

# Reduced tillage and green manures for sustainable cropping systems

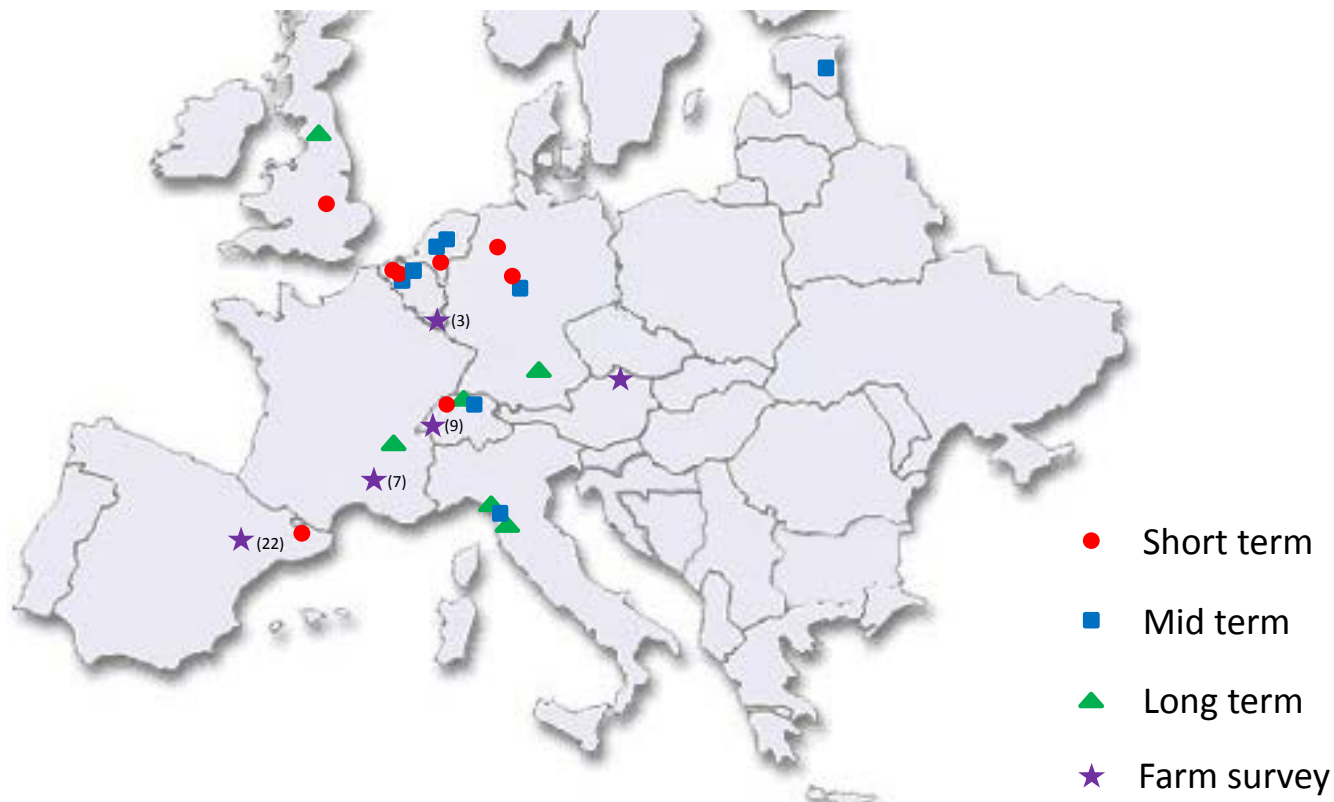
**Co-ordinator: Paul Mäder, FiBL**

**Deputy co-ordinator: Christoph David, ISARA**

# 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



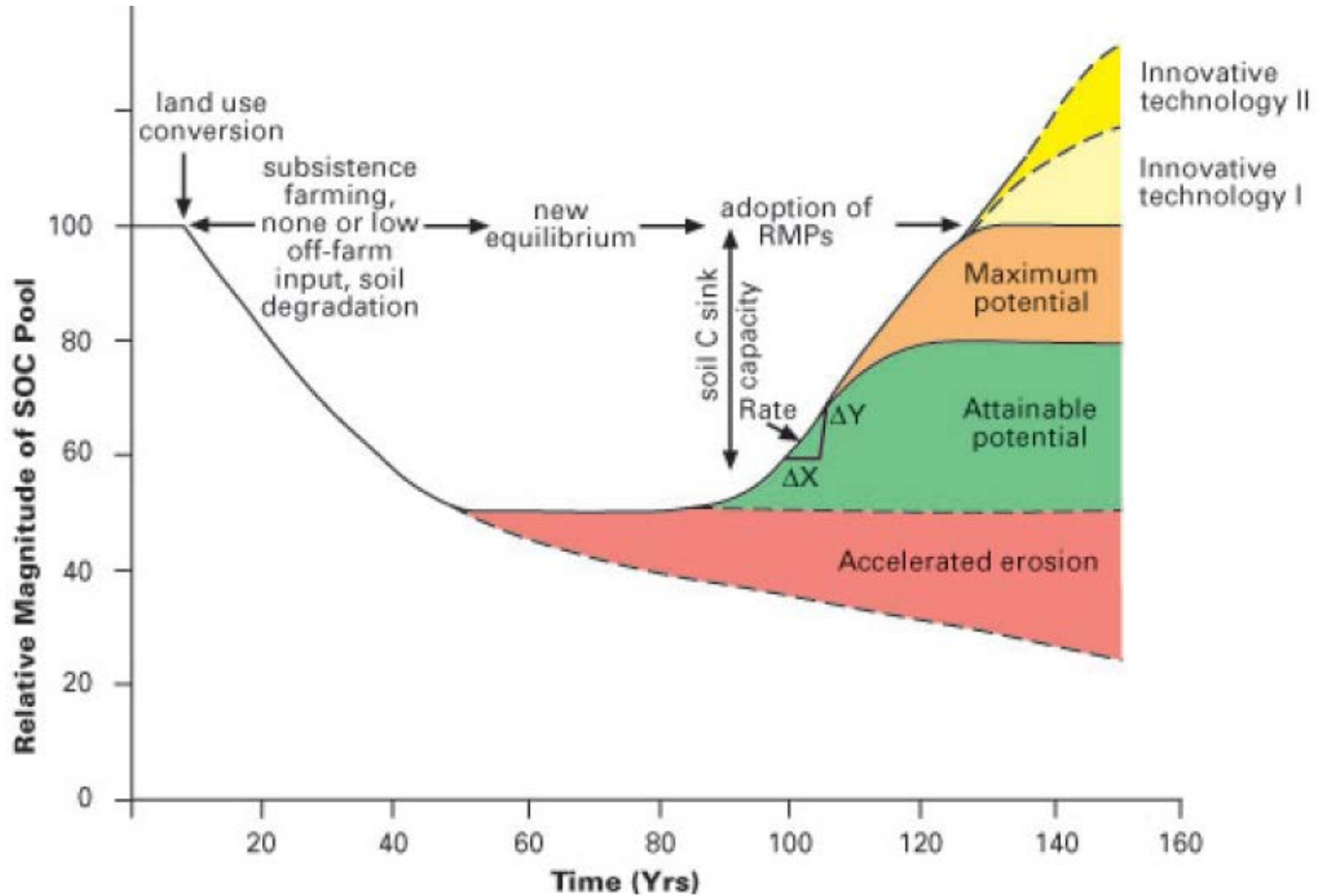
Switzerland, France, Germany, Netherlands, Belgium, Luxemburg, United Kingdom, Estonia, Italy, Spain, Austria

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



Photo:  
Alföldi,  
FiBL

# Soil organic carbon (SOC) dynamics



# Reduced tillage

Shallow ploughing  
e.g. stubble cleaner



Non inverting tillage  
e.g. chisel



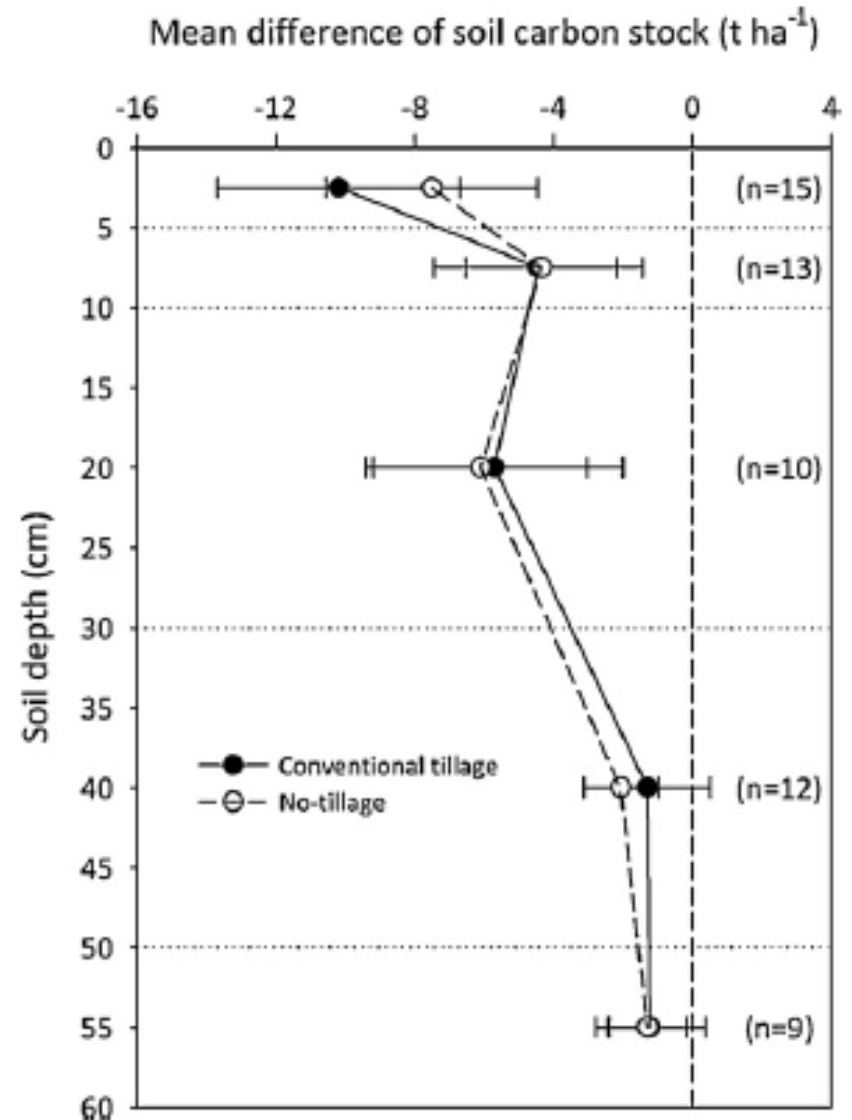
# Direct sowing of soybean in rye



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

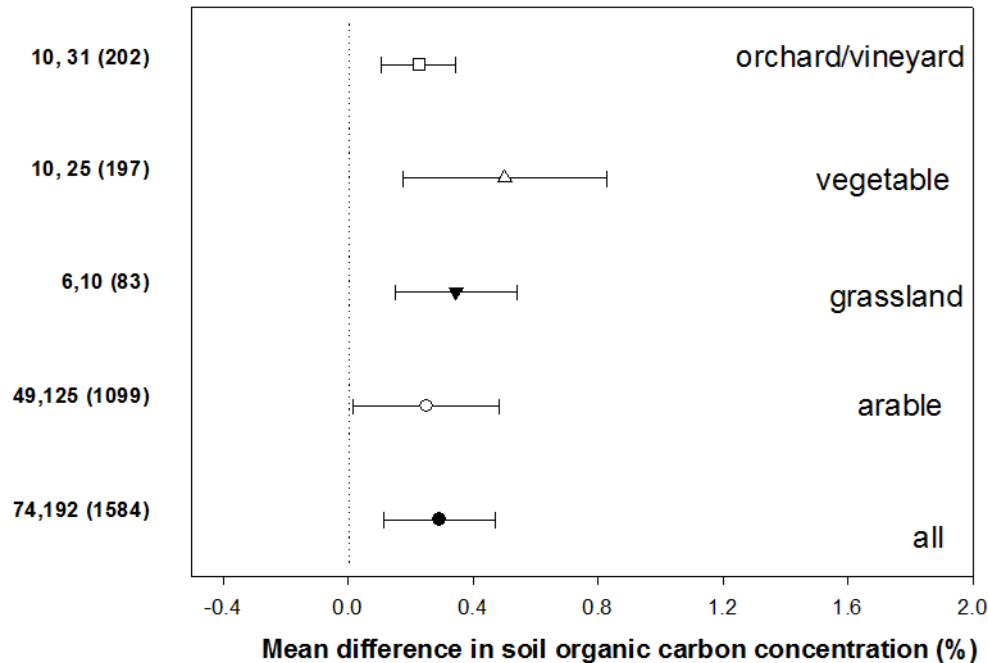




# Soil organic carbon organic vs. conventional

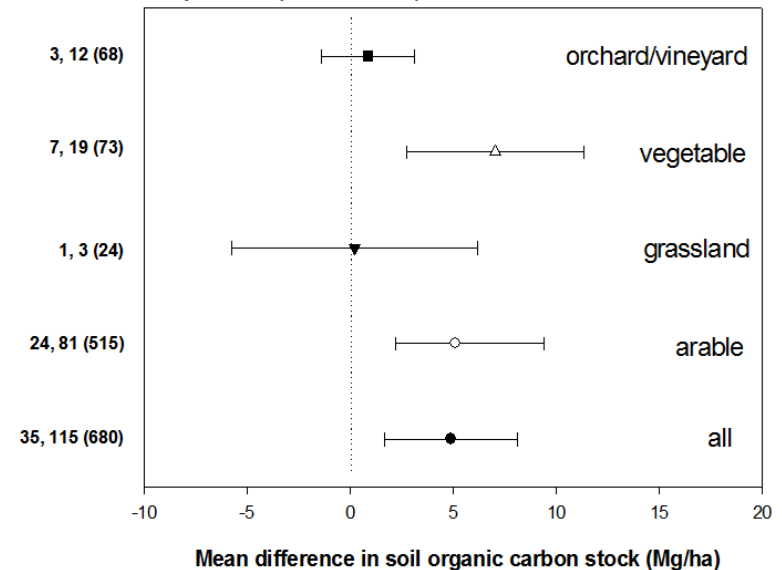
SOC concentration (C<sub>org</sub>)

Nr. of studies, comparisons (data points per treatment)

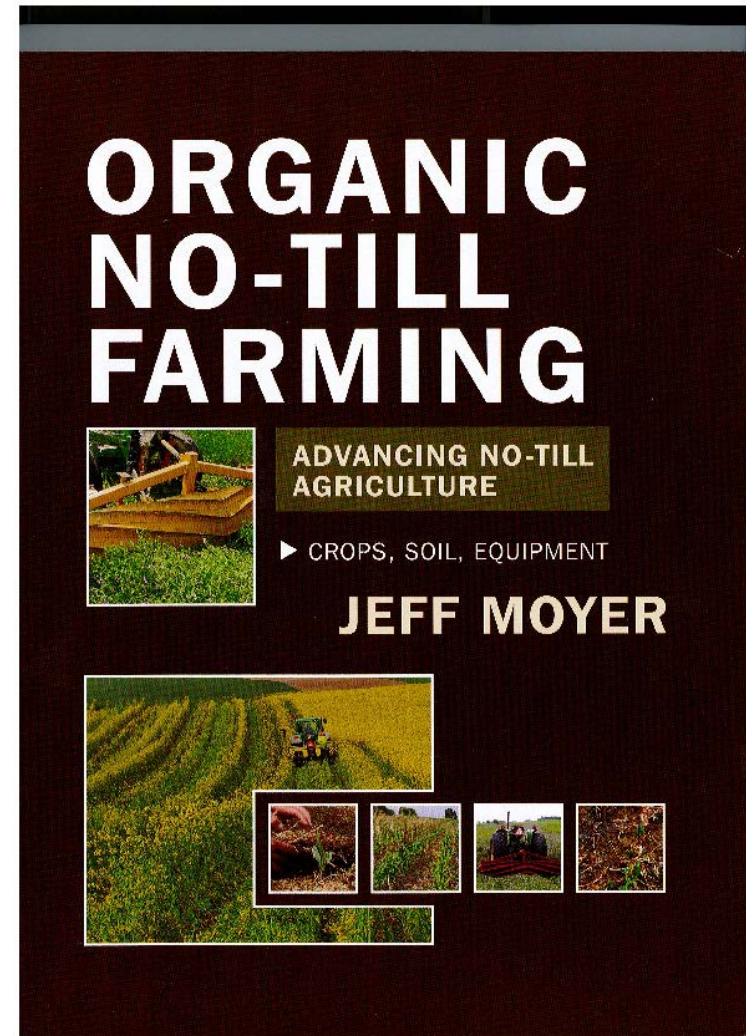


Carbon stocks (t C/ha)

Nr. of studies, comparisons (observations)



# 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

# 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

# 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<sub>2</sub>-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<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>) 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



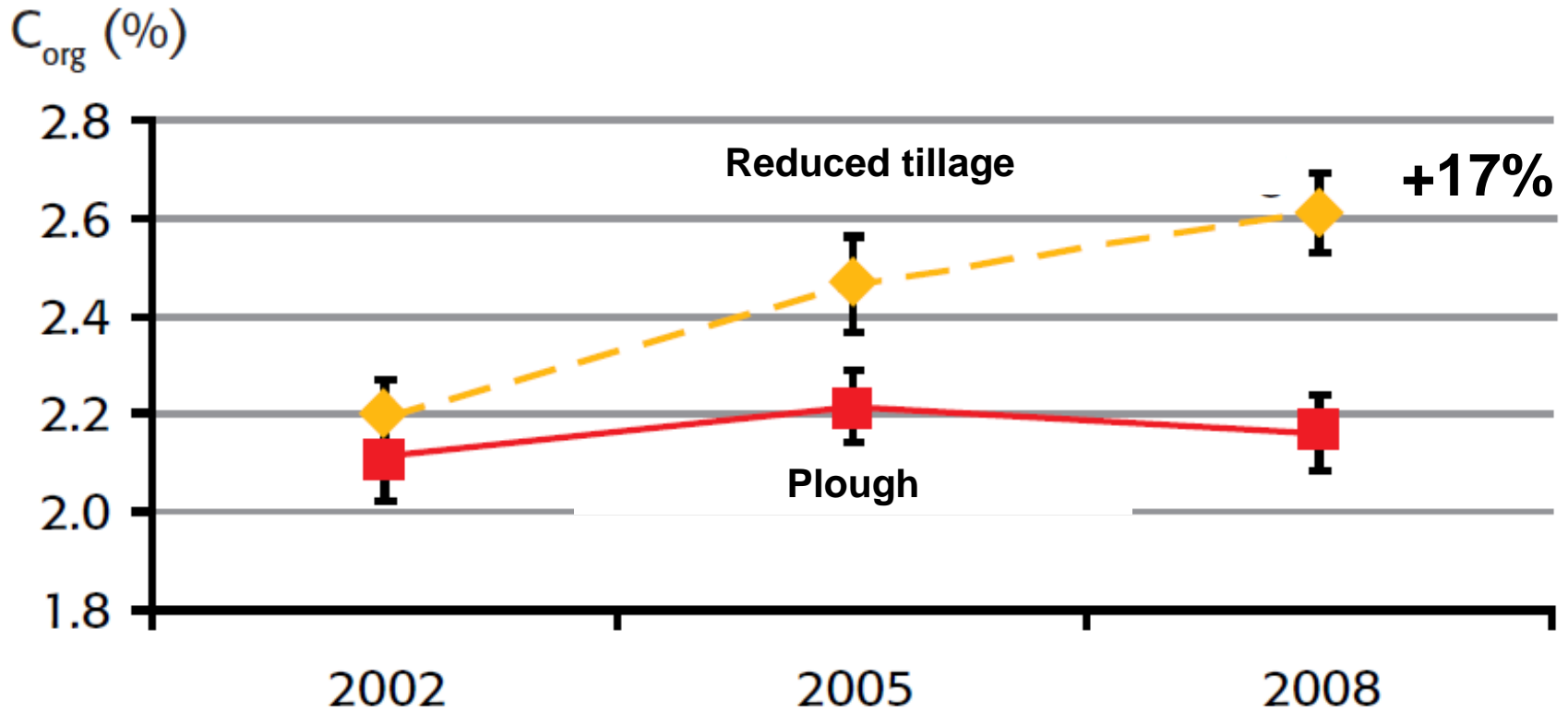
# Yields tillage experiment Frick (2003-2009)

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

<b>Average yields</b>	5.5	3.52	2.68	8.59	8.7	14.39	4.37
<b>Unit</b>	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%

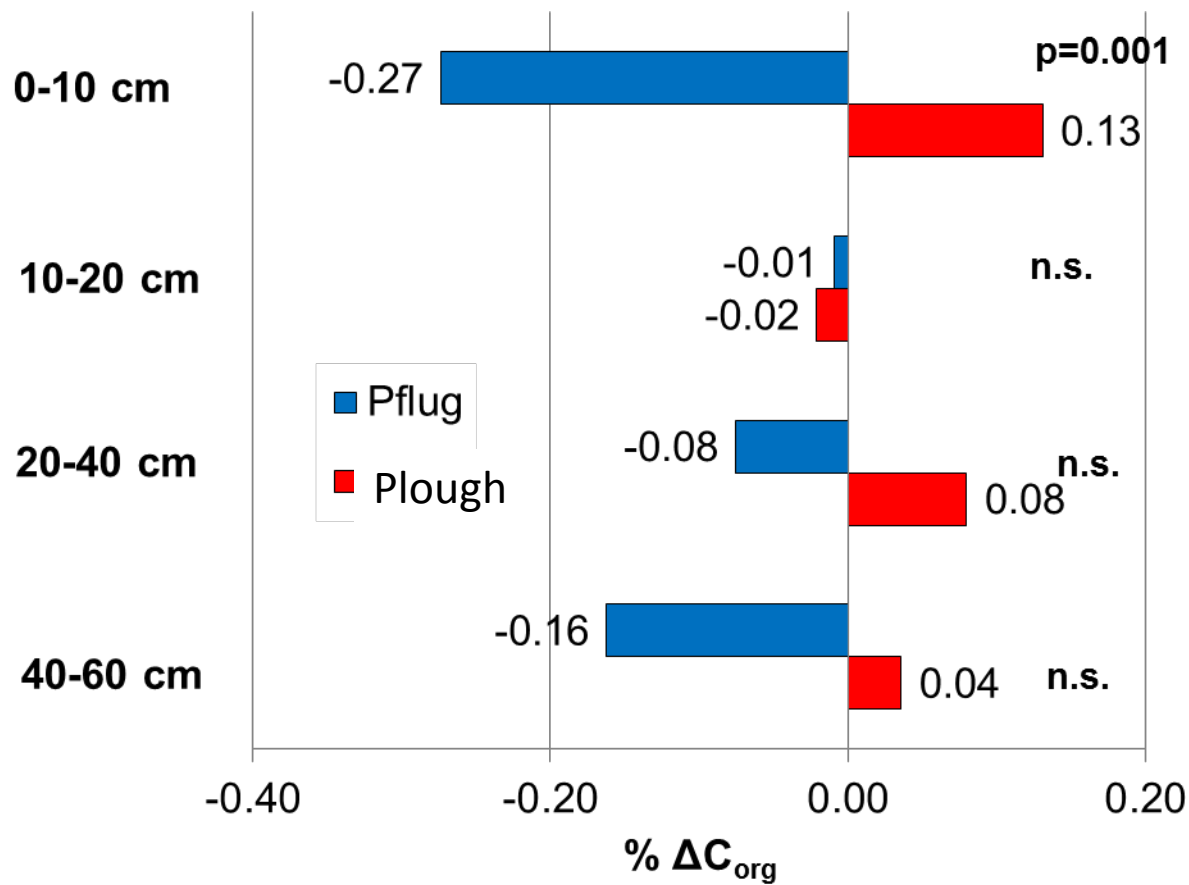
# Soil organic carbon



Soil depth 0-10 cm

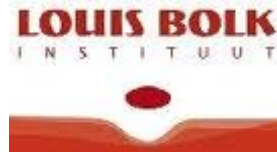
# Changes in C<sub>org</sub> in Muri

C<sub>org</sub> change Muri  
2009-2011





# TILMAN-ORG partners



# CORE organic II



Photo:  
Alföldi,  
FiBL

**Thank you!**