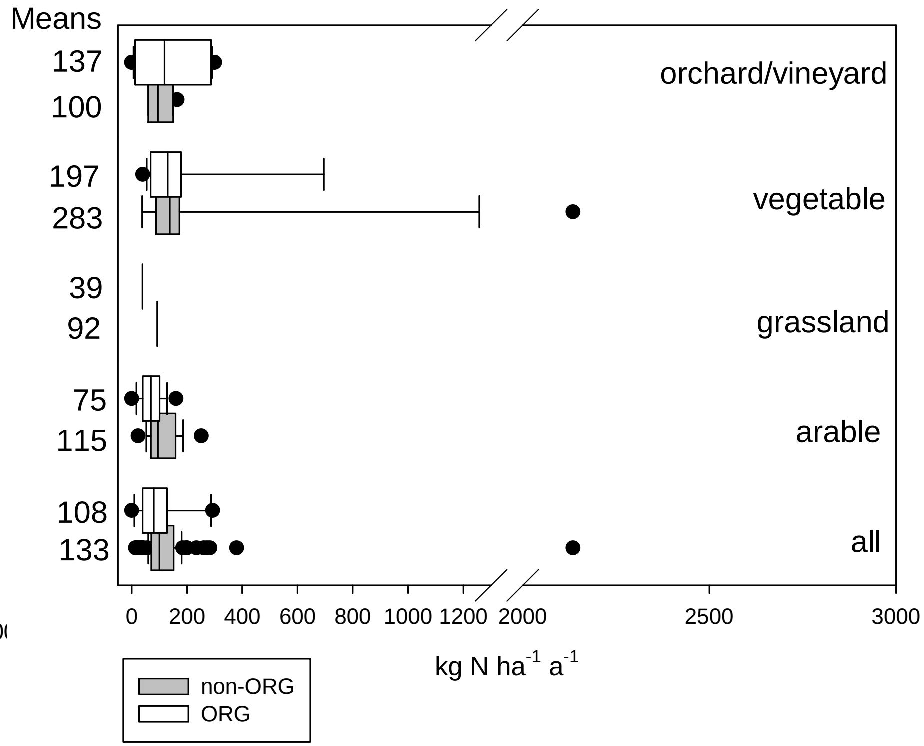


Management characteristics II

external annual C input (only organic fertiliser)



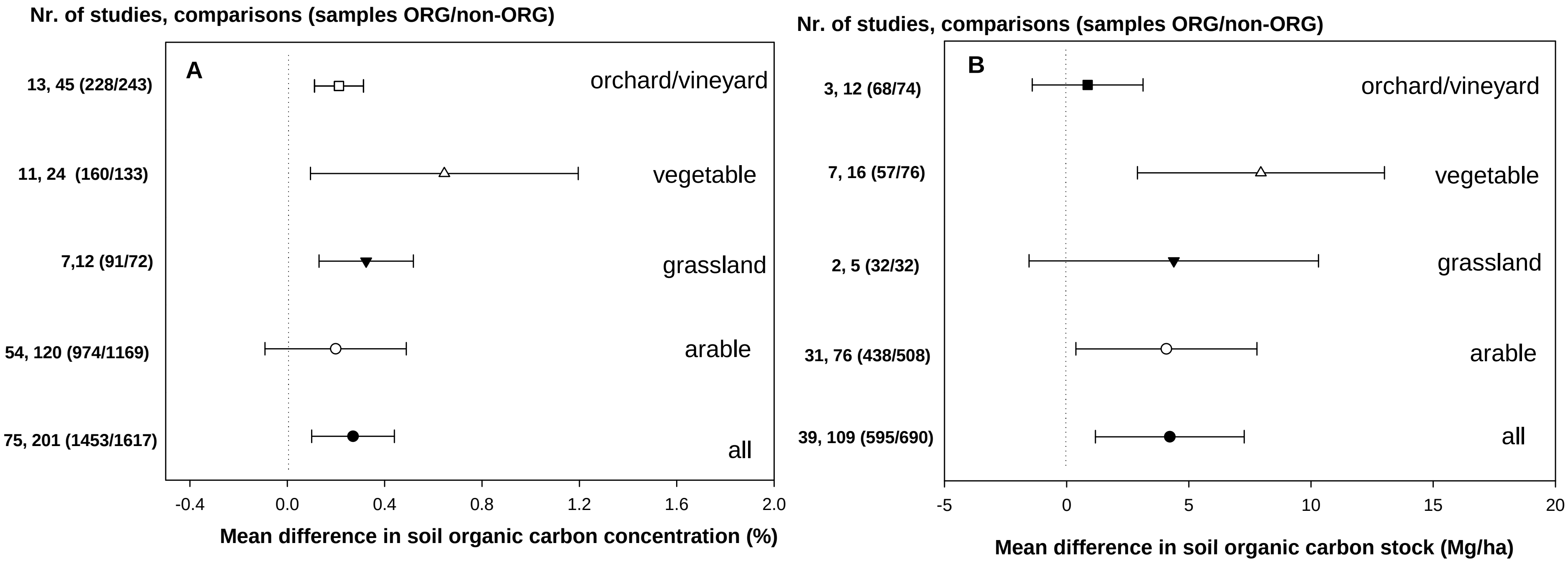
external annual N input (only manure and synthetic fertiliser)



More carbon in organically managed soils?

Soil organic carbon concentrations

Soil organic carbon stocks



in total: 189 organic and 210 non-organic treatments (= cases)

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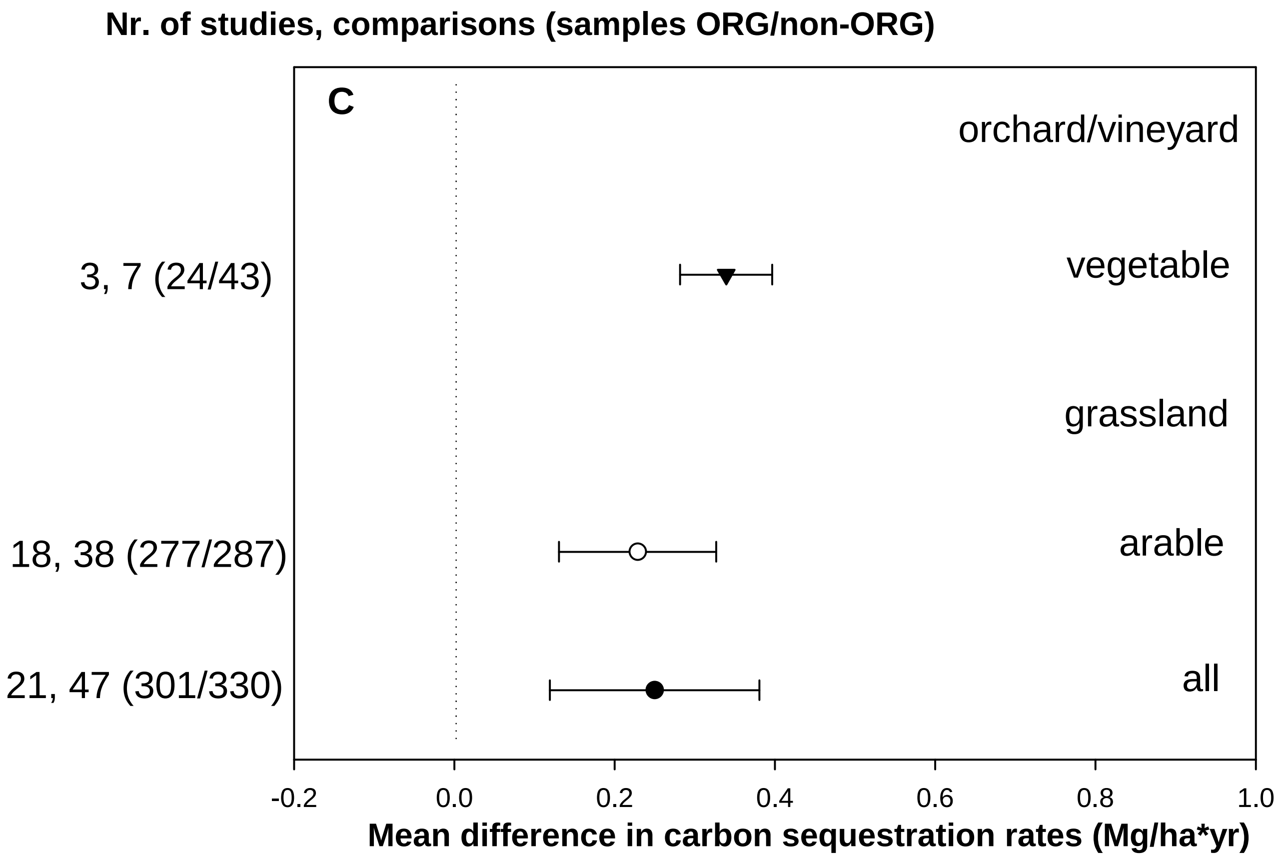
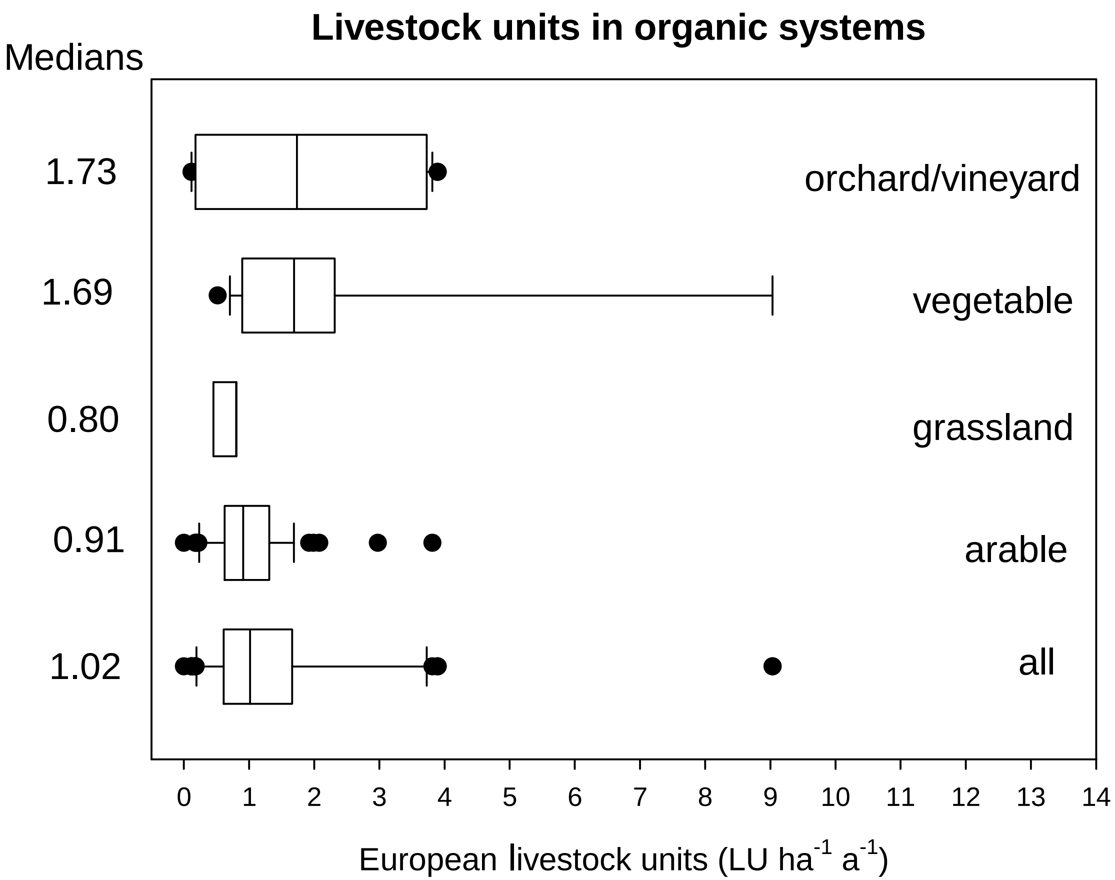
Do organically managed soils act as carbon sinks?



Are we moving carbon from non-organic to organic farming systems – the leakage problem?



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Greenhouse gas emissions from agricultural soils under organic and non-organic management – a meta analysis

C. Skinner, A. Gattinger, A. Muller, A. Fließbach, P. Mäder, M. Stolze, U. Niggli

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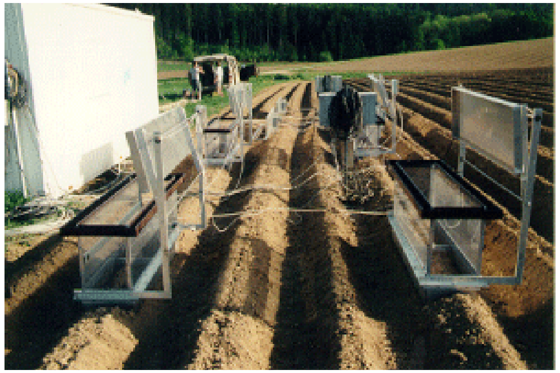
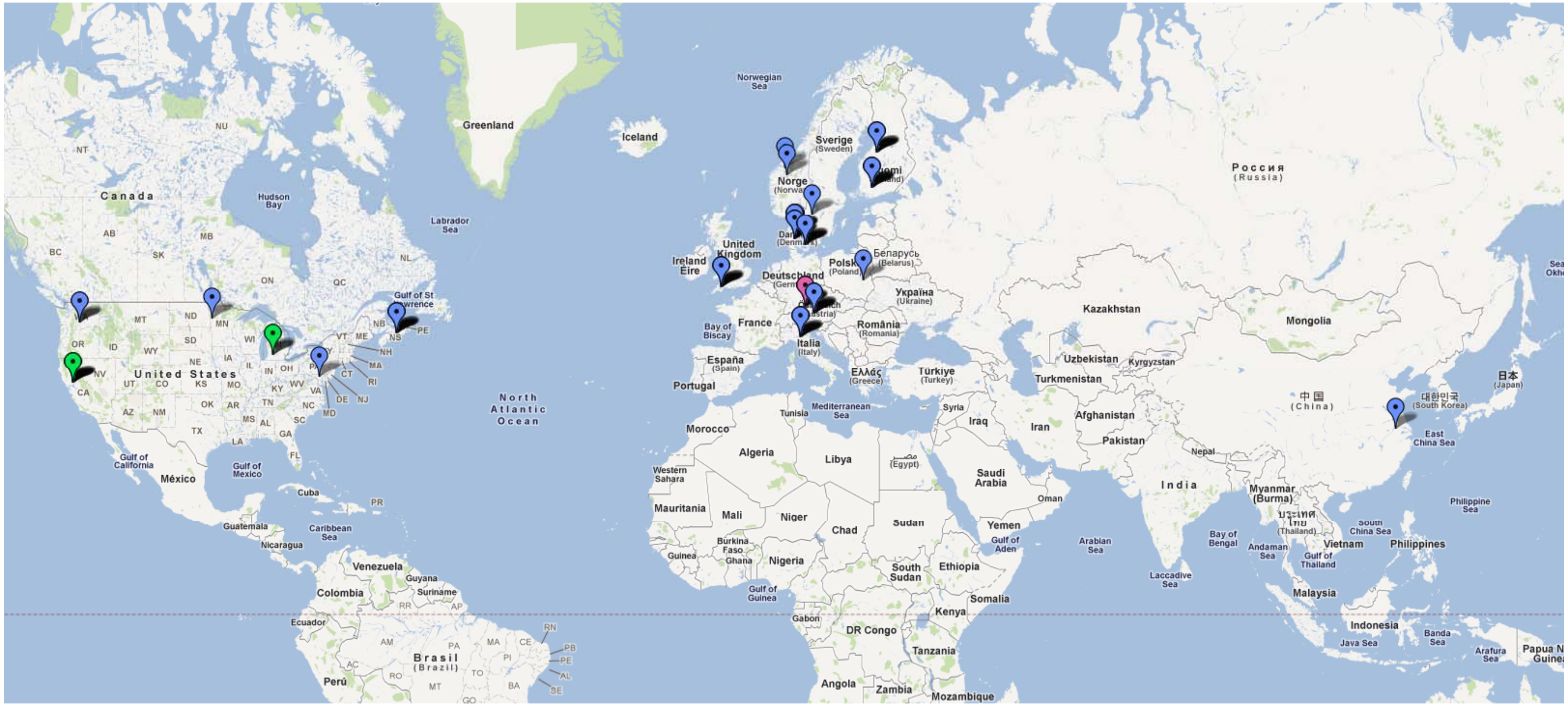
Approach

1. Literature search only for measured GHG data
2. Literature review/evaluation
3. If positive: integration into data matrix and parametrisation
4. Meta analysis with *Comprehensive Meta Analysis* software. Effect sizes (= target variables): N_2O fluxes (in kg CO_2 eq./ha*yr), CH_4 fluxes (in kg CO_2 eq./ha*yr)



Geographic distribution of the system comparisons

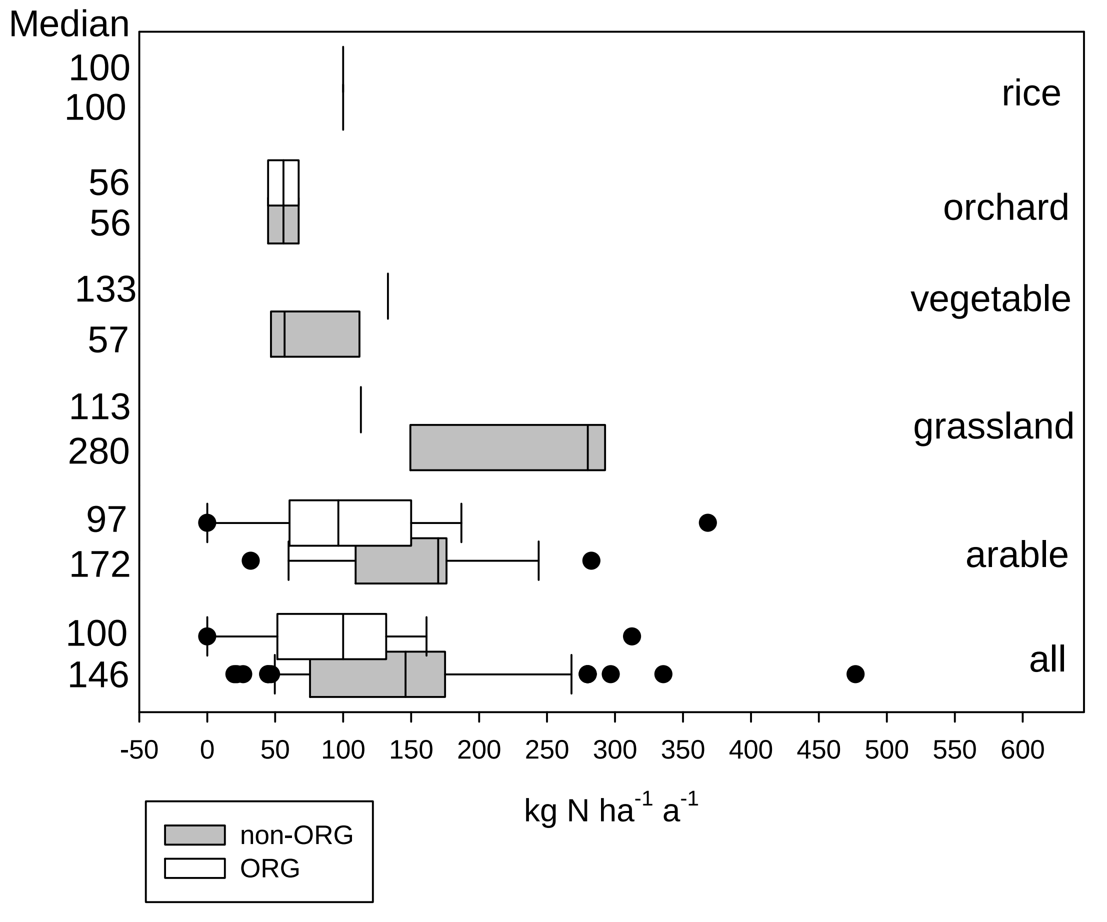


Overview of the obtained „greenhouse gas“ publications for meta-analysis

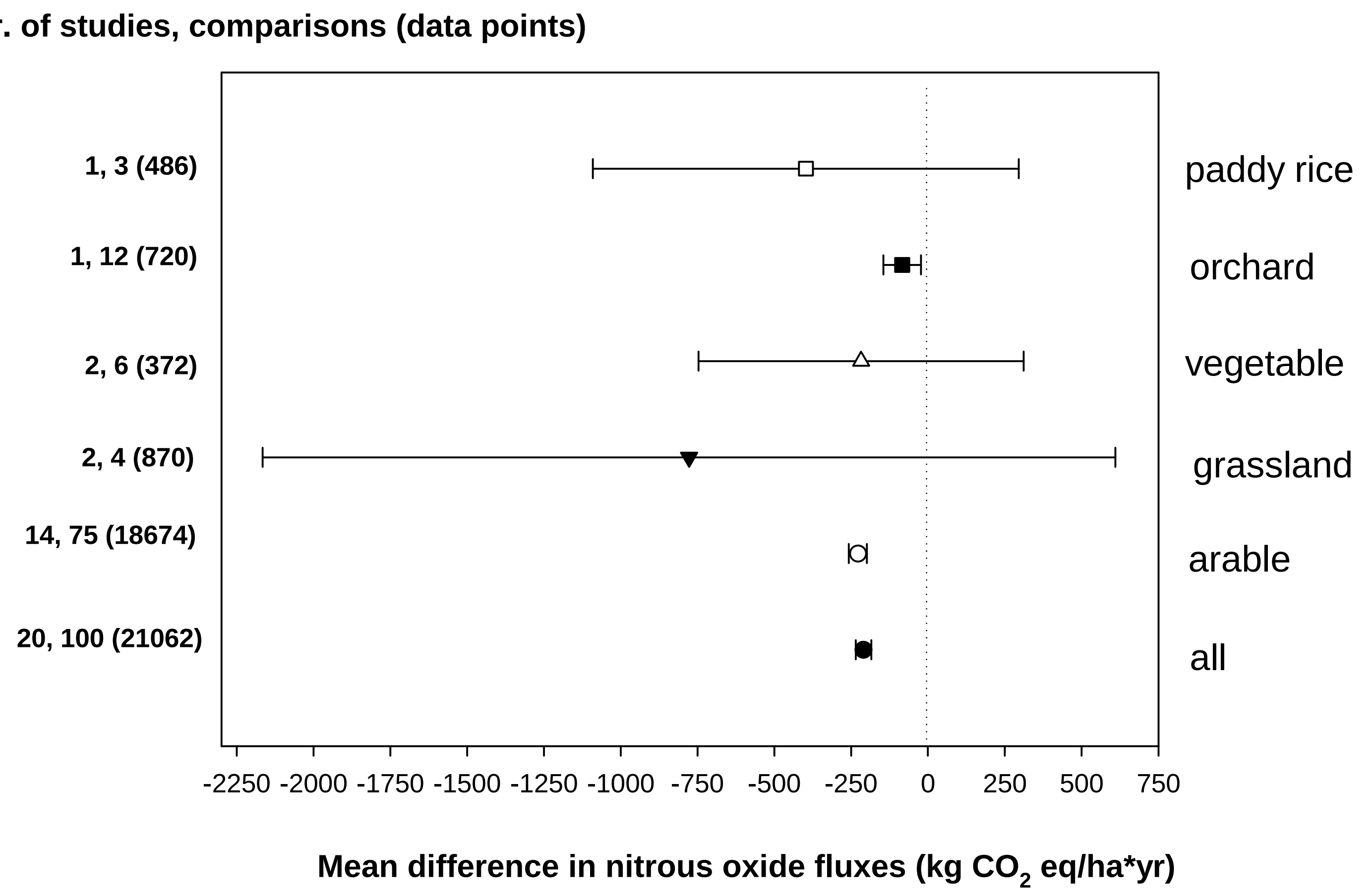
Criterion	N_2O fluxes N_2O ha^{-1} a^{-1} (in kg CO_2 eq.)	CH_4 fluxes CH_4 ha^{-1} a^{-1} (in kg CO_2 eq.)
Type of publication		
Scientific journals	15	5
Dissertation / book chapters / proceedings	5	2
Type of comparisons		
All plot scale		
Coverage of land use types:	Full coverage	Arable & rice paddies
Coverage of climatic zones	3, 4, 5	3, 5
Coverage of regions	USA, Canada, Europe, China(1)	Europe, USA
Average experimental duration	3	4.5
Duration of system comparison	9.2	7.6

Management characteristics

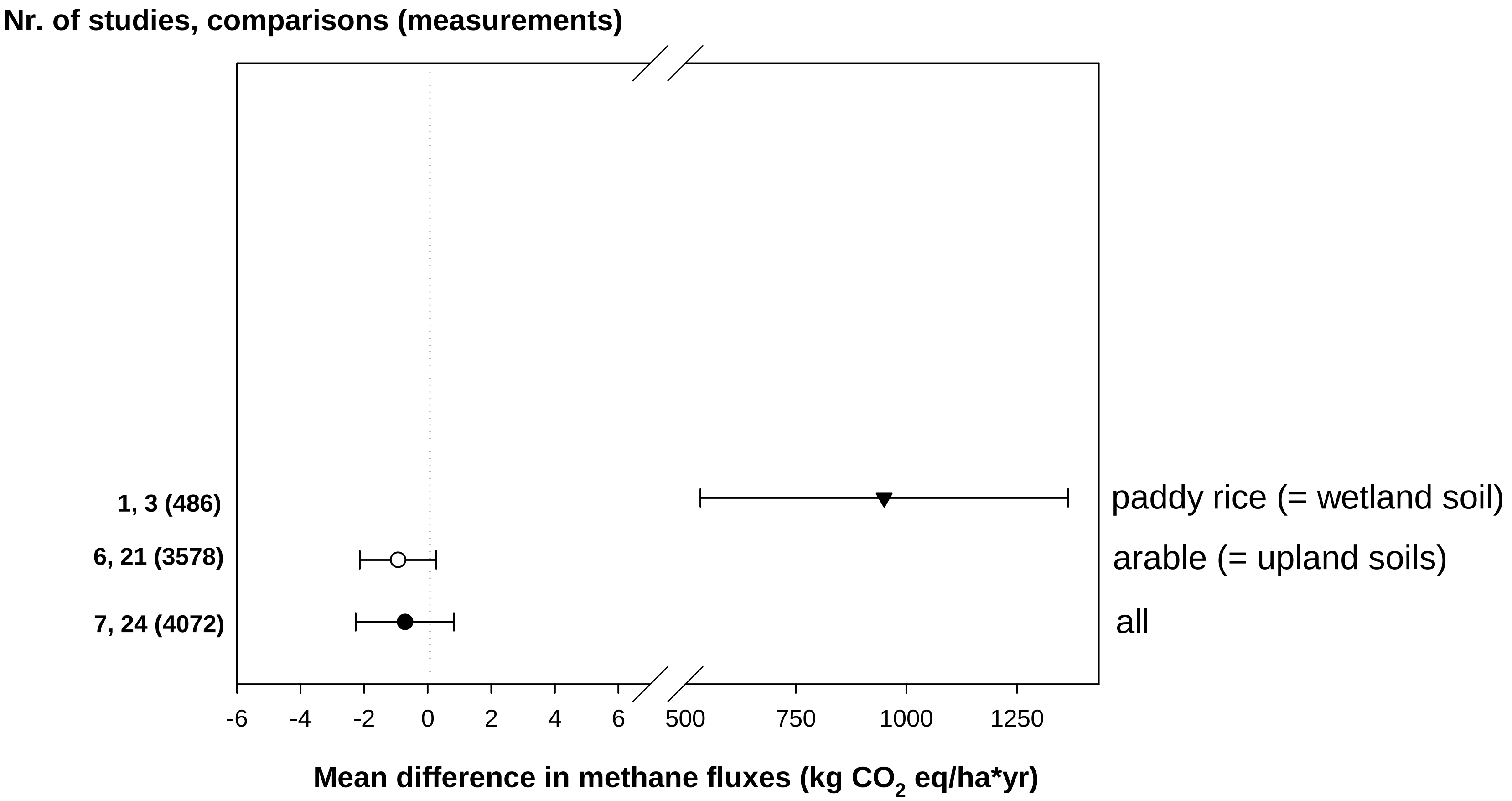
external annual N input (only manure and synthetic fertiliser)



Less N_2O emissions from organically managed soils?



Less CH_4 emissions/higher CH_4 uptake in organically managed soils ?



Summary and conclusions

- There is strong scientific evidence for higher soil organic carbon concentration and stocks under organic farming management (low uncertaintity).

- There is scientific evidence for net-net carbon sequestration in organically managed soils. The extent of this sink function is rather uncertain, due to poor coverage of land use types and pedo-climatic regions (moderate uncertaintity).

- There is scientific evidence for less nitrous oxide emissions from organically managed soils. The extent of this mitigation function is rather uncertain, due to poor coverage of land use types and pedo-climatic regions (moderate uncertaintity).

- There is a lack for comparative studies on SOC and GHG from Africa and many other countries from the global South. Further data from farming system comparisons are required!

- Organic farming as an option for climate change mitigation in global agriculture?

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Acknowledgements

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