SIXTH FRAMEWORK PROGRAMME
PRIORITY [Food Quality and Safety]
[5.4.1 Area: Total Food Chain**]**

INTEGRATED PROJECT

Final Publishable Activity Report
Executive Summary

Project acronym: **QualityLowInputFood**
Project full title: **Improving quality and safety and reduction of cost in the European organic and "low input" food supply chains**

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QLIF Integrated Research Project

Advancing organic and low-input food

Photo: ICROFS and Organic Denmark

Improving quality and safety and reduction of costs in the European organic and low-input supply chains

The Integrated Project “Improving quality and safety and reduction of costs in the European organic and low input supply chains” (QLIF) was funded by the European Commission under the 6th Framework Programme for Research and Technological Development.

QLIF started in 2004 with 31 scientific and industry partners and supplemented the consortium with another five partners via open calls. The total budget was 18 million € of which the European Commission contributed 12.4 million €. The duration of the project was five years. The scope of QLIF was on quality and safety of organic and low-input foods in the context of cost efficiency and sound environments. Sixty-one work packages provided conclusive answers based on comprehensive analyses from scientific experiments, socio-economic data and complex modelling. The work was organized in 7 subprojects with interdependent aims. Here an outline is given on what the Integrated Project QLIF has achieved and what challenges remain. Individual subproject folders provide a further insight to the outcomes and a substantial amount of QLIF publications are available in the open access database Organic Eprints.

The major results of QLIF demonstrate the progress made by the approach of integrated research in organic and low-input food systems

1 The quality of organic foods is high and matches the expectations of European consumers

Experiments in different parts of Europe proved that the quality of crops and livestock products from organic and conventional farming systems differs considerably. In the case of dairy products, low-input systems like free-range grazing produced identical qualities as organic farming, but in most other cases, the low-input systems were more like conventional farming. The results showed that organic food production methods resulted in (a) higher levels of nutritionally desirable compounds (e.g., vitamins/antioxidants and poly-unsaturated fatty acids such as CLA and omega-3) and (b) lower levels of nutritionally undesirable compounds such as heavy metals, mycotoxins, pesticide residues and glyco-alkaloids in a range of crops and/or milk. In the case of milk, nutritionally desirable compounds were up to 70 pct higher in organic samples.

Photo: ICROFS

The multi-factorial design of the QLIF experiments made it possible for the first time to correlate the higher quality of organic food to management practices. The nutritional composition in a range of crops was improved by the non-use of chemo-synthetic mineral fertilisers, and in some cases pesticides. Dairy milk gained in quality when the feeding regime was roughage-based and maize silage was low in the diet or during outdoor grazing periods.

The QLIF results increased our knowledge on how producers can further improve the quality of organic plant and animal foods. Some experiments targeted very specific quality improvements, for example (a) to increase protein contents and quality of wheat through soil fertility management and variety choice, (b) to improve the intra-muscular fat content which affects the sensory quality of pork through the feeding of grain legumes or (c) to improve milk and milk protein yields through the feeding of red clover silages. Specific HACCP (Hazard Analysis and Critical Control Points) protocols were developed to support producers to manage quality attributes specific to organic products.

2 Organic foods are safe

Consumers regard organic foods not only as better, but also as safer, more hygienic, and free of chemical residues and artificial ingredients. Organic foods were shown to deliver against these expectations – this is another major result of the QLIF project. Studies in Denmark proved that there is a lower risk of faecal *Salmonella* shedding in pigs from outdoor rearing systems. This was shown for both organic and non-organic outdoor systems. Intensive indoor systems had 2 to 3 times higher *Salmonella* levels and therefore pose a greater risk of enteric pathogen transfer into the human food chain. A study in Germany looked at the microbiological safety of lettuce fertilized with organic manure. Even for worst case scenarios, no additional safety risks could be detected with respect to *Salmonella* nor *E. coli* transfer risks However these studies concluded that it is essential to follow good agricultural practice with respect to manure use and processing to minimise safety risks. Many nutritionally undesirable compounds are found in lower levels in organic foods than in conventional ones. Again, protocols for specific organic Hazard Analysis with the relevant Critical Control Points were developed.

3 Processing of organic commodities is a challenging trend

Regular purchasers of organic food are suspicious of over-processed organic foods sold in supermarkets. Occasional buyers on the other hand are sensitive to convenience food, and this customer group represents the most dynamic potential for further market

Photo: ICROFS

growth. Therefore, there is a high demand for processing methods that only sparingly use chemicals, additives and preservatives. The QLIF project proposed a code of practice, guiding processing standards which also include the aspect of maintaining the authenticity and naturalness of organic foods. In a case study with fresh-cut vegetables, alternative disinfectant strategies with ozone were successfully tested on both laboratory and industry level in order to avoid chlorine treatments. Furthermore, processing technologies were assessed that may improve the nutritional composition of dairy products.

4 Health claims for organic foods are not yet substantiated

The positive findings on the quality and safety of organic foods might be the reason why a majority of European baby food producers already shifted to processing organic raw materials. In contrast, studies investigating the effect of organic food consumption on the health of experimental animals only produced preliminary, but not yet conclusive results. Interestingly, organic and conventional feed from the field trials affected the hormonal balances and immune status of rats differently and significant correlations with fertilisation and crop protection techniques occurred. However, further and more detailed studies are required to provide proof for positive health impacts of organic diets on human and animal health.

5 Factors identified that impede an increased consumption of organic and low-input foods

The main barriers hindering the increase of demand for organic food are (a) insufficient availability, (b) limited range and assortment, and (c) high prices or an insufficient perceived price-performance ratio. The perception may possibly change with the information gained by QLIF research on the actual qualities of organic food. In countries where availability and assortment is very good (e.g., Denmark, Austria, Switzerland), the share of organic added up to 5 to 6 pct of all food purchases, but the relatively high premiums on consumer prices continue to obstruct large scale organic production.

6 Bottlenecks addressed and some solved along the organic food chains

A number of QLIF experiments addressed bottlenecks of organic crop and livestock production, which reduce yields, increase economic risks and therefore push up prices:

> In line with the organic concept, soil fertility management was a major focus in order to deploy the potential of soils to release nitrogen and to increase the suppressiveness to economically important diseases. The consequent application of good organic practices over decades was more effective than short-term interventions. Therefore, excellently managed organic farms become significantly more productive in the long run.

> Yield stability and increase was achieved by novel indirect and direct control of pests and diseases, e.g., by sowing companion plants in *Brassica* crops, attracting beneficial insects, by applying β-amino-butyric acid against mildew in lettuce, by treating seeds, e.g., with compost extracts and acidified nitrite solutions.

> Livestock performance was successfully improved, e.g., by preventive management strategies in the case of mastitis of dairy cows and in the case of two helminth species of poultry on outdoor runs.

> In other cases, alternative treatments such as diatomaceous earth and liquid formulation of silicas were successful against the red mite of poultry. Dried chicory roots included in the diet of sows and boars abolished egg excretion of parasitic roundworms. Some of these new techniques have been taken up by practitioners recently.

> Case studies of organic food supply chains revealed economically important weaknesses, especially in the high logistic and transport cost, high input costs and low spending on

research and product development. Good co-operation among the supply chain actors was identified as improving the non-financial and financial performance.

7 The scientific output from QLIF is big and the outreach for consumers and producers is highly relevant

Within five years of targeted research, the Integrated Project QLIF produced a solid scientific basis for organic food chains. The number of peer reviewed publications on organic food and farming grew considerably. Many findings were already disseminated to consumers and farmers by the end of the project. Further, the QLIF website now serves as entry to the open access database Organic Eprints, where an increasing number (more than 100) of publications from the QLIF project are available.

8 Major challenges ahead

Productivity remains a weakness of organic food chains, affecting the costs and the ecological footprint. The QLIF project showed, e.g., that the higher energy efficiency and lower greenhouse gas emissions per land area partly melted away when calculated on per ton basis. These challenges have to be addressed by future research.

In addition to soil fertility management, intensified breeding under low-input conditions could probably better exploit effects of genotype x environment interactions on genetic gain in breeding programs, both in organic and low-input crop and livestock systems. To some extent, novel and innovative non-chemical direct treatments, especially for diseases, might also help. Novel farm, food chain and landscape strategies based on diversification by co-operation could increase system productivity and might reduce trade-offs between economic, ecological and social goals. Sustainable production and consumption will require transparent information and active participation of stakeholders – uncommon for most scientists. Developing markets and changing consumption patterns call for a stronger research focus on processing, packaging, transportation and storage.

These are some of the future challenges to be addresses by researchers for organic and sustainable food chains.

Further about QLIF

QLIF comprises seven subprojects on:

1) Consumer expectations and attitudes
2) Effects of production methods
3) Crop production systems
4) Livestock production systems
5) Processing strategies
6) Transport, trading and retailing
7) Horizontal activities

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Information on partners and subprojects is found at the project website **www.qlif.org**. The website also holds the library for project newsletters and serves as entry to Organic Eprints, where more than 100 publications from the QLIF project are available: http://orgprints.org/view/projects/eu_qlif.html

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QLIF subproject 1:

Consumer expectations and attitudes

Photo: Organic Denmark

Determining consumer expectations and attitudes towards organic / low-input food quality and safety

The objective of QLIF subproject 1 was to deliver in-depth analyses of consumer expectations, attitudes and buying behaviours, with respect to quality and safety of foods from organic and low-input production systems.

Results of the research showed that consumer attitudes towards quality and safety are not consistent - they are changeable, and linked to a whole bundle of assorted issues such as personal health, the natural environment, and ethics. Organic consumers appear to fall into two main types: regular and occasional purchasers. Regular consumers are committed insofar as the products satisfy their quality and safety requirements, but they are suspicious of over-processed organic foods sold in supermarkets. Occasional consumers of organic and low-input foods are more price and convenience sensitive. A key finding is that consumer behaviour has co-evolved with market development. Availability has constituted the main barrier to increasing demand, and limited assortment as well as the perceived relationship between quality and price account for much of the fluctuation in demand among occasional users.

Regular and occasional consumers of organic food differ in attitudes and should be reached by different marketing strategies

Attitudes towards quality and safety
Results of the QLIF subproject 1 showed that consumer attitudes towards quality and safety of low-input and organic food are not consistent - they are changeable, and linked to a whole bundle of assorted issues such as personal health, the natural environment, ethics and self-image. These findings were based on analysis of existing studies and qualitative data from Austria, Denmark, Finland, France, Germany, Italy, Switzerland and UK. Although geographical differences were not significant, the place of production, particularly when local, did play an important role in developing trust. It was not clear from this analysis, however, what influenced fluctuations in household demand over time.

Photo: Organic Denmark

Regular and occasional consumers
Organic consumers appear to fall into two main types: regular and occasional purchasers. Regular consumers are committed insofar as the products satisfy their quality and safety requirements, but they are suspicious of over-processed organic foods sold in supermarkets. Occasional consumers of organic and low-input foods are more price and convenience sensitive. One dilemma, which needs to be addressed by the industry, is whether the concerns of both existing and potential consumers of low-input products can be satisfied at the same time, when their requirements differ quite markedly.

Perceptions of quality and safety
In another stage of the research we focussed on consumers who were not regular buyers of organic foods to determine what they understood by quality and safety and how this related to organic and low-input foods. The research was carried out by focus groups in France, Germany, Switzerland, Italy and the UK, concentrating on four products: bread, yoghurt, tomatoes, and eggs. For these consumers 'organic' was associated with freshness and a minimal level of processsing. Organic is thus linked to short distribution channels and on-farm production. However, consumers' knowledge of agriculture, food technology and processing seems weak and for some there might be confusion between 'organic' and any product purchased through short distribution channels.

Organic can also be considered an assurance of food safety for processed foods when farming or processing techniques are suspected. Thus, provision of information may not necessarily address the lack of knowledge. Some consumers seek more information while others feel overwhelmed by the quantity of information they need to make their food choices. Both attitudes can lead to support for organic consumption. The latter group wishes to have a label that provides an assurance of food safety and quality, without personal investment.

Quality indicators
Through a questionnaire survey across six countries we were able to collect information from almost 6000 consumers on their attitudes and perceptions of the quality and safety of organic, low-input and conventional foods. Again, we focussed on eggs, bread, tomatoes and yoghurt. There was evidence across the products and countries that low-input characteristics are important to consumers as quality indicators. For example, together with freshness and taste, the absence of chemical residues and artificial ingredients are regarded as very important quality indicators across all products and countries. At the other end of the spectrum, brand name and price were not regarded as particularly important indicators of quality for bread, tomatoes and eggs and brand name and packaging was regarded as the least important for yoghurt.

Low-input products are regarded as being safer, although a comparison of organic and non-organic consumers shows differences in the level of concern that they express. Comparisons of organic and non-organic consumers have implications for the marketing of low-input products. Table 1 shows the degree to which UK non-organic consumers regard organic products as better or not. The table indicates those aspects of product quality that provide most scope for increasing sales to previously non-organic consumers.

Table 1: Comparison of organic products with non-organic by UK non-organic consumers

Much better	- Chemical residues - Artificial ingredients - Impact on environment
Better	- Naturalness - Not mass produced - Quality of animal feed - Use of veterinary medicines - Animal welfare - Nutritional content - Taste - Food safety - Made in your own country - Local or regional identity
A little better	- Hygiene standards - Freshness - Reputation of seller - Distance transported - Quality assurance label
The same	- Providing fair price to producers - Appearance
Worse	- Shelf life/keeping quality - Value for money - Range of types available - Price

Consumers' actual buying behaviour

Consumers' actual buying behaviour was studied by choice experiments in Germany, France and Switzerland. It was found that consumers' attitudes towards higher prices for food quality and organic foods are highly significant determinants for the choice of the organic alternatives, while the attitudinal influences regarding choice of the low-input

Photo: Organic Denmark

alternatives are weaker. Interestingly, the relevance of particular attitudes depends on the processing level of the products. The low-input products compete with conventional rather than with organic products. The quality-oriented consumers are not very price-sensitive as long as a certain price limit is not exceeded. The findings suggest that a promising marketing strategy is to increase the perceived price-performance ratio of organic food. This could be achieved through better communication of the various quality criteria incorporated in organic food.

Development of household purchases

It is well-known that general demand for organic products has risen in recent years, but demand at household level fluctuates and is unstable over time, and almost nothing is currently known about factors that influence this instability.

During the most recent year for which data were available, more than 80 pct of organic products on the Danish and Italian markets (60 pct in the UK) were sold to households spending 10-25 pct of their food budget on organics. In all three countries, the purchasing pattern of these households had been more stable over a longer period of time than households that had spent smaller proportions of their food budgets (1 to 5 pct on average) on organic purchases.

A key finding is that consumer behaviour has co-evolved with market development. Availability has constituted the main barrier to increasing demand, and limited assortment as well as the perceived relationship between quality and price account for much of the fluctuation in demand among occasional users. Distribution, assortment and price are key elements of a marketing strategy aimed at the latter. However, the results also indicate the need for differentiating marketing strategies if the loyalty of regular users, who prize high quality, careful processing and local production, is to be maintained.

QLIF subproject 1: Determining consumer expectations and attitudes towards organic/low input food quality and safety

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Links

Find more information at www.qlif.org

Selected publications

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QLIF subproject 2:

Effects of production methods

Photo: ICROFS

Determining the effect of organic and low-input production methods on food quality and safety

The objectives of QLIF subproject 2 were to: (i) identify the effect of production systems (organic, low-input and conventional) on food quality and safety parameters; (ii) identify agronomic parameters responsible for differences in food quality and safety; (iii) carry out a pilot study into the effect of consumption of organic crops on hormonal balances and immune status in a model experimental animal system.

The results showed that organic food production methods resulted in: (a) higher levels of nutritionally desirable compounds (e.g., vitamins/antioxidants and poly-unsaturated fatty acids such as omega-3 and CLA); (b) lower levels of nutritionally undesirable compounds such as heavy metals, mycotoxins, pesticide residues and glyco-alkaloids in a range of crops and/or milk; (c) a lower risk of faecal *Salmonella* shedding in pigs. These nutritional benefits were linked to specific agronomic practices that are prescribed by organic farming standards. Pilot studies showed that these composition differences may translate into measurable health benefits in a model experimental system with rats. Further elaboration on the complex interaction between production methods and health benefits will have to be addressed in future studies.

Food from organic farming systems tends to have more nutritionally desirable compounds due to the organic fertiliser and feeding regimes

Effects of production systems

Organic farming systems prohibit the use of chemosynthetic mineral fertilisers, pesticides, growth regulators, hormones and most food additives. Standards also restrict the use veterinary medicines and impose longer withdrawal periods of products from medicine-treated animals. As a result, there are much lower levels of agrochemicals in organic compared to conventional foods. However, higher risks of contamination from mycotoxins, heavy metals and enteric pathogens have frequently been ascribed to organic production methods, although there are virtually no scientifically sound studies to support these claims.

Photo: Organic Denmark

In contrast, in the 1990s and early 2000s there were a range of studies reporting that foods from organic crop and livestock production systems had higher concentrations of nutritionally desirable compounds such as vitamins, antioxidants and certain poly-unsaturated fatty acids. Yet, there were also some studies reporting no significant differences in composition between organic and conventional foods and/or a few studies reporting higher levels of certain desirable compounds in conventional foods. Most of these studies were based on either systems comparisons of foods produced in organic and conventionally managed fields or studies in which organic and conventional foods were purchased in different retail outlets and compared.

While these studies provided an estimate of the differences in food quality a consumer is faced with, they were scientifically unsatisfactory, because they did not allow the reasons for differences in food quality to be linked to agronomic factors that differ between organic and conventional production. These factors include: (a) fertilisation, crop protection regimes, rotation design and/or variety choice in crop production and (b) feeding regimes, health management, husbandry methods and/or breed/ genotype choice in livestock production.

The aim of QLIF subproject 2 was to: (i) identify the effect of organic, low-input and conventional production systems on food quality and safety parameters; (ii) identify agronomic parameters responsible for differences in food quality and safety; and (iii) carry out a pilot study into the effect of consumption of organic crops on hormonal balances and immune status in a model experimental animal system.

Nutritionally desirable compounds in crops

Factorial field trials were established to identify the effect of fertilisation and crop protection regimes and rotational design on the nutritional composition of crops. Significantly higher levels of antioxidants, vitamins and/or other nutritionally desirable phytochemicals (e.g., glucosinolates in cabbage) were detected in a range of organic field vegetable and glasshouse crops (cabbage, lettuce, potato, tomato) when compared to conventionally grown crops.

In most crops, the increase in phytochemical content was linked to the fertilisation regimes (non-use of mineral fertilisers) used in organic production systems. Fertilisation regimes also affected gene expression, protein profiles and concentrations of resistance compounds, indicating that the impact of using organic matter rather than mineral fertiliser on crops has been underestimated.

For some crops (e.g., lettuce) significantly increased vitamin levels in organic crops were also linked to the crop protection regimes applied in organic systems (non-use of herbicides, pesticides and fungicides).

These data clearly indicate that the non-use of chemosynthetic mineral fertilisers, and in some cases pesticides, can improve the nutritional composition in a range of crops.

In contrast, insect-proof netting, used to protect organic cabbages against insect attack, caused a reduced concentration of certain antioxidants, compared to crops protected by pesticides. Clearly this is an area where organic farming practice needs to develop insect control strategies to improve the nutritional quality of crops.

Nutritionally undesirable crop compounds
In the factorial field trials, significantly higher levels of certain heavy metals (especially cadmium and nickel) were found in conventionally managed field vegetables, potato and wheat crops. In conventional potatoes, glycoalkaloid levels were also found to be higher. A meta-analysis of literature data showed that *Fusarium* mycotoxin levels were 2-3 times lower in cereal grains from organic production systems compared to conventional. According to the available literature, the lower levels in organic grain are due to a range of agronomic factors including the use of diverse rotations, non-use of high rates of chemosynthetic mineral N-fertilisers, certain fungicides and growth regulators that were all linked to higher *Fusarium* mycotoxin risk. As expected, levels of pesticide and growth regulator residues were only found in crops under conventional crop protection regimes.

These studies provide evidence that organic foods contain lower levels of many of the nutritionally undesirable compounds that are of concern to consumers. They also show that it is a myth that the risk of mycotoxin contamination increases when chemosynthetic pesticides are omitted from crop production.

Nutritionally desirable compounds in milk
A large scale, dairy-farm survey was carried out to investigate the effect of organic and conventional production methods on milk quality. In all four study countries (Sweden, Denmark, UK and Italy) composition differed between milk from organic and conventional dairy herds. A range of nutritionally desirable vitamins/antioxidants such as Vitamin E, β-carotene, lutein and poly-unsaturated fatty acids (e.g., omega-3 fatty acids) were found at higher levels (up to 70%) in organic compared to conventional milk samples from the same country. However, there were also differences in milk composition between countries and between the summer outdoor grazing and the winter indoor periods when cows are fed a conserved forage-based diet.

Importantly, differences in milk composition were smaller during the winter indoor period. The long periods of outdoor grazing and high level of forage prescribed for dairy cow diets under organic production standards were identified as the main reasons for the higher levels of nutritionally desirable fatty acids and vitamins/antioxidants. Results from the farm survey were recently confirmed by a comparison of organic and conventional milk based on samples from major UK retail chains.

Reduced risk of pathogen transfer from pigs
A study in Denmark compared the levels of faecal *Salmonella* shedding in contrasting pig production systems. Data showed that the proportion of pigs with detectable levels of *Salmonella* in their faeces was 2-3 times higher in pigs from intensive indoor systems compared to both organic and conventional outdoor rearing systems. This demonstrated that outdoor rearing systems not only provide a more natural, welfare-friendly environment for pigs, but also reduce the risk of enteric pathogen transfer into the human food chain.

Impact of organic food consumption
In a pilot study, rats were reared on diets made from crops grown in the factorial field trials (see above). Differences in fertilisation and to a lesser extent crop protection had a significant effect on hormonal balances and immune status of the animals. Also, close correlations were detected between the concentration of specific hormones and the dietary intake of phytochemicals found in higher concentrations in rat feeds made from organic compared to conventional crops. These studies are thought to represent an important first step towards gaining an understanding of how the way we produce food can impact on their composition and ultimately animal and human health.


Photo: ICROFS

QLIF subproject 2: Quantifying the effect of organic and low input production methods on food quality and safety and human health

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QLIF subproject 3:

Crop production systems

Photo: ICROFS

Strategies to improve quality and safety and reduce cost of production in organic and low-input crop production systems

Organic crop production seeks to produce high quality foods while reducing the inputs in order to promote environmental quality and conserve resources. This necessitates optimal production systems in terms of soil fertility and plant health. Studies in QLIF subproject 3 have shown that soils may gain an improved potential to release N from added amendments through adaptation of management practices. Likewise, long-term management strategies may influence suppressiveness of soils to economically important diseases. Application of manures and other organic soil fertility inputs do not pose any additional safety risk in ready-to-eat vegetables, such as head lettuce, if good farming practice is applied. Even under experimental worst-case conditions, pathogen transfer from soil treated with farmyard manure to vegetables was not substantial.

Pest and disease control was studied both at seed and field levels, and it was shown, e.g., that ß-amino-butyric acid was efficient in controlling downy mildew in lettuce under field conditions. Finally, for organic wheat production systems, an integrated assessment indicated that yields and protein contents can be increased by improved cultivar choice and fertility management regimes promoting biological N fixation in the soil.

Strategies to improve quality and safety and reduce cost of production in organic and low-input crop production systems

Organic farming seeks to attain high quality food production and ecological balance through the design of farming systems, establishment of habitats and maintenance of diversity. Inputs should be reduced in order to maintain and improve environmental quality and conserve resources. Technological bottlenecks in organic production systems potentially affect quality and safety in organic foods, the environment, as well as costs of production. These bottlenecks include insufficient and/or untimely availability of nutrients and occurrence of pests and diseases. The aim of the QLIF subproject 3 was to (i) improve the understanding of the functionality of inherent soil fertility as a base for crop productivity and health, (ii) to develop improved agronomic strategies, and (iii) to demonstrate the impact of improved management strategies in annual (tomato, lettuce, wheat) and perennial (apple) pilot production systems.

Photo: University of Bonn

Improving soil fertility by management

Soil management such as soil tillage, crop rotation, and organic amendments has an obvious impact on soil fertility as properties such as erosion stability, nutrient availability, or water-holding capacity are strongly affected. We examined the impact of site, long-term management, and short-term fertility input strategies on soil physical, chemical and biological parameters. Long-term management with organic-matter-based inputs (e.g., farmyard manure) had a profound impact on soil fertility. In the short term, however, the input of organic matter based manures did not alter the soil biological parameters significantly, suggesting that the maintenance of high soil fertility levels needs consequent management over decades. For instance, the soils that had been managed biodynamically consistently released more N from the added amendments than the other treatments. This suggests that through adaptation of management practices, soils can be developed with an improved potential to release N from added amendments.

Suppressiveness of soils to diseases

Soil properties affect the occurrence and severity of soil-borne diseases and diseases on foliar parts of the plant. We studied the impact of site, long-term management, and short-term fertility input strategies on the suppressiveness of soils to soil-borne as well as foliar diseases under controlled conditions. We found pronounced differences between the soil types under examination. Furthermore, site-specific suppressiveness can be modulated by long-term soil management, and, to a lesser extent, by short-term fertility inputs. However, site-specific factors that cannot be influenced by agronomic practices were found to have a greater impact than cultivation-specific effects within the same site. Nevertheless, short-term, but in particular long-term management strategies have been shown to have the potential to influence suppressiveness of soils to economically important diseases.

Food safety and organic manure

As consumption of raw ready-to-eat vegetables becomes increasingly popular, public concern about the microbiological safety of vegetable is increasing. Recently, concerns have been raised that intensive use of manures might lead to increased risk of food contamination by entero-pathogenic microorganisms. Unprocessed cattle manure may be a source of faecal bacteria that might be transmitted to crops that grow near the soil surface. However, composting of manures was shown to be an efficient way to reduce pathogen loads. The aim of these studies was to assess the effect of different fertiliser types on the transfer risk of enteric bacteria in head lettuce. Different treatments

of manure application were investigated and the effect of post-harvest handling (e.g. washing) was determined. No *Salmonella enteritidis* was detected in the samples. *E. coli* was isolated in low numbers independent of the fertiliser type. The numbers of aerobic bacteria and the levels of Enterobacteriaceae and coliform bacteria tended to be lower after application of mineral fertiliser, but were generally at a low level. Thus, the studies provide no evidence that organic soil fertilisers pose any additional safety risk, even if worst-case scenarios were studied. Also field experiments with different strategies of physical weed control did not confirm the hypothesis of a substantial pathogen transfer from soil treated with farmyard manure. Based on these trials, the application of manures in good farming practice could not be linked to any food safety risk.

Pest and disease control at seed level

Although a range of diseases are controlled efficiently by agronomic methods (e.g., crop rotation), certain pests and diseases can cause major problems in organic and low-input systems. The prerequisite for successful crop production is the use of disease-free planting material. Seed treatment is one of the options to remove pathogenic bacteria and fungi. In QLIF, the studies focused on the development of strategies to obtain disease-free tomato and wheat seeds. Good control of *Didymella lycopersici* was achieved in seed treatments, whereas control of *Fusarium* resulted only in slight reductions of damping-off. The bacterial disease *Clavibacter* was well controlled by acidified nitrite solutions, but also by a wide variety of compost extracts. Another option, which is currently evaluated on wheat, is to avoid seed contamination by *Fusarium* during seed production. Preliminary results show that cultivars differ in sensitivity to seedling blight, and that cultivars with stronger early growth rates appear to be less sensitive to seedling blight.

Efficient control of mildew in lettuce

Air-borne foliar diseases such as *Bremia lactucae* in lettuce or *Phytophthora infestans* in tomato may cause high losses in organic vegetable production systems. An alternative procedure to protect plants against disease is to activate their own defence mechanisms by specific biotic or abiotic elicitors. A major finding of this study was that ß-amino-butyric acid was efficient in controlling downy mildew in lettuce under field conditions, reducing the disease by 50-90 percent.

Photo: Organic Denmark

Pest control through beneficial insects

At field level, the need for intervention with pesticides can be reduced by promoting build-up of populations of beneficial insects. This approach has been explored in brassica crops in the UK. It was demonstrated that companion plants may decrease the number of cabbage root fly eggs and field margin companion plants may lead to increased predator populations not only in mid-European but also in more humid UK climates.

Integration of crop production strategies

One of the major aims of the QLIF subproject 3 was to integrate novel preventative crop protection techniques into improved crop production systems. For instance, yield and protein content of wheat produced under organic standards was repeatedly shown to be between 20 and 40 percent lower than levels achieved in conventional farming systems. This is thought to be at least partially due to lower N-supply to the crop later in the growing season and poor adaptation of the currently used wheat cultivars to organic production conditions. Our results indicate that two of the main problems relating to the sustainability of the current organic wheat production methods (lower yields and protein contents) can be addressed by changes in fertility management practices and cultivars choice. Strategies include (i) the promotion of legumes by *Rhizobium* inoculation of clover seeds prior to the wheat crop, (ii) and the choice of adapted wheat cultivars. Results showed that cultivar choice had the greatest effect on yields, but that fertility management practices also significantly affected wheat yields and protein quality for some of the cultivars. This clearly indicates that yields in organic wheat production can be significantly increased by improved cultivar choice and fertility management regimes.

QLIF subproject 3: Development of strategies to improve food quality and safety and production efficiency in organic and low-input crop production systems

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QLIF subproject 4:

Livestock production systems

Photo: ICROFS

Development of strategies to improve quality and safety and reduce cost of production in organic and low-input livestock production systems

Results obtained in the QLIF subproject 4 have provided recommendations to farmers and stakeholders on how to improve organic livestock farming. Progress was made in areas of housing, feeding and management. Often the recommendations are straight-forward, and ready for implementation. In other areas challenges remain. In some cases, progress with respect to one objective has created new challenges. In these cases it is difficult to decide whether a change is an overall improvement or not.

This leaflet includes a focus on means to prevent and control parasitic infections in pigs and poultry, e.g., by inclusion of dried chicory roots in the diet of sows and boars to reduce the level of roundworm infections. Further, it is stressed that control of *Ascaris suum* and *Ascaridia galli*, the main helminth parasite species in pigs and poultry, needs to be achieved through a package of measures rather than single measures, such as protocols for cleaning of the dunging area. Udder health, milk quality and animal welfare in organic dairy farms are other subjects where progress is described.

Focus on housing and management techniques is essential for quality, health and welfare in organic livestock production systems

Challenges in organic livestock

Organic production systems aim to provide various benefits to society. These benefits are associated with the four IFOAM principles of organic agriculture: Health, Ecology, Fairness and Care (www.ifoam.org). Implementation of the principles into organic livestock systems involves careful study on how housing and management factors affect the health and welfare of animals, the environment we live in, and the farmer's income. This is a challenging task, as the underlying housing and management techniques used to make the principles operational do not always complement each other. The QLIF subproject 4 aimed to address six of the most relevant gaps in our knowledge when taking up this challenge.

Photo: ICROFS

Preventing parasites in hens and pigs

The risk of parasitic infections is increased in hens in free-range systems compared to systems without outdoor access. Results of the present project have shown that improvements in run management and reducing the stocking density can significantly reduce faecal egg counts of the two helminth species of poultry (*Ascaridia galli* and *Heterakis gallinarum*) in outdoor runs.

In a second experiment two litter management regimes (replace or add litter material) were compared to unmanaged litter. The regimes had no significant effect on water content of the litter or on parasitological parameters. These results suggest that positive effects of run and litter management regimes on helminth infections of laying hens are often overestimated in practice.

On organic pig farms *Ascaris suum* is the most prevalent helminth and is transmitted mainly via the faeces. A first study therefore focused on assessing the efficacy of different protocols for cleaning the dunging area of pigs. The results suggest that improved cleaning protocols alone are not sufficient, but should be part of a package of measures against the parasite.

A second study quantified the effect of dietary inclusion of dried chicory roots on roundworm (*Oesophagostomum* spp) infections in naturally infected sows and boars, since pilot studies had shown that dietary inclusion of dried chicory roots may reduce infection and egg excretion levels in pigs. Dried chicory abolished egg excretion within 2-6 days and can therefore be recommended.

Control of parasites in poultry and pigs

Control of the poultry red mite *Dermanyssus gallinae* is a challenge for organic as well as conventional egg producers. A range of alternative treatments were tested *in vitro*. In on-farm experiments, diatomaceous earth was effective during a limited period only, whereas two liquid formulations of silicas had a good residual effect against the red mite.

To reduce the use of synthetic drugs to combat *Ascaris suum* in organic pigs, herbal preparations were tested for the prevention and control of a mild infection of *Ascaris suum* in growing and finishing pigs. Yet, none of the tested alternatives provided a sufficiently reliable reduction in worm burden.

Photo: ICROFS

Increased non-immune defence in pigs

To control gastrointestinal pathogens causing diarrhoea in pigs we tested the potential of probiotic *Bifidobacterium* strains as well as prebiotic and acidified nitrite supplements. It was demonstrated that microencapsulated probiotic strains were able to pass through the acid barrier of the stomach and establish increased population density in the intestine. However, although the ability of probiotic strains to inhibit enteric pathogens was demonstrated *in vitro*, this could not so far be confirmed in experiments *in vivo*. This was also true for antimicrobial activity of acidified nitrite treatments. Further, supplementing finishing pigs with maize silage, grass silage or a probiotic preparation did not significantly affect growth and carcass traits.

Photo: ICROFS

Eating quality of pork

Due to the restricted availability of limiting amino acids in organic livestock production, protein accretion capacity is limited compared to conventional production. This may restrain the intramuscular fat (IMF) content which influences the sensory quality of pork. In on-farm trials the effect of the implementation of a specific feeding strategy using a high proportion of home-grown grain legumes on the IMF content of pork was assessed under different conditions on German and Austrian organic farms. Results confirmed the great variation between the farms for IMF. It was thus concluded that there is a need for a direct assessment of IMF content of pork at the abattoir to fulfil the expec-tations of consumers with regard to a high eating quality of organic pork.

Photo: Organic Denmark

Prevention of mastitis

In QLIF subproject 4, a study was initiated to identify the main factors influencing udder health in organic dairy farms under different climatic and structural conditions. Results show that improvement of housing and environmental conditions and farmers' skills allow partial conversion to a treatment scheme based on teat sealant dry-off prophylaxis, which reduces the need to use antibiotics.

It was also found that calves reared with their mother grew faster, while no negative effect of suckling on the somatic cell count or negative impacts on animal health status were observed. However, the extra live weight gained by suckled calves up to 1 year of age could not be sustained into first lactation. There was high variation in milk production of raised heifers, resulting in no significant difference between treatments in terms of milk production.

Improved milk quality by feeding

Previous observations at IGER showed that feeding clover silages (CS) to cows increases the polyunsaturated fatty acid content of milk. However, it was not previously tested how the CS-based diets influenced the faecal shedding of enteric pathogens. The present studies gave no clear indications that feeding red clover silage (RCS) affects faecal shedding of *L. monocytogenes* or *E. coli*. However, it was demonstrated that milk and milk protein yields can be significantly improved by feeding RCS as 1:1 mix with maize silage, but that the efficiency of utilisation of forage N was reduced when diets contained more than 10 percent RCS.

QLIF subproject 4: Development of strategies to improve quality and safety and reduce cost of production in organic and low input livestock production systems

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QLIF subproject 5:

Processing strategies

Photo: BLE

Development of a framework for the design of low-input processing strategies that guarantee food quality and safety

Organic processing standards already prohibit the use of many chemicals, additives and preservatives, which are used in the processing of conventional foods. Yet, there are frequent discussions of the underlying principles on organic food processing regarding such aspects as environmentally friendly processing, minimal use of additives, sensory quality, and transportation. It is therefore essential to develop a framework or code of practice, which can be used to determine whether novel processing strategies are compatible with organic processing standards and principles as well as consumer demands and expectations in relation to quality characteristics of processed food.

In the present subproject part of the research comprised an assessment of alternative sanitising protocols under controlled laboratory conditions in the processing of fresh cut lettuce and mixtures of fresh-cut-vegetables. During these studies it was found that, with regard to ecological aspects, ozone is a good alternative to the existing disinfectants, such as chlorine, in the organic field. Further research concerned an assessment of processing technologies that may improve the nutritional composition of dairy products, such as increased content of conjugated linolenic acids (CLA).

Towards a framework for the design of minimum and low-input processing strategies, which guarantee food quality and safety

Processing strategies for organic foods
Organic processing standards prohibit the use of chemicals, many preservatives and other food additives which are widely used in the processing of conventional foods. However, there are frequent discussions as to the underlying rationales and criteria used to allow some processing methods and additives but not others. There is also evidence that consumers of low-input and organic foods have specific expectations with respect to quality characteristics of processed food. It is therefore essential to develop a framework/code of practice, which can be used to determine whether novel processing strategies are compatible with organic processing standards and/or principles and consumer demands and expectations.

QLIF subproject 5 addressed these issues through three targeted research efforts.

Processing for food quality and safety
The first research area focused on the development of a consolidated framework/code of practice for the evaluation of minimum and added-value processing strategies in organic and low-input food production and processsing with respect to food quality and safety. The specific aims were:

- to identify the different underlying principles proposed for organic and minimum-processing and low-input food processing
- to analyse current approaches and concepts in organic food processing
- to identify differences in processing standards/regulations in Europe in order to identify areas for harmonisation and revision and further development

Photo: BLE

Photo: University of Helsinki

The main results of the research show that there is an importance of clear principles and related criteria for the evaluation of additives and processing methods. In the mind of consumers additional principles are present, when compared with the present rules. The gap between consumer expectations and the given rules (EU Regulation 2092/91, IFOAM Basic Standards, Codex Alimentarius Guidelines) can cause problems. Thus, it is important to build a solid link between the regulations and consumer perceptions. The principle of carefulness/careful processing might be helpful for the communication between manufactures/retailers and consumers. Generally, other means instead of new state rules are recommended (e.g. code of practice).

Replacement of chlorine for cut vegetables
The second research area comprised an assessment of chlorine replacement for fresh cut vegetables. The focus was on the use of alternative sanitising protocols under controlled laboratory conditions in the processing of fresh cut lettuce and mixtures of fresh-cut-vegetables. This was followed by microbiological assessments and sensory evaluation after different storage temperatures. The aim was to evaluate the disinfection methods under commercial conditions and to develop guidelines for the use of acceptable processing strategies for fresh-cut-vegetable products.

During the studies it was proven that, with regard to ecological aspects, ozone is a good alternative to the existing disinfectants, such as chlorine, in the organic field. Thus, the

results of the pilot test could be proven in industrial application and basic data for a specific application were obtained and are available. However, basic data for a general application as disinfectant are not yet available and research in this field is needed. In addition, the fact that ozone makes a chemical reaction does not comply with the council regulation (EC) No 834/2007 of June 2007, but with the use of all allowed and existing disinfectants, a chemical reaction is occurring.

Photo: Organic Denmark

Nutritional composition of dairy products
The third research area was devoted to an assessment of processing technologies that may improve the nutritional composition of dairy products. Issues treated were related to:

- comparison of fatty acid profiles and CLA (conjugated linolenic acids) content between organic, low-input and conventional processed dairy products
- shelf life analyses: identify differences in product stability and sensory quality
- evaluation of novel processing procedures which maintain or increase the CLA content of dairy products.

CLA in organic and processed dairy products
During the studies it was found that organic dairy products show higher levels of CLA than standard products (influenced by diet of cattle). Further, the normal processing procedures of dairy products and storage do not affect the content and isomer profile of CLA in dairy products. Thus, in commercial fermented dairy products like yoghurt, cheese, and butter made from fermented cream, the fermentation has no effect on the CLA content.

Oxidation processes related to shelf life
Conventional butter and PUFA/CLA-enriched butter (diet of cows supplemented with sunflower seeds) were produced at the ALP pilot plant twice (May 2006 and September 2006).

Using different methods to assess oxidation (GC-O, sensory method, holistic method) it was found that enrichment of CLA by diet of cattle (oilseed) has an influence on quality of milk products. For butter this included nutritional-physiological advantages and softer texture. Aroma extraction dilution analysis was performed to identify the most potent odorants in UFA/CLA butter and in conventional butter. The quantification of the most potent odorants of UFA/CLA and conventional butters was performed using stable isotope dilution assays.

Processing procedures to enhance CLA
Processing procedures to enhance the CLA content in dairy products were tested during the experiments. One technique tested was based on the use of reported micro-organism strains with high CLA-producing potential. Yet, a methodology to measure unesterified CLA as produced by micro-organisms in fermented products could not be firmly established and therefore the potential for CLA enhancement could not be properly evaluated.

As another type of procedure, selected physical separation process enables CLA enrichment. And such physical enrichment processes are accepted by international organic farming and food groups. The test results showed that a higher CLA content was found in the olein fraction in both types of butter. However, while a CLA enrichment of 32.5 percent was obtained in the olein fraction for conventional anhydrous butterfat, alpine butter shows only 15.3 percent enrichment. Given the costly and complex process involved, this is low, and furthermore too small to achieve any decisive positive impact on human health.

Photo: ICROFS

QLIF subproject 5: Development of a framework for the design of minimum and low input processing strategies, which guarantee food quality and safety

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QLIF subproject 6:

Transport, trading and retailing

Photo: Organic Denmark

Development of strategies to improve quality and safety and reduce costs along the food supply chain

One of the aims of QLIF subproject 6 was to provide a better understanding of the supply chain performance and the collaboration system of organic supply chains. A notable finding was that supply chain actors with a high collaboration index outperformed respondents with a lower collaboration in terms of overall, non-financial and financial performance. Also, there is evidence that the higher theperceived risk for quality and safety is, the higher the probability that collaborative practices were in place. Nevertheless, overall, the level of collaboration is still too low.

In a second part of QLIF subproject 6, HACCP case studies and training courses have been developed with special reference to organic agriculture. A HACCP approach to food safety management can be applied throughout the food chain, from farm to fork. Although a HACCP approach is not a legal requirement in primary production in the EU, it is recognised as an effective and logical means for food safety control that is equally applicable to agriculture including organic and low-input production systems.

Quality and safety of organic products is advanced by controls to prevent potential hazards and by sharing of information

Case studies of organic supply chains
One of the aims of QLIF subproject 6 was to provide a better understanding of the supply chain performance and the collaboration system of organic supply chains. This specifically included a focus on the effect of supply chain relations on quality and safety performance.

Photo: Organic Denmark

As supply chains for high-quality foods are complex and product-specific, a case study approach was chosen, which was conducted for six organic supply chains: milk, apples, pork, eggs, wheat and tomatoes. Thus, on the basis of case studies, we analysed the supply chain structures for these organic commodities in Europe, and identified the economic pressures in organic supply chains which impact on food safety and quality.

Strengths and weaknesses of the chains
Our analysis identified a number of strengths and weaknesses of European organic supply chains. Thus, the following *strengths* appear:

- adoption of traceability procedures
- costumer feedback procedures
- labour force and managerial skills
- use of extra quality management systems

On the other hand, main *weaknesses* are:

- high logistic and transport costs
- high levels of input costs
- low spending on research and product development

While input, logistic and transport costs are considered to have only a low impact on food quality and safety, the situation is different for expenditures on research and product development. Increased expenditure on research and product development offers the greatest potential for quality and safety improvement in organic food supply chains.

Supply chain collaboration structures
Collaboration between supply chain actors is a means to reduce the costs identified as weaknesses. To analyse organic supply chain collaboration, we looked at relationships with respect to: (1) trust, perceived risk to food quality and safety and level of formalisation; (2) the impact of collaboration on financial and non-financial supply chain performance.

There were five main reasons for the organic supply chains to establish close supplier-retailer relationships, all of which were related to information-sharing: product quality, timely delivery, product safety, prices and price changes, and demand forecasts.

The level of collaboration was measured with respect to information sharing, decision synchronisation and incentive alignment. While we found a high level of collaboration on information sharing, there was a very low level of collaboration with respect to incentive alignment and decision synchronisation. Indeed, there is almost no collaboration with respect to joint decisions on optimal order quantity and inventory requirements as well as for all cost relevant issues of the supply chain. Similarly, collaboration with respect to research and product development is low.

A notable result was that supply chain actors with a high collaboration index outperformed respondents with a lower collaboration in terms of overall, non-financial and financial performance. Also, there is evidence that the higher the perceived risk for quality and safety is, the higher the probability that collaborative practices were in place. Thus, when significant risks are perceived – here for product quality and safety – the chain actors engage in knowledge creation and sharing of information benefits. Nevertheless, overall, the level of collaboration is still too low.

Systems for hazard and quality control
HACCP (Hazard Analysis and Critical Control Point) is a system of food safety assurance based on the prevention of food safety problems. The philosophy in HACCP therefore has a role to play in food safety and quality assurance in organic production, including management of quality attributes special to the organic nature of the product.

A HACCP approach to food safety management can be applied throughout the food chain, from farm to fork. Although a HACCP approach is not a legal requirement in primary production in the EU, it is recognised as an effective and logical means for food safety control that is equally applicable to agriculture including organic and low-input production systems.

In QLIF subproject 6, HACCP case studies and training courses have been developed with special reference to organic agriculture.

Outline of HACCP case study documents
Case study documents have been prepared for field vegetables, wheat for bread making, apples, eggs and diary (milk production). The focus is on on-farm operations (primary production), where the application of the HACCP technique is most problematic and where guidance on best practice most applicable.

The case studies, published as a single document, are based on a common format and are in three sections.

Section 1: How to set up and conduct an organic HACCP study. Firstly, a description is given of stages that need to be considered in sequence to develop a HACCP system in the organic sector. This has proved important as it is necessary to incorporate current best practice and to help the organic sector meet international standards such as ISO 22000.

Section 2: Hazards in organic production. Here an overview is given of the different hazards, including food safety and product quality attributes. The latter is particularly relevant to the organic sector, where issues such as organic integrity and nutritional quality are potentially important issues to be identified and controlled within a hazard analysis and control system.

Section 3: Example of an organic HACCP study. To demonstrate the application of HACCP principles a worked example is presented for the crop or animal production system under consideration. The example is used to illustrate the application of HACCP principles involving identification of prerequisite programmes, operational and Critical Control Points (CCP).


Photo: Organic Denmark

Role of prerequisite programmes and CCP
The control of food safety hazards in primary production relies principally on reducing the likelihood of introducing a hazard to the product rather than eliminating or reducing the hazard in the product. The former are controlled by prerequisite programmes and the latter at CCPs. In general, the severity of the consequence in the case of failure of the control measure is greater at a CCP which therefore needs more frequent monitoring. In agriculture there are few, if any, true CCPs. There are, however, a number of points in the process where specific control is necessary to prevent the occurrence of a hazard. These may be designated operational prerequisite programmes where there is greater focus on checking the performance of the control.

HACCP training
An organic sector HACCP course was developed and specifically tailored with practical exercises adapted from the case studies. Focus was on the primary sector (crops and livestock production) and food safety hazards and key organic quality attributes. The main priority was to train the trainers, i.e., those people who can then transfer the ideas in their own country - that is to the practitioners. In this way an active dissemination of the subproject results was facilitated. Courses were held in five countries with QLIF partners and attended by ~100 participants.

QLIF subproject 6: Development of strategies to improve quality and safety along the supply chain

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Links

Find more information at www.qlif.org

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QLIF subproject 7:

Horizontal Activities

Photo: ICROFS

Horizontal Activities

QLIF subproject 7 represents four horizontal activities common to the project, namely:

- Environmental and sustainability audits
- Cost-benefit analyses and socio-economic impact assessments
- Dissemination and technology transfer
- Training of graduate and postgraduate researchers

Activities in the horizontal research have shown that organic crop production systems generally are more energy-efficient and have lower greenhouse gas emissions than the conventional production. In terms of dissemination the QLIF website has been central and the QLIF newsletter has attracted more than 1000 subscribers. Coupling of the website with the open access database Organic Eprints provides a prospective source of project information that can be accessed also by future stakeholders in organic and low-input systems. Training events arranged annually for students have contributed to proliferation of skills and knowledge gained in QLIF. Also, these events have served to mediate the attitude needed for research in organic and low-input farming.

Subproject 7 focused on horizontal issues such as resource efficiencies, socio-economics and dissemination activities

Resource efficiency of low-input systems
Within QLIF subproject 7 the resource efficiency was studied through detailed analyses of actual rotation experiments, and model simulation studies of N and C dynamics. The results show that organic production systems generally have lower greenhouse gas emissions per unit of product than conventional systems (Fig. 1). Differences are largely due to the energy use and CO_2 emissions associated with N fertilizer manufacture. In terms of energy efficiency the picture is more complex as conventional systems are more productive and the 'cost' of organic fertilizer from green manure and animal manure would need to be accounted for.

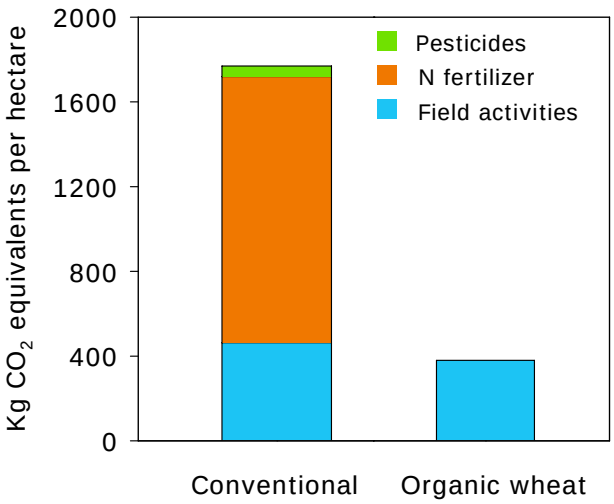

Fig 1. Relative emissions of CO_2 equivalents by field operations and external inputs for organic and conventionally produced wheat.

With animal production systems conclusions are more variable, and in some cases organic methods use more energy than conventional production. Organic pork production is clearly less energy-efficient and has higher nitrate leaching losses and higher N_2O losses by denitrification, because of the free range systems.

The conclusion that organic farming tends to show better energy balances and less greenhouse gas emissions, is based on a number of assumptions which should be kept in mind. While energy use in organic systems is often lower than conventional systems on an area basis, energy use per calorie of food produced may be higher in organic systems, because these systems often have lower yields. The significance of needing more land to produce organic crops because of lower yields is one challenge that needs to be discussed and addressed by the organic industry.

Socio-economic impacts of QLIF research
The financial and socio-economic outcomes of the QLIF project were assessed by means of a partial cost-benefit analysis of the research outcomes (such as increased yields, improved quality and safety, or reduced production costs) of individual QLIF projects and by a qualitative expert assessment of the broader policy and consumer-relevant socio-economic impacts. Five reports on dairy, wheat, pork, vegetables and poultry were produced, where the results of all projects relevant to a particular commodity were integrated. In some cases, notably the dairy projects, clear results demonstrating quality and other benefits of organic and low-input systems were obtained which could be translated into financial benefits for producers. However, in many others, either no significant differences were obtained, or the results were not sufficiently near market to demonstrate a potential financial benefit. Many of the projects did generate results which were likely to be rated as positive by policy-makers and consumers in terms of their societal impact, but these outcomes were not necessarily associated in their minds as outcomes of organic production, indicating a need for further communication of the results to these groups.

Photo: ICROFS

Dissemination through the QLIF website
The website www.qlif.org was established at the start of the QLIF project as a platform for public dissemination of background information and news from the project. The number of visits to the website increased steadily during the project with a maximum of 678 daily visits recorded in august 2008 (Fig. 2).

Through the website, QLIF offered free subscription to a biannual newsletter and news briefs. More than 1000 subscribers from 68 countries made use of this subscription. Next to research colleagues, the most frequent groups of subscribers were students, advisors and farmers. On a country basis, Germany, UK, and the Netherlands were the top three in terms of most subscribers. Information and research news published in the newsletters are available at the library of website and is accessible beyond the QLIF project period.

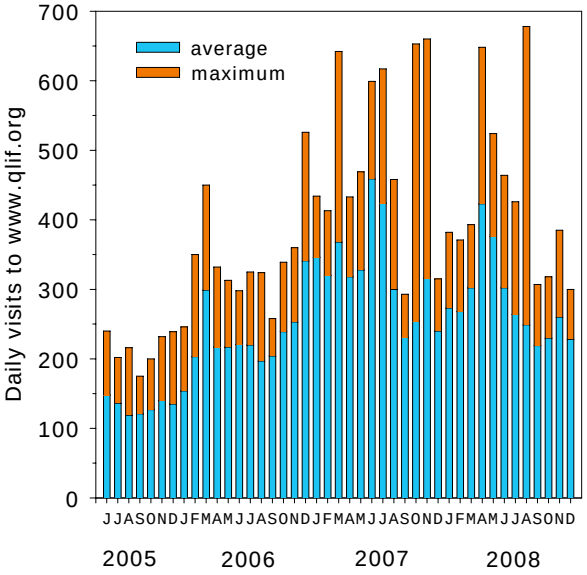

Fig. 2. Daily visits to the QLIF website during 2005-2008

In terms of dissemination of research output the QLIF website serves as an entrance to the open access database Organic Eprints, which has more than 10.000 registered users worldwide. QLIF so far have deposited more than 100 publications in the open access archive. Yet, a significant advantage of coupling the web-site to the database is that all research results published after termination of the project period will automatically be accessible through the QLIF website. Thus, a dynamic update of the research output will appear on the project website even after termination of the project.

Photo: Louis Bolk Institute

Training of graduates and postgraduates
Proliferation of knowledge, skills and attitude was part of the QLIF project. To this end, a yearly workshop was organised, covering different aspects related to quality:

- Healthy soil, healthy crops, healthy people (2005)
- Towards animal-oriented rearing methods in organic production systems (2006)
- Measuring food quality: concepts, methods and challenges (2007)
- Soil N: research and extension (2008)
- Towards improved quality in organic food production (2009).

In each workshop, QLIF researchers presented their work for an audience of 20-30 participants consisting of students, junior scientists and others. The contributions came from several European countries, the majority from QLIF-related institutions. The audience came from a wider area including UK, Netherlands, Italy Germany, Denmark, Norway, Poland, France, Belgium, Greece, Turkey, India, Malaysia, Georgia, and USA.

In the QLIF training workshops much time was planned for discussion to enhance the interaction between lecturers and participants. Besides transfer of knowledge, this interaction served to exchange the attitude needed for research in organic and low-input farming. Something like an organic science does not exist, but research in low-input agricultural systems requires an open attitude and a willingness to look for broader coherences in agricultural, economic and social systems. During each workshop an excursion was organised in which the theme of the meeting was illustrated and placed in real life. The proceedings of the workshops are published at Organic Eprints (www.orgprints.org).

QLIF subproject 7: Horizontal Activities

1. **Environmental and sustainability audits**
2. **Cost benefit analyses and socio-economic impact assessments**
3. **Dissemination and technology transfer**
4. **Training of graduate and postgraduate researchers**

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Links

Find more information at www.qlif.org

Selected publications

Hospers-Brands M and Burgt GJHM van der, eds. (2009) Towards improved quality in organic food production. Proceedings of the 5th QLIF workshop, Driebergen, the Netherlands, 21-23 January 2009

Thorup-Kristensen K (2007). Effect of crop management practices on the sustainability and environmental impact of organic and low input food production systems. In: *Improving Sustainability in Organic and Low Input Food Production Systems* (Niggli U, Leifert C, Alföldi T, Lück L and Willer H, eds). Proceedings of the 3rd International Congress of the European Integrated Project Quality Low Input Food (QLIF), March 20-23, 2007, Hohenheim, Germany, pp 432-438

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