

AGTEC-Org – Agronomical and TEchnological methods to improve Organic wheat quality



A project of the research network



Techniques to improve technological and sanitary quality

Summary

Agronomical ways for better quality and safety

Choice of cultivar is an efficient way to obtain higher grain quality. Intercropping legumes (grain or forage) improves weed competition and N availability for wheat crop or succeeding crop. Green manure can be an effective alternative to farmyard manure. Fertilization with readily available nitrogen improves yield and quality when water is available. Reduced tillage affects soil fertility and wheat yield but has little effects on grain quality.



Technological ways for better quality and safety

Milling process strongly influences flour characteristics. Stone milling improves nutritive value; characteristics remain very stable independently of the milling yield. Flour characteristics from roller milling appear very susceptible to the milling yield. Increasing the milling yield in the aim of enriching nutritional quality has a detrimental effect either on safety (DON) or on bread-making quality (bread volume). Debranning before milling has a very positive impact on flour safety by reducing its DON content by 50 %.

Context and challenges of the AGTEC-Org project

In the last two decades, demand for organic bread cereals has developed fast throughout Europe (Willer et al., 2008). The organic bread wheat market has been diversified over time throughout the emergence of different sale channels. Requirements from processors and consumers on quality and safety are getting higher for organic bread wheat. Even though European countries` consumption varies, quality requirements on baking value, nutritional aspects and safety risk are quite common. Organic bread wheat production has to be developed by new conversion and yield improvement to respond to the domestic demand from Western European countries, whereas quality could be improved by agronomical and technological methods. Nitrogen deficiency and weed infestation are the main limiting factors for wheat grain yield and grain protein content (Casagrande et al., 2009). Moreover, mycotoxin is often considered to impair sanitary quality of grain. The overall objective of AGTEC-Org was to identify agronomical and technological ways to improve the performance of organic wheat and flour. The findings will contribute to enhanced baking quality and nutritional value of organic flour, as well as the prevention of mycotoxin contamination. The project involved 9 research centres or universities from 5 European countries for a total budget of about 1.5 million €.

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Added value of AGTEC – Org project

Agronomists and cereal technologists working together

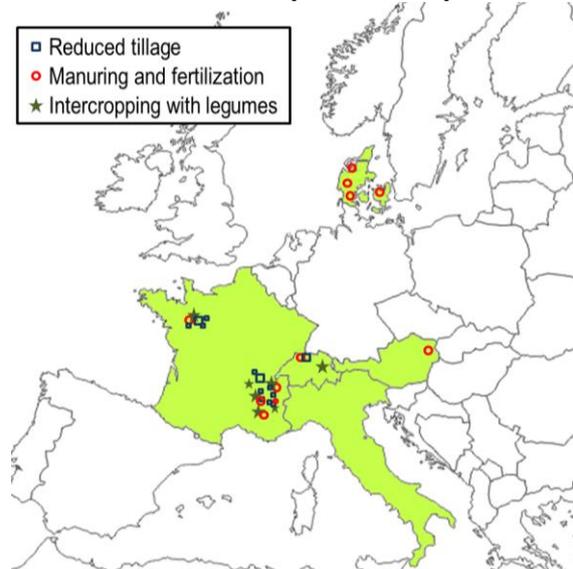
This project allows to improve knowledge on the incidence of agronomic and technological practices on bread wheat quality and safety performance. The collaboration also underlines how complex the consequences of agronomical practices and technological processes might be on quality variables, as they impact on numerous interacting factors (genetics, nutrition, milling technology etc.).

A transnational project

The consortium brings together partners with complementary and internationally recognized expertise in agronomy and food technology. The AGTEC-Org project makes it easier to identify and consider European diversity on farming systems, food processing and consumers` attitudes.

The consortium facilitates dissemination of findings and technical advances in both agronomical and technological fields for the different European countries.

A common experimental pattern



23 field experiments developed all over Europe

11 long-term field experiments and 12 farmers' field trials permitted to assess the impact of agronomical techniques on wheat grain and flour quality. Long-term field experiments considered cumulative effects of tillage and/or nutrition regimes on wheat performance and quality but also on soil fertility. The use of farmers' field experiments enabled us to test innovative practices (*e.g.* minimum tillage) under different pedoclimatic conditions and to evaluate the economic impact of these practices under real conditions. Agronomical practices were compared in 23 field experiments; over 150 treatments were tested.

Providing an overall view of the European organic wheat sector

A survey was realised in 5 EU countries (Austria, Denmark, France, Italy, Switzerland) representing the diversity encountered in Western Europe. 26 interviews of farmers and/or key informants were done. This survey was complemented with statistical data (Eurostat, IFOAM...) and literature reviews.

A heterogeneous situation in EU-27

It appears that wheat is the most important organically produced cereal in EU-27 with ca. 420.000 ha in production (data 2008). The situation and evolution differ among countries. France and Austria recorded growth of more than 25 % for the last decade. Denmark follows with a share of 12 %. Countries like Switzerland or Italy present low increase in organic soft wheat while the organic share has largely increased for other products. Durum wheat (117.686 ha – Eurostat 2006) is particularly grown in Italy whereas large areas for soft wheat production are found in Germany (45.000 ha), France (35.008 ha) and the United Kingdom (21.767 ha).

A large range of organic wheat production systems

From the beginning of the 1990s, organic agriculture has become much more specialized by the conversion of conventional grain systems. The large spectrum of organic cropping systems is characterised by variable levels of inputs (fertilization, machinery), crop diversity and crop management practices. Four types of cropping systems comprising soft wheat production were highlighted in this survey (David et al., 2011).

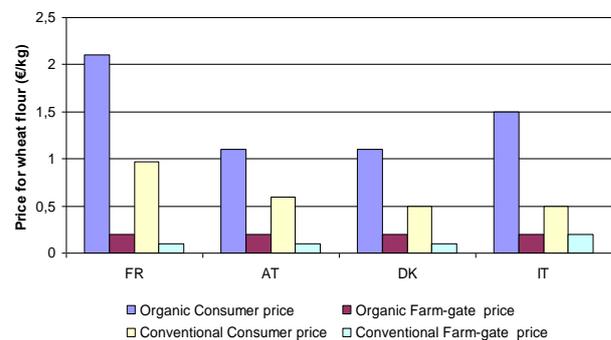
Profitability of organic wheat in Europe

The economic viability of wheat production in Europe is clearly affected by the support

payments policies, the technical performance and the existence of an adequate marketing structure.

Direct support for organic farmers via area payments or other subsidies is anticipated to have a substantial impact on the economic viability of organic production also in the future. This support greatly varies among the different member countries and regions of the EU, both in terms of the levels of payments and eligibility for the programmes.

Prices have fluctuated considerably as the world cereal market. Differences of wheat prices between organic and conventional productions differ among European countries. The development and expansion of the organic cereal sector is limited partly due to the large gap between farm-gate prices and prices for consumers. One key question is whether the relative profitability of organic wheat could be maintained if the price paid by consumers was reduced.



A large gap exists between farm gate and consumer price (EC, 2005)

During the last decade, the development of the organic market was strongly supported by the wholesalers. Supermarkets were important actors in developing sales by attracting new (occasional or regular) consumers.



Incidence of agronomical techniques

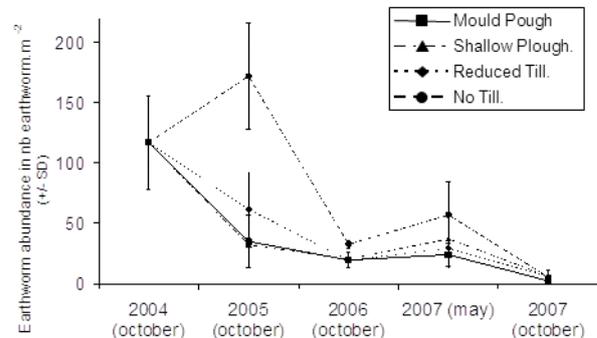
Cultivar choice, climate and soil conditions strongly influenced grain quality

In general, cultivars, location and soil type appeared to have a high influence on grain yield and grain protein content obtained in the different long-term field experiments. Thus the protein content of the samples from all experiments and years strongly varied, ranging from 6.7 to 15.8 g/100 g of dry matter.

The effects of reduced tillage, intercropping with legumes, organic fertilization and green manuring

Weed competition and soil texture were the main factors on wheat performance under reduced tillage. If weeds were well controlled, reduced tillage generally obtained similar results compared to traditional ploughing. Reduced tillage improved soil structure in the top-layer (up to 10 cm) of heavy clay soil, resulting in a higher germination rate and improved grain yields. On the contrary, soil compaction might appear in sandy and silty soils. The positive effect of reduced tillage on soil fertility could directly affect crop nutrition by good rooting, if initial soil structure was good. Direct seeding and the insertion of a cover crop can significantly increase earthworms' density and activity.

Earthworm abundance is improved with direct seeding and cover crop (Peigné et al, 2009).



Wheat quality parameters were less affected by soil management than grain yield. Protein content and most of the commonly used quality indicators like Zeleny Index or Falling number remained unchanged when switching from traditional ploughing to reduced tillage.

A significant increase in mycotoxin content (DON) due to reduced tillage was only detected in sites with the pre-crops maize and lupin. However, the DON contamination level never exceeded the European threshold. In general, wheat quality was satisfying under different soil management treatments.



Intercropping with legumes is an effective strategy to improve protein quantity and quality in wheat. Pea and clover grass turned out to be most effective. Catch crops and crop rotations including forage legumes contributed to an improved wheat performance as well. Green manure can be an effective alternative to farmyard manure. Nitrogen fertilization is finally the best way to increase grain protein content, particularly when the readily available nitrogen content is high.

The impact of intercropping and N fertilization on grain quality is generally positive while the effect of green manure remains low. Wheat offers advantage compared to other crops, because of its ability to control weed seed germination and improve soil quality due to its deep reaching root system and high root biomass. Nonetheless, managing nutrient supply and controlling annual and perennial harmful weeds is essential. Therefore, premium price for special quality can be obtained by optimized choice of genotype, diversified crop rotations, and adjusted organic fertilizer inputs.



aleurone layer (beneficial for nutritional quality) but also a higher DON content (detrimental for safety) compared to roller milling. Moreover, in the case of the stone milling process, the bread volume was lower (detrimental for sensorial properties) and couldn't be modulated by adjusting the milling yield. Interestingly, this could turn into an advantage when making whole-meals breads, since bread volume was little affected by different milling yields of stone milled flours. The contrary applies to roller milled flours. With both stone and roller milling, gluten Index (a protein quality indicator of common use) indicated strong gluten and it remained stable with increasing milling yield, even if the gluten extractability decreased at the highest extraction rates.



Grain pre-treatment by debranning before milling had a very positive impact on flour safety by reducing DON content by 50 %. However this pre-treatment had no effect on bread volume. Grain pre-treatment with ozone had also a beneficial impact on DON content and had an oxidizing effect on the flour which might also impact on bread-making behaviour.

Post-harvest treatments can improve organic wheat grain quality

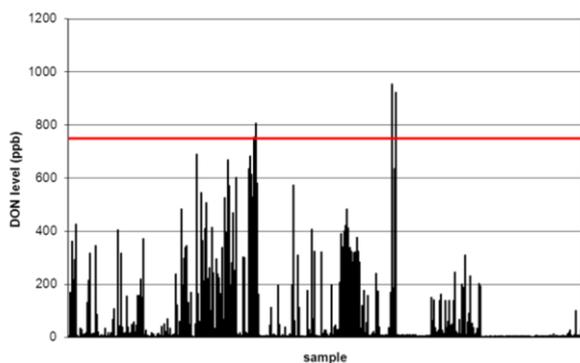
Lab-experiments in the AGTEC-Org project provided evidence that composition of organic flour and its characteristics are strongly affected by the milling technique as well as the milling yield. Flour manufactured by means of stone milling exhibited a higher content of

Organic wheat grain presents an overall good quality

Sanitary quality turns out to be satisfying in most organic conditions

The broad range of treatments and situations assessed (more than 400 treatments), suggests

that DON contamination of organic grain wheat is limited in the field. Low levels of DON were generally observed on tested grain samples (95 % of grain samples presented DON levels below 500 ppb, more than 75 % DON levels lower than 200 ppb). However, large variations of DON levels occurred due to climate, edaphic and genetic conditions. Consequently, it was difficult to highlight significant impacts of the tested agronomical practices on DON contamination.



DON contamination was generally low in organic grain samples

Technological quality is generally fair to good

Despite highly variable protein contents, sometimes below the minimum threshold accepted by European millers, organic flour samples acceptable to good baking quality and loaf volume.



In many cases, the low protein content is counterbalanced by higher proportions of glutenins and by a better aggregation of this protein class resulting in acceptable dough strengths. These results help to understand the

observation that grain protein quality indicators like Zeleny index and Gluten index, commonly used to predict the baking quality of conventional might not be suitable for organic wheat.

Selected publications

*Celette F, Goulevant G, Amosse C and David C (2010) **Associating wheat crop and undersown forage legumes in organic agriculture: Incidence of forage legumes species.** In: Wery J, Shili-Touzi I and Perrin A (Eds). Proceedings of AGRO2010, XIth Congress of the European Society of Agronomy, Montpellier, France, August 31-September 3 2010. Agropolis International Editions, Montpellier, France. ISBN: 978-2-909613-01-7. <http://orgprints.org/18891/>

*David C, Celette F, Abecassis J, Carcea M, Friedel J, Corre-Hellou G, Hiltbrunner J, Messmer M, Peigné J, Samson MF, Schweinzer A, Thomsen IK and Thommen A (2011) **New challenges to improve organic bread wheat production in Europe.** In: 3rd ISOFAR Scientific Conference in the frame of the 17th IFOAM Organic World Congress, Gyeonggi Paldang, South Korea, September 26-October 5 2011. <http://orgprints.org/19483/>

*Naudin C and Corre-Hellou G (2011) **Producing organic wheat with high grain protein content: the significance of intercropping and the need for diagnostic tools.** In: 3rd ISOFAR Scientific Conference in the frame of the 17th IFOAM Organic World Congress, Gyeonggi Paldang, South Korea, September 26-October 5 2011. <http://orgprints.org/19416/>

*Thomsen IK, Samson MF, Carcea M, Narducci V. (2011). **The influence of long-term inputs of catch crops and cereal straw on yield, protein composition and technological quality of a spring and a winter wheat.** International Journal of Food Science and Technology. 46: 216–220. <http://orgprints.org/18803/>

* Publications from the project



Acknowledgement

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