CORE organic II

TILMAN-ORG
A European Network

Reduced tillage and green manures for sustainable cropping systems

Co-ordinator: Paul Mäder, FiBL

Deputy co-ordinator: Christoph David, ISARA

FiBL

isaralyon
Une école d'ingénieurs au cœur de la vie

Organic Producer's Conference, Birmingham
Jan 22-23, 2013

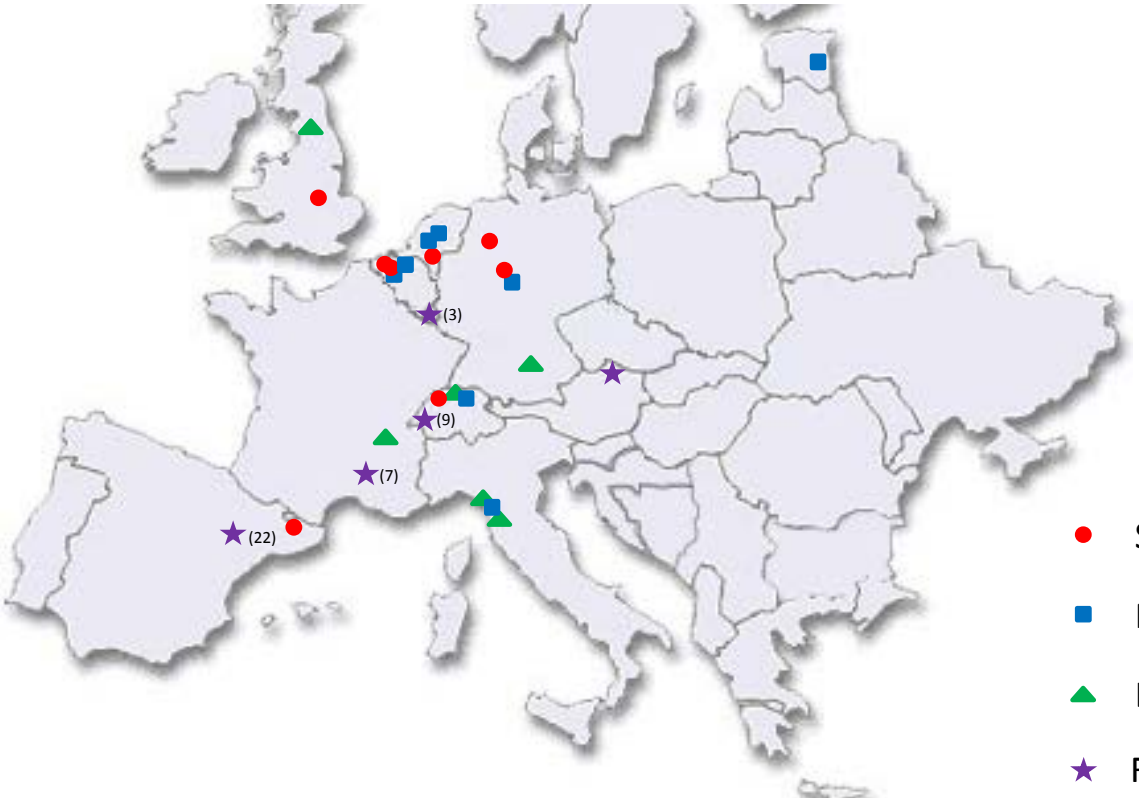
Research Approach

- to explore knowledge on reduced tillage under organic farming conditions from published literature, running field trials and to gather farmer's knowledge

- to conduct case studies on soil fertility, weed control and biodiversity, green manure and nutrient management

- to model data obtained and to prototype sustainable organic cropping systems

Geographical distribution of partners and trials



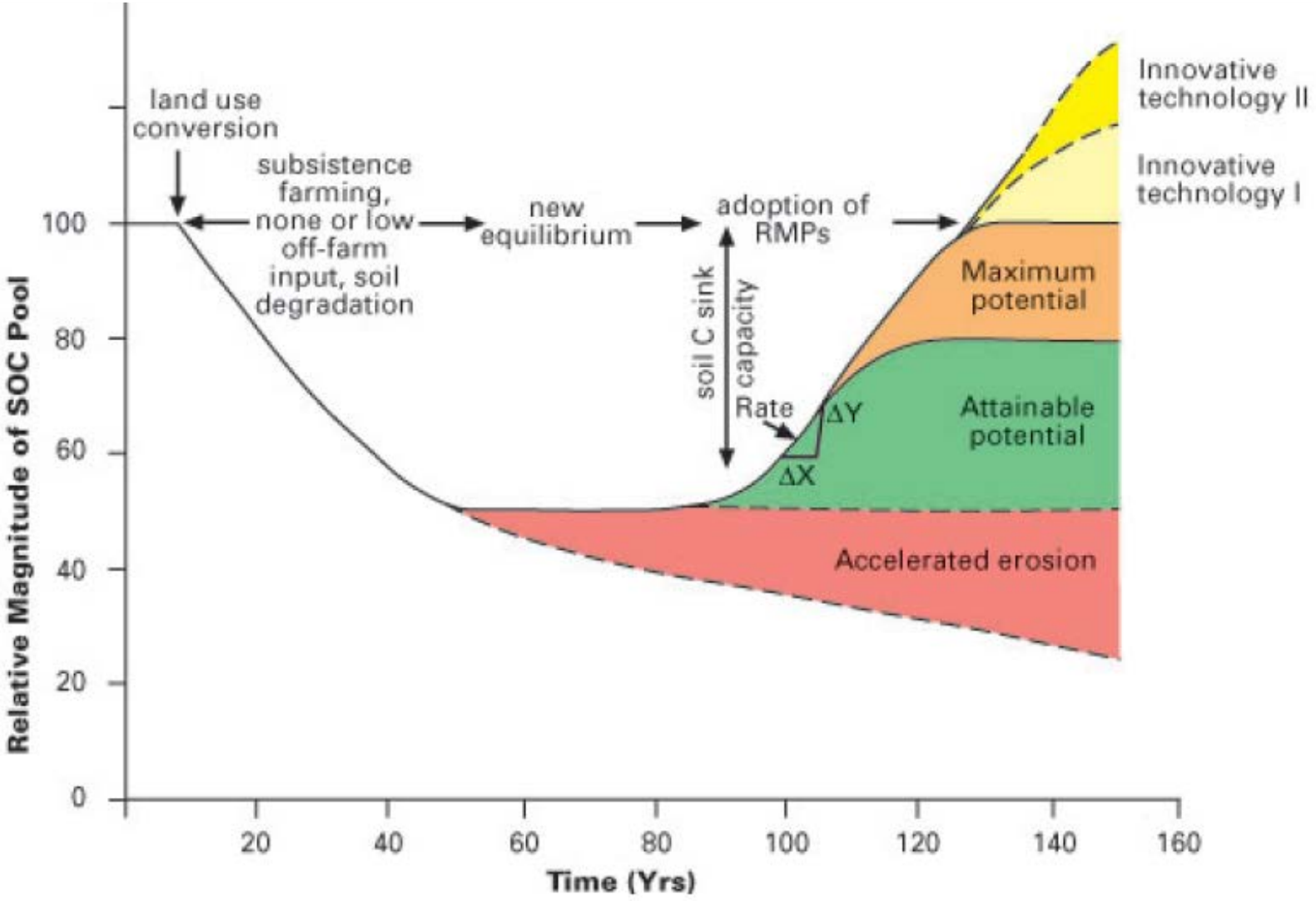
- Short term
- Mid term
- Long term
- Farm survey

Switzerland, France, Germany, Netherlands, Belgium, Luxemburg, United Kingdom, Estonia, Italy, Spain, Austria

TILMAN-ORG Kick-off Meeting 14./15. Nov. 2011

Photo: Alföldi, FiBL

Soil organic carbon (SOC) dynamics



Lal, 2004

Reduced tillage

Shallow ploughing
e.g. stubble cleaner

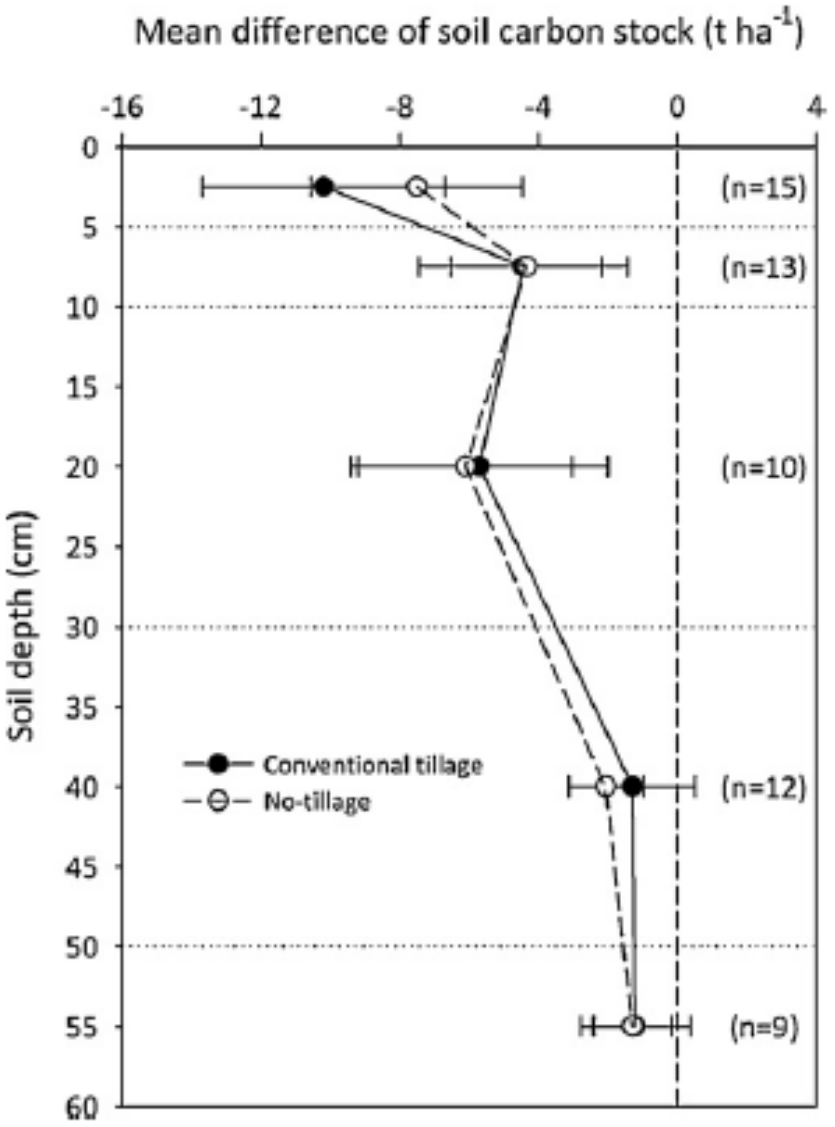
Non inverting tillage
e.g. chisel

Direct sawing of soybean in rye

Photo: ISARA, Lyon

Soil organic carbon in no-tillage vs conv tillage

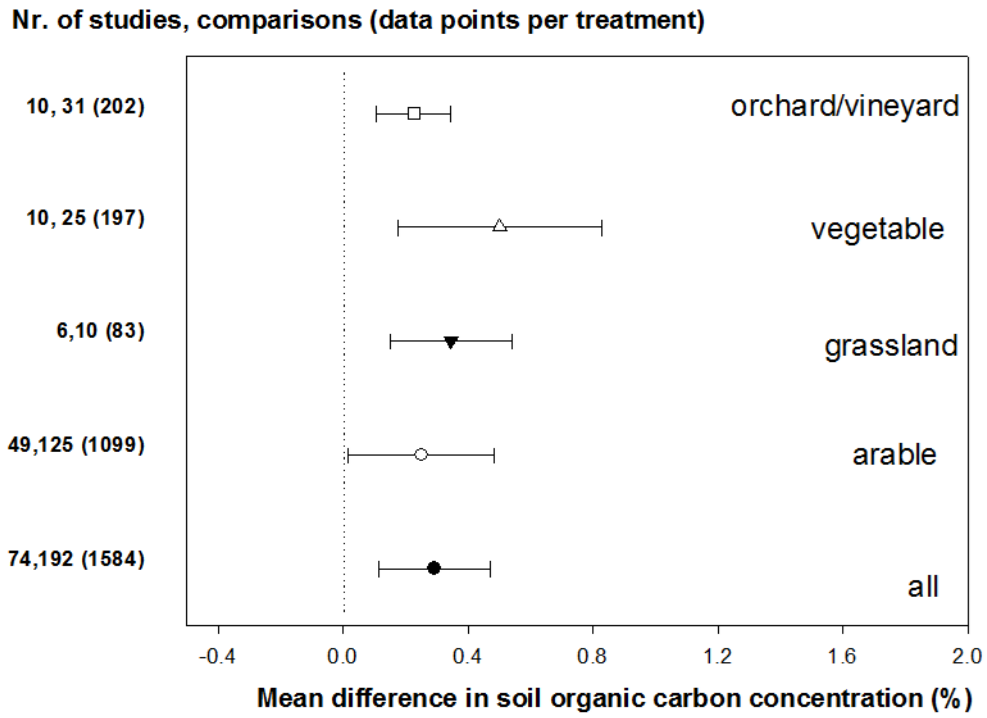
Fig. 1. Mean difference (MD) of soil carbon contents at different soil depth in cropland soils under conventional tillage (solid circles) and no-tillage (open circles) as compared with in adjacent natural soils. Horizontal bars show the 95% confidence interval; numbers of observations are the same for the tillage treatments and given in parenthesis



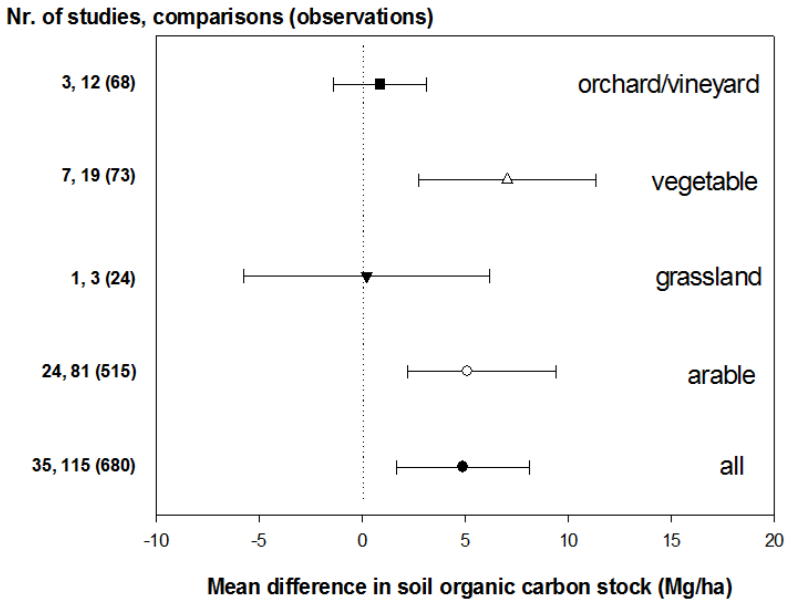
Luo et al., 2010

Soil organic carbon organic vs. conventional

SOC concentration (Corg)



Carbon stocks (t C/ha)



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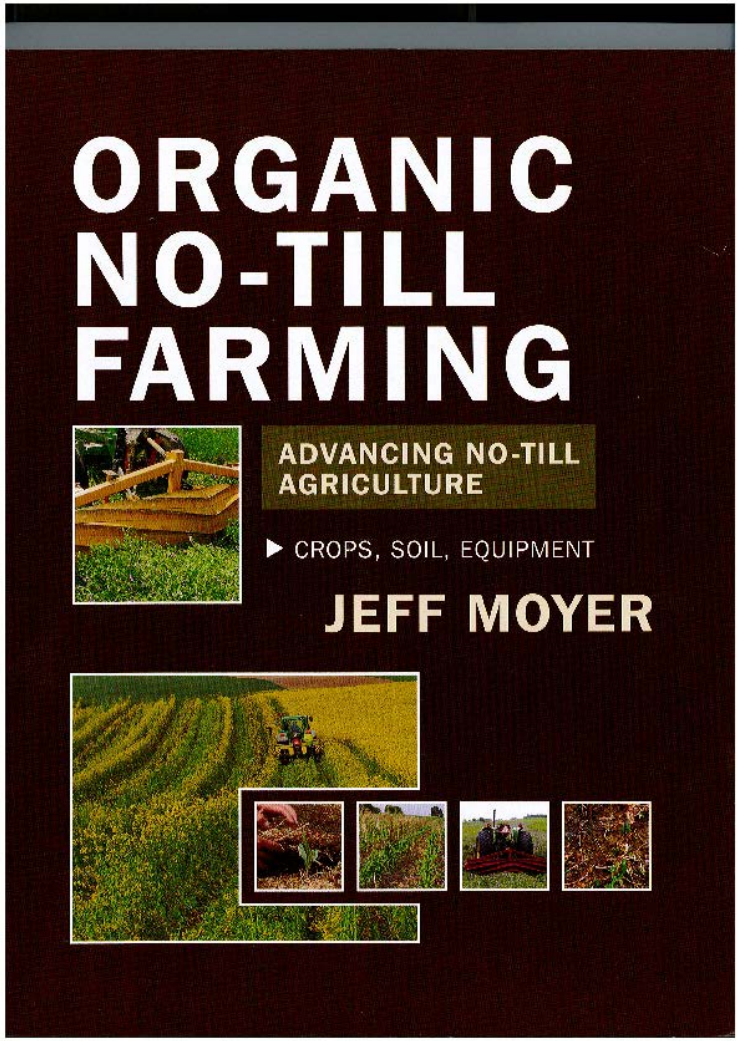
Gattinger et al., 2012, PNAS

Available knowledge



No-tillage/reduced tillage in organic farming

US:

Conservation TILLAGE ISSUE: Conservation Tillage Strategies in Organic Farming:

- *Renewable Agriculture and Food Systems 27, 2012*

Europe:

Peigné, J., Ball, B. C., Roger-Estrade, J., David, C. (2007): Is conservation tillage suitable for organic farming? A review. *Soil Use and Management* 23, 129-144.

Rational for reduced tillage in organic in Europe (as opposed to no-tillage in US)

- Humid and cold climate in large areas of Europe
  - Faster warming up of soil
  - Higher N mineralization
  - Better control of (perennial) weeds by shallow undercutting of the whole field
- Mixed organic farms
  - Incorporation of organic manures
- Plant health aspect
  - Better control of *Fusaria sp.* by shallow incorporation of maize stubbles in e.g. maize – wheat rotations

Mäder & Berner, 2012: Renewable Agriculture and Food systems

Published literature on reduced tillage in organic farming in Europe (selection, in English)

Experiment	Country	Tillage system	References
Rommersheim (1995-2004) SÖL	DE	Plough vs. reduced	Hampl, 1996 (proc.) Emmerling, 2001 Vakali et al, 2011
Scheyern (1995 -)	DE	Plough vs. reduced Farming system Fertilisation	Kainz et al., 2005 (proc.)
Gladbacherhof (1998 -)	DE	Plough vs. reduced Crop rotation	Schmidt et. al., 2006 (ISOFAR Booklet) Schulz, Brock and Leithold, 2008 (proc.)
Kleinhohenheim (1998 -)	DE	Plough vs. reduced Stubble tillage	Pekrun and Claupein, 2004 Pekrun and Claupein, 2006 Gruber and Claupein, 2009
Tillage Trial Lyon (1999 -)	FR	Plough vs. reduced	Vian et al., 2009 Peigné et al., 2009
Tillage Trial Frick (2002 -)	CH	Plough vs reduced Bd preparation Fertilisation	Berner et al., 2008 Krauss et al., 2010 Börstler et al., 2010 Sans et al., 2011 Gadermaier et al., in press
Staatdomäne Frankenhausen (2002 -)	DE	Plough vs. reduced	Metzke et al., 2007 Müller et al., 2009a, b
Borovece (2006 -)	Slov Rep	Plough vs. reduced	Lehocka et al., 2009

Mäder & Berner, 2012: Renewable Agriculture and Food systems

On-farm production of nitrogen

Potential of 140 Million tons N, which can be fixed by leguminous understory crops, intercrops, and overwintering cover crops in arable systems (Badgley et al., 2007).

Reference: 100 Million tons N with use of fuel

TILMAN-ORG Project aims

- Development of robust and sustainable arable crop production systems
- Weed management
- N supply

"The TILMAN-ORG project's overall goals are to design improved organic cropping systems with:

- enhanced productivity and nutrient use efficiency,
- more efficient weed management and (c) increased biodiversity, but
- lower carbon footprints (in particular increased carbon sequestration and lower GHG emissions from soils)."

TILMAN-ORG Project objectives I

- to summarise existing knowledge and experiences on reduced tillage and green manures in organic systems in a wide range of soils and climates across Europe (WP1 and 2),
- to stimulate bio-geochemical processes governed by soil microorganisms and soil carbon build-up via reduced tillage and strategic integration of green manures into organic rotations (WP3),
- to improve weed control by integrating management techniques such as green manures, mechanical weeding and crop diversification, while evaluating impacts on weed diversity and their functional role in agro-ecosystems (WP4)

TILMAN-ORG Project objectives II

- to increase the efficiency of nutrient use by green manures (including N_2-fixing legumes), thereby reducing off-farm inputs (WP5),
- to calibrate the farmers' decision support tool NDICEA to assess the effects of reduced tillage options and green manuring on N cycling and C pools (WP5), and
- to design viable organic cropping systems applying reduced tillage and green manures at the farm level for major European regions (WP6).

Project structure

WP 0 WP0: Coordination and Dissemination
Co: Paul Mäder (FiBL); DCo: Christophe David (ISARA); Dissemination M: Helga Willer (FiBL)

WP 1 Management of mid-term and long-term experiments on reduced tillage and green manure across Europe M: Paul Mäder (FiBL); DM: Julia Cooper (UNEW)

WP 2 Effects of reduced tillage and green manures on crop performance, weed management and soil quality
M: Julia Cooper (UNEW); DM: Joséfine Peigné (ISARA)

WP 3 Impact of reduced tillage and green manure on soil quality and greenhouse gas emissions
M: Michael Schloter (HMGU)
DM: Andreas Gattinger (FiBL)

WP 4 Improved weed management and functional weed biodiversity under conservation methods
M: Paolo Barberi (SSSA)
DM: Xavier Sans (UB)

WP 5 Improved nutrient management in reduced tillage systems by use of green manures and appropriate off-farm inputs
M: Geert-Jan van der Burgt (LBI);
DM: Thorsten Haase (WIZ)

WP 6 Prototyping of sustainable conservation agriculture systems by use of knowledge based assessment M: Josefine Peigné (ISARA); DM: Wijnand Sukkel (DLO-PRO/PRI)

Visions and outcomes I

- TILMAN-ORG will contribute to stopping degradation of European agricultural soils
- TILMAN-ORG will provide new strategies for increasing yields while maintaining soil quality.
- TILMAN-ORG will restore soil fertility, promote biodiversity and enhance nutrient cycling.
- TILMAN-ORG will result in more resilient cropping systems with higher yields and yield stability in the context of more variable and extreme weather patterns as predicted by the IPCC
- TILMAN-ORG will enhance the C sequestration and storage potential of arable soils.

Visions and outcomes II

- TILMAN-ORG will contribute to better estimates of how reduced tillage systems under organic farming management can mitigate climate change. Trials will generate data on both soil C sequestration and GHG emissions (CO_2, N_2O and CH_4) from soils
- TILMAN-ORG will deliver scientifically validated decision-support tools, and guidelines on most suitable agronomic practices and approaches, techniques and technologies adapted to different crop production systems/rotations and pedo-climatic conditions found in Europe.
- TILMAN-ORG will also contribute to the economy of the European community

Case study Frick tillage trial

Yields tillage experiment Frick (2003-2009)

	Winter wheat 2003	Sunflower 2004	Spelt 2005	Clover grass 2006	Clover grass 2007	Maize 2008	Winter wheat 2009	Crop average
Reduced Tillage Plough = 100%	**86%**	**105%**	**92%**	**129%**	**123%**	**135%**	**122%**	**113%**

Average yields	**5.5**	**3.52**	**2.68**	**8.59**	**8.7**	**14.39**	**4.37**
Unit	t/ha with 15% moisture	t/ha with 8% moisture	t/ha with 15% moisture	t DM /ha	t DM /ha	t DM /ha	t/ha with 15% moisture

Legend

- +26% to +35%
- +16% to +25%
- +6% to +15%
- +/- 5%
- -6% to -15%
- -16% to -25%
- -26% to -35%

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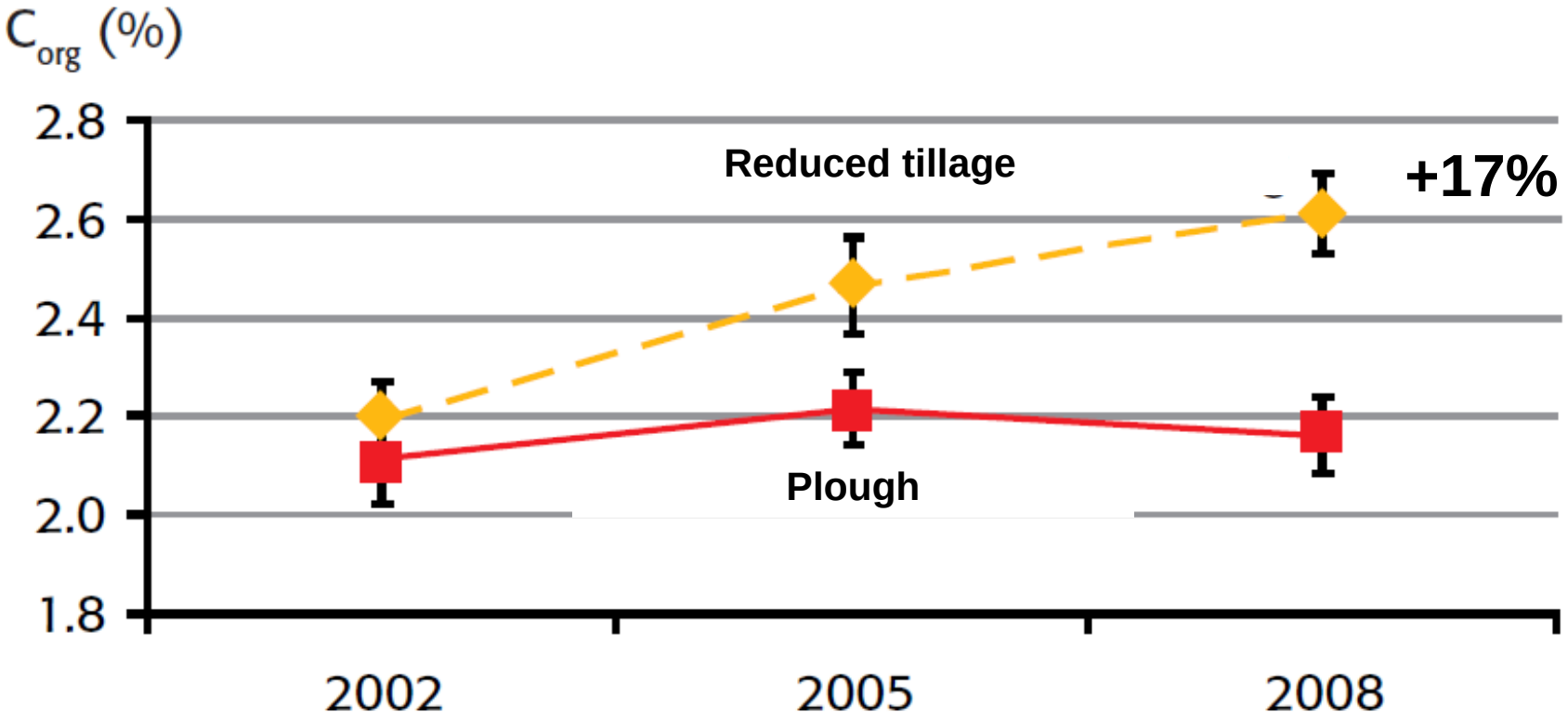
Berner et al. 2008: Soil & Tillage Research

Krauss et al., 2010: Soil Use & Management

Soil organic carbon



Soil depth 0-10 cm

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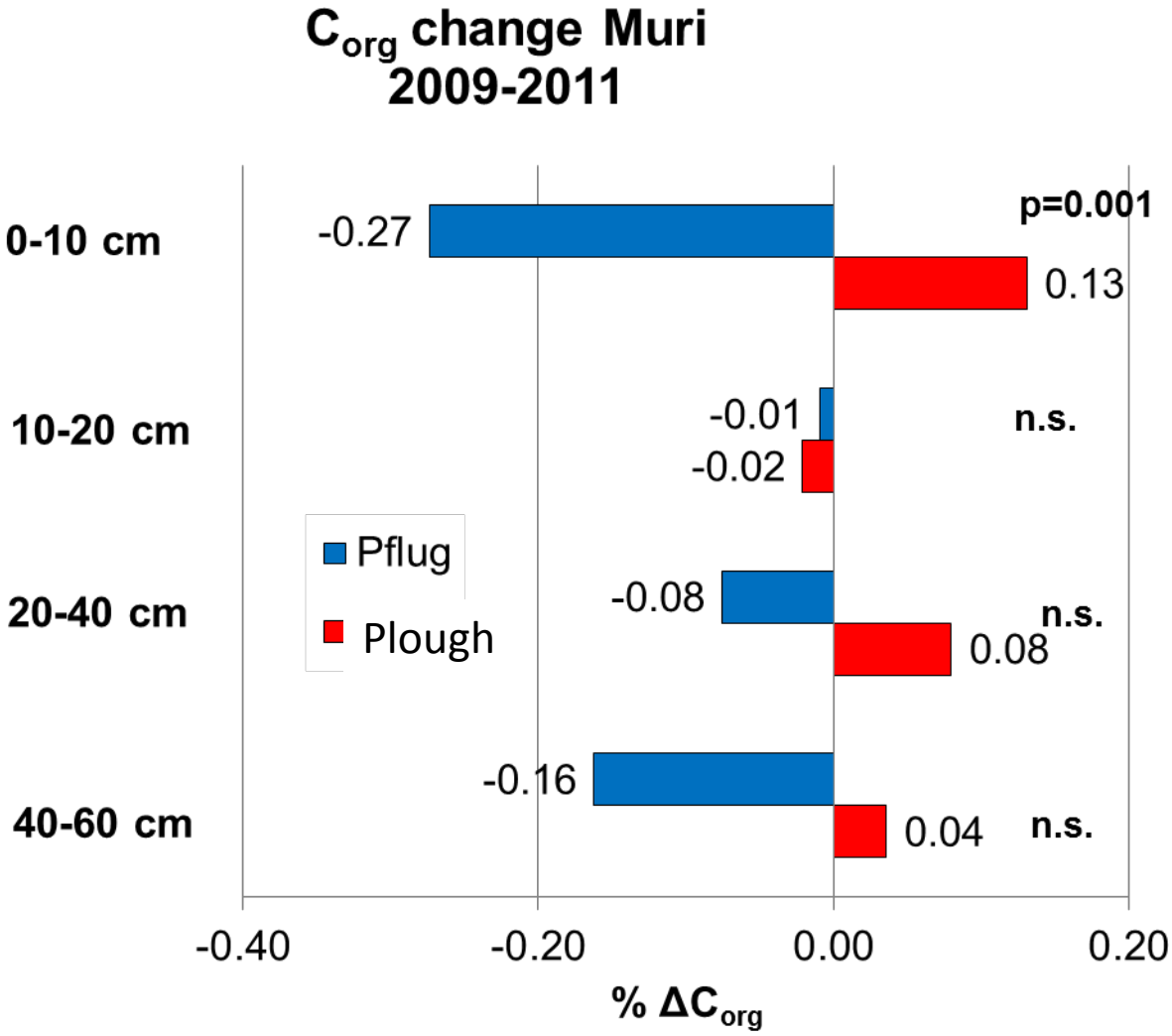
Gadermaier et al., 2012: Renewable Agriculture & Food Systems

Changes in Corg in Muri



TILMAN-ORG partners

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HelmholtzZentrum münchen
Deutsches Forschungszentrum für Gesundheit und Umwelt

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IN SUPREMÆ DIGNITATIS 1343

UNIVERSITAT DE BARCELONA

C.I.R.A.A.
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Photo:
Alföldi,
FiBL

Thank you!

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