AGronomical and TECHnological methods to improve ORGanic wheat quality


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Objectives

- 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
CORE organic

Illustration of main results

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

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
Organic wheat market in Switzerland

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

Organic wheat market in France
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

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)

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

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.
Multifactorial analysis

Bread making properties
- Dough reological analysis
- Redox status
- Zeleny sedimentation index
- Gluten index
- Flour reological 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
Strong influence of cultivar on protein composition, and then, on breadmaking quality
In incidence of N management on protein level

**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

**ART - WP 2.4 Intercropping**

Total protein

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

Positive effect of N fertilization

Positive effect of white clover living mulch

**N management strongly influenced protein and gluten content**
N management does not directly influence 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
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

Exchange scientific expertises
Intercropping and undersowing system on organic wheat

Minimum tillage on organic grain systems

Ozonation and heat treatment

Soil-crop modelling & Scenario analyses

Environmental & Economic assessment

Gross Margin in € ha⁻¹

-150
-100
-50
0
50
100
150
200
250
300
350
400
450
500
550

Observed Gross Margin
Predicted Gross Margin

CORE organic
Develop agronomic and technological innovation
• 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