



## AGronomical and TEChnological methods to improve ORGanic wheat quality

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MF, Stolze M, Thommen A, Thomsen IK, Vian JF.

ISARA, France, ESA France; Agroscope Reckenholz Tänikon, Research Station (ART), Switzerland; Forschungsinstitut für Biologischen Landbau (FiBL), Switzerland; University of Natural Resources and Applied Life sciences (BOKU), Austria; Aarhus Universitet (AU) Denmark; Istituto Nazionale di Ricerca per gli Alimenti e la Nutrizione Roma (INRAN), Italy and INRA Montpellier, INRA Grignon, France

- Evaluate the **current practices** for organic grain wheat production and flour-processing in Europe (WP1).
- **Improve crop management strategies** (soil tillage and N management) ....to prevent **mycotoxin contamination** and **enhance bread making quality and nutritional value** (WP2).
- **Develop optimal post-harvest treatment** ..... to prevent **mycotoxin contamination** and **enhance bread making quality and nutritional value** (WP3 – *start Sept 2009*).
- Evaluate **technological & nutritional value and mycotoxin content** of organic wheat grains and flour (WP4)
- **Generalise results** from field experiments to enhance farm management strategies (WP5 – *start June 2009*).



### Long term experiments

- DOK Trial (Fibl-FAL) 1978-
- CROPSYST Trial (AU) 1997-
- MUBIL Trial (BOKU) 2003-
- SoilMan Trial (ISARA-ESA) 2004-

### Transnational Field experiments

#### N management and crop rotation

- N fertilization (AU, FIBL, FAL, ISARA)
- Green manure (AU, BOKU)
- Intercropping (ESA, ISARA, FAL)
- Soil tillage management (ISARA, ESA, FIBL)

### Baking properties (INRAN, INRA)

### Nutritional properties (INRAN)

### Mycotoxin contamination (AU)

### Post-harvest treatments

(INRA, INRAN, Goëmar)

- Milling process –stone vs roller
- Ozonation and heat treatments

### WP1 Management

Project management  
Organic wheat-flour survey

### WP2 Agronomy

Soil tillage & N management

### WP3 Technology *2009-2010*

Post harvest treatments

### WP4 Quality value

Technological properties, Nutrition value  
and DON content

### WP5 Generalization *2009-2010*

Soil-crop Modeling  
Economic Analysis



# Objectives

Evaluate the current practices for organic wheat production and flour-processing in Europe.

1. Typology of the organic grain systems in Europe

2. Characteristics of the organic wheat-flour food chain

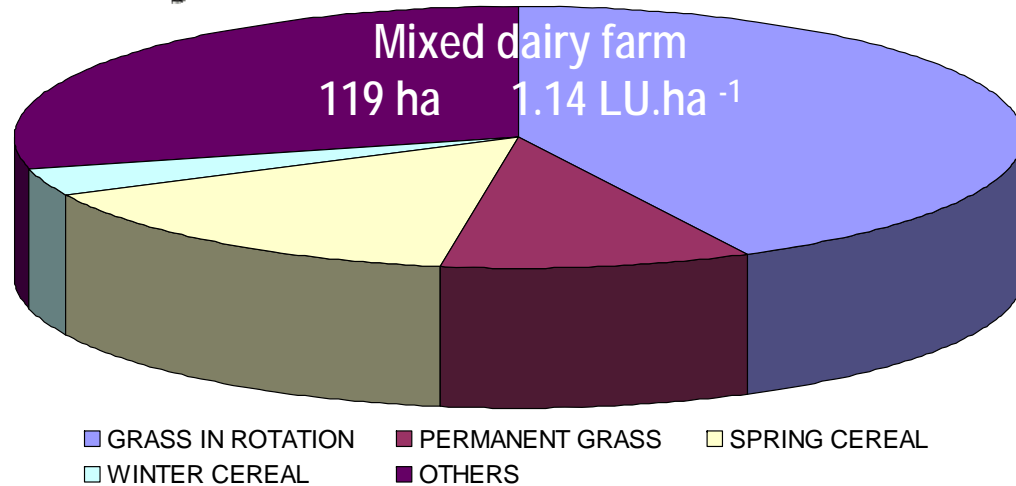


David, C., Celette, F., Thommen, A., Thomsen I.K., Carcea, M., Friedel, J. K., Rinnofner R., Schweinzer, A., and co

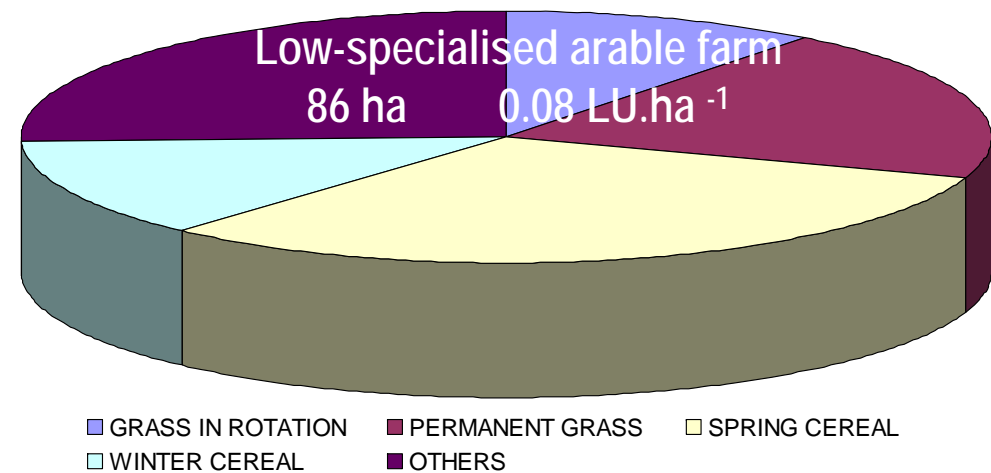
## Methodology

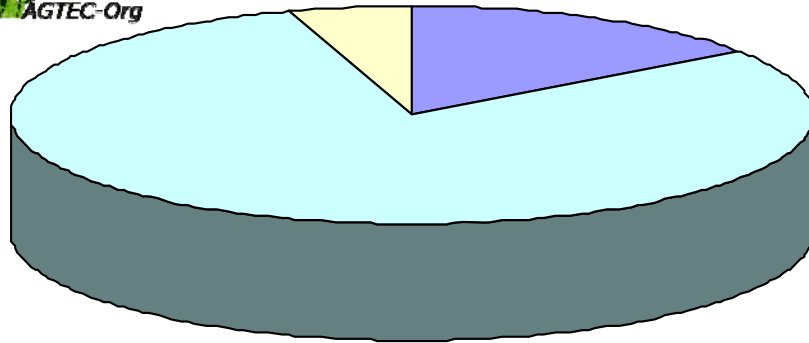
- **Literature review**  
*International articles and national papers*
- **Quantitative data (statistics 1990-2006)**  
*National statistics on organic data and international survey*
- **Key-experts interviews (25)**
  - *Common questionnaire*
  - *Typology of organic grain system and case study*
  - *Wheat-Flour Food chain survey*
  - *National and EU statistics*





- Large diversity in the farming systems (mixed FS vs grain FS, rate of legumes, crop rotation)
- Homogeneity in the crop management on organic wheat except cultivar and N management



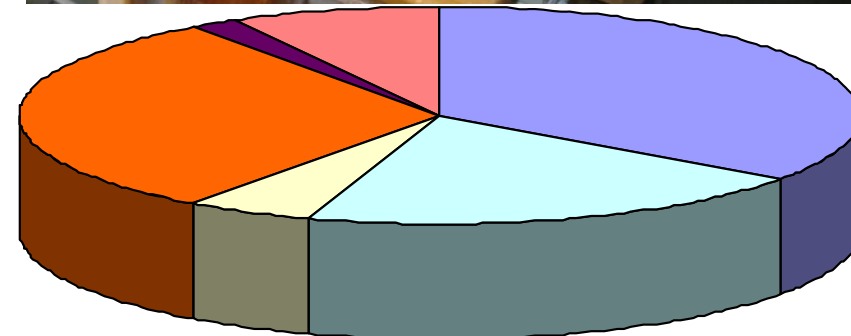


■ Bakers ■ Supermarkets ■ Direct sale

### Organic wheat market in Switzerland



Organic wheat market in France



■ Bakers ■ Supermarkets ■ Direct sale  
■ Industries ■ Export ■ Conv Millers

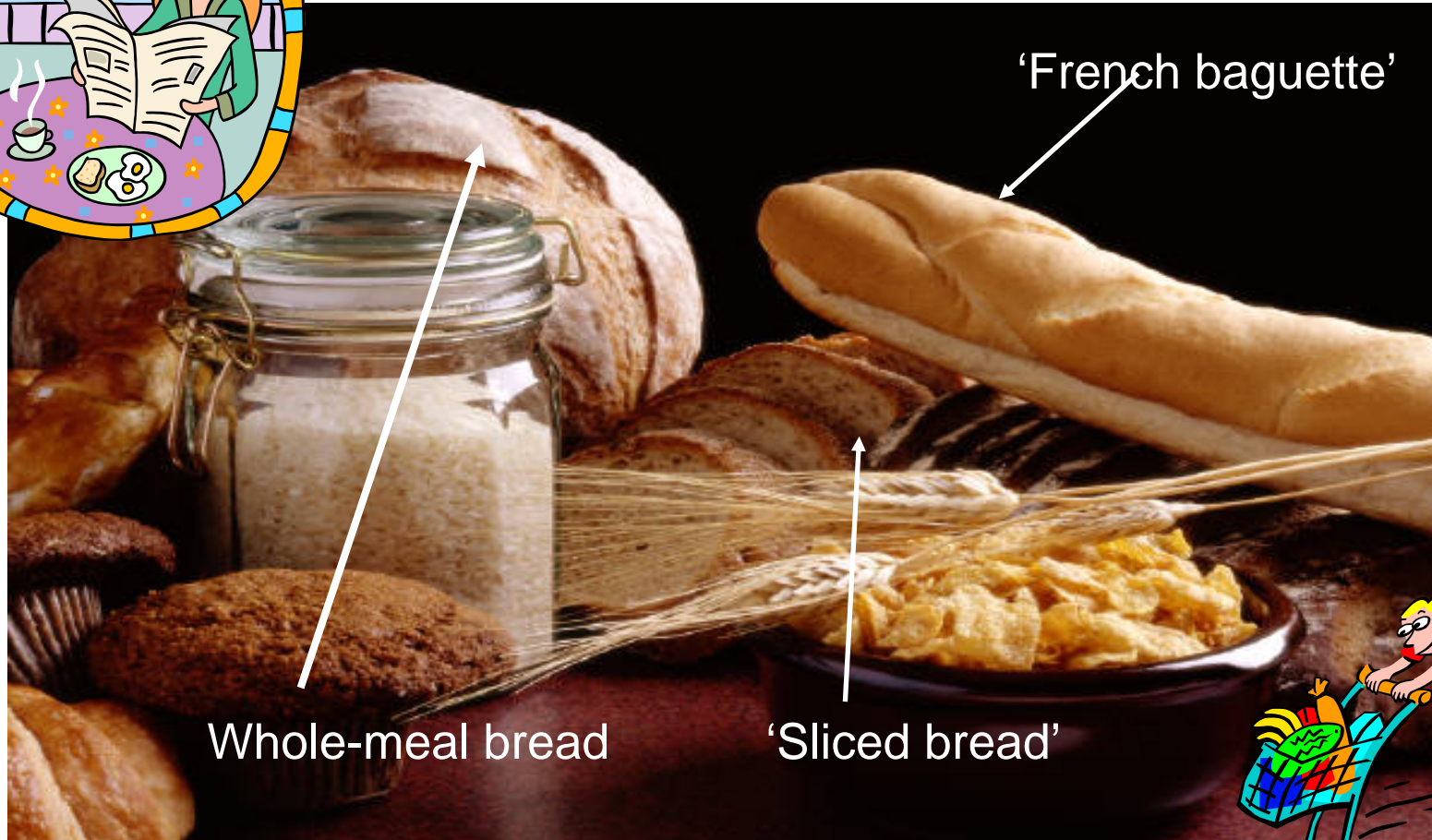
Large diversity in the wheat-flour food chain  
Concentration vs Diversification





# CORE organic

## Consumers attitudes and requirements



Whole-meal bread

'Sliced bread'

'French baguette'



Diversity in the consumers attitudes .... But common requirements on technological quality and safety



# Objectives

Improve crop management strategies to prevent mycotoxin contamination and enhance bread making quality and nutritional value

1. Experiments on soil tillage management
2. Experiments on N management

Celette, F., David, C., Friedel, J. K., Hellou, G., Messner, M., Peigne, J., Thommen, A., Thomsen I.K., and co

# CORE organic Combine & compare agronomic solutions

## Intercropping or undersowing system wheat-pea / wheat-clover mixtures

3 experimental factors – 24 treatments  
1 site

Wheat / Pea ratio : 50/50 - 70/30 – 100/0 – 0/100

N fertilization strategies

Time of N application (3 dates)

N amount (2 levels)

3 experimental factors – 5 sites

Seed rate of clovers grass (3 levels)

## N fertilization

2 experimental factors 4 sites

Crop rotation with high vs low proportion of N-fixing crops

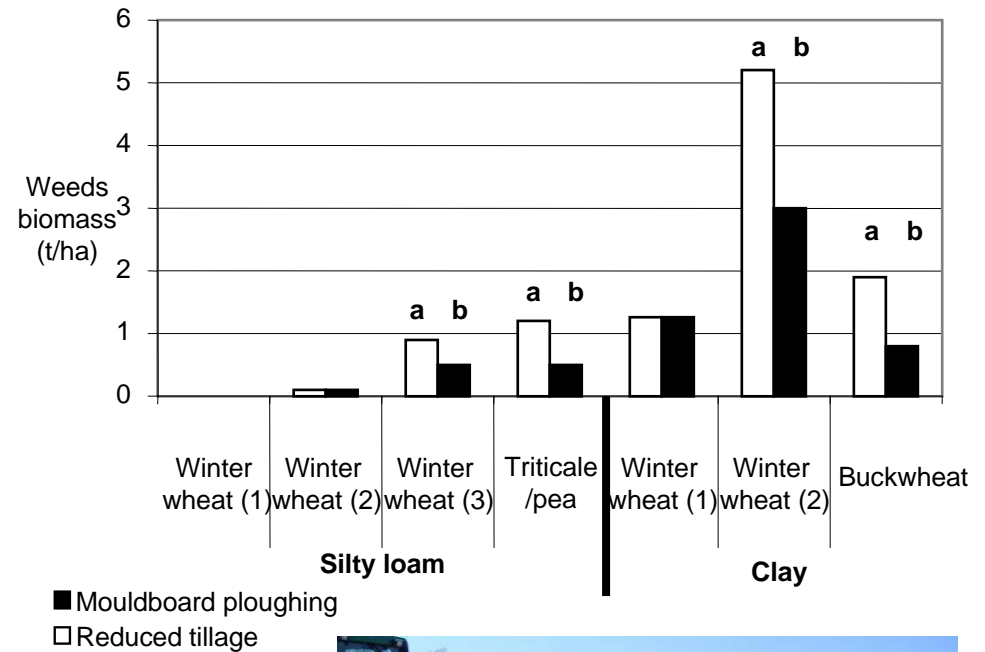
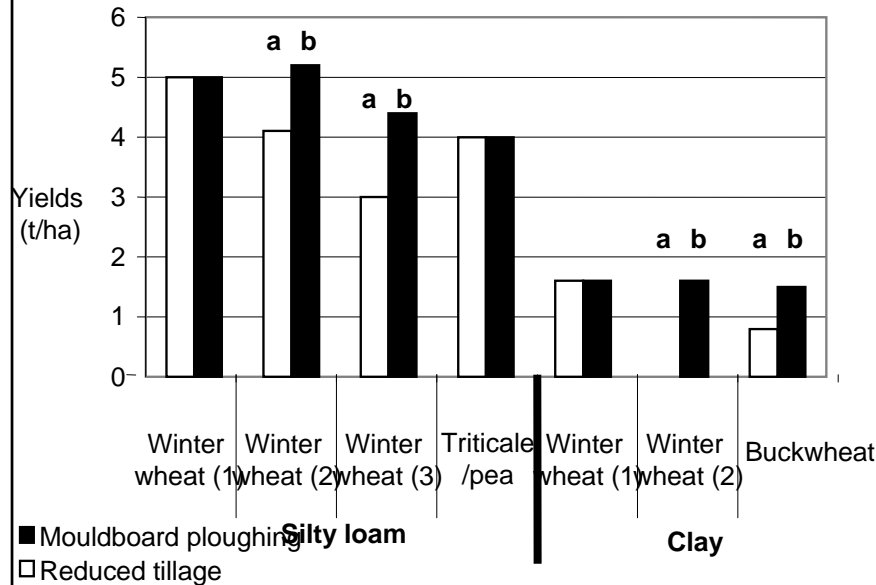
N fertilization with vs without fertilization with animal slurry or farmyard manure

## Green manure

2 experimental factors 4 treatments – 3 sites

Type of green manure

Time of incorporation in the rotation



Grain yield limited with reduced tillage ... mainly explained by weed competition

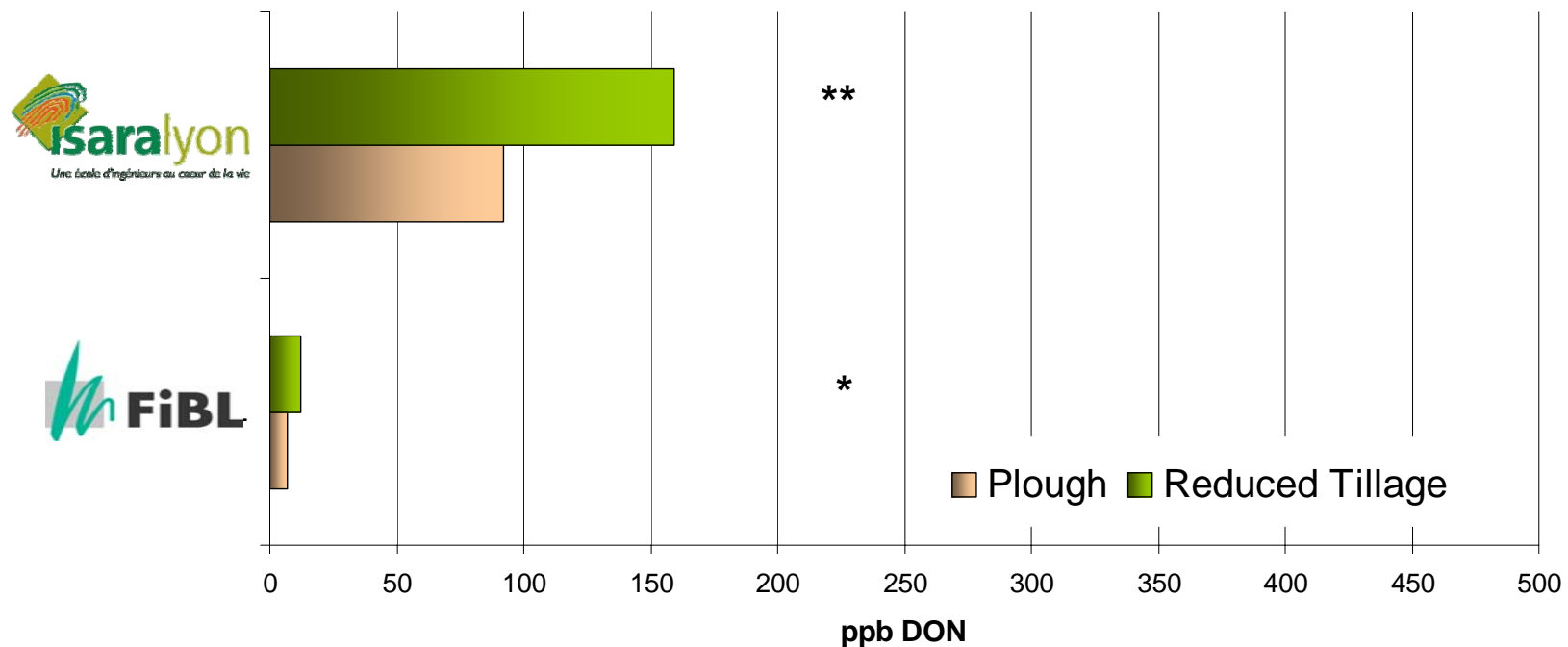
Microbial biomass and activity increased after 3 years of reduced tillage

### DON = Deoxynivalenol

German threshold value= 500 ppb

Swiss threshold value= 1000 ppb

European threshold value= 750 ppb



Data 2003, 2007 & 2009

Fusarium toxins on wheat grains were slightly increased in reduced tillage compared to mouldboard ploughing, but well below the threshold

## WP4: Grain and flour quality

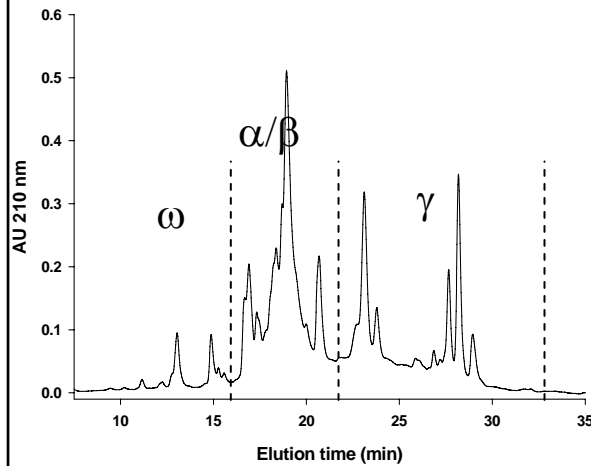


Analysis of grain quality  
Protein composition, technological and  
nutritional value



Carcea, M., Narducci, V., Samson, MF.





## Bread making properties

- Dough rheological analysis
- Redox status
- Zeleny sedimentation index
- Gluten index
- Flour rheological properties
- Baking test

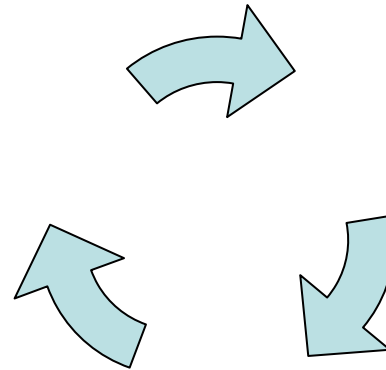


## Mycotoxin contamination

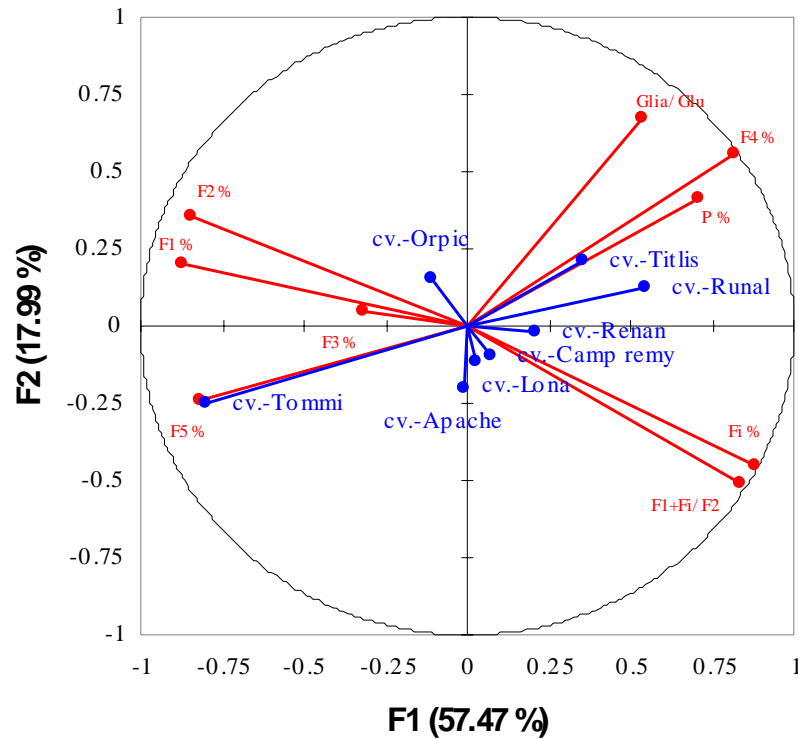
- Fusarium sp. Detection
- Ridascreen Test kit
- DON concentration

## Nutritional values

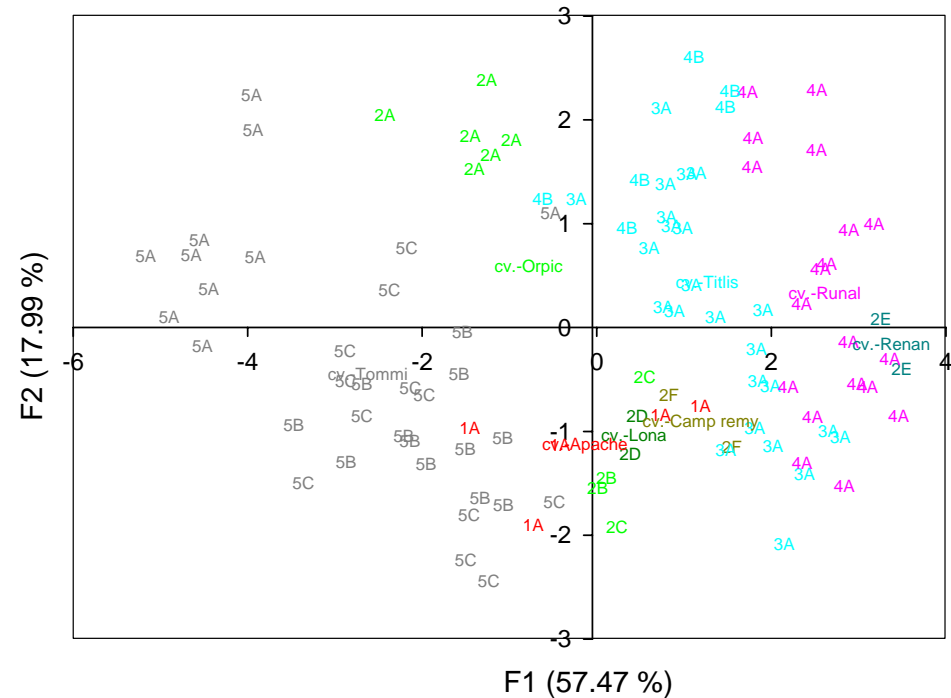
- Dietary fibre
- Bound Hydrophilic antioxidants
- Hardness
- Mineral content
- Total protein



Variables (axes F1 et F2 : 75.47 %)



Biplot (axes F1 et F2 : 75.47 %)



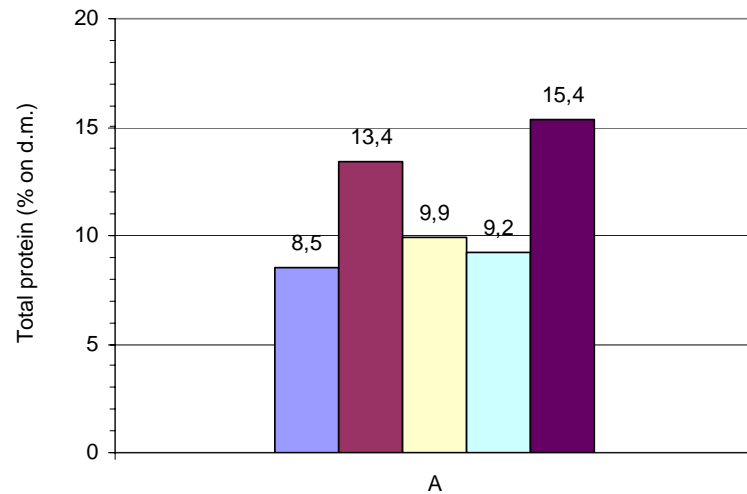
Apache  
Orpic  
Lona  
Renan  
Camp Remy  
Titlis  
Runal  
Tommi

Strong influence of cultivar on protein composition, and then, on breadmaking quality



### ESA - WP2.4 Intercropping Total protein

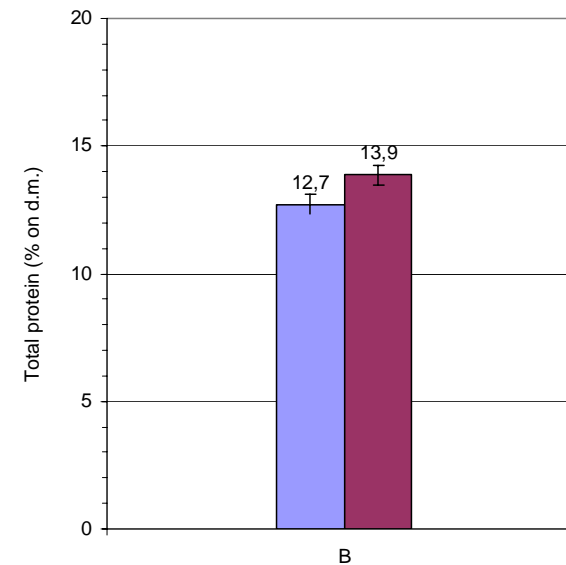
- T1 100% wheat, without N fertilization
- T2 100% wheat, with N fertilization
- T3 50% wheat - 50% pea, without N fertilization
- T4 70% wheat - 30% pea, without N fertilization
- T5 50% wheat - 50% pea, with N fertilization



Positive effect of N fertilization

### ART - WP 2.4 Intercropping Total protein

- T1 wheat sown in bare soil
- T2 wheat sown in white clover

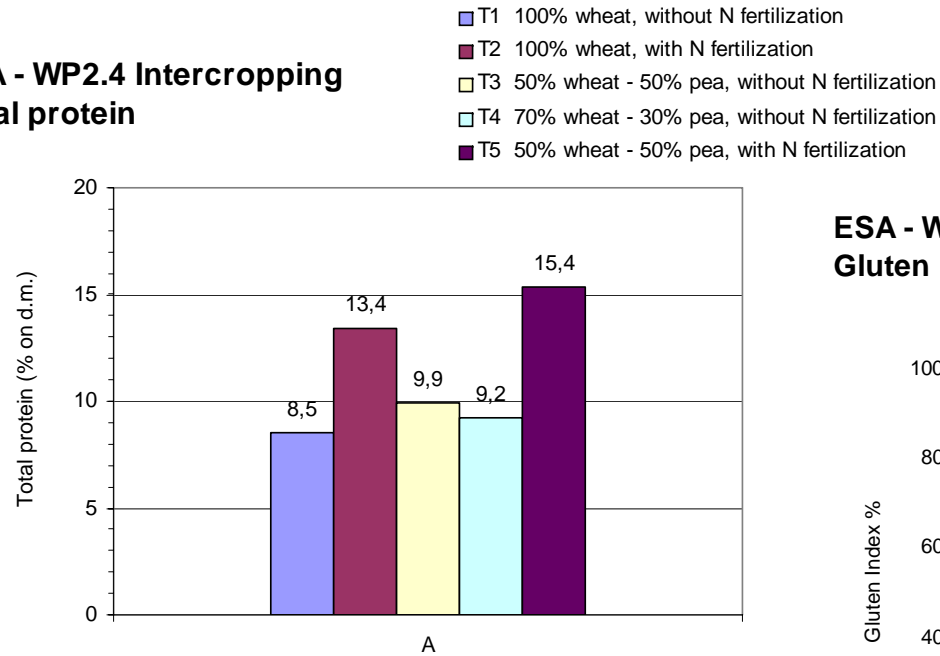


Positive effect of white clover  
living mulch

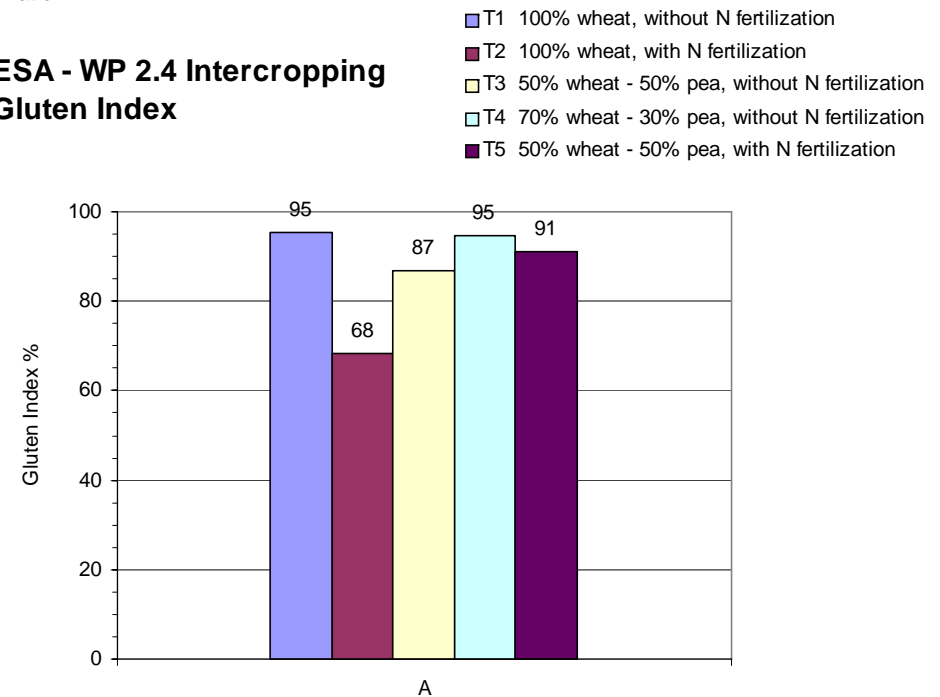
N management strongly influenced protein and gluten content



### ESA - WP2.4 Intercropping Total protein



### ESA - WP 2.4 Intercropping Gluten Index



N management does not directly influenced the breadmaking quality .....

No relation between protein content and gluten index determined by the protein composition

- **The incidence of the intercropping or mixed crops on ecological services needs to be further explored and optimized with respect to high quality and sustainable wheat production**
- **The interaction of genotype x management x location needs to be explored in order to choose the optimal crop management for high quality bread wheat production for each system and region**
- **The standard baking trials and assessment of quality parameters needs to be adjusted to the organic sector asking for different baking protocols and other wheat products**
- **Simple quality tests need to be identified as reliable predictors for bread making quality of organically produced wheat for the processors (millers and bakers) as well as for the breeders**





Experience with transnational  
research and added value



# CORE organic

Exchange scientific expertises

## FIBL Trial

3 experimental factors – 8 treatments  
1 site

Mouldboard ploughing vs Reduced tillage

Slurry vs Slurry+manure compost

Biodynamic preparations vs no preparations

## SoilMan Trials

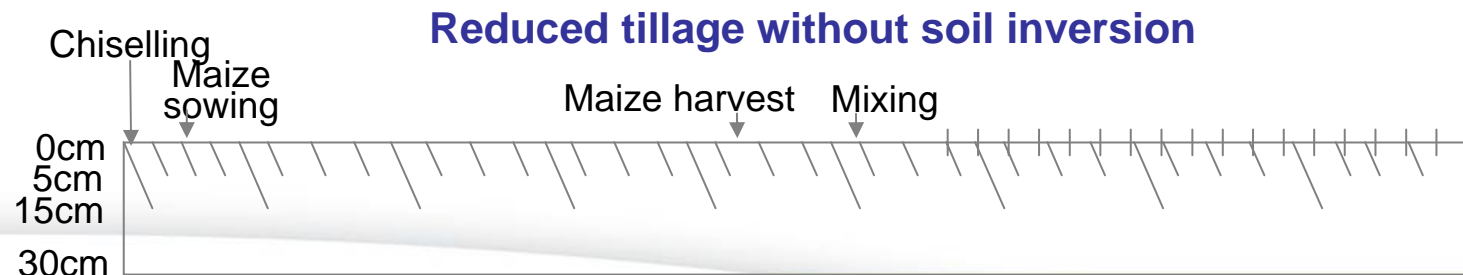
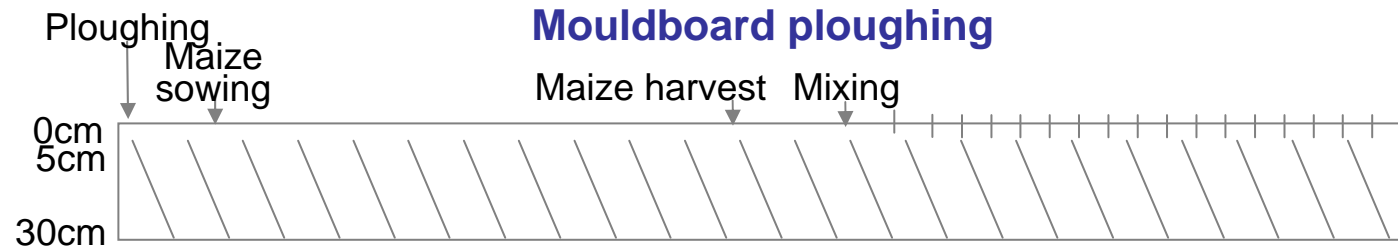
1 experimental factor 4 treatments – 2 sites

**Mouldboard ploughing** - 30 cm - soil inversion

**Shallow mouldboard ploughing** - 15 -20 cm - soil inversion

**Reduced tillage** with tine tool 10 - 15 cm – no soil inversion

**No tillage** - 0 -5 cm – no soil inversion



# CORE organic

Develop agronomic and technological innovation

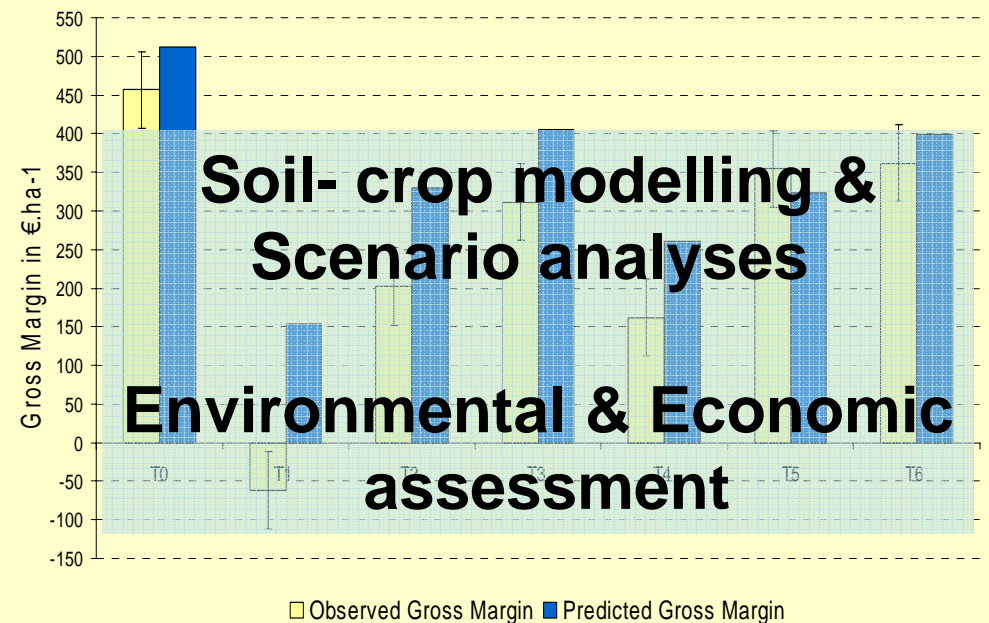
Intercropping and undersowing system on organic wheat



Ozonation and heat treatment



Minimum tillage on organic grain systems



# CORE organic



- **Exchange of existing protocols, databases and techniques & Produce common methodology**
- **Improved knowledge due to multidisciplinary research team** (agronomist, food technologist ... modelist and economist)
- **Strengthening the collaboration on the whole food chain ... *From Seed to Bread***

