



A decade of EU-funded, low-input and organic agriculture research (2000-2012)



*Research and
Innovation*

EUROPEAN COMMISSION

Directorate-General for Research and Innovation
Directorate E – Biotechnologies, Agriculture and Food
Unit E.4 – Agriculture, Forests, Fisheries, Aquaculture

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Cataloguing data can be found at the end of this publication.

Luxembourg: Publications Office of the European Union, 2012

ISBN 978-92-79-26540-2

doi:10.2777/19796

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Printed in Belgium

PRINTED ON ELEMENTAL CHLORINE-FREE BLEACHED PAPER (ECF)

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Foreword

Research and innovation are just as important in maintaining the competitiveness of Europe's farming industry as they are in other key sectors of economic activity. Indeed, Europe's farmers are coming under increasing pressure from all sides: commercial pressure to increase product quality and reduce costs; environmental pressure to adopt eco-friendly practices; and societal pressure to adopt sustainable practices. And against this background farmers are also faced with the uncertainties of the effects of climate change.

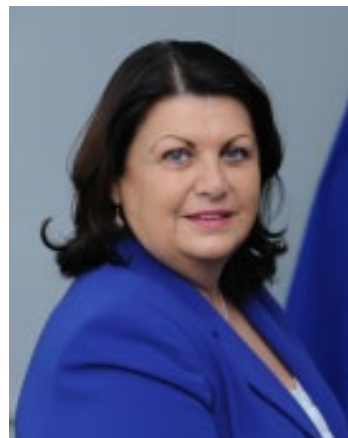
This is why the issues I raise above are taken up in the Europe 2020 strategy for smart, sustainable and inclusive growth, and are being addressed in its Innovation Union and Resource Efficiency flagship initiatives. In fact, the European Union has been supporting research on farming and related areas over many years, but the recent economic crisis has really brought into sharp focus the need to invest more in both research and innovation to stimulate growth and job creation in all areas of economic activity.

The organic farming sector offers many innovation opportunities and so it is both symbolic and timely to take stock of EU support for research in this area. Symbolic, because this review covers a decade of EU funding for research on organic and low-input agriculture; and timely, because the lessons learned are helping to shape key parts of the new research and innovation support programme "Horizon 2020" which will supersede the current EU research framework programme in 2014.

The signs are good for this sector in Europe. The market for organic food and drink has continued to expand over the past decade both in Europe, where it benefits from a clear labelling policy, and all over the world where there are potentially significant business opportunities still to be exploited.

I believe that this publication very effectively highlights the potential impact of our research funding on improving the sustainability of agricultural production as well as in achieving social and ecological innovation, and delivering social benefits and public goods.

I am convinced that additional innovation opportunities will arise from sharing this new knowledge with those involved in other forms of agriculture, and from developing synergies between the different sets of research results presented in this volume.



*Máire Geoghegan-Quinn
European Commissioner for
Research, Innovation and Science*

Preface

Investing in research is vital for addressing societal challenges such as food security and safety, climate change adaptation and mitigation, coping with scarce natural resources and achieving a sustainable, eco-efficient and competitive bio-economy. In this context the low-input and organic agriculture sector offers several pre- and post-harvest innovation opportunities, while contributing to the development of eco-efficient solutions to the societal challenges, and to more resource-efficient Europe.

Over the past decade the EU Research Framework Programmes have been supporting many aspects of research on organic and low-input agriculture and its results are presented in this catalogue. The great variety of research topics addressed and the multi-disciplinary approaches taken have helped to develop agro-ecosystems that produce high value products and are respectful to the environment.

The catalogue being part of a series published by the Agriculture, Food and Biotechnologies Directorate of Directorate General for Research and Innovation has the objective of presenting the outputs of the many research projects funded over three European research framework programs in the period 2000 - 2011. The catalogue brings together the fruits of European research efforts targeting low-input and organic agriculture; it includes almost fifty projects with a total European Commission contribution of more than 150 million euros. Not all are strictly limited to the certified organic market sector, but contribute to and support its development. The three main chapters cover large scale coordination projects, policy support, and sector development projects. The scope of the work is vast, ranging from an analysis of the relevance of this research from a policy maker, researcher and consumer viewpoint and gives indications of the remaining research gaps and drivers necessary to implement commercial uptake. Some of the projects provided actual blueprints for the drafting of regulations. Other projects contribute to a resilient agriculture which is able to produce quality products in a world of scarce, expensive resources and high energy prices. Organic and low-input agriculture of the future is based upon a high level of knowledge input, both from scientists and farmers. Ecological intensification is a driving concept behind the approach and the outcomes are often appropriate tools that can be used directly by farmers and other stakeholders.



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Moreover, low-input and organic agriculture has high potential for green technology development based on innovative combinations of improved biological understanding and use of automation, information and communication technologies in food and agriculture. This research programme has delivered in this respect through improving synergies between the efficient production of high quality products and other ecosystem services and delivering healthy food with a minimum of external input.

Chapter 1

Coordination and large multidisciplinary projects



Introduction

The importance of support to coordination of the European organic research

*Niels Halberg, Director of
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Europe has been among the global leaders in research and innovation in high-quality food from organic agriculture serving the dual purpose of responding to consumers' demand in high-value markets and responding to national and EU agri-environmental and rural development policies. There has been — and still is — a great need for research and innovation in organic food and farming because of its relatively recent development and because it is an alternative, which is very knowledge-intensive: a knowledge that cannot always be covered by results from mainstream agricultural research. In order to follow the principles of organic agriculture as laid out in, for example, Council Regulation (EC) No 834/2007 ⁽¹⁾ (e.g. 'the appropriate design and management of biological processes based on ecological systems using natural resources which are internal to the system'), it is necessary to further develop the research-based knowledge on agro-ecological methods and on careful processing in practice. Moreover, research is needed to assess the degree to which organic agriculture complies with the principles and — in a wider perspective — delivers on the promises regarding important societal goals (e.g. reducing externalities).

However, research resources directly targeting organic agriculture and food are scarce in most Member States and the research environments are often relatively small with a risk of too little and too narrow expertise and slow capacity-building. Therefore, there is potential for improved efficiency of the use of research funds in organic agriculture across European countries and research environments by improving the coordination of the research work. There are, especially, two important examples of such European coordination efforts within organic research, the ERA-NET 'CORE Organic' and the IP 'QLIF'.

The two projects (both described in more detail later in this publication) differ in important aspects but they also share characteristics, which makes it relevant to consider a combination of such funding modus for future research programming. The ERA-NET is a tool for the exchange of views on national research needs and priorities between funding bodies in several EU countries and seeks areas of mutual interest for funding of

1 Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products, OJ L 189, 20.7.2007, p. 1.

transnational research involving scientists from a number of institutions with complementary competences. The European Commission supports the coordination costs of the participating funding bodies but the definition of call areas and selection and monitoring of research projects is the responsibility of the ERA-NET partners.

The Integrated Project (IP) was a tool (in the sixth framework programme) for the funding of very large research projects which allowed the build-up of a critical mass of scientists covering a complex set of linked research questions through the integration of research groups within and across several countries. As described later in this publication, 31 scientific and industry partners participated in QLIF (2004–09) covering the complex interactions between production methods, yields, product quality, food safety and consumers' expectations for a range of crop and livestock products. Moreover, the IP QLIF also included funds dedicated to an open call for sub-projects based on topics to be defined by the QualityLowInputFood (QLIF) partners during the first part of the research period and administered by the project coordinator. This way, another five partners became involved (partly focusing on environmental assessment methods).

Thus, by this mechanism, the EC outsourced part of the project administration from their work programme and allowed for a combination of research and innovation answering to topics predefined by the EC and potentially addressing emerging specific research ideas with greater speed. In the case of QLIF — the only IP within the organic research area — the result has been a long list of results with significant relevant and potential impact on the sector in terms of development potential and wider credibility including an impressive list of scientific publications and — probably — with relatively limited administration costs for the EC compared to the outcome.

The main objective of the Core Organic ERA-NET was 'To enhance the quality, relevance and utilisation of resources in research in organic farming and food systems and its contribution to the development and integrity of the organic sector', which was to be achieved by reducing the fragmentation and the risks of duplication in organic research across European countries. Starting with so-called funding bodies from 11 countries (see list in the detailed description later), Core I (2004–07) pursued an ambition of agreeing on topics, terms and funds for a joint call within the first three years and building on a mapping of national research programmes and priorities. This was achieved successfully and the eight so-called pilot projects ran from 2007–10 covering topics in animal health management, product quality and food safety and health aspects of organic food. The topics reflected priorities of the national partners with most projects combining partners from northern and southern Europe (e.g. sharing research experience in serving organic food serving to young people and in developing a health management tool for organic pig

production) and others being more geographically focused (e.g. northern European countries using complementary expertise in researching the salutary effects of milk under different feeding regimes).

While each research partner in these transnational projects formally referred to their national funding body, the ERA-NET members decided that in order to secure efficient project coordination and enhance dissemination and impact, it was necessary to set up a more centralised coordination at the programme level. Therefore, the ERA-NET coordinator took on the role as the main entry point for the projects and subsequently coordinated the assessment of progress and results/deliverables across the countries involved. This approach has been carried on into the second phase ERA-NET, Core Organic II (2010–13), which followed a period of collaboration in the network of funding bodies without funding from the EC.

In Core Organic II, the focus has been to organise joint calls based on a thorough and mutually agreed understanding of the main challenges for the European organic sector and translated into research and development needs based on a combination of national priorities and inspiration from the pan-European Technology Platform, TPOrganics. Thus, the first call was launched within six months from the official start of Core II and the second call, a year later. Both calls built on a high level of internal organisation with clearly divided responsibilities among partners for, for example, synthesising ideas and preparing call texts, coordinating actual calls, proposal evaluation and the selection of projects, follow-up on ongoing projects and a number of more strategically focused tasks. Because of the large number of partners (24 from 21 countries), the funding bodies decided to divide each call into two to three main themes with a separate call board to be responsible for formulating the call topics and select projects for funding. This would better accommodate a situation where only a subset of the partners would support research in a specific thematic area.

An important effect of the organisation of the ERA-NET has been an exchange of identified research needs, which has been very fruitful and inspirational. This is proven by the fact that many partners have ended up co-funding projects within topics, which they had not originally identified as important but were inspired to join due to the joint discussions between partners in general and in the call boards. This is linked to another benefit of the ERA-NET: the exchange of practices for identification of research needs and involvement of stakeholders and the liaison with other transnational bodies such as TPOrganics and the Mediterranean network for organic research, which are official observers at Core Organic meetings.

There are several good examples of Core Organic research results of importance for the European organic sector, and with potential use also

in non-organic agriculture. Thus, in a project including 11 partners from eight countries, the scientists developed important new approaches to securing pig health and welfare including a HACCP-based tool. Another advantage is that the ERA-NET funding mechanism also allows for continuity. For example, these HACCP tools will be employed and further refined in a new research and development project funded under Core Organic II — after going through the same independent assessment and selection process as all other proposals. The next ambition in the Core Organic II ERA-NET is to prepare for a call using a real common pot (where funds are pooled across national partners) and to secure long-term collaboration, including follow-up, on the funded projects, which obviously lasts longer than it takes to organise the calls themselves.

In the broader perspective, the reasons for the need for coordination of research in organic food and farming are: (i) **important topics are transnational** (e.g. climate mitigation and adaptation, livestock disease management, social and environmental assessment of food chains and improved transparency of food products and chemical footprints of organic products); and (ii) some **topics need large research efforts** (e.g. eco-functional intensification, breeding varieties for low-input farming systems, automation, sensors, ICT, health aspects of organic food and organic processing methods).

The large research initiatives described here have significantly contributed to creating a critical mass of capable scientists who — together with other stakeholders — can contribute to the further innovation in organic agriculture and food systems based on an understanding of the organic ideas and principles and with a critical and development oriented approach. A combination of the two mechanisms, the ERA-NET and a revised form of 'Integrated projects' could improve synergy between national and EU funding, for example in the form of ERA-NET+, where the Commission supports a transnational call with supplementary funding for a mutually agreed topic.

In the future, new mechanisms for handling larger goal-oriented funds from the EU, and possibly integrating these funds with transnational funding over a certain time frame, could be a method to seek more coherence in the European Research Area and create significant funds for tackling the important and large research challenges.

In conclusion, there seems to be a great need and potential to further develop a modus operandi for research and innovation programming and support, which can secure a proper integration of research and development needs identified by EU Member States and via other channels, such as Technology Platforms and EC organised bodies and 'think tanks', as well as organising joint funding, administration and dissemination processes. This is especially important when research and development

funds are scarce in comparison with the important challenges facing Europe.

Foresights of the future of food and farming towards 2050 highlight the need for an integrated approach linking the development of diets and sustainable agriculture in order to address challenges with climate, scarcity of resources and environmental concerns and securing a balance in land use and crop-livestock production. This calls for further innovation in food systems with potential for the integration of consumers' demand for healthy and high-quality food with environmental and animal friendly agriculture.

Strategic development of organic agriculture by research and innovation with a high degree of stakeholder participation can provide solutions and models for creating such synergies between goals of sustainable agriculture for food security and high-quality diets, reducing climate impact, securing high biodiversity and water quality and maintaining rural livelihoods.

Improving quality and safety and reduction of cost in European organic and ‘low input’ supply chains

Summary

The QualityLowInputFood project (QLIF) started in 2004 with 31 scientific and industry partners and the consortium was expanded to include the expertise of another five partners via open calls.

The overall aim of the project was to develop strategies to improve quality and safety of organic and low-input foods in the context of cost-efficiency and sound environments. The project was divided into seven sub-projects focused on R & D:

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; and
7. Horizontal activities covering environmental and economic impact assessments and training and dissemination activities.

Sixty-one work packages provided conclusive answers based on comprehensive analyses from scientific experiments, socio-economic data and complex modelling.

Problem

The demand for foods from organic and low-input farming systems is based on consumers' perceptions/expectations that such foods are associated with higher ethical (e.g. animal welfare) food quality and safety and sustainability-related gains/outputs than high-input systems. However, while the environmental benefits of low-input systems are well documented there was controversy about whether organic and low-input systems deliver significant food quality and safety gains. Furthermore, since price premiums were the most important barrier for a more rapid increase in consumer demand for especially organic foods, there was a need to focus on improving the production efficiency in low-input systems, without compromising environmental and potential food quality and safety benefits.

Acronym:

QualityLowInputFood

Project No:

506358

EU contribution:

EUR 12.44 million

Duration:

63 months

Start date:

1.3.2004

End date:

31.5.2009

Framework programme:

FP6 (sixth framework programme)

Instrument:

Integrated project

Project website:

<http://www.qlif.org> (active)

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The QLIF project was, therefore, designed as a large integrated project, which focused on a farm-to-fork approach to improving the production efficacy, food quality and safety parameters in the organic and low-input food supply chains in Europe.

Background and objectives

BACKGROUND

For society, organic and other 'low-input' farming systems provide an effective means of responding to the increasing consumer pressure to omit or reduce agricultural inputs (in particular pesticides, mineral fertilisers, veterinary medicines and growth promoters). However, in order to ensure that European society benefits optimally from this mechanism, it is necessary to address the actual and perceived problems or benefits which are of particular importance for low-input farming systems.

Lower production costs and coupling of lower production costs with improved quality and safety and consumer perceptions of higher quality and safety will enable low-input farmers to provide higher value-added food that maximises the benefits to consumers and producers alike. It is particularly important to ensure that consumers will be able to make their choices based on defined knowledge of the value provided by different types of products, and that these values may be reflected in more accurate and realistic business planning all along the production supply chain.

OBJECTIVES

The main objectives of the QLIF project were, therefore:

1. to understand the relative importance for different groups of consumers of the different 'added value' benefits of foods, as a necessary prerequisite to effectively improve the benefit/cost ratio;
2. the development of production protocols which provide food of high sensory and nutritional quality with a good shelf life, with minimal spoilage due to pathogen/pest attack, while avoiding excessive or unacceptable processing;
3. to understand and, if relevant, alleviate actual and perceived health risks from enteric pathogens and noxious compounds (e.g. mycotoxins, heavy metals);
4. to document, improve or disprove alleged health benefits related to differences in food composition that are determined by the type of production system;
5. to ensure or improve impacts on the environment and animal welfare;

6. to optimise production efficiency and reduce costs to satisfy actual and potential consumer demands.

Methodology

Consumer studies were based on standard questionnaire-based structured and semi-structured interview methods and consumer choice tests.

Studies focused on addressing the technological bottlenecks in crop and livestock production and impacts of low-input food production systems on food quality and safety parameters were mainly based on field trials using factorial, dose-response and 'additive' experimental designs. These were complemented by molecular, physiological and biochemical analytical tests and standard food composition analyses where appropriate. *In vitro* studies, bioassays and greenhouse experiments were also used especially in studies focused on developing new pest and disease control methods for crops and livestock.

Economic impact assessments were based on existing gross and profit margin assessment systems and environmental impact assessments were based on previously developed nutrient/emission budgeting and modelling (including LCA) methods.

A large proportion of field trials were carried out using farmer-participatory approaches to increase the industry relevance of field experiments and to support rapid dissemination and technology transfer.

Main findings and outcomes (results) or expected results

QUALITY AND SAFETY OF FOOD FROM ORGANIC AND LOW-INPUT SYSTEMS

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 differ considerably. In the case of dairy products, low-input systems such as 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 higher levels of nutritionally desirable compounds (e.g. vitamins/antioxidants and polyunsaturated fatty acids such as CLA and Omega 3) and lower levels of nutritionally undesirable compounds such as heavy metals, mycotoxins, pesticide residues and glycoalkaloids in a range of crops and/or milk. For example in milk, nutritionally desirable compounds were up to 70 % higher in organic samples.

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The multifactorial 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 chemosynthetic 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;
- (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.

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 on 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 2–3 times higher salmonella levels and, therefore, pose a greater risk of enteric pathogen transfer into the human food chain.

The microbiological safety of salad vegetables from production systems using organic fertilisers was also studied. The study concluded that it is essential to follow good agricultural practice with respect to manure use and processing to minimise safety risks and an improved HACCP-based quality assurance protocol for low-input production was published. Many nutritionally undesirable compounds are found at lower levels in organic foods than in conventional foods. For example, in wheat, potato and vegetables produced without mineral fertiliser inputs in organic and low-input systems concentrations of the nutritionally undesirable heavy metal cadmium were approximately 50 % lower.

FOOD PROCESSING

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 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 at 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.

HEALTH CLAIMS

QLIF studies investigating the effect of organic and low-input food consumption on the health of experimental animals only produced preliminary and 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.

FACTORS LIMITING CONSUMER DEMAND FOR ORGANIC AND LOW-INPUT FOODS

The main barriers hindering the increase of demand for organic food are (a) insufficient availability and continuity of supply, (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 compositional qualities of organic food. In countries where availability and range/assortment of organic foods is very good (e.g. Austria, Denmark, Switzerland), the share of organic comprised 5–6 % of all food purchases, but the relatively high premiums on consumer prices continue to hold up large-scale organic production.

TECHNOLOGICAL BOTTLENECKS/PROBLEMS ADDRESSED UNDER QLIF

A significant number of QLIF R & D activities addressed bottlenecks/problems of organic crop and livestock production, which reduce yields, increase economic risks and, therefore, push up prices. Major results are now summarised.

- 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 resistance to economically important

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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 term.

- ▶ 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 with, for example, 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 in outdoor runs).
- ▶ Alternative treatments such as diatomaceous earth and liquid formulation of silicas were successful against red mite in 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 logistics and transport cost, high input costs and low spending on research and product development. Good cooperation among the supply chain actors was identified as improving the non-financial and financial performance.

Potential applications

Within five years of targeted research, the QLIF Integrated project produced a solid scientific basis for the implementation of improvements in the organic and low-input food supply chains with respect to production efficiency and food quality and safety parameters.

To facilitate rapid dissemination and application of the results, QLIF established an extensive website-based information portal, and organised five stakeholder-focused conferences, five training workshops for early-stage researchers and agricultural advisors and six HACCP (Hazard Analysis and Critical Control Points) workshops for food industry technologists. The number of peer-reviewed publications on organic food and farming grew considerably through QLIF activities. As a result, many findings from the project were already disseminated to consumers and farmers by the end of the project. Furthermore, 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.

Innovation contribution

The QLIF project developed protocols for a range of innovative management practices and treatments that can be immediately applied to crop and livestock production and food processing to improve production efficiency, food quality and safe farming parameters.

This has significantly increased the innovation toolbox available to organic and low-input producers. This toolbox will allow them to identify individual strategies or combinations of strategies that are applicable to their specific production systems and economic and pedoclimatic background conditions.

Conclusions

As described above, and according to the evaluation by external peer reviewers, QLIF fulfilled all of its main objectives. However, the project identified a range of areas in which there is a need for further innovation/improvements.

Productivity remains a weakness in organic food chains, affecting the costs and the ecological/environmental footprint. The QLIF project showed, for example, that the higher energy efficiency and lower greenhouse gas emissions per land area partly melted away when calculated on a 'per tonne of food produced' basis. This is the most important overall challenge that should be addressed by future research.

In addition to soil fertility management, the development of crop and livestock breeding under organic and low-input conditions is thought to be required to better exploit effects of genotype x environment interactions on genetic gain in breeding programmes. QLIF also identified a need to develop novel and innovative non-chemical direct treatments, especially for certain plant diseases and pests. At the organisational level, novel farm, food chain and landscape strategies based on diversification by cooperation could increase system productivity and might reduce trade-offs between economic, ecological and social goals. Finally, 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 addressed by researchers for organic and sustainable food chains.

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Coordination of European transnational research in organic food and farming

Acronym:

CORE Organic

Project No:

11716

EU contribution:

EUR 1.2 million

Duration:

36 months

Start date:

1.10.2004

End date:

30.9.2007

Framework programme:

FP6 (sixth framework programme)

Instrument:

ERA-Net

Project website:

<http://www.coreorganic.org/> (active)

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Summary

(http://www.coreorganic.org/library/pub/core_i_final_scientific_report.pdf)

Research in organic food and farming is a fairly new, but rapidly expanding, discipline on the European research scene. One of the problems faced by the authorities seeking to initiate research programmes in organic food and farming is that the present research effort in Europe is characterised by small research communities, which are often scattered and fragmented both geographically and institutionally. Therefore, a gathering of the dispersed expertise to a critical mass in order to increase the competitive quality and relevance of the research as well as the dissemination and use of the research is needed.

CORE Organic was a three-year FP6 coordination action with the aim of improving the coordination of transnational research in organic food and farming. The project was carried out by 13 public funding bodies representing 11 European countries: Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom. The overall objective of CORE Organic was to gather a critical mass and enhance the quality, relevance and utilisation of resources in research in organic food and farming in the partner countries, and to establish a joint pool of at least EUR 3 million per year by the end of the project for funding selected transnational research projects. This was accomplished by the implementation of the following four objectives.

1. Increased exchange of information and establishment of a common open web based archive
2. Coordination of existing research and integration of knowledge
3. Sharing and developing best practice for evaluating organic research
4. Identification and coordination of future research

Objectives 1 and 2 were reached by means of various tools.

- ▶ The establishment of an internet and intranet site for coordination and communication externally and internally (<http://www.coreorganic.org>).
- ▶ The publication of eight electronic newsletters.

- The building and running of a common Internet portal on research in organic food and farming (<http://www.coreportal.org>) with information on history, organisation, research programmes, financing, research facilities, initiation of research, selection and evaluation, utilisation of research and scientific education plus research schools in the 11 partner countries linking to further information.
- Extending the open access electronic archive for research publications related to organic production (<http://www.orgprints.org>), which was established by DARCOF in 2002, to include research publications etc. from all the partner countries. The archive is maintained by the three partners — BLE (DE), DARCOF (DK) and FiBL (CH) — and each partner has a nominated national editor responsible for depositing publications and other relevant information from their country. In 2007, Organic Eprints contained more than 200 descriptions of research organisations, programmes and facilities, 500 descriptions of research projects and more than 10 000 research papers: there were 200 000–300 000 visits per month (autumn 2007).
- A workshop was held in May 2006 at the Joint Organic Congress in Odense, Denmark, to identify and discuss the most important research topics of common interest for the joint transnational CORE Organic call to be launched later in the project.

Thereby, topics for increased future cooperation as well as new research areas suitable for transnational cooperation and development of training schemes for research personnel and experts were identified.

The 11 partner countries organised organic research funding in different ways. Some countries mainly fund organic research through universities or public/private research centres (Germany, France and Switzerland) while others fund organic research through general research funding schemes or specific organic funding schemes with regular or irregular calls every one to five years or up to several times a year (Norway). All of the partner countries had organic research farms (76 in total), except Italy and Norway, which carried out a large number of experimental fields. Long-term experiments were established in all countries except the Netherlands. Fields for nutrient leaching experiments were only established in the Nordic countries (Denmark, Finland, Norway and Sweden). Eight countries (AT, CH, DE, DK, FI, NO, SE and UK) had organic animal research facilities, of which three for beef production, 14 for dairy production, seven for pig production, seven for poultry production and five for sheep production.

The most important research topics identified among the partners for a five-year period within 2000–07 were within the categories crop husbandry, animal husbandry, farming systems and food systems, while

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less important research topics were environmental aspects, values, standards and certification, knowledge management and soil science.

Objective 3 focused on the joint development of best practices for evaluation and quality assurance at project and programme level to ensure high-quality research in organic food and farming. To reach this objective, a questionnaire investigation involving various stakeholders in the 11 partner countries was used: this revealed that the evaluation criteria for organic research are quite similar in the partner countries and close to those used for the evaluation of general research programmes. In eight countries, the research proposal evaluation is carried out anonymously (i.e. the evaluation experts are not known to the applicants), while the evaluation experts are known to the applicants in three countries (Italy, Sweden and Switzerland). Reporting and monitoring of projects is very similar in most countries and annual reporting and a final report are requested, but Finland and Norway request semi-annual reporting. Based on these findings, a concept for the evaluation of the proposals for the first CORE Organic call was developed and a list of excellent European experts to peer review transnational CORE Organic pilot project proposals was drawn up.

Objective 4 concerned the identification and coordination of future research. This objective was reached by identifying research topics of common high priority and developing plans for future coordination and agreement on a range of procedures for transnational funding. Of seven high priority research topics, the following three topics were selected for the joint transnational pilot call.

- ▶ Animal disease and parasite management, including preventive and health improvement therapies to reduce reliance on antibiotics
- ▶ Quality of organic food — health and safety
- ▶ Innovative marketing strategies — identification of successful marketing methods, local markets

In 2007, the CORE Organic partners launched a pilot call for joint transnational research projects within these three common research topics. Of 37 project proposals, eight were selected for transnational funding by means of a virtual common pot approach (i.e. each national funding body funds researchers from its own country), and all partner countries participated in the transnational funding. The overall funding budget for the eight three-year projects was about EUR 8.3 million — close to the aim of EUR 3 million per year. The following were the eight CORE pilot projects for the period 2007–10.

- ▶ **AGTEC-Org** — Methods to improve quality in organic wheat
- ▶ **ANIPLAN** — Planning for better animal health and welfare

- ▶ **COREPIG** — A tool to prevent diseases and parasites in organic pig herds
- ▶ **FCP** — How to communicate ethical values
- ▶ **iPOPY** — Innovative public organic food procurement for youth
- ▶ **PathORGANIC** — Assessing and reducing risks of pathogen contamination in organic vegetables
- ▶ **PHYTOMILK** — What makes organic milk healthy?
- ▶ **QACCP** — How to assure safety, health and sensory qualities of organic products

(also see <http://www.coreorganic.org/research/index.html>)

After the selection procedure, an evaluation of the evaluation criteria and the procedure used for the CORE Organic pilot call was made by means of a questionnaire investigation involving, among others, the applicants and evaluation experts. Furthermore, a literature review was carried out. This study showed that the 19 evaluation criteria clustered within six main categories fulfilled the expectations of most target groups, but interdisciplinarity and innovative aspects should be addressed in a more appropriate way. Moreover, the gap between the initial scientific evaluation and the final selection of CORE Pilot projects should be reduced; the evaluation should be made more transparent and the way national priorities were integrated in the decision-making process should also be considered in more detail.

At a kick-off meeting for the eight CORE Organic projects in September 2007, the partners decided to continue the cooperation in a CORE Organic Funding Body Network after the end of the project in order to monitor and evaluate the eight research pilot projects and to broaden and deepen the cooperation between European organic research funding bodies in the future.

Problem

Research in organic food and farming is a fairly new, but rapidly expanding discipline on the European research scene. One of the problems faced by the authorities seeking to initiate research programmes in organic food and farming is that the present research effort in Europe is characterised by small research communities, which are often scattered and fragmented both geographically and institutionally. Therefore, a gathering of the dispersed expertise to a critical mass in order to increase the competitive quality and relevance of the research as well as the dissemination and use of the research is needed. Many organic research topics are of common European interest and they will be better addressed by a transnational approach, at the same time increasing the outcome of the resources put into organic research in each country.

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Background and objectives

(http://www.coreorganic.org/library/pub/core_i_final_scientific_report.pdf)

BACKGROUND

Organic farming represents a possible alternative with a more holistic view of agriculture and food production, and directly addresses the problems faced in many areas of conventional agricultural practice. Concerns for the environment, biodiversity, rural development and social aspects, animal welfare, product quality and safety are thus essential ingredients of the philosophy behind organic farming. A sustainable development of agriculture, environment and the rural districts are key policy objectives of the common agricultural policy (CAP). At its full potential, organic farming may constitute a solution to a number of current difficulties in the CAP. This is most obvious in terms of reducing environmental pressure, supporting ecosystem functions, and in terms of improving food safety and quality, animal welfare, etc. Moreover, as organic production often is smaller, but more valuable and labour intensive, organic farming also provides potential in terms of supporting rural development, improving farm income, market internalisation of the public goods produced by agriculture and supporting decreased resource use in primary production (multifunctional agriculture), and — obviously — in terms of reducing surpluses of agricultural commodities.

On several occasions, the European Council has recognised that organic agriculture improves the sustainability of farming activities and thus contributes to the general aims of the common agricultural policy. According to the Commission staff working paper (SEC(2002) 1368) 'Analysis of the possibility of a European Action plan for organic food and farming', the main documents on Community policy on agriculture have highlighted the importance of organic farming as an environmentally friendly farming system and have called for actions to further support the development.

In 1999, a conference — organised by the European Union — was held in Baden (Vienna), 'Organic farming in the European Union — Perspectives for the 21st Century'. As a follow-up, a new conference, 'Organic Food and Farming — Towards Partnership and Action in Europe', was held in 2001 in Copenhagen. This conference highlighted that:

- ▶ organic farming is a highly relevant tool in simultaneously solving a range of problems related to food production, environment, animal welfare, and rural development;
- ▶ organic food and farming is becoming a major opportunity for food producers in Europe, due to a growing consumer interest for certified organic products: this should lead to a developing market for organic food and create income for farmers;
- ▶ organic food and farming should be developed further.

Furthermore, the conference recognised research as a tool for developing organic food and farming, and a number of research issues were suggested, namely research to support the development of:

- ▶ organic foods of high quality;
- ▶ a stable production of organic food and feed for livestock;
- ▶ long-term and sustainable progress of organic farming;
- ▶ coherence between practice and principles.

It should also be said that in order to become a tool for a sustainable development, future research initiatives must consider market demands, while preserving the values associated with organic principles. These highlights and recommendations were meant to inspire the elaboration of the *European Action plan for organic food and farming*. At the latest hearing concerning this in Brussels on 22 January 2004, Dr Franz Fischler, Commissioner for Agriculture, Rural Development and Fisheries, said in his opening speech that improving the funding for research in organic farming, was identified as a very important issue in the coming action plan.

Essential to the achievement of such comprehensive goals is the development of appropriate research methodology, but also a close liaison between sponsors of research, researchers and the users of the research. Because of these objectives and the complexity of organic farming, it is necessary to focus on a development of research that is holistic, relevant and of high quality. Organic farming research methods include:

- ▶ research which generates general and communicable knowledge;
- ▶ whole systems, multidisciplinary and interdisciplinary approaches should be used (rescaling continually the focus of research, e.g. cell, plant, field, farm, region);
- ▶ both short and long-term impact on agro-ecosystems should be considered — this includes models that allow amplification of environmental cost or benefits of a technology;
- ▶ views of stakeholders (e.g. farmer, processors, consumers, environmentalists) should be integrated (participatory/action research);
- ▶ a specific analysis of stakeholders' expectations, since, according to organic farming objectives and principles, any situation is specific; therefore, paradigms and technical solutions cannot be implemented in the same way everywhere.

However, there are barriers to conducting relevant and high-quality research in organic farming. Organic farming is a fairly new research field with small national research communities, especially in specific areas, and there is a need to gather a critical mass in research in organic farming. Although research of relevance to organic farming can be undertaken by many different research groups and in different disciplines,

organising organic farming research within the currently completely segregated agricultural research structures is not appropriate. The prerequisite to strengthening research in the field of organic food and farming is thus to have strong and efficient core structures or schemes (national or regional hubs), which support specialists in research programmes of complex systems. For a European research programme on organic farming, it would be necessary to have the complete information about existing programmes.

Collaboration and coordination is essential in strengthening the overall performance of European research in organic farming. Among other things, it is important to establish networks in organic research and it is important to utilise possibilities for cooperation between national research programmes. Collaboration in education and extension as well as participatory or farmer-driven research should also be possible. Finally, identification of common evaluation procedures relevant to organic farming is seen as crucial for safeguarding and enhancement of research quality.

It is, therefore, desirable to establish a coordination network at the European level, which can secure collaboration, quality and relevance of research. The network, should compile the research projects in progress, project results and scientific publications throughout Europe, making them accessible via common databases and Internet portals to the interested public and to policymakers. With this background, the present ERA-NET proposal was prepared as a result of the seminar 'How to facilitate the development of Transnational cooperation in research in Organic Farming by member and associated states' on organic farming research in Europe. The seminar was held in Brussels, 24 and 25 September 2002, and was arranged by the European Commission.

OBJECTIVES

Because public research and development in organic food and farming is scattered and fragmented both geographically and institutionally in Europe, with small research communities, there is a need to gather the dispersed expertise to a critical mass to keep and increase the competitive quality of European organic research and development.

The overall objective of CORE Organic was to gather this critical mass and enhance the quality, relevance and utilisation of resources in European research in organic food and farming. The ultimate goal was to establish a joint pool of at least EUR 3 million per year by the end of the project to fund selected transnational research projects. This should be accomplished by implementation of the following four objectives.

1. Increased exchange of information and establishment of a common open web-based archive

2. Coordination of existing research and integration of knowledge
3. Sharing and developing best practice for evaluating organic research
4. Identification and coordination of future research.

Methodology

To reach the objectives, the project was structured in seven work packages (WPs).

Objective 1: Increased exchange of information and establishment of a common open web-based archive:

- WP 1: Coordination
- WP 2: Mediation and communication
- WP 3: Mapping of existing research programmes and facilities

Objective 2: Coordination of existing research and integration of knowledge

- WP 4: Coordination of existing research and integration of knowledge

Objective 3: Sharing and developing best practice for evaluating organic research

- WP 5: Sharing and developing best practice for evaluating organic research

Objective 4: Identification and coordination of future research

- WP 6: Identification and prioritising of future research topics
- WP 7: Coordination and implementation of future research topics with joint funding

The project also held three workshops, the first two were for stakeholder consultations:

- ▶ a public workshop on how to increase transnational cooperation in organic food and farming research at the Joint European Organic Congress in Odense, Denmark in May 2006;
- ▶ an open workshop on the third QLIF Congress in Hohenheim, Germany, in March 2007, where the open access web-based archive, Organic Eprints (<http://www.orgprints.org>) was presented and discussed.

The third workshop, the kick-off meeting for the eight transnationally funded CORE Organic pilot projects, was held in Vienna, Austria, in Sep-

tember 2007, and was for an invited audience consisting of the CORE Organic pilot project coordinators, the Core Organic partners, invited staff from the European Commission's Directorate-General for Research and Innovation (Jean Francois Maljean and Wolf Wittke) and the Directorate-General for Agriculture and Rural Development, Organic Unit, represented by Marta Fladl, plus representatives from public funding bodies in Estonia, Spain, Latvia and Slovakia.

Main findings and outcomes (results) or expected results

Objective 1, Increased exchange of information and establishment of a common open web-based archive and Objective 2, Coordination of existing research and integration of knowledge, were reached by means of the following tools.

- ▶ The establishment of an internet and intranet site for coordination and communication externally and internally (<http://www.coreorganic.org>).
- ▶ The publication of eight electronic Newsletters.
- ▶ The building and running of a common Internet portal on research in organic food and farming (<http://www.coreportal.org>) with information on history, organisation, research programmes, financing, research facilities, initiation of research, selection and evaluation, utilisation of research and scientific education plus research schools in the 11 partner countries lining to further information.
- ▶ Extending the open access electronic archive for research publications related to organic production (<http://www.orgprints.org>), which was established by DARCOF in 2002, to include research publications etc. from all the partner countries. The archive is maintained by the three partners — BLE (DE), DARCOF (DK) and FiBL (CH) — and each partner has a nominated national editor responsible for depositing publications and other relevant information from their country. In 2007, Organic Eprints contained more than 200 descriptions of research organisations, programmes and facilities, 500 descriptions of research projects and more than 10 000 research papers: there were 200 000–300 000 visits per month (autumn 2007).
- ▶ A workshop was held in May 2006 at the Joint Organic Congress in Odense, Denmark, to identify and discuss the most important research topics of common interest for the joint transnational CORE Organic call.

Objective 3 was reached by means of a questionnaire investigation involving various stakeholders in the 11 partner countries: this revealed that the evaluation criteria used for organic research are quite similar in the partner countries and close to those used for the evaluation of general research programmes. In eight countries, the research proposal

evaluation is carried out anonymously (i.e. the evaluation experts are not known to the applicants), while the evaluation experts are known to the applicants in three countries (Italy, Sweden and Switzerland). Reporting and monitoring of projects is very similar in most countries and annual reporting and a final report are requested, but Finland and Norway request semi-annual reporting.

Based on these findings, a concept for the evaluation of the proposals for the first CORE Organic call was developed and a list of excellent European experts to peer review transnational CORE Organic pilot project proposals was drawn up.

Objective 4 was reached by identifying research topics of common high priority, developing plans for future coordination and agreeing on a range of procedures for transnational funding. Of seven high priority research topics, the following three topics were selected for a joint transnational pilot call.

- ▶ Animal disease and parasite management, including preventive and health improvement therapies to reduce reliance on antibiotics
- ▶ Quality of organic food — health and safety
- ▶ Innovative marketing strategies — identification of successful marketing methods, local markets

In 2007, the CORE Organic partners launched a pilot call for joint transnational research projects within these three common research topics. Of 37 project proposals, eight were selected for transnational funding by means of a virtual common pot approach (i.e. each national funding body funds researchers from its own country), and all partner countries participated in the transnational funding. The overall funding budget for the eight three-year projects was about EUR 8.3 million — close to the aim of EUR 3 million per year. The following were the eight CORE pilot projects for the period 2007–10.

- ▶ **AGTEC-Org** — Methods to improve quality in organic wheat
- ▶ **ANIPLAN** — Planning for better animal health and welfare
- ▶ **COREPIG** — A tool to prevent diseases and parasites in organic pig herds
- ▶ **FCP** — How to communicate ethical values
- ▶ **iPOPY** — Innovative public organic food procurement for youth
- ▶ **PathORGANIC** — Assessing and reducing risks of pathogen contamination in organic vegetables
- ▶ **PHYTOMILK** — What makes organic milk healthy?
- ▶ **QACCP** — How to assure safety, health and sensory qualities of organic products

(also see <http://www.coreorganic.org/research/index.html>)

After the selection procedure, an evaluation of the evaluation criteria and the procedure used for the CORE Organic pilot call was made by means of a questionnaire investigation involving, among others, the applicants and evaluation experts, and through a literature review. This study showed that the 19 evaluation criteria clustered within six main categories fulfilled the expectations of most target groups, but interdisciplinarity and innovative aspects should be addressed in a more appropriate way. Moreover, the gap between the initial scientific evaluation and the final selection of the CORE pilot projects should be reduced; the evaluation should be made more transparent and the way national priorities are integrated in the decision-making process should also be considered in more detail.

The project was represented and had presentations at various Commission meetings and conferences:

- ▶ at an exhibition which took place in parallel with the second 'Communicating European Research' conference, arranged by the Directorate-General for Research and Innovation in November 2005, in Brussels, Belgium;
- ▶ at the workshop 'The life cycle of ERA-NET projects: from proposal submission to project-contract implementation', arranged by the Directorate-General for Research and Innovation in May 2006, in Brussels, Belgium;
- ▶ at a SCAR committee workshop held by the Directorate-General for Agriculture and Rural Development in June 2006, in Brussels, Belgium;
- ▶ at a workshop for ERA-Nets and technology platforms in the field of biotechnologies, agriculture, fisheries and food research arranged by the Directorate-General for Research and Innovation February 2007, in Brussels, Belgium.

Potential applications

At a kick-off meeting for the eight CORE Organic projects in September 2007, the partners decided to continue the cooperation in a CORE Organic Funding Body Network after the end of the project in order to monitor and evaluate the eight research pilot projects and to broaden and deepen the cooperation between organic research funding bodies in the 11 partner countries in the future.

This cooperation resulted in a broadening of the cooperation and the launch of a new call in the 'follow-up' coordination project under FP7: CORE Organic II (2010–13), which involves 21 European partner countries' (<http://www.coreorganic2.org>). The CORE Organic Funding Body Network is open to all countries which have a funding programme for organic research or are interested in the implementation of such a programme, so the network may later also involve countries outside Europe,

which may lead to even more efficient use of the limited research funding resources, better transnational cooperation at the funding body level as well as the research level and improved usability of the research results.

The CORE Organic Funding Body Network has also made contact with other ERA-networks to establish further cooperation on calls, evaluation methods, transnational funding models, etc., in order to improve and harmonise such procedures.

Innovation contribution

The project produced an overview of organic farming research in the 11 European CORE Organic partner countries (i.e. the history, organisation, research programmes, financing, research facilities, initiation of research, selection and evaluation, utilisation of research and scientific education and research schools) — presented in the CORE Organic Research Portal (<http://www.coreportal.org>) (possibly no longer active).

An open access web-based archive, Organic Eprints (<http://www.orgprints.org>) was also produced by the project. It contains more than 200 descriptions of research organisations, programmes and facilities, 500 descriptions of organic research projects and more than 10 000 research papers: in 2007, there were 200 000–300 000 visits per month (September 2007). To increase and improve the submission and use of Organic Eprints, national editors in each partner country were appointed.

CORE Organic was one of the first ERA-NETS to launch a transnational call based on a virtual common pot with participation of all partner countries. Furthermore, the project contributed to the harmonisation and improvement of call and evaluation procedures for organic research projects in the 11 partner countries.

The formation of a lasting CORE Organic Funding Body Network for continued collaboration and improvement of future transnational calls and funding procedures plus the widening of the network to other European countries after the end of the CORE Organic project was also an important contribution to innovative international collaboration on funding of research with important aspects as regards future improved quality and usability of organic research and funding efficiency in Europe.

Conclusions

The ERA-NET CORE Organic was successful in bringing 13 partners from 11 countries together to carry out common activities in transnational organic research. CORE Organic successfully launched a transnational pilot call and subsequently selected eight research projects to be funded by a means of a virtual common pot. These projects ran until 2010. The

ERA-NET allowed partners to obtain a map of various aspects of organic research in the partner countries, and to prioritise topics and develop common approaches for the pilot call. The CORE Organic evaluation of the pilot call and the recommendations made throughout the project regarding priorities, best practices and evaluation methods, etc., was important for the continued and improved transnational collaboration between the partners after the end of the project.

After the final selection of project CORE pilot project proposal, a self-evaluation was carried out by the members at the management board (MB). It revealed that MB members had perceived the coordination and implementation of the call as generally good. However, they also saw room for improvement concerning details of the evaluation procedures, the transparency of the funding selection process and asked for more flexibility concerning the applied funding model.

The following suggestions on how to improve the call procedure were given for the different call phases.

PREPARATORY PHASE

The use of a two-step application procedure.

- ▶ A formalised procedure to define call topics including common issues at European level and complex interdisciplinary problems, additional to the pooling of national programmes
- ▶ Full agreement on call topics (i.e. no particular national restrictions) among funding partners
- ▶ Assignment of funds to each individual call topic and/or allow for restricted calls with a smaller number of funding institutions
- ▶ Aim towards a more even funding between participating partners in the call
- ▶ More detailed information in call documents (e.g. national funding rules)
- ▶ The use of milestones and deliverables in application documents
- ▶ Larger application document, with more space for project description (e.g. four to six pages only for the first step application draft and a larger more detailed, final project description in the second step)
- ▶ Involvement of all the CORE Organic partners already early in the preparatory phase
- ▶ The early setup of a FAQ forum

APPLICATION PHASE

- ▶ The setup of a central contact point (e.g. call secretariat) or at least improved communication and information exchange between individual NCCPs on FAQ.
- ▶ The use of a fully adapted web-based application system.

EVALUATION PHASE

- ▶ If funding is assigned to each specific topic of the call, it is suggested that evaluation by experts be restricted to the applications in their field of expertise.

SELECTION PHASE

- ▶ A formalised procedure including discussion on selection of criteria and written selection feedback to applicants.

Comparison of the CORE Organic call with a survey on joint activities in individual ERA-NETs showed that problems encountered during the different call phases were comparable to those in other ERA-NETs. This was due to the evident learning-by-doing aspects in ERA-NETs, as participants of ERA-NET projects usually have no previous experience with the scheme.

Strategic issues and future cooperation

Strategic aims for the future were established by the CORE Organic Funding Body Network. The following subjects should be considered:

- ▶ increasing the research community in organic farming;
- ▶ exchange of information and experiences on funding mechanisms;
- ▶ coordination of knowledge production;
- ▶ strategic topic formulation.

Subjects that need further cooperation and research

- ▶ Topic formulation: openly formulated v restricted calls
- ▶ Number of participating organisations: all v few funding institutions participating in a call
- ▶ Funding model: virtual pot v true common pot

Future aims for the CORE Organic funding body network collaboration

Based on the different evaluations and taking into account experiences from other ERA-NETs four strategic aims were identified. They are now presented in no particular order of priority.

INCREASE OF RESEARCH COMMUNITY IN ORGANIC FARMING

Several partners expressed a wish to increase the organic farming research community. One aim with the CORE Organic joint call was to create a critical mass of researchers (from different partner countries) of the somewhat scattered and small organic food and farming research community. In this way, funding organisations can expect more efficient knowledge production/generation which gives more value for spent money/funding.

An additional aim mentioned by some partners was to not only increase the organic farming research community by involving national researchers in organic farming, but also to complement or integrate it with researchers from adjacent research areas such as health, food quality, environment or climate. The goal of such an enrichment of complementary scientific competence would be an improved scientific quality of research but it could also improve the management in research of more complex interdisciplinary problems of organic food and farming systems in relation to sustainable development issues. Special activities in order to create forums for researchers from different fields to meet and interact would be needed to obtain such future integrated research applications.

EXCHANGE OF INFORMATION AND EXPERIENCES ON FUNDING MECHANISMS

The prerequisite of ERA-NET projects, that partners are restricted to programme owners and managers, was appreciated by several CORE Organic partners. In the formed network, funding institutions were able to learn from different funding mechanisms and procedures in partner countries and exchange experiences.

Although most partners judged that virtual common pot funding was the most realistic in a short and medium-term perspective, they were also positive concerning a development towards true common pot funding or rather interpreted as mixed funding. One approach in this direction is restricted calls with only few partners.

COORDINATION OF KNOWLEDGE PRODUCTION

Coordination of knowledge production and avoidance of duplication was identified as an important outcome by the CORE Organic Governing

Board (GB). The thorough work in CORE Organic on screening research mechanisms, funding, programmes and ongoing research on organic food and farming systems in the partner countries was an important source of information to minimise duplication of knowledge production. To maintain the possibility to coordinate future knowledge production, the database Organic Eprints needs to be maintained and actively updated by CORE Organic partners. A maintained network with at least annual meetings will probably also be necessary in order to coordinate future national activities in food and organic farming research.

STRATEGIC TOPIC FORMULATION — NATIONAL AND COMMON TOPICS

Some problems of the call application and selection phases were related to the earlier topic formulation. Partners prioritised the involvement of all partners in the CORE Organic pilot call and all national research needs of partners were pooled and negotiated. A somewhat differing commitment between participating partners of the CORE Organic joint call could, however, be noted. Partners also chose to devote substantially different amounts of funding to the joint call and selected projects.

The problem of topic formulation has also been reported in other ERA-NETs as 37 % of partners who chose not to participate in ERA-Net calls referred to difficulties in reaching a common agreement on a common call theme. In future calls, CORE Organic partners should not be able to apply national restrictions to the topics. Apart from this, actions need to be taken to attract enough funding institutions. The joint calls should offer a solution to problems of generating research in prioritised areas at the national level.

Procedures for the formulation of additional strategic research need to be further developed and this could possibly create a more even commitment for future joint calls. One aim of the CORE Organic ERA-NET was to increase the interdisciplinarity of research. To obtain interdisciplinary research applications and consortia, a more complex problem formulation is needed in the topics from the beginning. Common research needs on a European level must be developed and the involvement of national and European stakeholders in the formulation of such research needs is important. The challenge is to formulate topics that are interesting enough for a sufficient number of funding institutions to allocate funds.

Conflicts

OPENLY FORMULATED OR RESTRICTED CALLS

There were different views between partners on topic formulation. Some partners preferred restricted, narrowly formulated calls by funding institutions with or without the involvement of food chain stakehold-

ers (i.e. top-down formulated topics). Other partners argued for more openly formulated calls to let researchers formulate the most relevant research questions (i.e. bottom-up formulated topics). This probably reflects a true difference in research traditions between the CORE Organic partners. One possibility to handle this difference is to open several joint calls with fewer participating funding bodies.

ALL OR FEW FUNDING INSTITUTIONS PARTICIPATING IN CALLS

Partners judged it important that all CORE Organic partners took part in the CORE Organic pilot call, and enough partners were prepared to moderate their demands on chosen topics to obtain this. For future calls, funding institutions can be expected to be more demanding on the choice of topic. With a smaller number of funding institutions, fewer funds will be assigned to the chosen topics. On the other hand, with fewer partners, agreement on the funding model and more even funding or other means (i.e. mixed models) to facilitate the application selection phase will be easier.

VIRTUAL COMMON POT VERSUS TRUE COMMON POT

The drawbacks of virtual common pot funding were evident in the CORE Organic pilot call. Due to virtual common pot effects and the selection of topics, there was no optimum relation between the outcome of the scientific evaluation and the final selection of projects to be funded; there is, therefore, a need to investigate the pro and cons plus national legal restrictions on the use of a true common pot funding model. As long as topic selection is only based on pooling of national programmes it could, however, be expected that true common pot funding could imply some negative effects on contextualisation and specific national relevance of individual research projects.

Lessons learned — recommendations bridging to future cooperation

TIMING OF CALL PROCEDURES

The CORE Organic ERA-NET budget was less than first planned for and there was a shortage of time during the whole call process, especially during the evaluation and selection phases, but the important preparatory phase with topic selection also suffered from time pressure. Other ERA-NET experiences show that the implementation of the call was considered much more complex than national calls by 41 % of ERA-NETs and the preparation of the call was regarded by some as the most difficult and time-consuming element of organising a joint call. A time frame for future calls has been suggested to meet the need for sufficient time for planning of the call and to make space for continuous follow-up, analysis and adjustments (Table 1).

Table 1: Suggested time frame for future calls

CALL PHASE	TIME PERIOD
Preparatory phase	8 months
Application phase	3 months
Evaluation phase	4 months
Selection phase	1 month
Contract and funding phase	4 months
Total call procedure	20 months

The setting-up of a call secretariat (avoiding increased bureaucracy) for future calls would also simplify planning of the call phases.

PROCEDURE FOR TOPIC FORMULATION

A crucial aspect for future topic formulation is to reach a shared view among partners on strategic research issues. This could be obtained by applying methods and tools used for rational decision-making, and by opening up common research needs both within and outside existing national research programmes.

TWO-STEP PROCEDURE

Experiences from other ERA-NETs are that a two-step procedure was used for larger calls with project durations of several years. The reason for choosing a one-step procedure in the CORE organic pilot call was entirely due to time constraints.

COMMUNICATION AND INFORMATION TO APPLICANTS

The applicants' evaluation of the pilot call showed the importance of fast and clear information throughout the call process. Communication channels and information including the early set-up of a home page, FAQ and information on the call concerning national restrictions and assigned funding to high-quality science and selection feedback need further planning and coordination in future calls.

PROCEDURE FOR FINAL SELECTION

The final selection procedure needs to be clearly defined in advance and fully understood by all partners as well as all applicants when the call is launched. The use of mixed models for funding could tighten the relation between scientific evaluation and final selection.

Coordination of European Transnational Research in Organic Food and Farming Systems

Acronym:

CORE Organic II

Project No:

249667

EU contribution:

EUR 999 976

Duration:

36 months

Start date:

1.3.2010

End date:

28.2.2013

Framework programme:

FP7 (seventh framework programme)

Instr QJAB12009BGC ument:

ERA-Net

Project website:

<http://www.coreorganic2.org/> (active)

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Summary

Organic agriculture and food markets have grown considerably, and organic agriculture addresses important challenges of European agriculture, such as the sustainable production of high-quality food, reducing dependency on high energy inputs, improving environmental and nature conservation, climate change adaptation, animal welfare and rural livelihoods. Organic farming and food systems still have a huge potential for innovation and improved solutions. Research activities will be important for this.

Coordinated transnational research has the potential to create a less fragmented research area in this fast growing sector. CORE Organic II builds on the outcome of the first CORE Organic. Aiming at an effective and sustainable transnational research programme, it will identify common research priorities for the organic sector where a transnational approach will give added value, launch at least two transnational calls, initiate research projects, organise project monitoring and dissemination of results, and consider funding models.

CORE Organic II will also develop all components to continue the transnational research activities beyond the ERA-NET. The results of CORE Organic II will be a strong and sustainable network of funding bodies, all components for the effective continuation of collaboration, a series of ongoing research projects and a plan to support dissemination.

The expected benefits for Europe will be to reinforce its leading status and excellence in organic research, enhance the European research area on organic agriculture, increase the efficiency in use of organic research funds and improve the impact of research on the organic sector's development. Initiating projects on topics identified as common priorities will allow the sector to better meet the demand for organic food and products. This will contribute to sustainable development in food production and improve the general competitiveness of the European agriculture.

Problem

Organic research is a rather small research area in the individual partner countries, and therefore tends to be fragmented.

By making transnational calls, the research will be less fragmented. A transnational approach in organic research will allow initiation of research on topics of common interest and will benefit from the diversity of conditions and practices in the countries involved. In particular, some specific areas of organic farming and food would be better addressed by a transnational approach due to their transboundary nature and general importance (e.g. climate change, genetic improvement of plants and livestock, regulatory and trade aspects).

Background and objectives

BACKGROUND

The EU currently has the leading role globally in organic research. However, there is a need to strengthen the partnership between Member States, associated countries and the European Community, so that coordination of transnational research in organic farming and food systems will address the EU Commission's concern for improved coordination of research efforts with a long-term perspective and create a less fragmented research area in this fast growing sector. Increasing the transnational cooperation will therefore reinforce Europe's leading status and excellence in organic research, increase coherence across Europe and improve the overall impact of research on the development of the organic sector.

As a first step in establishing transnationally funded research for organic farming and food systems at the EU level, an FP6 ERA-NET, Coordination of European Transnational Research in Organic Food and Farming (CORE Organic; ERAC-CT-2004-011716; referred to as CORE Organic I) was established in 2004 by 11 European partner countries: Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland and the United Kingdom.

Among other things, the project carried out a mapping of research programmes and research infrastructures. In the prioritisation of transnational research topics, the following three topics were chosen for a transnational pilot call: animal disease and parasite management; organic food, quality and safety; innovative marketing strategies. Some 37 proposals were submitted and evaluated by peer review. Eight research projects were selected (<http://www.coreorganic.org/research/index.html>) and funded by means of a virtual common pot. The projects were initiated just before CORE Organic I ended in 2007, and they have finished/will finish between June 2010 and June 2011.

The ERA-NET also successfully contributed to meeting the demand for transparency within national and transnational research in organic farming and food systems by the establishment of an open archive,

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Organic Eprints (<http://www.orgprints.org>), which contains more than 9 000 research papers.

The experience gained in CORE Organic I lead to expectations that transnational collaboration for organic farming and food systems:

- ▶ is necessary to increase the volume, quality and common relevance of research in organic farming and food systems and to tackle important research topics, which demand high investment, are interdisciplinary, and which have a cross-national relevance;
- ▶ makes it possible to develop and share 'good practices' in programme implementation and monitoring, and to provide better inputs for evidence-based policymaking and further development of future joint research programmes;
- ▶ makes it possible to speed up research in new areas of common importance for the development and integrity of organic farming and food;
- ▶ increases comparability of research results and enables channelling of significant parts of national research funding into common programmes;
- ▶ makes it possible to learn from each other;
- ▶ ensures transparency in terms of easily accessible information regarding research priorities, programmes, funding mechanisms and ongoing research projects as well as publications and results, which are in great demand by different stakeholders.

The 11 partner countries in CORE Organic I recognised the benefit of transnational collaboration for organic research and decided to continue and expand the collaboration. They formed the CORE Organic 'Funding Body Network' in order to monitor and evaluate the eight CORE Organic I pilot projects, to broaden the collaboration and to pursue efforts towards a long-term collaboration in organic research. Since then, the Funding Body Network has continued to work towards these objectives. It has expanded from 11 to 21 countries. The framework of an ERA-NET and the support of the European Commission will ensure that the network is fully operational and will deepen the collaboration between the national funding bodies in the 21 partner countries. It will facilitate the integration of the 10 new countries in the network activities, including the prioritisation of research topics in all partner countries, and will allow consideration of further expansion to other countries. It will thereby give impulse to the future of organic research in all partner countries involved.

OBJECTIVES

The main strategic objective of CORE Organic II is to enhance the quality, relevance and utilisation of resources in research in organic farming and food systems in Europe. CORE Organic II will contribute to the de-

velopment and integrity of the organic sector by making joint transnational calls, selecting and initiating research projects, and establishing the framework for a strategic research agenda as a basis for long-term collaboration between the partner countries. Some general objectives of CORE Organic II through its different components are:

- ▶ to launch transnational calls;
- ▶ to strengthen the leading role of the EU in organic research in building up a less fragmented research area by consolidating a strong network of Member States and associated countries able to confirm the role of European organic research on the global map;
- ▶ to give momentum to long-term transnational collaboration for organic research between the partners and secure the effective continuation of the collaboration beyond the ERA-NET, by putting in place the structures and models for lasting collaboration and transnational research beyond CORE Organic II;
- ▶ to ensure the involvement of stakeholders and dissemination of research results, and to promote circulation of knowledge (not only in Europe but also globally);
- ▶ to refine, develop and deliver best practices and tools for organising and conducting transnational research in organic farming and food systems.

Methodology

CORE Organic II will ensure the transition between the model call and pilot projects of CORE Organic I and a stable long-term collaboration for launching regular transnational calls, conducting organic research projects and disseminating their results. It will also take account of the experience of, and synergies with, other ERA-NETs, and of the content of the toolbox developed by ERALEARN.

Main findings and outcomes (results) or expected results

The CORE Organic II identified the research topics for the first call at the kick-off meeting in April 2010. During the following months, the call texts were finalised and adopted. Three thematic areas were selected for the first call: (i) Cropping: Designing robust and productive cropping systems at field, farm and landscape level; (ii) Monogastric: Robust and competitive production systems for pigs, poultry and fish; and (iii) Quality: Ensuring quality and safety of organic food along the whole chain.

CORE Organic II launched the first call for pre-proposals in September 2010 with a pre-announcement of the call text 1 July 2010. Fifty-nine applications were received and the partners selected 25 who were invited to submit full proposals. These full proposals were assessed by scientific expert

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panels and 17 of them were recommended for funding. The partners will meet in May 2011 to select the projects to be funded.

The second call is under preparation. The first draft of the call texts will be discussed in May 2011 and call boards will be established to finalise the call texts until the final agreement at a meeting in November 2011. The second call will be launched in January 2012.

For the second call, the possibility of a shared call with the ERA-NETs ICT-AGRI and RURAGRI is being sought. CORE Organic II will suggest topics of mutual interest which will be discussed by ICT-AGRI and RURAGRI.

Funding by the true common pot would be a way to ensure funding of transnational research of the highest quality and with a lower administrative burden for the researchers. The existing legal, policy, administrative and project/programme barriers in the partner countries have been explored in CORE Organic II. Only a few countries are able to join the true common pot at this point, and if these countries have a common interest in a narrow research area, the true common pot will be tested in the second call. For future calls, recommendations to the partner countries on how to make the use of the true common pot or mixed mode possible have been prepared.

Stakeholder involvement at national level for research prioritisation has been explored in the partner countries of CORE Organic II. Based on the collected information and a literature review, suggestions were made for countries in the process of developing a good practice for stakeholder involvement. Furthermore, a plan of action for transnational stakeholder involvement in relation to CORE Organic II activities has been drawn up.

Monitoring and evaluation of the funded research projects are tasks that go beyond the lifetime of the ERA-NET. The experiences gained from monitoring and evaluation of the CORE Organic I pilot projects, the needs and requirements from the new partner countries and recommendations from ERA-LEARN will form the basis of a model to organise efficient and transparent project monitoring of CORE Organic II projects. Templates for deliveries, annual abstracts, midterm and final reports are being prepared, as well as evaluation forms.

To identify appropriate ways for disseminating results to stakeholders and end-users on a national and transnational level, the best practice of dissemination used in the eight CORE Organic I projects and the best practices used in the national projects funded by the partners have been explored, and a report is under preparation.

CORE Organic II seeks to increase synergy with other ERA-NETs through mutual learning and joint development of tools for proposal handling, evaluation and for project monitoring.

Potential applications

At the end of CORE Organic II, there will be a strong network of partners, all the elements necessary for the effective continuation of the collaboration, a series of ongoing transnational research projects, and a plan and structure to support dissemination. The network will have gained experience in the coordination and management of parallel calls and projects, and will be well prepared to continue collaboration beyond the termination of CORE Organic II.

CORE Organic II will maximise the efficiency in use of research funds across countries, by facilitating channelling of significant parts of national research funding budgets for organic agriculture and food into common pots for transnational projects. It should therefore reduce duplication of research across Europe, and increase collaboration within costly research facilities.

By using a common approach, the ERA-NET will increase the quality and common relevance of research in organic farming and food systems. The network will offer support to researcher consortia with complementary competencies and best available methods and facilities. CORE Organic II will ensure the high scientific quality of research, inter alia, by the independent expert evaluation of project proposals using state-of-the-art scientific evaluation criteria. The ERA-NET will promote the excellence of research by organising monitoring of the selected research projects, ensuring interactions with the project teams and developing tools for impact assessment.

Through joint efforts, the ERA-NET can successfully address, with excellent research and innovation, the most important areas of common interest where organic farming and food systems need improvement in order to fulfil important objectives in terms of sustainability, food safety and quality, climate change adaptation, animal health and welfare and other important aspects of the organic food chain. CORE Organic II will develop the perspective of European funding bodies on the priorities for organic research (with appropriate links to other networks and organisations active in organic agriculture and with a sufficient volume).

Innovation contribution

The dissemination of research results will be optimised by dissemination to all partner organisations and not only the funding bodies of the specific project. Each project will have a dissemination sub-site related to the coreorganicII.org site. Newsletters will be produced for dissemination in all partner countries. Efficient dissemination and communication will be targeted to European organic farming journals, magazines and other media as well as relevant stakeholders and decision-makers across Europe in order to ensure maximum impact of the project results.

Organic Eprints, an international open access archive for papers related to research in organic agriculture, will be used by all funded research projects to publish all results gained. Each partner country of CORE Organic II has appointed a National Editor of Organic Eprints that will help to increase the National use of the archive in the partner countries.

The use of these two instruments will ensure that the results of research projects are widely available to the stakeholders and end users concerned, and that they are effectively used to the benefit of the organic sector and European society.

Conclusions

It is too premature to draw final conclusions, however the objective of the CORE Organic II will be reached as the first call has already been carried out.

It will, however, be a challenge to secure funding for a continuation of the collaboration. The partners will have to fund an efficient secretariat to take care of coordination, calls, proposals and projects, including the monitoring of progress of funded projects and dissemination efforts. In addition, partners have to meet physically at least twice per year to prioritise research and select projects for funding. Several models for continuation will have to be considered.



Chapter 2

Policy support

Introduction

Organic farming projects for policy support

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The European Commission recognises organic farming as an important way towards attaining the CAP (common agriculture policy) reform objective of promoting environmentally friendly quality products. In recent years, the economic importance of organic agriculture has grown considerably in many countries in Europe as well as outside Europe.

Since 1991, organic farming in the EU has been governed by Council Regulation (EEC) No 2092/91 ⁽¹⁾, which set out the rules for labelling food products as 'organic', or the equivalent terms 'biological' or 'ecological'. The Regulation was a response to growing consumer demands for organic products in the EU, and the result was a legally enforceable and officially recognised common standard for organic crop production, certification, and labelling in the EU, which had to be implemented in all Member States by 1993. Since then, this regulation has been adapted many times. A major revision took place from 2005 until 2009, which was supported by several EU research projects.

The rationale for research support can be justified by the dual societal role of organic farming as explicitly mentioned in the new Regulation ⁽²⁾: 'The organic production method thus plays a dual societal role where it on the one hand provides for a specific market responding to a consumer demand for organic products, and on the other hand deliver public goods contributing to the protection of the environment and animal welfare, as well as to rural development' (recital 1, Council Regulation (EC) No 834/2007).

For many years, the policy dimension of organic farming research has been recognised as relevant for research support by the Directorate-General for Research and Innovation. The first policy-oriented project for organic farming was financed under the fourth framework programme with the title 'Effects of the CAP reform and possible further developments on organic farming within the EU' (OFCAP, 1997–2000) and made recommendations on how to reorient the CAP to organic farming.

1 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.1991, p. 1.

2 Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, OJ L 189, 20.7.2007, p. 1.

With the entry of new Member States, it became obvious that a special focus was needed on the situation in Central and Eastern European (CEE) countries. Therefore, the project 'EU-CEEOPF — Further development of organic farming policy in Europe, with particular emphasis on EU enlargement' (EU-CEEOPF, 2003–05) was supported under the fifth framework programme. This project helped to guide the further development of European organic farming policy, including policy instruments and institutions that address the full range of conditions necessary for organic growth. This was based on analysis of (a) the development of organic farming in selected EU countries under implementation of EU Agenda2000, and (b) the pattern of development of organic farming in CEE accession nations. The relationship between results from the two analyses assisted in determining the impacts of EU enlargement on organic farming development in EU and CEE nations. Recommendations outlined further developments to organic farming policies to promote organic agriculture in the EU.

On 4 June 2004, the European Commission adopted the European Action Plan for Organic Food and Farming 'in order to facilitate the expansion of the organic farming sector and also to increase its production capacity with new information and, above all, new technologies'. Of the 21 actions decided on by the EC in the European Action Plan for Organic Food and Farming, 'strengthening training and research at all levels, from the adoption of research programmes in universities or other research bodies, to on-farm training to ensure suitable technology transfer to farmers' was one of the crucial policy instruments. Several action points in the EU Action Plan addressed the revision of the EU Regulation on organic production.

The need for scientific support in the implementation of the proposed European Action Plan for Organic Food and Farming was taken up in the sixth framework programme in a specific call in the Area 8.1 Policy-oriented research, under 1.2 Tools and assessment methods for sustainable agriculture and forestry management, as well as in the seventh framework programme as a special sub-area. Five projects directly addressed the revision of the regulation (Organic Inputs Evaluation in FP5, EEC 2092-91 REVISION and ORWINE in FP6, and CERTCOST in FP7) and one supported the EU Organic Action Plan (ORGAP in FP7). These projects were initiated mainly by the Directorate-General for Agriculture and Rural Development and supported by the private sector umbrella organisation (IFOAM EU Group). The purpose of all these projects was to support these actions and to provide scientific background to an appropriate development of legislation to increase consumer confidence in organic products and help to improve the framework conditions for organic farming. Emphasis was placed on broad stakeholder involvement.

The EEC Regulation 2092/91 REVISION project was a Specific Targeted Project (STREP) with the main aim to support revision of Regulation

(EEC) No 2092/91 on organic agriculture as a result of the European Action Plan for Organic Food and Farming (EC, 2004). The project identified basic ethical values in a broad participatory discussion process working on drafting new ethical principles of organic agriculture, as input for a specific section on principles of organic production in Regulation (EC) No 834/2007. A database was developed for the comparison of national public and private organic standards with Regulation (EEC) No 2092/91 (<http://organicrules.org>). The differences were analysed in relation to consumer and public perception, risk of trade distortion and compliance with the principles of organic agriculture and, based on this analysis, recommendations were made in areas of Regulation (EEC) No 2092/91 where harmonisation, regionalisation or simplification could be implemented. Furthermore, the project provided more background knowledge for policymakers on how to achieve 100 % organic rations in diets for livestock and how to reduce the use of seed and vegetative propagation materials from conventional sources in organic farming.

The Organic Inputs Evaluation project also supported the EU Regulation for organic production. The project proposed harmonised and standardised procedures for the evaluation of plant protection products, fertilisers and soil conditioners for use in organic agriculture. The results were successfully fed into the consultation process on Article 7 on the criteria for amendments to the Annexes. The project also recommended that an expert panel assists in the evaluation process. Such a panel was formed in 2010 to assist the EC and the SCOF (Standing Committee for Organic Farming) in the evaluation and development of the EU Regulation for organic production.

Within the EU-funded ORGAP project, a toolbox for the evaluation of the European as well as national action plans for organic food and farming has been developed (<http://www.orgap.org>). This toolbox was based on a comparative analysis of national action plans in eight countries (Czech Republic, Denmark, Germany, Italy, the Netherlands, Slovenia, Spain, Switzerland and the United Kingdom) and included a meta-evaluation of existing evaluations of national action plans, workshops with national stakeholders and a European Advisory Committee, and interviews with experts. Furthermore, synergies and conflicts between the national and the European action plans were identified. ORGAPET — the Action Plan Evaluation Toolbox — and the ORGAP Manual — a resource handbook for the development, implementation and evaluation of organic action plans — are unique and innovative tools. This is the first time that such tools have been developed for specific EU actions plans which complement the EU's general evaluation tools.

The ORWINE project aimed at supporting the development of the legislative framework for wine from organic viticulture. Data about currently applied practices and consumer and market needs in significant areas were gathered in main significant wine-producing areas of the EU, new

Member States and accession countries. Test series with suitable and innovative technologies to improve the quality of wines from organic viticulture, allowing the use of a low level of sulphites were conducted and validated on a network of selected pilot farms. A participatory approach with stakeholder involvement at national and EU levels followed, so ensuring a wide and deep discussion on the proposed legislative framework. A code of best practices (translated into five languages) and an integrated environment assessment tool were produced in order to provide guidance to wine producers for high-quality wine while limiting their impact on the environment.

The CERTCOST project aimed at combining the experience and knowledge of researchers and small and medium-sized enterprises in the analysis how organic certification systems are implemented. The analysis has shown that the implementation of the organic certification systems in different European countries varies substantially — and to a degree that sometimes impedes comparison and quantitative analysis. Moreover, this project estimated all relevant expenditures or transaction costs for different certification systems along the organic food supply chain. Using data on consumers' recognition and willingness to pay for different organic logos and trademarks, the project will analyse the benefits of certification. And, finally, the project provides recommendations to the EC, national competent authorities, and private actors how to make organic certification more efficient and cost-effective.

In conclusion, policy-oriented organic farming projects have significantly contributed to improving the regulation for organic farming as well as broad stakeholder involvement, which is also very relevant for international regulations (e.g. *Codex Alimentarius* guidelines for organically produced food).

Innovative research ideas, concepts leading to a supportive policy environment and a credible and feasible regulation for organic farming will strengthen the competitiveness of the organic food and farming sector in the EU and increase its sustainability benefits for the whole of society. Organic systems can, thus, be seen as a forerunner to sustainable food and farming, efficient in producing a secure supply of high-quality foods whilst delivering a range of crucial public goods.

Overcoming barriers to conversion to organic farming in the EU through markets for conversion products

Acronym:

CONVERSION

Project No:

QLK5-CT-2000-01112

EU contribution:

EUR 1 043 413

Duration:

36 months

Start date:

1.1.2001

End date:

30.6.2005

Framework programme:

FP5 (fifth framework programme)

Instrument:

Shared cost RTD

Project website:

No

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Summary

In recent years, the EU has become a net importer of organic food to satisfy increasing demand. Financial support for farmers during conversion has been made available to help expand organic production as this was seen as a barrier to conversion. Meanwhile, farmers have been marketing products produced in this conversion period and labelled as such, the extent to which was described in the project. Consumers' attitudes towards, and willingness-to-pay for, conversion-grade food was examined. It was found that consumers would be prepared to pay a premium for conversion-grade produce of around half the premium for organic produce with vegetables attracting a higher premium than meat. Finally, the potential of policies for marketing conversion-grade products to encourage more conversion was examined. It was concluded that barriers to marketing such products, particularly from retailers, will be formidable.

Problem

Research shows that the decisions taken by farmers to convert to organic production depend on financial incentives and their perceptions of the market for organic products. It is now accepted that farmers will only convert if the loss of income from the lower yields associated with organic production is offset by higher farm-gate prices for the produce. Such a barrier was seen to merit study in case ways of overcoming it could be devised.

Background and objectives

This research project aimed to identify barriers to conversion to organic production in five EU countries (Denmark, Ireland, Italy, Portugal and the United Kingdom) and evaluate ways to overcome these, particularly through establishing markets for products from the conversion period.

To achieve this aim, the project had the following main objectives:

- (i) identify incentives for farmers to convert to organic production;
- (ii) identify and quantify the constraints that limit the conversion of farmers to organic production within the EU;

- (iii) estimate the potential market demand for conversion-grade production;
- (iv) quantify the extent to which marketing conversion-grade products might reduce constraints to the conversion to organic production;
- (v) identify constraints that might limit the marketing of conversion-grade products within the study countries;
- (vi) identify potential mechanisms through which the identified constraints to the marketing of conversion-grade products might be alleviated; and
- (vii) make recommendations regarding policy actions that might facilitate the effective marketing of conversion-grade products.

Methodology

An initial literature review provided a detailed picture of the organic sector in each study country. It included details of production, producers, government incentive schemes, consumer attitudes to organic products and market statistics.

Case studies involving interviews with 27 farmers who had expressed an interest in converting to organic production, but had yet to actually do so, were carried out in each country. As well as attitudinal information, data on costs of conversion, loss of yields and price premiums were collected in order to carry out a budgetary analysis.

Simultaneous postal surveys were carried out in each country using an identical questionnaire to 500 registered organic producers. The survey was designed to identify the marketing channels used for conversion-grade and organic products, the volumes and values of such sales by channel, as well as price premiums obtained.

Up to 28 interviews were carried out in each study country with food retailers, distributors, marketing organisations and other institutions. These explored markets for organic products, examining issues such as labelling, price premiums, official procurement, market constraints and the potential for marketing conversion-grade products.

Focus groups were formed in each study country to explore consumer beliefs and attitudes to organic and conversion-grade products, concerns about food issues and organic purchasing behaviour.

A survey of 300 consumers in each study country was carried out by telephone in the same week using an identical questionnaire to examine beliefs and attitudes to purchasing conversion-grade products and to determine the price premiums consumers might be willing-to-pay for such products.

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The feasibility of establishing markets for conversion-grade products was assessed at the end of the project through resurveying the case study farms to establish the impact of marketing such products on budgets and to identify other constraints to conversion as well as obtaining feedback and opinion on feasibility from policymakers, representatives of farmers, conservation and food retailer groups.

Main findings and outcomes (results) or expected results

THE BASELINE PICTURE

The literature review showed rapid demand-led growth in Ireland and the United Kingdom; an underdeveloped market in Portugal; and a mature, saturated market in Denmark. In Italy, supply was growing, with 50 % of production being exported. In Portugal, supply-side problems were highlighted while, in Denmark, reversions from organic production were beginning to occur. Some obstacles were revealed by the review, particularly consumer opposition to high prices stemming from a poor understanding of the organic concept.

KEY DRIVERS OF, AND BARRIERS TO, ORGANIC CONVERSION AND MARKET DEVELOPMENT

Drivers include such factors as increasing disposable incomes, making specialist foods more affordable, leading to a more demanding and discerning consumer. However, the primary driver is health concern, having developed as a result of recent food scares. Organic farmers and food chain actors in the study countries believed a main obstacle to market development is a lack of understanding of organic production by consumers and a lack of awareness of certification schemes and their logos. In all the study countries, there were vociferous calls for more government funding for public education and, in countries where supermarkets dominate the organic market (Ireland, Italy and the United Kingdom), there were also calls for more supermarket investment in the promotion of organic brands and awareness. High organic prices were also believed to be an obstacle to further market growth. Italy and Portugal highlighted lack of market outlets and processors as primary obstacles to further market development.

FINANCIAL IMPACT OF CONVERSION PERIOD

With few exceptions, the farm case studies found that change in Family Farm Income (FFI) during the conversion period is not an obstacle to organic conversion. Although FFI during conversion is, in some cases, less than for conventional, the conversion period should not be seen as a barrier to conversion. These conclusions are heavily dependent upon the price premium assumptions used. In the case of the conversion pe-

riod, the results are extremely robust as it was assumed that no price premiums would be obtainable on conversion-grade products.

ASSESSMENT OF MARKETING CHANNELS FOR CONVERSION-GRADE PRODUCTS

Some farmers were selling products during the conversion period labelled as 'conversion-grade'. Most of this was for animal feed, but there was also small-scale marketing of other products for which there was no such regulatory derogation (i.e. fruit, vegetables and meat), as well as sales of livestock to other farms. Such products were generally marketed in the same way as equivalent organic products, although there was a trend for more direct and local marketing of conversion-grade products. The bulk of organic and conversion-grade cereal sales, in all the study countries, were made through intermediary organisations. Marketing of conversion-grade fruit and vegetables showed a definite geographical split for, in northern Europe marketing was dominated by direct selling, while in the south, it was dominated by intermediaries. There was little variation in premiums on conversion-grade products between countries with cereals and fodder obtaining the highest price premiums. Premiums for conversion-grade products other than cereals were relatively modest, although worthwhile premiums could be obtained where direct and local marketing outlets were used.

POTENTIAL FOR FUTURE MARKETING OF CONVERSION-GRADE PRODUCTS

When asked about marketing conversion-grade products, those in food retailing in all the study countries were hostile to the notion. For example, the costs associated with keeping conversion-grade products separate and establishing the concept of conversion-grade products in the minds of consumers and building brand recognition.

CONSUMER ATTITUDES TO ORGANIC AND CONVERSION-GRADE PRODUCTS

The level of awareness of the organic sector was low in all the study countries, except Denmark. The main motivation for the purchase of organic products was 'self-centred', a belief in the greater 'safety' of organic products or their 'health-giving' properties. Whilst environmental considerations were generally understood, they were subordinate to health and safety in organic purchasing decisions. The main obstacle to further development of the organic market was clearly price. There was little awareness of the conversion period, and nearly total unfamiliarity with conversion-grade products in all the study countries. There was agreement that before a market could be established for such products, major education campaigns would be needed to raise levels of understanding and awareness. Most would consider buying conversion-grade products on ethical grounds if by doing so, they could encourage more farmers to

convert to what are perceived as benign methods of production. Consumers perceived several obstacles to the establishment of a market, not least the confusion that the arrival of a conversion-grade brand might cause in a market already filled with ethical and environmental brands. However, should such a market be established, the majority who indicated that they would buy such products also indicated that they would pay a price premium, perhaps 40–50 % of the organic premium.

DISSEMINATION OF FINDINGS AND FEEDBACK FROM STAKEHOLDERS

Feedback was largely elicited from workshops of stakeholders. In the United Kingdom, discussion was dominated by the issue of market stability over the longer term, as the numbers of farmers converting would eventually fall (as in Denmark and Italy), leading to a decline in the supply of conversion-grade goods. This would affect marketing them under a conversion brand. In Portugal, the problem of low support payments to both converting and converted farmers was highlighted, together with low demand for organic products. This prompted calls for large-scale public education policies to raise awareness, also echoed in Ireland. In Denmark, it was felt that a reduction in the costs of organic products was needed to grow demand. In Italy, where there are several certification systems and more emphasis on local markets, the focus was on the failure of the European certification scheme.

Potential applications

The project methodology is applicable for studying the early period of adopting new types and methods of farming.

Innovation contribution

The project represented the first time that conversion to organic production had been studied right across the food chain.

Conclusions

The aims and objectives of the project were achieved in full. However, it was found that little research had been carried out on the financial impact of the conversion period and the technical and marketing problems faced by converting farmers. The project showed that the conversion period itself is not a significant barrier to farmers converting to organic production, provided that price premiums for produce are available. The primary motive for buying organic food is their reputed health benefits so new scientific data in support of this belief is needed as is that on the environmental benefits of organic methods of production. The continuing expansion of organic market demand will depend on increasing consumers' awareness of organic food issues.

Organic marketing initiatives and rural development

Summary

The main research focus was to analyse under which market and policy conditions emergent initiatives (described as Organic Market Initiatives, or OMIs) formed by organic farmers to collectively market, and also sometimes process, their output can be successful in economic, social and ecological terms. Additionally, the intention was to explore how such beneficial downstream impacts of organic agriculture can be further multiplied in rural regions. These questions were investigated through comprehensive surveys of OMIs in EU Member States and comparative accession and EEA states, analyses of their market environment, a study of success factors, and a detailed case study inquiry into selected local economic, social and environmental impacts of OMIs. The main conclusions were that such initiatives were growing in response to favourable market conditions, that the vertical integration along the supply chain that they provided formed a valuable contribution towards the sustainability of organic farming enterprises and rural economies.

Problem

In the late 1990s, rapid change and growth in the European market for organic products had not been accompanied by corresponding advances in the development of the supply chain, so strengthening consumer demand for organic products had not been entirely transmitted to producers, particularly for the livestock products that are characteristic of less favoured areas. The overall motivation of the project was to explore how improved marketing might help further develop the contribution of organic farming to the generation of employment in peripheral rural regions, firstly, by investigating the potential for better environmental, ethical and regional product identity of organic foods, and, secondly, by identifying and contributing to the development of marketing institutions and strategies that satisfy these growing dimensions of consumer demand.

Background and objectives

1. Provision of a broad assessment of the development of the organic market in Europe, including demand and supply factors, recent consumer trends, the interaction of market prices and production-related subsidies, initiatives in marketing, processing, distribution and promotion of organic produce, and the degree of market integration

Acronym:
OMIaRD

Project No:
QLK5-CT-2000-01124

EU contribution:
EUR 2 63 million

Duration:
38 months

Start date:
1.1.2001

End date:
29.2.2004

Framework programme:
FP5 (fifth framework programme)

Instrument:
NA

Project website:
No longer active

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2. Improvement of knowledge of success factors in marketing, through comparative narrative case study analysis in selected regions
3. In the same case study regions, identification of OMIs' contribution to sustainable rural development
4. Development of foresight through prospective investigation of future organic consumer demand trends, attitudes and behaviour, focusing on ethical, social and environmental dimensions, together with the quality and place identity of organic products
5. Consolidation and integration of research findings into recommendations for market development and policy

Methodology

Empirical methods used include postal questionnaires and personal interview surveys, Delphi inquiries, focus group discussions, and comparative case study analysis. For the latter two inquiries, interpretivist methodologies were used for analysis.

Main findings and outcomes (results) or expected results

OMIs are particularly diverse in terms of objectives, type of organisation, management and marketing activities. Those located in countries with less developed organic markets tend to be initiated by processors and consumers, whereas in stronger market environments, they tend to be initiated by farmers. The objectives tend to focus not just on improved farm income but also on social and environmental goals. Vegetables, cereals and fruits are the most commonly sold products, followed by the two processed product groups of milk and meat. Many sell a significant proportion of their products within their home region but outside sales are also quite common. OMIs are generally small and regionally focused, but 55 % of their products are sold through multiple retailers.

Analysis of the market environment faced by OMIs shows differences in the market situation and prices between countries but, overall, the share of organic in total food production is still quite low, and a major proportion of the organic food produced still has to be sold on conventional markets without price premiums. There were significant differences in overall market shares of organic products between countries: Switzerland and Denmark had market shares of 3.7 % and 3.5 % respectively, while Austria and Germany showed between 2 and 2.5 %, but all the other countries surveyed had market shares below 1 %.

A three-round Delphi expert survey, conducted in 18 countries, expected annual growth for coming years to vary among countries and product groups, with the lowest rates anticipated in Denmark (approximately 2 %) and for cereal markets, and the highest rates in Germany and the

United Kingdom (7–8 %) and for meat and convenience products. Experts agreed that organic marketing structures need to improve in order to absorb expected increases in both supply and demand; furthermore, a broader product range could help stimulate demand and that new consumer groups should be targeted.

Internal business-related factors are more decisive for OMI's success than external, context-related factors, although in some cases external factors (such as niche demands, policy support measures) can improve potential. It is mainly the vision of founders, their strategic options and their management choices that primarily determine an OMI's success. However, those aiming for social or environmental objectives tend to underestimate financial needs, and those focusing mainly on economic objectives tend to neglect both human relations and regional networking. The most challenging management issues are improving supply policies, keeping logistic costs to a minimum and avoiding over-reliance on public funding. A final key success factor for an OMI is networking; along the supply chain and also in the region.

The impact of OMIs on rural development in four case study regions showed that social and environmental (and, sometimes, also political) objectives are achieved effectively, though on a rather small scale, for example, by enhancing the status of farming, preventing abandonment of the countryside and improving the image of the region. Further potential to contribute to sustainable rural development is far from being realised. A necessary condition for joint action by farmers to improve quality in the marketing and processing of their products is financial support, but is not sufficient: for consistent and sustained development, ideas and effort must come from organic producers themselves and the communities in which they are embedded.

Qualitative consumer research distinguished three main groups of consumers of organic food: regular consumers, who have a generally higher awareness of environmental issues; a large majority of occasional consumers; and non-consumers. Organic products are associated mainly with health, environmental and animal-welfare friendliness, and also representing a positive, informed lifestyle that is generally desirable for the whole of society. Negative associations relate to the high price of organic products, their occasional poor appearance, and limited availability. Absolute price seems to be less important in assessing organic prices than the price-performance ratio, whose low rating implies that the value of organic quality is not generally discerned or accepted. Smaller retail outlets are generally favoured because of the personal contact and trust. However, both regular and occasional consumers are aware that making organic products available in supermarkets is necessary and inevitable if they are to reach more people.

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Selected publications:

Hamm, U., Gronefeld, F., Halpin, D. (2002), *Analysis of the European Market for Organic Food*, OMIaRD Series Vol. 1, School of Management and Business, Aberystwyth.

Sylvander, B., Kristensen, N. H. (2004), *Organic Marketing Initiatives in Europe*, OMIaRD Series Vol. 2, School of Management and Business, Aberystwyth.

Midmore, P., Foster, C., Schermer, M. (2004), *Organic Producer Initiatives and Rural Development — Four European Case Studies*, OMIaRD Series Vol. 3, School of Management and Business, Aberystwyth.

Zanoli, R. (ed.) (2004), *The European Consumer and Organic Food*, OMIaRD Series Vol. 4, School of Management and Business, Aberystwyth.

Hamm, U., Gronefeld, F. (2004), *The European Market for Organic Food: Revised and Updated Analysis*, OMIaRD Series Vol. 5, School of Management and Business, Aberystwyth.

Schmid, O., Richter, T., Hamm, U., Dahlke, A. (2004), *A Guide to Successful Organic Marketing Initiatives*, OMiARD Series Vol. 6, Institute of Organic Agriculture, Frick, Switzerland (FiBL).

Schmid, O., Sanders, J. and Midmore, P., eds. 2004. *Organic Marketing Initiatives and Rural Development*, OMiARD Series Vol. 7, School of Management and Business, Aberystwyth.

This consumer-focused study provides arguments for adopting different strategic approaches according to each level in the supply-chain or to target market segments. Main barriers should be overcome by means of an appropriate marketing strategy and, in particular, increased communication effort.

A scenario analysis describing the possible future environment for OMIs was conducted to develop appropriate recommendations. Scenarios involving liberalisation in the food market and a reduction in regionalisation would present the strongest challenges; on the other hand, increased regionalism within an effective regulatory framework, even with ongoing liberalisation, would strengthen OMIs' activities.

Potential applications

The output of this project informed both the development of the EU Action Plan for Organic Farming and contributed to redrafting of Council Regulation (EC) No 1698/2005 ⁽¹⁾ which broadened the framework of support for quality production and processing of agricultural produce.

Innovation contribution

Publications have been influential in providing market intelligence at overall level. The project also produced a handbook on marketing for organic producer groups.

Conclusions

The project achieved all its objectives. Simple options that OMIs should consider include: improved decision processes and management skills; realistic finance policies; cooperation with conventional agriculture and other supply chains as well as with organic food and farming organisations; improved vertical networking along supply chains; and horizontal networking in regions.

Policy support measures are also recommended to improve market transparency, support for knowledge transfer, financial aids for initiatives, better consumer information and education, more public procurement of organic products and facilitation of cooperation and networking.

The analysis showed that many OMIs, by improving their business activities and the environment in which they operate, can go much further in achieving social and ecological goals, and can become a model for sustainable rural development.

1 Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), OJ L 277, 21.10.2005, p. 1.

Recommendations for improved procedures for securing consumer oriented food safety and quality of certified organic foods from plough to plate

Summary

The Organic HACCP project reviewed studies of consumer concerns and preferences in relation to organic production systems and collected information about typical production chains for seven commodities — milk, wheat bread, cabbage, tomatoes, eggs, apples and wine — in regions across Europe.

For each of the seven commodities, the following seven criteria were analysed:

- ▶ microbial toxins and abiotic contaminants;
- ▶ potential pathogens;
- ▶ natural plant toxins;
- ▶ freshness and taste;
- ▶ nutrient content and food additives;
- ▶ fraud;
- ▶ social and ethical aspects.

The information was used to identify Critical Control Points (CCPs), defined as the steps in supply chains where the qualities of the final product can be controlled most efficiently. CCPs were identified using methods developed for Hazard Analysis by Critical Control Points (HACCP), which is a standard procedure to prevent food safety risks.

The work identified steps in the production chains that are particularly important in order to control the qualities of the final product and what can be done at each step in the chain.

This information was then used to build a database listing CCPs in the examined chains, and produce a series of 14 four-page leaflets, each of which were published electronically in six languages and are available on the web page (<http://www.organichaccp.org>).

Acronym:

Organic HACCP

Project No:

QLK1-CT-2002-02245

EU contribution:

EUR 432 430

Duration:

24 months

Start date:

1.2.2003

End date:

31.1.2005

Framework programme:

FP5 (fifth framework programme)

Instrument:

Concerted Action

Project website:

<http://www.organichaccp.org/OrganicHACCP.asp> (active)

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Problem

Organic food is usually sold at a premium price, and consumers of organic products tend to have certain expectations of the products, which justify them paying the higher price compared to corresponding conventional products. Before 1992, when organic food was a very exclusive niche product, in each country, the communities of producers and consumers were small and close-knit, ensuring efficient communication between consumers and producers on expectations and feasibility of meeting those expectations.

However, due to the rapid growth in organic production in the EU 1992–2002, the numbers of both consumers and producers of organic products increased by double digit percentages in every one of those years, resulting in a situation where most consumers and producers were relatively inexperienced, in particular regarding familiarity with the other group (consumers with producers and vice versa). Due to this, it often happened that both consumers and producers felt let down by the other side: producers were perceived as not trying to live up to consumer expectations and consumers were perceived as not appreciating the efforts by the producers. This resulted in several cases of negative media coverage and was one of the reasons for the reduction in the growth rates for organic production which occurred at this time.

Background and objectives

This project was designed to develop and provide practical tools and information for both consumers and producers relevant to their own situation.

The background state of the art was, on one hand, social science research on consumer expectations and attitudes providing the tools for analysis of the views of the organic consumers and, on the other hand, the already well-established method known as HACCP for management of safety issues in food production.

The objectives were the following.

1. To provide a differentiated overview of existing studies regarding consumer concerns — needs, attitudes and responses with regard to food safety and quality — and criteria with regard to the safety and quality of organic foods within the European region, and a conceptual framework regarding the perspectives of future consumer research in this field.
2. To establish a database of existing procedures for current production management and quality assurance related to the chains of production, processing, labelling and distribution of certified

organic foods and relevant control points for seven selected organic food production chains, prepared with data from each of four to five European regions, in a manner that would allow for expansion to include additional commodity groups and updated procedures.

3. To undertake systematic analyses of each selected commodity chain using the procedures developed for Hazard Analysis by Critical Control Points (HACCP), for each of the seven aspects of safety and/or quality: microbial toxins and abiotic contaminants; potential pathogens; natural plant toxins; freshness and taste; nutrient content and food additives: fraud; and social and ethical aspects.
4. To assess the adequacy of current procedures for production management and control regarding each identified CCP in the light of consumer criteria regarding the safety and quality of these products and to produce a series of recommendations to participants in these commodity chains.
5. To formulate and disseminate targeted recommendations to the four groups of stakeholders involved (consumers and their organisations; wholesale and retail distributors, producers; regulating bodies and safety authorities; researchers and research policymakers) with regard to measures that could improve the safety and quality of certified organic foods with specific regard to meeting consumer criteria of assessment.
6. To identify all key areas with regard to the quality and safety of the foods examined, in which the current state of the art does not yield a basis on which practical recommendations can be grounded due to insufficient data or knowledge at the present time and, accordingly, to formulate recommendations to researchers, research policymakers and other stakeholders regarding issues that should be addressed in future research programmes. These recommendations will target agriculture in general, as well as organic production in particular, using the system of certified organic production as a well-defined model for any system that aims at simultaneous improvements of environmental impact, food quality, food safety and economic viability of local production.

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Methodology

Consumer perceptions of organic products were analysed based on literature studies and this analysis was published as a report, which can be downloaded from the website.

For each of the seven commodities — milk, wheat bread, cabbage, tomatoes, eggs, apples and wine — three to six chains of production and distribution representing different regions in Europe and different scales of production were analysed by interviewing representative participants

at each step from producer to retailer, using the same methods as are used for the safety management procedure called HACCP.

However, the analysis comprised seven criteria — microbial toxins and abiotic contaminants, potential pathogens, natural plant toxicants, freshness and taste, nutrient content and food additives, fraud, and social and ethical aspects — of which only the first three relate to safety, while the other four are critical criteria for consumer trust, despite not representing any health threat to the consumers. The information from the interviews was used to populate a database, where the critical issues and control points for each chain are summarised. The database can be accessed and explored from the website.

The outcome of these analyses were used to compile 14 leaflets covering all the commodities and criteria, in a format that can be read and used directly by consumers and producers: these 14 leaflets were translated into six languages. All of these leaflets can be downloaded from the website.

Main findings and outcomes (results) or expected results

- ▶ Consumers of organic products value the same criteria as consumers of conventional products, but prioritise differently, in particular regarding the ethical and moral aspects of the production methods.
- ▶ In most analysed chains, elements were found where small/inexpensive changes could result in substantial improvements in terms of consumer satisfaction, either directly (consumers would notice the improvement) or indirectly (the risk of consumers becoming disappointed with something would be reduced).
- ▶ The most common potential improvement was to improve the communication between the consumer and the producer about who they are and what they desire, thus improving trust and, where relevant, quality. For example, providing the consumer with contact details for the producer, to demonstrate that the producer is interested in feedback about the quality of the product, because they want to improve it further if possible.
- ▶ The topic with the greatest need for research and other attention is authenticity; the expansion and industrialisation of organic production requires a much more robust approach for the detection of fraud and errors than previously, and neither legislation nor science have been able to keep up with the needs in this area.

Potential applications

The leaflets supplemented with guidelines on the website for the practical establishment of quality control procedures in individual enterprises

allow both producers and consumers to implement many important improvements immediately.

The chain-based analysis approach and the review of consumer perceptions are useful tools for further research and development in this area.

Innovation contribution

Most of the recommendations to producers imply the incorporation of innovative concepts into existing and future production concepts, allowing a large number of producers, mostly SMEs, to improve their commercial achievements.

Conclusions

The project fulfilled its aims, which specifically included a comprehensive analysis of the problems and needs of the area and recommendations for future research. These recommendations are detailed in the conclusion document from the final workshop available on the website. The overall conclusion was that efficiency of the procedures for certification and inspection in organic supply chains is the one key topic where new, independent research and development is urgently needed.

Further development of organic farming policy in Europe, with particular emphasis on EU enlargement

Acronym:
EU-CEEOPF

Project No:
QLK5-CT-2002-00917

EU contribution:
EUR 2 020 452

Duration:
36 months

Start date:
1.1.2003

End date:
30.6.2006

Framework programme:
FP5 (fifth framework programme)

Instrument:
NA

Project website:
No

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Summary

This project examined the future development of organic farming policy in Europe. The primary concern of the project was to guide the further development of European organic farming policy, including policy instruments and institutions that address the full range of conditions necessary for organic growth. Recommendations for the further development of organic farming policy was based on analysis of (a) the development of organic farming in selected EU countries under implementation of the EU Agenda 2000 and (b) the pattern of development of organic farming in Central and Eastern Europe (CEE) accession countries. The relationship between results from the two analyses assisted in determining the impacts of EU enlargement on organic farming development in EU and CEE nations. Recommendations outline further developments to organic farming policies to promote organic farming in the EU.

Problem

Addressing the issue of complementarity between the development of organic farming in western European and CEE accession countries requires a detailed knowledge of present conditions at both the production and the policy level. At the production level, it is necessary to gather data on the structure and development of the organic farming sector. At the policy level, it is necessary to know the existing policy measures and their impacts on that structure. This will assist in identifying policy instruments that are 'successful' or have the desired impacts. Having decided what is 'successful', from a scientific perspective 'desirable', one must also be concerned with the political 'acceptability' of organic farming relevant policy instruments and the 'opportunities' available for reform of these instruments. In combination, an accurate picture of these two levels will allow national and EU level policymakers to better define the parameters for the further development of European Organic Farming Policy. Policymakers will be able to set objectives for desired farm structures and patterns of production as well as be able to elaborate organic farming policy instruments that are likely to succeed in achieving the desired restructuring.

Background and objectives

The project identified how the complementary development of organic farming in both existing EU Member States, Switzerland, and in Central and Eastern European (CEE) accession countries can be fostered through policy design and innovation. This project, covers all EU Member States ⁽¹⁾, Switzerland and CEE accession countries ⁽²⁾; however, it concentrates detailed research efforts on only a selected number of countries. Of the western countries selected for detailed analysis, Austria (AT), Denmark (DK) and Switzerland (CH) are included as representatives of those states with more developed organic farming relevant policies. Germany (DE) is included due to it being the largest organic market in Europe. Italy (IT) and the United Kingdom are included as representatives of those countries at a stage of dynamic development. In addition, detailed analysis is also conducted in those CEE states that are part of the first 'accession wave' ⁽³⁾ (i.e. Czech Republic (CZ), Estonia (EE), Hungary (HU), Poland (PL) and Slovenia (SI)).

Whilst the different conditions for the growth of organic farming in both CEE and EU states has been noted (Lampkin and Midmore, 2000) the relationships between these development patterns has not been systematically considered. With regard to the enlargement process, the two very different patterns of organic farming development are combined under a new and unique market and policy framework. To ensure further growth in organic farming — achieved through the investments made by political, market and farm actors in both sets of countries — a detailed analysis of activities in both sets of countries is required.

The overall goal of defining parameters to guide the further development of European organic farming policies can be divided into the following objectives:

1. evaluate the overall impact of implementing organic policy measures on organic farming in EU Member States and Switzerland;
2. evaluate the regional/spatial impact of existing and potential organic farming relevant policies on farm structures and the pattern of production in EU Member States and Switzerland;
3. describe the development of organic farming and analyse its relationship to the policy and regulatory environment in CEE accession countries;
4. analyse the extent of development and implementation of regulations for organic farming as well as the domestic and export markets for organic products in CEE accession countries;

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1 EU-15.

2 Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, Slovakia.

3 Cyprus is also part of those countries that belong to the first accession wave but was not included in this project as it is not situated in central and eastern Europe and organic farming has no significance to the agricultural sector.

Selected publications:

Stolze, M., Lampkin, N., (2009), 'Policy for organic farming: Rationale and concepts', *Food Policy*, 34, pp. 237–244.

Häring, A.-M., Vairo, D., Dabbert, S., Zanolli, R. (2009), 'Organic farming policy development in the EU: What can multi-stakeholder processes contribute?', *Food Policy*, 34(3), pp. 265–272.

Offermann, F., Nieberg, H., Zander, K. (2009), 'Dependency of organic farms on direct payments in selected EU Member States: Today and tomorrow', *Food Policy*, 34(3), pp. 273–279.

Moschitz, H., Stolze, M. (2009), 'Organic farming policy networks in Europe: Context, actors and variation', *Food Policy*, 34(3), pp. 258–264.

Moschitz, H., M. Stolze (2010), 'The influence of policy networks on policy output — A comparison of organic farming policy in the Czech Republic and Poland', *Food Policy*, 35(3), pp. 247–255.

Moschitz, H. (2009), 'Moving on — European organic farming movements between political action and self-reflection', *International Journal of Agricultural Resources, Governance and Ecology*, 8(5), pp. 371–387.

Vairo, D., Häring, A.-M., Dabbert, S., Zanolli, R. (2009), 'Policies supporting organic food and farming in the EU: assessment and development by stakeholders in 11 European countries', *Journal of International Food and Agribusiness Marketing*, 21, pp. 214–217.

Zander, K., Nieberg, H., Offermann, F. (2008), 'Financial relevance of organic farming payments for western and eastern European organic farms', *Renewable Agriculture and Food Systems*, 23(01), pp. 53–61.

Lampkin, N., Stolze, M. (2006), 'European Action Plan for Organic Food and Farming', *Law, Science and Policy*, Vol. 3, pp. 59–73.

5. model and analyse the farm level economic impacts of organic farming policy and Agenda 2000 implementation as well as the EU enlargement in selected European countries;
6. analyse the capacity of relevant policy networks to establish and operate an 'organic farming Action Plan' process and the acceptance by policy actors of 'successful' or 'potentially successful' organic farming policy instruments.
7. involve CEE, EU and EU Commission and national policymakers in identifying the parameters that could guide the further development of European organic farming policy post EU-expansion in current EU Member States, Switzerland and CEE accession countries in a complementary manner.

Methodology

To achieve the project's aims, the project applied the different methodologies now summarised.

IMPACT OF IMPLEMENTING ORGANIC POLICY MEASURES ON ORGANIC FARMING IN EU MEMBER STATES AND SWITZERLAND

The evaluation of organic farming policy impacts builds on the approach defined in the MEANS framework (European Commission, 1999) and was carried out by (i) using the Nominal Group Technique (NGT) in expert panel workshops and (ii) a documentary analysis with the midterm review of the regional Rural Development Plans as the major source. Finally, a multi-criteria analysis technique was used in combination with the risk analysis tool @RISK to define the cost effectiveness of the organic farming and agri-environmental policies.

ANALYSIS OF THE EFFECTS OF AGENDA 2000 ON ORGANIC FARMING DEVELOPMENT AT A REGIONAL LEVEL IN EU MEMBER STATES AND SWITZERLAND

Based on collected statistical data from organic and conventional farms in the EU, the influence of structural factors on organic farming uptake, the effect of the structure of regional cropping on the distribution and growth of organic farming across EU, and the influence of national/regional agri-environment policies on the distribution of organic Utilisable Agricultural Area (UAA) was analysed using following approaches:

- ▶ analysis of land-use specialisation in EU countries by crop type and through time;
- ▶ analysis of barycentre variation in organic production;
- ▶ analysis of the growth components of organic UAA, through the shift-share analysis focusing on the effects of crop structure and country/region-specific factors;

- analysis of the spatial relationship between organic UAA and specific explanatory variables.

DESCRIPTION OF THE DEVELOPMENT OF ORGANIC FARMING AND ANALYSIS OF ITS RELATIONSHIP TO THE POLICY AND REGULATORY ENVIRONMENT IN CEE ACCESSION COUNTRIES

The development of organic farming and the policy environment in CEE accession countries was documented on the basis of a survey of representatives of the government, NGOs, farmer associations and control/certification bodies.

ANALYSIS OF THE DEVELOPMENT AND IMPLEMENTATION OF ORGANIC REGULATIONS AND DOMESTIC AND EXPORT MARKETS FOR ORGANIC PRODUCTS IN CEE ACCESSION COUNTRIES

The implementation of organic regulations was analysed by (i) a documentary analysis of organic regulations in the CEE countries (CEEC) and the EU regulations (Council Regulation (EEC) No 2092/91 and amendments ⁽⁴⁾) as well as private standards. Furthermore, semi-structured interviews with the key actors responsible for the development and implementation of organic regulations and standards were conducted.

The analysis of the market for organic food products in the New Member States as well as candidate countries from Central and Eastern Europe (CEE NMS), was based on the supply balance sheet approach developed by Hamm and Gronefeld (2004).

FARM LEVEL ECONOMIC IMPACTS OF ORGANIC FARMING POLICY AND AGENDA 2000 IMPLEMENTATION AND EU ENLARGEMENT

As Farm Accountancy Data Network (FADN) data for the new Member States was scarce, typical farms have been modelled for 2003 based on the concept developed by the International Farm Comparison Network (IFCN). In order to gain a deeper insight into specific restraints, a survey of 50 farms was conducted in 2004 by means of face-to-face interviews.

ANALYSIS OF POLITICAL INSTITUTIONS RESPONSIBLE FOR THE ELABORATION OF POLICY MEASURES RELEVANT TO ORGANIC FARMING AT EU AND NATIONAL LEVEL IN SELECTED EUROPEAN COUNTRIES

An analysis of the development of political institutions involved in organic farming policy elaboration applied the methodological concept of

Hrabalova, A., Zander, K. (2006), 'Organic beef farming in the Czech Republic: structure, development and economic performance', *Agricultural Economics* (Czech), 52(2), pp. 89–100.

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Books

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4 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1–15.

political institutions by Michelsen et al. (2001) and Michelsen (2002). It considers two theoretical concepts:

- (a) the concept of institutions playing an essential role in the policy process; and
- (b) the concept of societal domains in which institutions operate.

Network analysis was used to investigate the political structures of organic farming in 11 countries. In this network, the collaboration and contacts between the network actors on issues of organic farming policy were investigated.

IDENTIFICATION OF THE DIMENSIONS OF A NEW EUROPEAN ORGANIC FARMING POLICY POST EU-EXPANSION

A structured form of participation of, and consultation with, policy stakeholders was developed to contribute to a scientifically based formulation of policy recommendations at the national and EU level. Stakeholder involvement was achieved through a series of workshops (national and EU level). These workshops were designed as to facilitate policy learning among stakeholders of a country and across countries in the European countries involved.

Main findings and outcomes (results) or expected results

The documentation of organic farming policies implemented in the EU-15 and Switzerland in the period 1997–2003, and the evaluation of policy outputs, results and impacts indicates that a very diverse range of measures have been put into practise in different countries, particularly in the context of rural development and organic action plans. It is difficult to make a direct link between the policies implemented, the development of the organic sector and the impact of broader policy goals such as the environment and animal welfare in these countries, because of the wide variety of organic farming systems and policy measures used in combination. Exogenous factors, such as exchange rates, food safety and animal health scares, and changes in general agricultural policy may have more significant impacts on the development of the organic sector than specific policy measures. The complex nature of organic farming policy evaluation suggests that direct evidence-based assessments may be difficult to achieve. Approaches based on expert judgement may permit a more comprehensive assessment.

The analysis of the effects of Agenda 2000 on organic farming development at a regional level in the EU-15 and Switzerland show an organic farming sector that, in the main, mimics the spatial localisation of conventional farming, with only a few differences. Spatial dependency between regions regarding their share of organically managed land

seems to be an important factor influencing the spatial distribution of organic farming. The results of shift-share analysis applied to the period 1998–2003 show very different trends in two sub-periods: 1998–2001 is characterised by greater growth; 2001–03 by a slowing down.

The first period is characterised by growth differentials which were faster in some countries, above all the Mediterranean countries, where organic farming had a greater boost and greater development. Grassland, which is the most representative crop in European organic farming, has values tending towards positive in the northern countries and negative in the Mediterranean area. The second period differs from the first in that the growth rates are more balanced, with a slowing down in all the Mediterranean countries except Portugal. There is a clear positive relationship between the share of organically managed land and the share of organically managed land financially supported by agri-environment programmes. However, the lack of correlation between the magnitude of economic support to organic farming per hectare and the share of organically managed land in the total UAA seems to suggest that farmers decide to convert on the basis of a broader set of motivations.

In the 10 CEE NMS, the accession process has been a strong incentive to adopt organic farming policies. Most of the legislation concerning organic farming was put in place during the pre-accession period and no major changes had to be made to adopt EU regulation on organic farming policy after accession: all 10 CEECs studied have implemented the legislation, laid down general rules for organic farming, and harmonised with EU legislation. In eight of the 10 CEECs (all except Bulgaria and Romania), area support payments for organic farming were implemented before EU accession and in all new Member States, organic farming has been supported by Rural Development Plan (RDP) agri-environment schemes since 2004. All 10 CEECs have an established inspection and certification system, which, in some countries, has recently been improved. Area payments for organic farming were the most important support measure and the main reason for the increase in organic farming area. Processing and marketing of organic products are particularly weak, and consumer awareness is low.

Organic markets in the CEE NMS are at an initial, immature state of development. There is a general lack of reliable data on the market for organic food in the CEE NMS which hinders the development of effective marketing strategies and the definition of policy goals in order to ensure the balanced development of organic farming in the CEE NMS in relation to the EU-15. The development of the organic food market in the CEE NMS and the EU-15 is disproportionate in relation to the size and structure as a result of both supply and demand factors. Whilst the existing organic farming support system stimulates the development of organic production in the CEE NMS, there is a lack of policy instruments

to encourage the development of the domestic market and, in particular, the consumption of organic food.

The results from the farm survey, FADN data and typical farms models indicate that the economic situation of organic farms is generally satisfactory. The share of the common agricultural policy (CAP) first pillar payments in gross output is higher in conventional than in organic farms in nearly all countries. The importance of extra support payments for organic farming for the farms' financial results differs between the countries analysed. The share of extra support for organic farming in gross output ranges from 4 to 6 % in the EU-15 study countries, while it was between 3 and 26 % in selected NMS before accession. Farmers' assessments of the current level of support for organic farming were mixed, with approximately half saying that it was satisfactory or even very satisfactory, while the other half thought it unsatisfactory. Marked differences in the level of support for organic farming and in other direct payments may influence the competitiveness of organic farms on international markets. The Agenda 2000 reform had only a marginal effect on organic farms.

The analysis of political institutions responsible for policy measures relevant to organic farming at EU and national level in selected old and new Member States shows that, although developing under one common agricultural policy, there are different stages of development of both the organic sector and related policies in Europe. The organic farming policy networks identified can be differentiated by old and new EU Member States but not according to the different sizes of the countries' organic sectors. In the context of general farming policy, organic farming organisations have a fairly weak position whereas the agricultural ministries have a high influence on both general and organic policy domains in all countries. At the EU level, organic farming as a policy domain developed only recently when the CAP became more sensitive to environmental issues. A network of organic farming policy has not yet been established at the EU level, and organic and general farming policies are perceived as two different policy domains. While the IFOAM EU Group is recognised as the representative for organic farming issues at the EU level, it has a limited reputation for general farming policy. Environmental and consumer interest groups are not highly involved in organic farming policy and the most important general farmers' union, the Committee of Professional Agricultural Organisations (COPA), also shows limited activity for organic farming. We conclude that organic farming policy actors must be taken into consideration at both the macro- and micro-level of policy analysis (i.e. account must be taken of the broader political and socio-economic structure of organic farming in the countries surveyed and of the mutual influence of individual actions and organic farming policy networks).

A broad political debate among stakeholders in Europe was initiated through a specifically developed bottom-up approach to stakeholder involvement in agricultural policy design. This consisted of a series of three workshops, which were a first step to policy learning, innovation and transfer for the organic farming sector in the EU. A range of policy instruments for the long-term development of organic farming were developed and disseminated widely. Furthermore, three discussion papers outlining policy recommendations for the further development of organic farming policy were disseminated to all participants in the three workshops as well as through the most common dissemination channels for the organic farming sector in Europe. These discussion papers fed into the discussion on the development of the national Rural Development Plans in the second half of 2005.

Potential applications

- ▶ Further development of organic farming policies in the EU
- ▶ Organisation of stakeholder participation processes in EU projects and in policy elaboration

Innovation contribution

- ▶ The project was innovative as, for the first time, a comprehensive review and analysis of the organic farming sector and the organic farming policies in the CEE Member States was conducted.
- ▶ For the first time, land-use data were analysed with statistical models to investigate the possible effects that location factors may have in organic farming uptake, and measures regional changes in organic farming growth.
- ▶ The project furthermore succeeded in a systematic analysis of the organic farming policy institutions on the basis of the network analysis approach.
- ▶ A particular strength of the project was the interaction with stakeholders and policymakers at national and EU level.

Conclusions

The project achieved its aims. The conclusions drawn from the project are now summarised.

The policies for organic farming developed in Europe since the late 1980s have been developed in the context of production surpluses, loss of biodiversity due to agricultural intensification and a heavy reliance on commodity support for mainstream agriculture. The market for organic products was initially developed as a means to support the financial viability of farmers trying to deliver broader objectives.

Approaching the next European policy planning period (2014–20), the circumstances that have influenced organic farming policy development over the last two decades are very different. Widespread policy support has reduced, and in some case eliminated, the need for producers to rely on the market while, at the same time, the success of the organic market has generated its own challenges with respect to organic principles and values. Commodity support has been decoupled and increasingly these resources are being diverted to agri-environmental and rural development programmes. Surpluses, as a problem, have been replaced by renewed concerns about food security. Climate change now tops biodiversity and pollution as the key environmental concern. At the same time, the global economic downturn is severely constraining market growth and government ability to fund support programmes of this type.

The transition pathway for organic farming development will need to recognise that the international trade in organic products is already reality while, at the same time, organic agriculture could add an important economically, culturally, ecologically and value-based plus to the trend of European agriculture's role in empowered local economies.

There is an European dichotomy in (i) the organic production structure and (ii) the level of organic farming development. For example, while in the CEE NMS, consumer information, domestic market development, environmental/organic capacity building and educational programmes for farmers on environmental issues are priority issues that should be addressed through organic farming policies, in countries like Denmark and Germany, the challenges of a post-productionist agriculture and global trade are gaining importance.

With the ongoing growth of the organic sector and the growing relevance of international trade in organic products, the field of organic certification has become a maze of competing labels, different private and public standards, in addition to European law. This diversity reflects the specific conditions for organic operators in countries or regions but can also lead to confusion for both producers and consumers, may create a variety of costs, and could increase the risk for fraud. As the basis of the current certification model was developed decades ago when organic farming was in its early stages and the level of international trade was low, innovative and efficient certification approaches need to be developed without making cuts in certification quality.

With the focus on climate change, there are now strongly competing claims as to which farming systems deliver most in terms of reducing greenhouse gas emissions. Organic farming's reduced productivity and reliance on livestock as an integral part of the system is seen by some as a weakness, but by others as a way of significantly reducing fossil energy inputs, reducing nitrous oxide emissions associated with manufacture and use of nitrogen fertilisers and providing opportunities for soil or-

ganic carbon sequestration. At the same time, other environmental concerns still need to be part of the equation. More robust evidence-based assessments of these issues are needed to help identify the relative merits of different approaches and optimal future development paths.

The renewed focus on food security is also perceived as a key challenge for organic farming with its lower yields, at least in an industrialised farming context. On the one hand, increased food production is seen as essential, with GM crops and more intensive methods playing a significant role. However, there is also a need to examine how what is currently produced is actually utilised. Does it make sense to produce more cereals to feed to livestock in competition with human food needs? In many cases, grass-fed livestock can make better use of the biomass production potential of land, so integrated organic systems may exhibit similar total productivity to conventional production systems, while being less dependent on inputs from non-renewable resources. In developing countries, the potential of agro-ecological approaches such as organic farming to directly enhance food security has also been recognised.

Harmonised and standardised procedures for evaluation of plant protection products, fertilisers and soil conditioners for use in organic agriculture

Acronym:

ORGANIC INPUTS EVALUATION

Project No:

QLK5-CT-2002-02565

EU contribution:

EUR 310 393

Duration:

36 months

Start date:

1.1.2003

End date:

31.12.2005

Framework programme:

FP5 (fifth framework programme)

Instrument:

Concerted Action

Project website:

<http://www.organic-research.org/organicinputs.html> (active)

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Summary

The 'Organic Regulation' ⁽¹⁾ establishes the regulatory framework for organic farming in the European Union. Annex IIA of this Regulation lists the products which are allowed for use as fertilisers and soil conditioners (F&SC), while Annex IIB lists the allowed plant protection products (PPP). Article 7 contains the criteria for amendments to the Annexes. The ORGANIC INPUTS EVALUATION project has made an inventory of the current implementation of these regulations in various EU Member States and elaborated proposals for improvements of Article 7, and procedures for their implementation.

Concerning the current regulation of PPP, most of the products listed in Annex IIB are available for use only in some EU countries. The requirements for pesticide registration often pose insurmountable hurdles for these products, because these are less effective than conventional PPP, or because their market is too small to justify the costs of dossier preparation. On the other hand, several countries have established simplified procedures for certain low-risk products, but these are very different in each case. Many of the PPP allowed for organic farming are currently (March 2006) subject to re-evaluation under Council Directive 91/414 ⁽²⁾. If this is successfully completed, their availability may become more homogenous across the EU. However, there is also a danger that they may not complete re-evaluation, particularly for the financial reasons outlined above. One major discussion point is copper fungicides, which are perceived as undesirable in organic farming. As a corollary, producers in some countries fear that they might be deprived of copper fungicides before efficient alternatives are available. Another discussion point is inert ingredients of PPP. Many organisations believe that these should also comply with organic farming regulations. However, there are no generally accepted evaluation criteria for inert at present.

1 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1-15.

2 Council Directive 91/414 of 15 July 1991 concerning the placing of plant protection products on the market, OJ L 230, 19.8.1991, p. 1.

Concerning the current regulation of F&SC, nutrient supply is highly correlated with the stocking rate, which tends to be lower in southern European countries than in the countries of northern Europe. The range of products available for use is more homogeneous than in PPP. The only exception is fertilisers made from slaughterhouse residues, which are prohibited or severely restricted in many countries since the BSE crisis. One major discussion point is the impact of the Nitrate Directive ⁽³⁾ for the protection of vulnerable zones, which has been interpreted as being relevant to all organically managed land.

Further discussion points concern the lack of an official definition of factory farming and whether the composition of substrates should be regulated.

Finally, concerns were frequently expressed that fertilisers such as manure and composts might be contaminated with GMO in the future. The following changes to Article 7 are proposed.

- (i) To replace the current evaluation criteria (Section 1(a) and (b)) by a more complete set of criteria covering all aspects relevant for organic farming. Some of these criteria are new in Regulation (EEC) No 2092/91, but consistent with other regulations on organic farming.
- (ii) To restrict the 'non-contact clause' (Section 1(a)), which currently applies to all new PPP, to synthetic products which come into contact with edible crop parts.
- (iii) To allow the use of products of microbial origin, provided that they fulfil the evaluation criteria.
- (iv) To expand the scope of the evaluation criteria and Annex II to cover also products used for 'other purposes related to crop production', such as plant strengtheners, for which there is no common definition or regulation in the EU. This will help to close gaps and prevent disparities between countries.
- (v) To remove the 'traditional use clause' from Article 7 (Section 1(a)) and to consider traditional use together with other criteria during evaluation. To put the new evaluation criteria into practice, the project developed a 'criteria matrix'. The criteria matrix contains detailed questions relating to each of the criteria in Article 7, and provides guidance for applicants and evaluators. Factual information has to be provided on the application form and this is then evaluated against organic farming principles on the evaluation form. In case studies, hydrolysed proteins (nitrogen fertilisers) and Spinosad (insecticide) are evaluated within the criteria matrix. These case studies illustrate how to use the matrix. They are also interesting because

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3 Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources, OL L 375, 31.12.1991, pp. 1–8.

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Selected publications:

Baker, B. (2004), 'A promising molluscicide — iron phosphate', *Ecology and Farming*, 35:8 (B. Speiser assisted in the writing of this article; see acknowledgement).

Canali, S., Di Bartolomeo, E., Nisini, L. (in press), 'Produzioni vegetali ed allevamento: caratterizzazione dei sistemi colturali mediante indicatori agroambientali', Povellato, A. (ed.), *La zootecnica biologica bovina e suina in Italia — Tecniche e mercato*, Chapter V, INEA.

there is a public debate concerning both of these products and whether they should be allowed in organic farming. The project proposes that an expert panel assists in the evaluation process. This expert panel is, or is part of, the 'independent expert panel for technical advice' cited in Action 11 of the EU Action Plan for Organic Food and Farming. It is further proposed that Member States establish similar, national panels to ensure stakeholder involvement.

The following procedures are proposed.

- (i) Application: The Commission tables requests for amendments to Annex II. A request is generally submitted by a Member State (applicant) that needs to provide all the information required to evaluate the application. It is recommended that the Member State discusses the request with its national consultation group before application.
- (ii) Review: The expert panel reviews the application for correctness. In case of major disagreement with the applicant, it should discuss the issue with the applicant. The aim is to reach a high degree of consensus regarding the facts underlying the application. Whenever an application is likely to meet strong opposition during Member State evaluation, the expert panel should consider whether appropriate specifications/restrictions might alleviate the opposition. When the application is reviewed, the expert panel makes a provisional evaluation.
- (iii) Evaluation: Member States evaluate the reviewed application, using such national consultation and expertise as they think fit.
- (iv) Final recommendation: The expert panel reviews all Member States' evaluations with special emphasis on key areas of difference. In the event of a wide discrepancy of national evaluations, the Commission may decide to return the summarised evaluations to all Member States for their further evaluation, with the aim of arriving at more consistent national evaluations. Based on the national evaluations, the expert panel makes a final recommendation to the Commission.
- (v) Final Decision: The Commission services table the request for amendment with the expert panel's final recommendation to the Standing Committee on Organic Farming (SCOF). The SCOF assists the Commission in making a final decision.

The project identified a need for further research and actions in the following areas:

- (i) closer cooperation with general (non-organic) regulation, in particular the fourth stage of PPP re-evaluation;
- (ii) evaluation of commercial products, which includes evaluation of inert ingredients;

- (iii) transparent communication of decisions concerning inputs for organic farming;
- (iv) improvement of the 'need recognised' restriction;
- (v) regulation of products used against pests of stored products;
- (vi) review of the PPP and F&SC currently listed;
- (vii) regulation of the use of the term 'organic' in labelling of PPP and F&SC;
- (viii) regulation of on-farm trials on organic farms.

Problem

The strict regulation of plant protection products (PPP) and fertilisers and soil conditioners (F&SC) authorised for use in organic agriculture according to Regulation (EEC) No 2092/91, Annex II, is of crucial importance for the trust of the consumers in the safety and quality of certified organic plant products. It is also of utmost importance to the organic farmers, as the regulation of PPP and F&SC has great implications on farming practices and on the crop-specific economy, and thereby on the income and the competitiveness of the organic farmers.

However, there is no harmonised and standardised procedure for the evaluation of new products to be included on the lists of authorised products in Annex II, nor for the re-evaluation of products already on the lists. Nor are there any standardised procedures for the setting of limits and other conditions for the use of PPP and F&SC in various crops. Therefore, the interpretation of which PPP and F&SC are allowed in various crops, and under which conditions and in which amounts they are allowed varies considerably between the EU Member States and associated countries, resulting in unequal competition conditions for the organic farmers in Europe.

At the same time, these differences may cause confusion concerning the quality of organic products, thereby reducing the credibility of certified organic products in the view of the European consumers. Furthermore, the lack of harmonised and standardised procedures for evaluation of PPP and F&SC may result in very time-consuming and complex evaluation procedures for the inclusion of new products and removal of existing products, this being an obstacle for the development of organic agriculture in the EU.

Background and objectives

The 'Organic Regulation' establishes the regulatory framework for organic farming in the European Union. Annex IIA of this Regulation lists the products which are allowed for use as fertilisers and soil conditioners (F&SC), while Annex IIB lists the allowed plant protection products (PPP). Article 7 contains the criteria for amendments to the Annexes.

Canali, S., Natalini, M., Dell'Orco, S., Riva, F., Sequi, P. (2003), 'Uno strumento a servizio dell'agricoltura bio: al terzo anno l'esperienza del Registro dei fertilizzanti', *AzBio – Agricoltura e zootecnia biologica*, Edagricole, 4, 30.

Canali, S., Trinchera, A., Intrigliolo, F., Pompili, L., Nisini, L., Mocali, S., Torrisi, B. (2004), 'Effect of long-term addition of compost and poultry manure on soil quality of citrus orchards in Southern Italy', *Biology and Fertility of Soils*, 40, pp. 206–210.

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Speiser, B. (2007), 'Authorization of inputs for EU organic farming', *The Organic Standard*, 70, pp. 10–11.

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Speiser, B. (2007), 'Bewegung bei den Betriebsmitteln für den Öko-Landbau?', *Ökologie & Landbau*, 141, pp. 47–48.

Speiser, B., Blake, F., Micheloni, C., Stopes, C., Andersen, M., Baker, B., Bywater, S., Canali, S., Eriksen, R. Ø., Gonzálvez, V., Hozzank, A., Jespersen, L. M., Jørgensen, L. N., Kelderer, M., Kleeberg, H., Koopmans, C., Kromp, B., Manstretta, M., Maurer da Costa, A., Monnier, M. C., Pauler, A., Schmid, O., Schreyer, A., Slabe, A., Tamm, L., Trapman, M., von Fragstein, P. (2005), *Evaluating inputs for organic farming — a new system*, FiBL, Frick, ISBN 3-906081-78-8.

Speiser, B., Wyss, E., Maurer, V. (2006), 'Biological control in organic agriculture: first choice or last option?', Eilenberg, J., Hokkanen, H. (eds), *An Ecological and Societal Approach to Biological Control*, Springer.

The objective of this Concerted Action is to develop recommendations for harmonised and standardised procedures for evaluation of PPP and F&SC authorised for use in organic agriculture according to Regulation (EEC) No 2092/91, Annex II, in order to harmonise and improve the quality of organic products and to give organic farmers in Europe more equal competitive conditions.

Methodology

The project consists of six work packages (WPs) and five workshops. WP 1 concerns coordination and project management. Inventories on implementation of Annex II and evaluation procedures in the participating countries representing north, west, south and central Europe are elaborated in WP 2 (PPP) and WP 3 (F&SC). Standardised procedures for evaluation of PPP and F&SC are elaborated in WP 4 and WP 5. Recommendations on evaluation procedures for FPP and F&SC plus research needs and dissemination are discussed in WP 6.

Main findings and outcomes (results) or expected results

The 'Organic Regulation' establishes the regulatory framework for organic farming in the European Union. Annex IIA of this Regulation lists the products which are allowed for use as fertilisers and soil conditioners (F&SC), while Annex IIB lists the allowed plant protection products (PPP). Article 7 contains the criteria for amendments to the Annexes. The ORGANIC INPUTS EVALUATION project has made an inventory of the current implementation of these regulations in various EU Member States and elaborated proposals for improvements of Article 7, and procedures for their implementation. Concerning the current regulation of PPP, most of the products listed in Annex IIB are available for use only in some EU countries.

Potential applications

The criteria matrix evaluation form developed in the project may be used in the evaluation of F&SC and PPP input materials at EU level as well as at national level and it is expected to give a more harmonised and better evaluation of the input products used in organic farming.

Innovation contribution

To put the new evaluation criteria into practice for the evaluation of F&SC and PPP, the project has developed a 'criteria matrix'. The criteria matrix contains detailed questions relating to each of the criteria in Article 7, and provides guidance for applicants and evaluators. Factual information has to be provided on the application form. This is then evaluated against organic farming principles on the evaluation form.

Conclusions

The aim of the project was reached, as the project successfully fed into the consultation process on Article 7 on the criteria for amendments to the Annexes.

The project also recommended that an expert panel assists in the evaluation process. Such a panel was formed in 2010 to assist the Commission and the SCOF committee in the evaluation and development of the EU Organic Regulation. It is expected that the panel will make use of the criteria matrix developed in the ORGANIC INPUTS EVALUATION project for the evaluation of fertilisers and soil conditioners allowed for use in organic farming, which is to take place in May–June 2011.

The project identified a need for further research and actions in the following areas:

- (i) closer cooperation with general (non-organic) regulation, in particular the fourth stage of PPP re-evaluation;
- (ii) evaluation of commercial products, which includes evaluation of inert ingredients;
- (iii) transparent communication of decisions concerning inputs for organic farming;
- (iv) improvement of the 'need recognised' restriction;
- (v) regulation of products used against pests of stored products;
- (vi) review of the PPP and F&SC currently listed;
- (vii) regulation of the use of the term 'organic' in labelling of PPP and F&SC;
- (viii) regulation of on-farm trials on organic farms.

European Information System for organic markets

Acronym:

EISfom

Project No:

QLK5-CT-2002-02400

EU contribution:

EUR 749 737

Duration:

36 months

Start date:

1.2.2003

End date:

31.1.2006

Framework programme:

Quality of Life (fifth framework programme)

Instrument:

Concerted Action (CA)

Coordinator:

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Abstract

This CA aims to develop a framework for statistics on organic food production, trade and consumption in the EU/EEA/CEE states to meet the market analysis needs of food producers, processors, distributors and retailers considering investments, and the need of regulators and policymakers to monitor this rapidly growing sector including traceability issues and sustainability indicators.

The project aims to combine results from EU research projects (FAIR3-1996-1794 OFCAP, QLK5-2000-01124 OMIARD and QLK5-2000-01112 CONVERSION), commercial market analyses and Eurostat data collection on Regulation (EEC) No 2092/91, and to support improved data quality, standardisation and detail on specific commodities. These aims will be achieved by reviewing existing data collection systems, producing a database and website, developing quality standards, conducting case studies in key countries and making recommendations for establishment and resourcing of a European Information System for organic markets.

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Research to support revision of the EU Regulation on organic agriculture

Acronym:

REVISION of Regulation
(EEC) No 2092/91

Project No:

502397

EU contribution:

EUR 868 654

Duration:

38 months

Start date:

1.3.2004

End date:

30.4.2007

Framework programme:

FP6 (sixth framework programme)

Instrument:

Specific Targeted Research Project
(STREP)

Project website:

<http://www.organic-revision.org/>
(active)

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Summary

Since 1991, organic Farming in the EU has been governed by Council Regulation (EEC) No 2092/91 ⁽¹⁾, which set out the rules for labelling of food products as 'organic' or the equivalent terms 'biological' or 'ecological'. The Regulation was a response to growing consumer demands for organic products in the EU, and the result was a legally enforceable and officially recognised common standard for organic crop production, certification, and labelling in the EU, which had to be implemented in all Member States by 1993.

Regulation (EEC) No 2092/91 paved the way for organic management options to be included in the EU agri-environment policy support programmes (Council Regulation (EEC) No 2078/92 ⁽²⁾) and through its provisions for imports from non-EU countries it also affected organic standards worldwide. In 1999, the Regulation was amended by Council Regulation (EC) No 1804/1999 ⁽³⁾ setting out rules on organic livestock production, which included a flexibility clause allowing Member States to maintain stricter rules on animal production. Furthermore, a prohibition of GMO was introduced in 1999. Regulation (EEC) No 2092/91 mainly covered rules on labelling (main text) and production (Annex I) plus permitted inputs and inspection rules (other annexes). The Regulation did not contain an explicit definition of organic farming: it was defined by the practices rather than by the principles and ethical values behind. Since its introduction, more than 25 amendments have been included.

In the growing market for organic food, there was concern that the involvement of large companies and global trade would encourage producers to cut corners and forget about the ethical values. This concern resulted in a renewed interest in the values and principles of organic farming. At the same time, private standard-setting organisations and some governments within and outside the EU had long-established or-

- 1 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1–15.
- 2 Council Regulation (EEC) No 2078/92 of 30 June 1992 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside, OJ L 215, 30.7.92, pp. 85–90.
- 3 Council Regulation (EC) No 1804/1999 of 19 July 1999 supplementing Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock production, OJ L 222, 24.8.1999, pp. 1–28.

ganic standards, which, in some areas, were more detailed and/or more demanding than the EU Regulation. This, and the flexibility in relation to organic livestock rules, resulted in differences in the implementation of Regulation (EEC) No 2092/91 in the Member States and to private standards, which raised concerns about unfair competition and trade barriers.

Therefore, the European Action Plan for Organic Food and Farming ⁽⁴⁾ called for a review of the legal framework with the aims of ensuring simplification and overall coherence, to establish principles that encourage harmonisation of standards and, where possible, to reduce the level of detail. Following this, it was decided to revise Regulation (EEC) No 2092/91. This project, EEC 2092/91 Revision, was set up to support this revision of Regulation (EEC) No 2092/91. The project began in March 2004 and lasted 38 months until April 2007 and was, therefore, ongoing and feeding into the revision during the first phases of the revision of the Regulation. A first proposal for a new regulation was published by the European Commission in December 2005 ⁽⁵⁾ and was negotiated by a Council Working Group during 2006. The opinion of the European Parliament was given in May 2007 and the text for the new Council Regulation (EEC) No 834/2007 ⁽⁶⁾ was agreed in June 2007 and came into force in January 2009.

The overall objective of the EEC Regulation 2092/91 Revision project was to provide recommendations for the revision and further development of Regulation (EEC) No 2092/91 and other standards for organic agriculture.

Specific objectives were:

- ▶ to identify the basic ethical values and differences in organic agriculture in Europe and develop a procedure for balancing and integrating the basic values in developments of the Regulation (WP 2);
- ▶ to compare the organic standards from national and private organisations in Europe with the Regulation in order to provide recommendations on further harmonisation (WP 3);
- ▶ to provide more knowledge on how to achieve 100 % organic rations in diets for livestock (WP 4);

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⁴ Commission of the European Communities, Communication from the Commission to the Council and the European Parliament 'European Action Plan for Organic Food and Farming', COM(2004) 415 final of 10 June 2004, Brussels.

⁵ Commission of the European Communities, Proposal for a Council Regulation on organic production and labelling of organic products, COM(2005) 671 final of 21 December 2005, Brussels.

⁶ Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, OJ L 189, 20.7.2007, pp. 1–23.

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- ▶ to provide more knowledge on how to reduce the use of seed and vegetative propagation materials from conventional sources in organic farming (WP 5);
- ▶ to discuss and disseminate project results in collaboration with stakeholders (WP 6).

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The project identified basic ethical values in collaboration with a task force group under the auspices of the IFOAM (International Federation of Agricultural Movements) working on drafting new ethical principles of organic agriculture. Four overarching ethical principles for organic production were identified: the principles of health, ecology, fairness and care. An empirical value inquiry performed with stakeholders from farm to fork in various regions of the EU supported the ethical values identified. The enquiry was carried out in a focus group study comprising 16 groups with organic producers and 10 groups with other stakeholders in five partner countries (Austria, Italy, the Netherlands, Switzerland and the United Kingdom).

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Furthermore, three case studies were carried out comparing ethical values with current practices of organic farming in the three contested areas of 'localness', 'intensification' and '(in)dependency from non-organic inputs'. These areas seemed to be highly relevant in relation to the Proposal for a new Council Regulation on organic production and labelling of organic products (COM(2005) 671 final of 21 December 2005).

Selected publications:

(for a complete list, see <http://www.organic-revision.org/pub/index.html>)

Alrøe, H. F., Noe, E. (2008), 'What makes organic agriculture move — protest, meaning or market?

A polyocular approach to the dynamics and governance of organic agriculture', *International Journal of Agricultural Resources, Governance and Ecology*.

Padel, S., Jespersen, L. M., Schmid, O. (2007), 'EEC 2092/91 (Organic) Revision Final Project Report'.

Padel, S. (2008), 'Values of organic producers converting at different times: results of a focus group study in five European countries', *International Journal of Agricultural Resources, Governance and Ecology*, 7(1), pp. 63–77 (in press, 2008).

Padel, S. (2007), 'Principles of organic agriculture and the market place', Sorensen, Neil (ed.), *Conference Proceedings of the First IFOAM International Conference for Marketing of Organic and Regional Values*, Schwäbisch Hall, Bonn, Germany, 26–28 August 2007, pp. 49–55.

The project also considered procedural issues in relation to integrating basic organic values in standards and, in particular, in the revision of Regulation (EEC) No 2092/91 on organic production. Some core ethical values of organic agriculture were expressed as objectives and principles at the top of the pyramid structure of the later adopted Council Regulation (EC) No 834/2007 on organic production and labelling.

The project also developed a database for the comparison of national public and private organic standards with Regulation (EEC) No 2092/91 (<http://organicrules.org>). In total, 34 standards from 14 European countries, one from USA and three international standards (Codex Alimentarius Guidelines, IFOAM Basic Standards and Demeter International) were analysed for differences. Of the 734 entries in the database, 714 concerned differences to Regulation (EEC) No 2092/91 and most of them were of a technical nature.

In the field of crop production (Annexes IA, IIA and B), there were 206 submissions and in the field of animal husbandry, there were 294 submissions (Annexes IB, IIC and D). The differences were analysed in relation to consumer and public perception, risk of trade distortion and compliance with the principles of organic agriculture; based on this analysis, recommendations were made in areas of Regulation (EEC) No 2092/91 where harmonisation, regionalisation or simplification could be implemented.

Based on a literature meta-analysis and discussions with stakeholders and experts, the project investigated possibilities and limitations of protein supply in organic poultry and pig production. An overview of the current situation to characterise the availability of protein sources for 100 % organic diets for pigs and poultry was produced. The demand and supply for organic concentrate feeds (both cereals and protein sources) was calculated using statistical data from other sources (Eurostat and two EU research projects (EU-CEE-OFP: QLK5-2002-00917; OMIARD: QLK5-2000-01124) and expert opinions on feeding of organic live-stock. Furthermore, an overview of supply and demand for concentrated feed in organic agriculture in the EU 2002–04 with a particular focus on protein sources for monogastric animals was produced and revealed that for 2002–04, there would be a calculated under-supply of high-quality protein sources of approximately 100 000 tonnes, equivalent to 33 000 ha for each year. This was equivalent to 9 % of the calculated demand for concentrated feeds for all monogastric organic animals in the EU. Based on this and other sources on criteria for use of organic inputs, evaluation criteria for Annex IIC: Feed materials, and Annex IID: Dietary supplements, of Regulation (EEC) No 2092/91 were developed. This report made reference to the draft text for the total revision of the Regulation on organic farming published in December 2005 (7). It also considered the principles of organic farming on which the more detailed rules should be based, which have implications on the criteria for which inputs should be permitted in the Annexes. Finally, the results were summarised in a guide to operators on how to deal with limitations in protein supply in the nutrition of mono-gastric animals in organic farming.

To provide knowledge on how to overcome problems related to seed-borne diseases in cereals, legumes and vegetables, a literature review of 68 scientific publications was carried out in 2005 and updated in July 2006 to obtain information on methods and products for control of seed-borne diseases, potentially acceptable in organic farming. Afterwards, an expert survey (questionnaire) was carried out with 20 experts in eight countries, involved in the research, production, trade and use of organic seeds. Documents outlining EU, international, national and private regulations, thresholds concerning seed-borne diseases on seeds (organic and conventional) were analysed, as well as national reports on the status of organic seed health for the last three years. Furthermore, five national workshops were organised with stakeholders. A survey of variety trials in organic farming, supplemented by expert consultations, was also carried out to describe and analyse the requirements of organic farming systems in terms of variety selection and breeding. Based on these studies, recommendations were made for the identification of species, for which derogations may continuously be needed.

Padel, S., Jespersen, L. M., Schmid, O. (2007), 'Final project report: EEC 2092/91 (ORGANIC) Revision', EEC 2092/91 (Organic Revision Project Report), Final report.

Padel, S., Nicholas, P., Jasinska, A., Lampkin, N. (2008), 'Ethical concerns associated with organic food in Europe', *Cultivate the future, Proceedings of the 16th IFOAM Organic World Congress* (CD), Modena, Italy, 16–20 June 2008.

Padel, S., Röcklinsberg, H., Schmid, O. (2009), 'The implementation of organic principles and values in the European Regulation for organic food', *Food Policy*, 34, pp. 245–251.

Plakolm, G., Fromm, E. (2007), 'Biolandbau und Werte: Was ist Biobauern in Österreich wertvoll? — Organic Farming and values: What is valuable for Austrian Organic Farmers?', *Zwischen Tradition und Globalisierung - 9. Wissenschaftstagung Ökologischer Landbau*, Universität Hohenheim, Stuttgart, Deutschland, 20–23 March 2007.

7 Commission of the European Communities, Proposal for a Council Decision on Community strategic guidelines for Rural Development (Programming period 2007–2013), COM(2005) 304 final of 5 July 2005, Brussels.

Finally, the national reports from 12 Member States on the implementation of the seed derogation regime according to Commission Regulation (EC) No 1452/2003 ⁽⁸⁾ were analysed.

Based on the above mentioned studies, a list of criteria for the appropriateness of the available varieties for organic production and a guide for the evaluation of the seed derogation regime was made and the relevance of these criteria was shown for major crops. Recommendations were made on how the seed derogation system and database system could be harmonised at EU level in order to prevent competitive advantages or disadvantages for growers in various EU Member States due to the lack of clear criteria for the derogations.

Based on all the work carried out in the project a number of recommendations, both to the European Commission and to other actors within the field of regulation and standard- setting for organic production, were made. Several of these recommendations had already been considered during the development and negotiation of the new Council Regulation (EC) No 834/2007 on organic production and labelling. Lastly, the project gave recommendations in relation to the further research needs identified during the course of the project.

Problem

Since 1991, organic farming in the EU has been governed by Regulation (EEC) No 2092/91, which set out the rules for labelling of organic food products . The Regulation was a response to growing consumer demands for organic products in the EU, and it had to be implemented in all Member States by 1993. In 1999, the Regulation was amended by Regulation (EEC) No 1804/1999 setting out rules on organic livestock production, which included a flexibility clause allowing Member States to maintain stricter rules on animal production. Furthermore, a prohibition on GMO was introduced in 1999. The Regulation did not contain an explicit definition of organic farming or set out the principles and ethical values behind. Since its introduction, more than 25 amendments have been included.

Therefore, the European Action Plan for Organic Food and Farming called for a review of the legal framework with the aims of ensuring simplification and overall coherence, to establish principles that encourage harmonisation of standards and, where possible, to reduce the level of detail. Following this, it was decided to revise Regulation (EEC) No 2092/91, and this project, EEC 2092/91 Revision, was set up to support this revision.

8 Commission Regulation (EC) No 1452/2003 of 14 August 2003 maintaining the derogation provided for in Article 6(3)(a) of Council Regulation (EEC) No 2092/91 with regard to certain species of seed and vegetative propagating material and laying down procedural rules and criteria relating to that derogation, OJ L 206, 15.8.2003, pp. 17–21.

Background and objectives

Regulation (EEC) No 2092/91 has been of great importance for the credibility and harmonisation of organic standards in Europe but, due to the lack of principles and ethical values behind organic production methods and numerous amendments to the Regulation over the years, the European Action Plan for Organic Food and Farming of 2004 called for a review of the legal framework with the aim of establishing principles and encouraging harmonisation and simplification of the Regulation where possible.

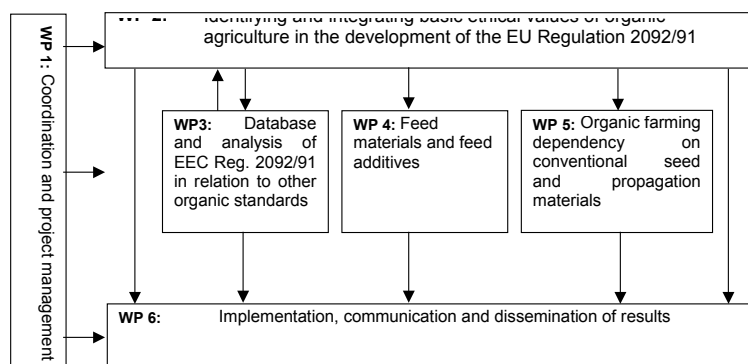
Therefore, the overall objective of the EEC 2092/91 Revision project was to provide recommendations for the revision and further development of Regulation (EEC) No 2092/91 and other standards for organic agriculture.

Specific objectives were:

- ▶ to identify the basic ethical values and value differences of organic agriculture in Europe and develop a procedure for balancing and integrating the basic values in developments of the Regulation (WP 2);
- ▶ to compare the organic standards from national and private organisations in Europe with the Regulation in order to provide recommendations on further harmonisation (WP 3);
- ▶ to provide more knowledge on how to achieve 100 % organic rations in diets for livestock (WP 4);
- ▶ to provide more knowledge on how to reduce the use of seed and vegetative propagation materials from conventional sources in organic farming (WP 5);
- ▶ to discuss and disseminate project results in collaboration with stakeholders (WP 6).

Methodology

The project was structured into six work packages (WPs).



Two WPs formed the frame of the project, WP 1: Coordination and project management and WP 6: Implementation, communication and dissemination.

The other four WPs were divided according to four key subject areas: WP 2: Value inquiry with regard to regulation developments; WP 3: Analysis of organic standards as means to stakeholder communication and provision of general recommendations on EU organic regulation revisions surveys; WP 4: Evaluations on the use of conventional feed and feed additives; and WP 5: Seed and propagation materials in organic farming as means to provide specific recommendations on the EU organic regulation revisions.

The overall methodology, which was designed to meet the project objectives, consisted of a systemic approach that consciously worked with stakeholder involvement, the role of values, and policy relevance. It included different types of methodologies such as philosophical and analytic research (e.g. identification of key concepts and values in written material and analysis of their relations), empirical qualitative research, surveys, literature reviews, and evaluations of expert knowledge. The work also included developments of new databases and procedures, and electronic communication (e.g. websites, open databases, discussion forums), targeted and open workshops, and written material (e.g. reports, scientific papers).

Main findings and outcomes (results) or expected results

The project produced 12 reports, seven scientific publications in peer-reviewed journals, a project web page (<http://www.organic-revision.org>) where all reports are available and a standards comparison database (<http://www.organicrules.org>) containing information on 34 organic standards (of which three international and the rest from 14 European countries and the United States).

The partners analysed these standards and submitted 714 differences between these standards and Regulation (EEC) No 2092/91. The project also organised three workshops with stakeholders and had ongoing communication with the Unit on Organic Farming in the Directorate-General for Agriculture and Rural Development, which is responsible for the Organic Regulation. Members of the project team produced in total more than 250 dissemination items in the form of book chapters, scientific conference papers published in proceedings, workshop presentations, posters and papers, articles in magazines and newsletters and direct E-mail communications in national languages as well as in English.

The project recommended that ethical values would function most effectively in regulations, if they were stated in one place where they can eas-

ily be identified. This was largely realised in the text of the new Council Regulation (EC) No 834/2007, where most values are mentioned in Articles 1–7 (Objectives and Principles). The project further recommended that the Commission should consult affected stakeholders and involve the Expert Panel mentioned in the European Action Plan for Organic Food and Farming ⁽⁹⁾ in the development of the implementing rules. This could help identifying potential value conflicts before the rules become law. One of the tasks of such an expert panel should be to consider the coherence in the interpretation of the objectives and principles. Such an Expert Panel was formed by the Commission in 2010.

The analysis of differences in the standards between governmental and private organic standards compared to Regulation (EEC) No 2092/91 identified areas where harmonisation, simplification and regionalisation might be introduced in the revised organic regulation. Harmonisation of rules should focus on areas that show a high level of differences that are important to consumers, that distort trade and/or that could potentially conflict with the organic core values. Many recorded differences related to fertilisation and animal feeding, which should be considered for harmonisation. For example, extending the requirement on a minimal proportion of the feed that has to come from the holding (similar or lower to the existing rule of at least 50 % for herbivores) to all livestock species would limit intensification and encourage greater balance between livestock and crop production. Conversion and provisions related to the use of fertilisers and manure are also areas where harmonisation of the rules would be relevant. Other areas are subjects not yet covered by the Regulation (e.g. special plant production systems such as hothouses, environmental protection and rules for processing). Simplification of the Regulation would be possible by reducing derogations or providing clearer criteria for derogations. However, regional flexibility may be necessary (e.g. for seed and feed where non-availability is documented). Moreover, harmonisation of the EU rules should be supported by better communication, more transparency and by research into areas where limited experience with the implementation of regulations and standards exist.

Potential applications

The project results were particularly aimed at feeding into the process of the revision of Regulations (EEC) No 2092/91 and (EC) No 1804/1999 on organic production.

The project provided direct support for specific revisions of the Regulation on, for example, the use of conventional feed and seed, as stated in one of the specific objectives.

9 Commission of the European Communities, Communication from the Commission to the Council and the European Parliament 'European Action Plan for Organic Food and Farming', COM(2004) 415 final of 10 June 2004, Brussels.

The identification of basic ethical values of organic agriculture and of differences in national and private standards supports the potential for *harmonisation* and *simplification* of organic regulations. Emphasising identification and harmonisation of the ethical values behind the rules as a substitute for a complete harmonisation of the organic regulations may enable *regionalisation* of the organic production regulations in the EU as far as the natural and cultural conditions demand. Furthermore, increased knowledge and communication on the values behind the organic regulations and the reasons for regional differences and local characteristics will support *consumer confidence* in organic products from different EU countries. Moreover, increased knowledge on the potential for a more self-sufficient organic agriculture can *reduce dependency* on conventional agriculture, and this can further support *consumer confidence* in organic food.

The identification of current values among organic stakeholders will enable *strategic developments* of EU regulations with respect to possible conflicts related to differences in values within organic agriculture and in relation to other EU policy objectives and public interests, and identifying differences in the national and private organic standards and facilitating discussions of these differences through IT tools can support the development towards *common platform* and *increased competitiveness* of organic agriculture outside and inside Europe.

By supporting the development of organic agriculture through targeted revisions of EU regulations, this project may contribute to a larger *agricultural diversity* in the European rural landscape and environment and a larger *diversity of food* for consumers.

It also supports the development of other organic standards by:

- ▶ identifying basic ethical values of organic agriculture;
- ▶ providing recommendations concerning use of basic ethical values in standards evaluations and revisions;
- ▶ identifying value differences among different organic stakeholders;
- ▶ suggesting a procedure for balancing and integrating basic ethical values and value differences in the development of organic standards;
- ▶ identifying value-based conflicts in the organic regulations;
- ▶ identifying and displaying differences among organic regulations;
- ▶ providing recommendations on key areas of organic regulation such as the use of conventional feed and seed.

It may also support the development of other agricultural or non-agricultural regulations by way of exemplifying a method for handling stakeholder values in the evaluation and development of regulations.

Innovation contribution

See 'Main findings and outcomes' and 'Potential applications'.

Conclusions

All the objectives of the EEC 2092/91 Revision project were achieved. The project consortium worked in close collaboration with the Commission to feed into the development on the new regulation on organic production, and several of the project recommendations had already been considered during the development and negotiation of the new Council Regulation (EC) No 834/2007.

For further information on recommendations to the Commission and other actors within the field of standards setting for organic production plus recommendations on research needs, Padel, S., Jespersen, L. M., Schmid, O. (2007), 'EEC 2092/91 (Organic) Revision Final Project Report', Chapter 6.

Opening channels of communication between the accession and candidate countries and the EU in ecological farming

Acronym:
CHANNEL

Project No:
3375

EU contribution:
EUR 392 850

Duration:
18 months

Start date:
15.11.2004

End date:
14.5.2006

Framework programme:
FP6 (sixth framework programme)

Instrument:
Specific Support Action

Project website:
<http://www.channel.uni-corvinus.hu/content.php?content.41> (active)

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Summary

In the participating countries, the characteristics of organic agriculture concerning the stages of development, the forms of organisation, the legislative systems, the economic frameworks and the cultural backgrounds were all different. The aim was to help with the harmonisation and equalisation of knowledge in the field of organic agriculture in the old, new and candidate EU countries. To reach the goals, it was decided to create a common database with information about the main fields of organic farming in the participating countries. The thematic groups are identical to the work groups; plant protection, organic seed and propagation material, animal husbandry, agrotechnology, weed management and soil fertility.

The CHANNEL project could be accessed online from the beginning of the project. A questionnaire was created for all work groups to collect data at three levels alongside a general questionnaire.

The compiled versions of these data are the so-called Country Profiles and Working Group Summaries, which could be reached via the home page of the project; the Proceedings of the Conference were also available for participants of the conference in a book and on two CD-ROMs. The summarised results of each working group can be found in the book (some books are still available from the coordinator). Conclusions on the needs and problems of organic agriculture were gathered and discussed by project participants and published and submitted to the European Commission. The CD-ROM contains the overall country results of each participating country. Besides this, organic plant protection techniques of the participating countries were gathered according to different cultures. Materials from the two CD-ROMs and the presentations at the final conference can be found online (<http://www.channel.uni-corvinus.hu/content.php?content.40>).

Problem

There are huge differences in the historical background and the level of development among the new EU member countries. Organic agricul-

ture is one area is at different stages of development in different countries. The different forms of organisations, the legislative and economic frameworks, the cultural backgrounds impose different tasks on the new member countries in this area.

Background and objectives

So, after EU accession, as before, organic agriculture is an important strategic area of agriculture in general both for the new Member States and the 15 well-established EU countries. No other branch of agriculture is capable of such a quick pace. It is not by chance; the growing number of food scandals only strengthens those processes that continuously and irreversibly change the consumption habits and make society aware of the negative consequences of the irresponsible mistreatment of the environment.

Concerning organic agriculture, the lack of information about the actual situation in the potential new Member States is characteristic all over the EU. There have been many misconceptions and distribution of irrelevant information.

Further problems on the path of communication between some countries are generated by the fact that some are practically unreachable through the Internet or e-mail, not to mention the language barriers where the very start of communication faces almost insurmountable obstacles.

There have been initiatives from western countries that have failed in many cases due to the cultural and historical gaps dividing the west and the east. For the western partner, the system of communication and metacommunication in a given country is simply unintelligible; it is difficult to trace the mechanisms of management and/or to adopt the different working habits and intensity as well as the reaction time.

Further causes of failure can be revealed through the fact that it is always the same persons representing their country in matters related to organic agriculture in Western Europe or elsewhere in the world while many of them are familiar only with a small segment of activities in their country and also often lack the knowledge of the basic principles and terminology of organic agriculture: it is characteristic that they appear only at sponsored events and are unable to join a real initiative or a cooperation.

The objectives of the project were to:

- ▶ monitor the situation of organic farming in the new accession candidate countries and in potential candidate countries;
- ▶ create links to stakeholders of participating countries;
- ▶ create communication channels between the new accession candidate countries and potential candidate countries and between these countries and the European Union;

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- ▶ disseminate knowledge in organic agriculture;
- ▶ create an interactive central databank;
- ▶ create a common website and discussion forum for the project.

Methodology

To reach the goals, it was decided to create a common database with information about the main fields of organic farming in the participating countries. The thematic groups are identical to the work groups; these are plant protection, organic seed and propagation material, animal husbandry, agrotechnology, weed management and soil fertility.

Data collection was carried out by all participating organisations who gathered information in their respective area (thematic or geographical) and disseminated them in their interest groups aiming at the equalisation of knowledge in organic agriculture, producing a multiplying effect by involving a large group of beneficiaries also from the circles of NGOs, farmers, SMEs, educational, administrative, religious and other institutions.

A questionnaire was created for all work groups to collect data at three levels (public authorities and decision makers, farmers' associations and advisors, researchers), alongside a general questionnaire.

Main findings and outcomes (results) or expected results

As a result of the project, available data concerning organic farming in the participating countries was collected. The CHANNEL project was introduced on several forums in Europe.

Knowledge was disseminated through leaflets and newsletters and the final CHANNEL disseminating conference, where the heads of the leading research programmes, researchers, experts, decision-makers and other interested parties (mainly organic farmers and students) attended from the old, new and candidate countries of the EU. This provided an excellent opportunity for those people to meet and discuss the state of the art in organic farming, and the research and educational programmes in this field. These communication channels established during the project will serve as an important tool in the harmonisation process. Besides this, the results from the database and presentations of the final conference are available for all the participants and those who are involved and interested in organic farming.

Due to this work, the EU gained a clear indication of the situation of organic farming in the participating countries, and these countries became acquainted with each other's organic farming methods. It helps in harmonising the level of knowledge about organic agriculture and familiarising this to the widest possible scope of stakeholders and all interested parties.

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Potential applications

The database is a large common database in organic farming from which the consolidated checked results are available for all interested experts, scientist or students online (<http://www.channel.uni-corvinus.hu>), under 'Final conference presentations' and 'CHANNEL Conference CD: Country profiles and Abstracts'.

Conclusions

The aims were to assess and analyse the development stages which the participating countries have reached in organic agriculture and to open communication channels at the different levels necessary for the harmonisation and equalisation of knowledge in organic agriculture in the old, new and candidate EU countries. This was satisfactorily reached with the above mentioned database and country profiles based on this database. Furthermore, several project meetings were held along with the final CHANNEL conference; here, the heads of the leading research programmes, researchers, experts, decision-makers and other interested parties (mainly organic farmers and students) from the old, new and candidate countries of the EU were able to create, maintain or even strengthen communication channels and enhance the harmonisation process of European organic farming.

The following problems and research needs were identified during this project.

GENERAL ASPECTS

- ▶ Organic farming is relatively new, short conversion period — there are gaps in knowledge, research and education.
- ▶ The infrastructure for organic farming is only slightly developed (marketing, investments, processing, etc.).
- ▶ In some countries, the market and export for (mainly) arable organic products is not established: therefore, the economic pressure and possibilities to improve management in practice is small.
- ▶ There are some specific traditions in land use, which are only partly covered by EC regulations (e.g. fruit and mushroom collection in the wild (open range); some small animal husbandry methods (e.g. rabbits); grassland-arable land rotations; set aside-arable land rotations).
- ▶ In some countries, there are extreme conditions in natural conditions (rainfall, moisture, soil acidity, low nutrient contents, wet soils ...) which require specific adaptation of land-use systems: this should be reflected in EC regulations.
- ▶ In organic farming, problems can only be solved through the use of multiple tools — knowledge is key to identifying the appropriate tools. Improvement in research and advisory services is essential: the aim is to create special research areas. The deepen-

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Selected publications:

'Surprising increase growth of organic farming', *Ukininko patarejas* (Farmer's Adviser, a national newspaper), No 5, 13 January 2005, p. 1750.

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Radics, L. (2006), 'Summarised results of the CHANNEL project', Szaktudás Kiadó Ház, Budapest, p. 111.

Glemnitz, M., Radics, L., Mackensen, K. (2007), 'Weed management in organic farming in the new EU Member States and the acceding countries — Status quo and main limitations', *Proceedings of the Third International Congress of the European Integrated Project Quality Low-Input Food*, Stuttgart-Hohenheim, Germany, 2007, március 20–23. 284–288.

ing of research topics must consider regional conditions (climate, soil type, etc.) as particular local factors have a major influence on organic agriculture. Regional aspects play a key role: the comprehension and solution of problems and the identification of factors of influence can be much more clearly and much more successful (e.g. dry land farming).

SPECIAL NEEDS

- ▶ *Development of the advisory service*
 There is a general demand in the participant countries for specific support to develop a further service specialised in organic farming. The established advisory service serves the purposes of conventional production in most countries.
- ▶ *Development of the training and education system*
 Further education of practitioners and the establishment of well-informed and qualified advisory services is a basic need.
- ▶ *Development of applied research and contact between producers and researchers*
 Establishing contact between those involved in production and research would be highly profitable. With establishing contact or approximating the parties, practice could significantly influence the trends in applied research thus ensuring the practical implementation of research results and their beneficial effect on the economy.
- ▶ *Development of the subsidy system*
 There is a need for more subsidies designed specifically for organic farming.
- ▶ Smaller regional projects enable members from new accession countries to conduct better and more effective project management. For these reasons, small dimension projects focused on local problems and conditions have a pronounced positive effect.

SPECIAL NEEDS IDENTIFIED BY THEMATIC WORK GROUPS

- ▶ *Organic plant protection*
 Several serious deficiencies in plant protection and forecasting that call for further research.
 The registration process for beneficial organisms is extremely difficult, elongated and expensive in the EU compared to other parts of the world. The simplification of the registration process and the reduction in costs would promote the success of organic plant protection.
- ▶ *Organic seed material*
 There is a need for acceptance of classic breeding and support for the system of Value for Cultivations and Use (VCU) tests for varieties for organic farming on European level.

Use of organic cultivars: according to EU-standards the used cultivars and plantlets have to be of organic propagation, confirmed by central European partners — this is only partly fulfilled.

More support is needed to improve local organic seed production on legal basis. *In situ* conservation of plant genetic resources need to be supported.

► *Organic agrotechnology*

Better rotation programmes: demand for sufficient proportions of legumes and green manures in crop rotations.

There is a great need for external N-sources, on the one hand, and insufficient practice of manure management on the other.

► *Organic weed management*

The main limitations in improving weed management practice are: economic costs of weed management, which are not yet covered by the market prices for organic products, and available machinery — new machinery hardly exists. Infrastructures to support investment in machinery are missing. Capital for investments is missing, as the level of available capital in farms in general seems to be very low.

► *Organic animal husbandry*

It is necessary to subsidise the gene conservation of rare local animal breeds, together with their breeding traditions, which are considered as the bases (both genetic and environmental) for ecological type farming and sustainable agriculture.

In fact, organic animal husbandry is inconceivable without local, well-adapted breeds. Most of the local breeds are threatened and many of them are not conserved. That is why it is highly recommended to support different countries (mainly in East- and South-Europe) saving local breeds together with breeding traditions, wherever it is possible.

Both financial and professional aid is needed: guidelines, instructions, professional education organised and subsidised by the EU. Above all, EU regulation(s) is also needed concerning gene conservation: it is vital to make it clear to all EU Member States and candidate countries that gene conservation is a duty!

► *Organic soil fertility*

Improvement of soil fertility management plays a key role. The soil organic matter is of high importance and needs to be protected and enhanced. Local network communities need to be established to answer the needs of the regions.

Especially in the new EU Member States, the relevance of soil fertility will increase in the future. The seasonal variations, and also variations in the local climate, are more pronounced than in western European countries. These conditions will be further amplified by the consequences of climate change. To soften these factors, more importance will be attached to soil fertility. For this reason, subsidies should be adapted more to the necessary measures for soil fertility improvement.

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European Action Plan of Organic Food and Farming

Acronym:
ORGAP

Project No:
6591

EU contribution:
EUR 878 323

Duration:
36 months

Start date:
1.5.2005

End date:
30.4.2008

Framework programme:
FP6 (sixth framework programme)

Instrument:
Specific Support Action (SSA)

Project website:
<http://www.orgap.org/> (active)

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Summary

Within the EU-funded project ORGAP a toolbox for the evaluation of the European as well as national action plans for organic food and farming was developed (<http://www.orgap.org>). This toolbox was based on a comparative analysis of national action plans in nine countries (Czech Republic, Denmark, Germany, Italy, the Netherlands, Slovenia, Spain, Switzerland and the United Kingdom), a meta-evaluation of existing evaluations of national action plans, workshops with national stakeholders and a European Advisory Committee, interviews with experts. Furthermore, synergies and conflicts between the national and European action plans were identified.

Problem

Previously, in 1995, the Danish Ministry of Agriculture launched the first Action Plan for Organic Food and Farming. Several European countries have, in recent years, elaborated and implemented such action plans. In December 2002, a Commission staff working document, 'Analysis of the possibility of a European Action Plan for organic food and farming', was prepared. After an Internet consultation in February/March 2003 and a hearing in January 2004, the Commission presented the action plan to the European Parliament and the Council in March 2004. In June 2004, the European Commission released the European Action Plan for Organic Food and Farming (EUOAP). With this action plan, the Commission intended to assess the situation of organic farming and to lay down the basis for future policy development. At the national level, many governments have also developed action plans to promote organic farming.

The integrative approach of the action plan suggests policy measures in very different policy areas with impacts on the whole organic supply chain and on broader policy goals. Until then, there was a lack of suitable scientifically based tools and concepts to evaluate such a broad policy approach on national and EU level with respect to both short and long-term effects. Therefore, to optimise the EUOAP, it was seen as necessary to develop appropriate evaluation criteria, tools and concepts, which will help analyse the impacts of the measures at European and national level and give guidance to the Commission and governments. Such criteria and tools should first be tested on a selected number of national action plans and, after a year when the European Action Plan is in place, at the European level.

Background and objectives

The need for scientific support in the implementation of the proposed European Action Plan for Organic Food and Farming has been taken up in the sixth framework programme in a specific call in Area 8.1 Policy-oriented research, under 1.2 Tools and assessment methods for sustainable agriculture and forestry management.

The overall objective of this project was to give scientific support to the implementation of the EUOAP by the development of an evaluation toolbox. The tool will be used, among others, by National and European relevant administrations and policymakers.

In detail, the following objectives were set.

- ▶ To identify, develop and test a set of indicators and procedures as a basis for the development of a toolbox (ORGAPET) to assess the long-term and short-term effects of the implementation of the EU Action Plan for Organic Food and Farming along the whole food chain in the following areas: information, training and education; research; production, processing, market development, certification, public expenditures.
- ▶ To identify areas of conflict between national and EUOAP targets concluding in policy recommendations to the Commission and national authorities.
- ▶ To make an early assessment of the potential risks and problems associated with the implementation of the EUOAP.
- ▶ Policy analysis for the implementation processes and procedures.
- ▶ To make recommendations to different actors.

Methodology

Firstly, the toolbox was tested on a selected number of ongoing national action plans (desk research, interviews with experts). Synergies and conflict areas between national and EUOAP targets were identified with national workshops and within an Advisory Committee.

For an evaluation of the internal and external coherence of the EUOAP, the ORGAP project team made use of empirical methods and techniques suggested for analysing the synergy of programmes as well as their cross-impacts. A policy analysis of key synergies (positive and negative) was performed by means of a matrix of cross impacts. In order to provide an early assessment of potential risks and problems associated with the implementation system of the EUOAP, the ORGAP team used an adapted version of (pro-cess) Failure Modes and Effects Analysis (FMEA) combining the knowledge of a core team made up of researchers from partner institutions with external expertise of a support team.

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Dabbert, S., Eichert, C. (2007), 'Public synthesis report on the scope of national action plans, their evaluation procedures and the operability and appropriateness of the developed evaluation concept at national level, as well as the impact of conflict/synergies and policy proposals for implementing the EU Action Plan in Member States', Report D8, University of Hohenheim.

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Finally, recommendations were made by the project consortium and backed up by the Advisory Committee. A web-based tool, the ORGAPET, was installed and tested and an easy-to-read manual for different actors was compiled (in English and French) to give guidance for the elaboration, implementation and evaluation of action plans. As post-project activity a mi-term evaluation of the EUOAP was made for the Directorate-General for Agriculture and Rural Development.

Ten partners from nine countries (Czech Republic, Denmark, Germany, Italy, the Netherlands, Slovenia, Spain, Switzerland and the United Kingdom) participated in the project, as well as the European umbrella organisation of the Organic Agricultural Movements (IFOAM EU Regional group), ensuring a broad stakeholder consultation process and dissemination all over Europe.

From May 2005 to July 2008, members of the team produced more than 250 dissemination items in total, in the form of book chapters, scientific conference papers published in proceedings, workshop presentations, posters and papers, articles in magazines and newsletters and direct e-mail communications in national languages and in English.

Main findings and outcomes (results) or expected results

In the project, a historical analysis of the European as well as national organic action plans for organic food and farming was made. Eight national action plans were analysed. They varied very much with regard to the development process, targets, objectives and the emphasis of measures on certain areas. This is due to quite different political and socio-economic framework conditions for organic farming in the various countries.

A main chapter concerned about organic action plans — what we know and do not know. When analysing the success of action plans the following question is crucial: What would have happened if the organic action plan had not been in place? To answer this question, it is important to keep in mind and to analyse the broader policy and market environment relevant to organic farming in order to judge the success of the action plan as well as new challenges for organic farming such as climate change. It is clear that just looking at the originally envisaged targets and objectives might not be sufficient to judge whether or not an action plan has been successful. One key argument going beyond clear targets and well-balanced measures is that embedding action plan development in the wider policy area seems to be absolutely essential for success. However, there are a number of other issues to be dealt with which are also quite important prerequisites for successful organic action plans, such as stakeholder involvement, coherence and consistency of action plans and an evaluation monitoring capacity.

Stakeholder involvement helps in improving the information basis and the legitimacy of public policies. This is especially important on complex issues such as organic action plans, which involve actors with stakes in issues as different as the values of organic food and farming, the food market and the public goods of organic food and farming at one and the same time: in the selection of stakeholders, these factors should be considered. The ORGAP project developed a theoretical model for stakeholder classification. Successful stakeholder involvement demands careful preparation of which stakeholders to include at any stage of the policy process and of the methods used to promote participation, and sufficient time for the stakeholder to react.

The development of an Organic Action Plan Evaluation Toolbox (ORGAPET, <http://www.orgap.org/orgapet>) was a central part of the ORGAP project to support the European Commission in evaluating the EUOAP. ORGAPET has been developed as a web and CD-ROM-based toolbox, with hyperlinks between the different elements designed to make navigation easy. ORGAPET is a collection of different information/data sources and evaluation tools, including participative techniques, quantitative assessments and methods to identify relevant indicators, which can be used selectively to meet the needs of a particular assessment of national or EU organic action plans.

Potential applications

The project results support different actors in successful planning, implementation and evaluation of action plans for organic food and farming.

When planning a new or revising an existing action plan, it is recommended the different approaches of other action plans (e.g. market-driven versus policy-driven) are first studied. When a participatory approach is chosen, stakeholders should be involved in the different phases of policy development (agenda setting, policy formulation, decision-making, implementation, evaluation). Furthermore, experience within the project showed that focus group discussions may be used to gain information from the organic food and farming sector itself, while less involved outsiders should be approached in a different way (e.g. by individual interviews after data had been collected from members of the organic food and farming sector in order to ask outsiders for comments to the main arguments of the organic sector).

For the evaluation of organic action plans, it is important not only to follow a generally accepted evaluation standard but also to elaborate and build up specific, tailored indicators (standards) adequate to the national action plan; here, ORGAPET provides both a procedure for selection as well as examples. Furthermore, it is important to differentiate clearly between the depiction of facts and areas more open to interpretation through the inclusion of stakeholder (e.g. by a stakeholder reflection

Eichert, C. (2008), 'Meta-evaluation of action plans — The case of the German Federal Organic Farming Scheme', *Cultivating the future based on science, Proceedings of the second Scientific Conference of the International Society of Organic Agriculture Research (ISO FAR)*, Vol. 2, Livestock, socio-economy and cross-disciplinary research in organic agriculture, ISO FAR, Bonn, Germany, and FiBL, Frick, Switzerland, pp. 810–813.

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workshop as in the German evaluation) and to ensure sufficient data availability and resources for data search.

The overview and regular updates of the national organic action plans around Europe on the project website were consulted by many website visitors and might have helped in several countries to initiate or revise national and regional action plans (e.g. in several regions of Spain).

The ORGAPET methodology and the post-project midterm evaluation of the European Organic Action Plan are also potentially useful for the Directorate-General for Agriculture and Rural Development, once a final evaluation of the EUOAP has to be made.

Innovation contribution

ORGAPET (the Action Plan Evaluation Toolbox) and the ORGAP Manual (a resource handbook for the development, implementation and evaluation of organic action plans) are unique and innovative tools. This was the first time that such tools have been developed for specific EU action plans and which complement the EU general evaluation tools (e.g. the MEANS framework and Evalsed). During the project, many dissemination activities were conducted.

Furthermore, 'Golden Rules' for organic action plans as well as recommendations for different actors such as the EU Commission, EU Member States and private stakeholders were summarised.

Conclusions

The objectives of this project were reached in different ways, in particular through the broad involvement of stakeholders in two rounds of national workshops, IFOAM EU as an umbrella organisation, a popular manual, through scientific and popular publications, regular dialogue with the Unit for Organic Farming at the Directorate-General for Agriculture and Rural Development, and an advisory committee.

Within the project, we also identified some problems with stakeholder involvement (e.g. it was more difficult to involve stakeholders from conventional farming in workshops focused specifically on organic action plans). Furthermore, in continuous stakeholder involvement, open networks tend to move to rather closed networks through a kind of self-selection mechanisms, which might need corrective action.

The following research needs for the future have been identified.

- More data are needed to make a proper evaluation of the success of both the European and national action plans.

- ▶ While relevant baseline data are in place as part of the monitoring of the EU organic regulations and the rural development programme, there is a need to prepare for evaluation of the effects of implementing the major regulatory changes, which, since 2008, have been made. In particular, the effects of the promotional campaign and compulsory adoption of the new EU organic logo on consumer recognition, understanding and trust cannot be captured by current data sources and should be the subject of a specific before and after consumer research, possibly as part of the *Eurobarometer* series.
- ▶ The methodology tested for organic action plans could also be adapted and tested for other action plans in the area of agriculture (e.g. animal welfare, bio-economy) as part of research projects.

Demonstration of an online multilingual biological agriculture eServices system for organic framers, traders, institutions and citizens

Acronym:

bio@gro

Project No:

11293

EU contribution:

EUR 1 600 000

Duration:

24 months

Start date:

1.1.2005

End date:

31.12.2006

Framework programme:

Information Society Technologies (sixth framework programme)

Instrument:

Demonstration contracts

Keywords

improving access to and expanding the use of public sector information

Coordinator:

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Abstract

The bio@gro project aimed at contributing to the integrated development of the Organic Agriculture (OA) sector throughout Europe by offering improved conditions and new opportunities both for organic farmers, agribusinesses and for European citizens. The overall objective of this proposal was to create a critical mass in OA material and mechanisms. It included OA actors from all links in the value chain and aimed to develop an eServices system as a single point of access for OA information and business opportunities.

The project developed an eServices system as a single point of access for OA information and business opportunities. The strategic objective was the development of a system (bio@gro) for all key actors involved in the OA value chain (organic farmers, agri-businesses and consumers/citizens), providing:

- ▶ a single point of access to accurate and multilingual OA information;
- ▶ e-business related services (business opportunities in terms of business collaboration, web presence);
- ▶ mobile services (m-services);
- ▶ e-Advertising services;
- ▶ advanced content search mechanisms;
- ▶ online form submission mechanisms.

The eServices, provided in English, German, Greek and Romanian, include content available for use by all users, independent of their country of origin.

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Organic viticulture and wine making: development of environment and consumer friendly technologies for organic wine quality improvement and scientifically based legislative framework

Acronym:
ORWINE

Project No:
22769

EU contribution:
EUR 1.35 million

Duration:
40 months

Start date:
1.2.2006

End date:
31.5.2009

Framework programme:
FP6 (sixth framework programme)

Instrument:
Small or medium-scale focused research actions (STREP)

Project website:
<http://www.orwine.org> (active)

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Summary

The project aimed at developing the legislative framework for wine from organic viticulture. Data about currently applied practices, consumer and market needs in significant areas were gathered in the main significant wine-producing areas of the EU, new Member States and accession countries.

Test series with suitable and innovative technologies to improve the quality of wines from organic viticulture, allowing using a low level of sulphites were conducted and validated on a network of selected pilot farms.

A participatory approach with stakeholder involvement at national and EU levels was followed, so ensuring a wide and deep discussion on the proposed legislative framework.

A code of best practices and an integrated environment assessment tool were produced in order to provide guidance to wine producers for high-quality wine while limiting their impact on the environment.

The project had the following objectives:

- (a) to identify practices applied in organic viticulture and winemaking in typical EU wine-producing areas and evaluate their impact on environment and wine quality;
- (b) to identify buying motives and organic wine markets needs in order to address labelling provisions and communication strategies;
- (c) to develop innovative winemaking technologies fitting to the organic concept and improving organic wine quality with particular regard to sulphite reduction;
- (d) to test on-farm innovative technologies in order to assess their practicability and acceptability;
- (e) to develop a code of best organic winemaking practices and recommendations for the development of an EU regulation on or-

ganic farming and policy support measures for the organic wine sector through a participatory approach.

Problem

Organic viticulture is an important part of the EU organic farming sector. It covers an important percentage of the EU agricultural area. On December 2003, the situation was: Italy, 31 709 ha; France, 16 259 ha; Germany 2 000 ha; Spain 16 435 ha; Austria 1 400 ha. In 2009, the surface had increased to: Italy 43 614 ha; France 39 146 ha; Spain 53 958 ha; Germany 4 400 ha.

Despite its relevance, the production of organic wine is regulated at EU level only at the grape production phase; there is no EU definition or regulation of the processing phase. Therefore, grape wine may not be labelled as 'organic wine' (clearly excluded by Council Regulation (EEC) No 2092/91 ⁽¹⁾, Annex VI, General Principles, first paragraph, but later included in the scope of Council Regulation (EC) No 834/2007 ⁽²⁾ but still requiring specific rules for its implementation on winemaking) while any other alcoholic drinks (beer, fruit wine, spirits, cider, etc.) is covered by Regulation (EEC) No 2092/91 (later by Regulation (EU) No 834/07) and may be regularly labelled and sold.

The lack of common regulation concerning wines from organic viticulture (organic wines), was, and is, preventing many organic wine producers from properly labelling their products. As a result, this situation creates confusion in many EU countries and unfair competition among those producers because they face the market with four kinds of predominant labelling systems:

- ▶ wine from organic grapes but conventionally processed;
- ▶ wine from organic grapes processed with no additives at all;
- ▶ wine from organic grapes processed according to private standards which limit the type and amount of additives and processing aids;
- ▶ no mention of certified organic origin at all.

The lack of a common EU definition of organic winemaking and the need for improved techniques to be applied for its production, in tune with the organic concept, were the basic problems the project addressed.

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1 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1–15.

2 Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products and repealing Regulation (EEC) No 2092/91, OJ L 189, 20.7.2007, pp. 1–23.

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Selected publications:

Cottareau, P., (2011), 'Choix de la levure: conséquences sur la teneur finale en SO₂', Congrès OIV, Porto, Portugal, June 2011 (poster accepted).

Cottareau, P., (2010), 'Choix des pratiques œnologiques: conséquences sur la teneur en SO₂', Présentation aux Journées Viticulture Biologique, Anger, France, December 2010.

Guezenc, S., Aguera E., Salmon, J. M. (2011), 'Pulvérisation de levures à la vigne: un outil de lutte préventif contre le développement d'*Aspergillus carbonarius*', *Numéro thématique Mycotoxines, Cahiers de l'agriculture* (in press).

Background and objectives

Despite the large interest for organic wine from producers and consumers, and regardless of the fact that wine is an important European product, strongly related to tradition and local identity, it is still missing a common definition and regulation.

REGULATORY SITUATION

Regulation (EEC) No 2092/91 was the legislative framework for organic agriculture in the European Union (later replaced by Regulation (EC) No 834/2007). However, grape-wine processing is not covered by this regulation yet, although it was planned from the beginning to include wine in a later stage. Therefore, in many countries, grape wine may not be labelled as organic wine while any other alcoholic drinks (beer, fruit wine, spirits, cider, etc.) are covered by the Regulation and may be regularly labelled and sold.

The lack of the EU regulation on organic winemaking is at present preventing many organic wine producers from properly labelling their products leading to confusion and unfair competition among producers.

Moreover, several non-EU countries that are important export markets for EU wines already have their own legal requirements concerning organic wine. For example, the USDA NOP in the USA which defines 'Organic wines' as wines without added sulphite or listed additives or processing aids.

Other relevant national regulations concerning organically produced wines have been developed in other non-European countries such as Canada, Japan, etc.

PRIVATE STANDARDS AND CERTIFICATION SCHEMES

In some EU Member States, private standards have been developed since 1980 for processing, packaging and preserving wines from organic agriculture, under private labels. The content of such standards, widely discussed at national and EU level, is not always consensual.

Private standards are applied in most of the European wine-producing countries, mostly supported by certifiers or producer organisations.

The differences concerning SO₂ use among the different countries and wine-producing areas might be one of the reasons why wine has not yet been regulated. But there are other reasons — such as the lack of scientifically sound data and a disagreement between the organic farming sector and the conventional wine sector.

The situation now is such that an EU legislative framework is urgently needed.

STATE OF THE ART OF OENOLOGICAL RESEARCH

Wine stability is considered as a fundamental aspect in modern oenology and, in the past, it was one of the most important objectives of winemakers. The approach in the past used for wine stabilisation was the development of 'hard' technological treatments (e.g. centrifugation) or the use of higher amounts of additives (sulphites, fining agents). Both strategies lead to the desired stabilisation, but neglected other fundamental aspects (e.g. the sensory aspects).

In recent years, rapid progress in knowledge, technologies and processes has produced new technological tools for oenologists' use, particularly concerning biotechnologies and wine chemistry. As a result of this, research moved to a compromise solution between wine stabilisation and sensory characters (flavour and taste), pushing on the development of more efficient processes and fining treatments to control the chemical stability and microbial population without affecting wine aromatic and colloidal structure. One of the main goals of the novel approach is to optimise wine stabilisation through good management of the natural biological and chemical processes (fermentation management and starter cultures, yeast nutrition, temperature control), or by introducing mild technologies (cross-flow filtration, natural enzymes, hyper-oxygenation, micro-oxygenation and oxygen management), in order to respect wine characters and preserve specific grape qualities.

Organic wine producers are following this approach as their goal is to use fewer additives than in conventional winemaking while assuring a high-quality product.

STRATEGIC OBJECTIVES OF THE PROJECT

The overall objective of the project is to provide a scientific background for the development of an EU legislative framework and a code of best practices for organic wine production and labelling.

SPECIFIC OBJECTIVES

- ▶ To identify and evaluate actual practices, standards, legislative framework, an existing environmental assessment tool and the quality status (hygienic, environmental and sensorial) of EU organic wines as well as consumers' expectations and market needs.
- ▶ To develop innovative winemaking technologies that respect the concept of organic agriculture and improve organic wine quality

Hofmann, U. (2010/11), 'Anwendung von ökologischen Verfahren und Behandlungen beim Weinausbau in Betrieben des ökologischen Weinbaus: Status Quo Analyse', *Deutsches Weinbaujahrbuch*, 61, pp. 85–97; 62.

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Rauhut, D., Micheloni, C. (2010), 'Current issues in organic winemaking: consumer expectations, producer attitudes and oenological innovation', *Managing wine quality, Volume 2 Oenology and wine quality*.

Reynolds, Andrew G. (ed.), *Managing wine quality, Volume 2 Oenology and wine quality*, Woodhead Publishing Limited, 2010, Chapter 10, p. 271–289.

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Salmon, J. M. (2010), 'Retrait du règlement européen sur la vinification biologique : risques et opportunités pour le développement de la viticulture biologique en France', *Revue des Œnologues*, No 137, September 2010, p. 8.

Salmon, J. M., Muller, C. (2010), 'Les levures suscitent le débat', *Terre & Nature* (L'hebdo Romand de la vie au vert), No 48, 2 December 2010, p. 3.

in terms of sensorial properties, hygienic profile and environmental impact.

- ▶ To test on-farm innovative and suitable technologies in order to assess their possible implementation and acceptability in significant wine production areas and for different wine and winery types, taking into account their environmental impact.
- ▶ To develop a code of best organic winemaking practices and recommendations for the development of EU regulation as well as policy support measures for the organic wine sector while ensuring a wide stakeholder involvement at all stages of the process.

SCIENTIFIC AND TECHNOLOGICAL OBJECTIVES

The reduction of sulphites in wine processing is considered as a primary objective in oenology, but actually there are no specific tools that could completely substitute this toxic additive. Such a concern becomes particularly important for organic wine production, but it is valid also for traditional winemaking.

Different strategies to reduce or to avoid the use of sulphur dioxide and of other additives not in line with the concept of organic agriculture in oenological practice were evaluated at a laboratory scale and on-farm. The principles of wine quality, conservation and stability were the guideline of the project, not neglecting consumers' health. Some of these strategies were already known, such as the optimisation of fermentation management, yeast nutrition, and starter culture use. Nevertheless, traditional technologies are often not enough to ensure the proper performance for wine evolution and quality, especially in some years or regions, where grapes could be easily affected by bad ripening conditions (e.g. *Botrytis cinerea*). In this case, the introduction of innovative tools and technologies could be useful to reduce the overall amount of SO₂ used in the production process. Different technologies are useful for this purpose, on the basis of mild and healthy criteria. Physical treatments are one of the most recent instruments introduced to control microbial populations, chemical and physical stability (reducing sulphite needs); they have a very low impact on healthy aspects, but their effects on wine quality needed to be investigated and their application was optimised for organic winemaking. Moreover, different aspects related to yeast metabolism were studied such as the reduction in sulphite, and some natural derivative products (glutathione, cysteine, lysozyme) were tested as SO₂ alternatives.

MARKET AND CONSUMERS' OBJECTIVES

The market development of European organic wines is also influenced by the realities of the global wine market. In this sense, the organic wine sector is concerned by the current debate on which type of wines are

better required by the market, with clear opposition between 'modern' and 'classic' wines.

In the last years, the market for organically produced wine has developed. Main importing countries such as the United Kingdom, Scandinavian countries, Germany and Switzerland have started to import more and more organic wines, mostly from the Mediterranean countries.

Since 2001, there has been a trend in several countries, such as Italy, towards a greater use of organic labels for organically produced grapes and wines. One of the major problems is to produce quality organic wine with a reasonable price and a large range of qualities.

In France, most of the wines coming from organic certified farms are labelled as 'wines from organic grapes'. A significant number of very famous vineyards have chosen to produce their quality wines under organic certification with denomination of origin (AOC), in order to protect and value their *terroir* (region-specific characteristics), more than for marketing reasons. On the other hand, labelling the wine as organic seems to be a competitive advantage for popular premium and premium wines.

In order to investigate the potential and needs of the market, several consultations with experts were made in the countries covered by the Consortium and in other important countries. The focus was on retail chains and specialised wine firms, which already trade organic wines. In addition, at three major wine expositions (Biofach, VinItaly, VINEXPO) traders were interviewed.

Very little was known until now about consumers' expectations of organic wine. From qualitative consumer surveys, it can be assumed that, for consumers of organic food, the health aspect has the highest importance. Regular consumers also have environmental concerns as a purchasing motive and for non-regular consumers in some countries the taste is very important, which is certainly relevant as well.

Organic wine producers, in some areas, are still facing quality image problems, in particular with regard to taste. Therefore, the quality image of organic wines was investigated as well as the response to possible labelling schemes with qualitative consumer research.

Methodology

Oenological research was conducted in laboratories first and then applied to the network of pilot farms participating in the project. The combination of laboratory and on-farm research allowed the most appropriate solutions to be selected and then to combine them on a practical level. Moreover, it facilitated dissemination and technological transfer.

For consumer and market qualitative analysis, a focus group approach and interviews (direct and online) were used.

As the primary goal was a regulatory proposal so, considering the sensitivity of the issue, a participatory approach and a broad stakeholder involvement were applied.

Main findings and outcomes (results) or expected results

The whole project produced the scientifically based background used for the *EC proposal for a regulation on organic winemaking*.

Moreover, the *Code of good practices for organic viticulture and wine-making* was produced in five languages (which can be downloaded from the project web page) where all project findings were combined for easy and fast use by practitioners.

A *tool for environmental assessment* of organic viticulture was fine-tuned and is available to researchers.

Potential applications

The scientifically based regulatory background produced by the project was used by the European Commission in the preparation and negotiation of the regulation.

Technological innovation and the adaptation of existing techniques in the organic sector were produced which are being adopted by organic producers in all EU countries. The dissemination phase (especially the use of several languages) and the participatory approach (including the participation of pilot farms) resulted in strategic follow-up and the practical use of the project outcomes.

Innovation contribution

The project was focused on combining existing knowledge and technologies and not on the production of new techniques. Nevertheless, its practical impact on organic farms and cellars was important for the implementation of a combination of traditional strategies with clean innovative technologies.

An innovative proposal was successfully tested on the issue of Ochratoxin A control: yeast spraying in vineyards. It showed promising results in the laboratory and in field applications.

Conclusions

The goals of the project were fully reached:

- ▶ recommendations for the regulatory definition were elaborated with scientific background but considering all stakeholders' needs and demands;
- ▶ the *Code of good practice for organic viticulture and winemaking* was produced in five languages and widely disseminated;
- ▶ a contribution to organic wine quality enhancement through the implementation of technology and knowledge was achieved.

The methodology used (participation of all stakeholders involved in the regulatory proposal and pilot farms' network for innovation transfer) was appreciated by producers and SMEs and facilitated the use of project outcomes.

What clearly resulted from the project are the wide differences in winemaking procedures in the many EU wine-producing areas. Thus, a more detailed experimental approach is needed to address the different needs. Moreover, a further investigation into alternatives to the use of SO₂ is greatly needed and cannot be focused only on substances/additives but must have an integrate approach where techniques, materials and additives are all considered together.

Traditional United Europe Food (traditional food production systems)

Acronym:

TRUEFOOD

Project No:

016264

EU contribution:

EUR 15 499 993

Duration:

48 months

Start date:

1.5.2006

End date:

30.4.2010

Framework programme:

FP6 (sixth framework programme)

Instrument:

Integrated Project (IP)

Coordinator:

SPREAD EUROPEAN SAFETY GEIE

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Abstract

The proposed Integrated Project (IP) aims to improve quality and safety and introduce innovation into traditional European food production systems through research, demonstration, dissemination and training activities. The project focuses on increasing value to both consumers and producers and on supporting the development of realistic business plans for all components of the food chain, using a farm-to-fork approach.

The proposed project has five main objectives:

1. identify and quantify consumer perceptions, expectations and attitudes with respect to:
 - (a) safety and quality characteristics of traditional foods; and
 - (b) innovations that could be introduced into the traditional food industry. (5 % of project effort);
2. identify, evaluate and transfer into the industry innovations which guarantee food safety, especially with respect to micro-biological and chemical hazards (20% of effort);
3. identify, evaluate and transfer into the industry innovations which improve the nutritional quality, while at the same time maintaining or improving other quality characteristics (e.g. sensory, environmental, ethical) and recognised by traditional food consumers (35% of effort);
4. support the marketing and supply chain development of traditional food products (10% of effort);
5. facilitate effective technology transfer of innovations (those developed within the TRUEFOOD projects and in other EU, national and industry funded R&D projects) into traditional food industry (30% of effort).

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European Network for the Durable Exploitation of crop protection strategies

Abstract

The overall objective of ENDURE is to (i) restructure European research and development effort on the use of plant protection products and (ii) establish the new entity as a world leader of development and implementation of durable pest control strategies. This will include a focus on rationalising and reducing pesticide inputs as well as on mitigating inherent risks through a greater exploitation of alternative technologies, and/or basing control strategies on a more cohesive knowledge of the ecology, behaviour and genetics of pest organisms.

The operational and structural objectives of ENDURE are to:

1. overcome fragmentation in crop protection research and development within Europe through the design and implementation of a joint programme of research on crop protection as well as through the creation of a virtual crop-pest control laboratory;
2. reinforce the R & D capacities needed in Europe to improve the basic understanding of the crop-pest systems and develop durable pest control strategies;
3. progress towards a transnational entity aimed at reducing pesticides inputs by encouraging durable integration of the leading European crop protection institutions, forming a nucleus of excellence around, and from which, institutions and researchers can integrate their activities;
4. create a European centre of reference for supporting public policymakers, regulatory bodies, stakeholders and extension services;
5. increase mobility of researchers and cooperative use of facilities, equipment and tools;
6. ensure the spreading of excellence and support training to facilitate the adoption of safer and environmentally friendly crop protection approaches.

ENDURE brings together the leading crop protection institutions, the worldwide association of biocontrol industries (IBMA) and benefits from the support of the European Crop Protection Association (ECPA) to build a world-leading network for the development of durable pest control strategies.

Acronym:
ENDURE

Project No:
031499

EU contribution:
EUR 11 200 000

Duration:
48 months

Start date:
1.1.2007

End date:
31.12.2010

Framework programme:
FP6 (sixth framework programme)

Instrument:
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Opportunities for farm seed conservation, breeding and production

Acronym:

Farm Seed Opportunities

Project No:

SSP-CT-2006-044345

EU contribution:

EUR 808 000

Duration:

36 + 3 months

Start date:

1.1.2007

End date:

31.3.2010

Framework programme:

FP7 (seventh framework programme)

Instrument:

Small or medium-scale focused research actions (STREP)

Project website:

<http://www.farmseed.net/> (active)

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Summary

The strict rules for the marketing of seeds (Council Directive 98/95/EC ⁽¹⁾) combined with the small market niches for landrace varieties have threatened the conservation of local varieties and agrobiodiversity. In preparing the EU directive facilitating the certification and marketing of seed in the interest of conserving plant genetic resources, Farms Seed Opportunities will contribute to the enlargement of the market of local varieties by setting up a science and marketing-based framework involving all relevant actors.

To achieve this objective, Farm Seeds Opportunities will:

- (i) characterise the requirements of the different stakeholders with regards to the diversity of varieties derived from the on-farm conservation/management/breeding and of regional agricultural systems in Europe;
- (ii) identify bottlenecks and challenges for participatory on-farm breeding and seed production;
- (iii) develop methodologies, combining scientific approaches and farmers' know-how, suited to targeted improvements of conservation, breeding, seed production and marketing;
- (iv) provide practical recommendations for the decision-making processes relating to the market release of seeds of landraces, conservation and amateur varieties;
- (v) provide a practical framework for the protection and promotion of landraces, conservation varieties and amateur varieties, especially issued from the participatory plant breeding and small scale breeders;
- (vi) provide society at large with adequate information about scientific results and ongoing research in order to answer society's legitimate demand for locally produced food and the preservation of endangered agrobiodiversity and to stimulate its involvement in decision-making;

1 Council Directive 98/95/EC of 14 December 1998 amending, in respect of the consolidation of the internal market, genetically modified plant varieties and plant genetic resources, Directives 66/400/EEC, 66/401/EEC, 66/402/EEC, 66/403/EEC, 69/208/EEC, 70/457/EEC and 70/458/EEC on the marketing of beet seed, fodder plant seed, cereal seed, seed potatoes, seed of oil and fibre plants and vegetable seed and on the common catalogue of varieties of agricultural plant species, OJ L 25, 1.2.1999, p. 1.

- (vii) provide several regulation scenarios to cover most of the described situations in Europe according to the market, the farmers and the breeders' needs and rights taking in account the experimental data on the status of varieties and seed qualities — these scenarios, from the adaptation of the current DUS (Distinctness, Uniformity and Stability) regulation to the proposition of new legislations, will necessarily reflect the diversity of the varieties, their use and breeding methods.

The Consortium brings together six European countries to cover a great variability of regional characteristics. Combining scientific competences and farmers' knowledge will enable, in a participatory innovation approach, the development of on-farm plant breeding and genetic resources management.

Problem

Farm Seed Opportunities (FSO) was conceived to support the implementation of seed regulations on conservation varieties (Directive 98/95/EC and Commission Directive 2008/62/EC for agricultural species ⁽²⁾). For this purpose, FSO has been developing coherent definitions of the different kinds of varieties cultivated in farm fields following a survey and evaluation of practices at the national level. Even though the project aims mainly at responding to the needs of European policymakers, it will also significantly contribute to the recognition of the role of farmers in conserving diversity through the use of landraces and the breeding of new varieties. FSO took into account participatory plant breeding (PPB) experiences for organic or low-input agriculture, with the goal of proposing regulation scenarios that recognise and encourage on-farm varietal innovation and selection.

Background and objectives

Since 1900, as modern plant breeding practices were increasingly adopted, these variable landraces were gradually replaced by more uniform cultivars that often had higher yields. The industrialisation of agriculture has changed our vision of fields and plants, both for scientists and farmers. The standardisation and homogenisation of agricultural production, the increasing use of chemical inputs and water, and the standardisation of the market are the main pillars of what we define as agricultural modernisation. Alongside these dominant conventional agricultural practices, an agriculture strongly connected to its environment has been preserved and is now re-emerging in Europe. This alternative

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² Commission Directive 2008/62/EC of 20 June 2008 providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties, OJ L 162, 21.6.2008, p. 13.

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Bocci, R., 'Seed Legislation and agrobiodiversity: conservation varieties', *Journal of Agriculture and Environment for International Development*, 2009, 103 (1/2), pp. 31–49.

Osman, A., Chable, V., 'Inventory of initiatives on seeds of landraces in Europe', *Journal of Agriculture and Environment for International Development*, 2009, 103 (1/2), pp. 95–130.

Chable, V., Bocci, R., 'Peasant seeds in Europe: stakes and prospects', *Journal of Agriculture and Environment for International Development*, 2009, 103 (1/2), pp. 81–93.

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agriculture is based on different varieties than conventional agriculture, varieties with strong local adaptation. In effect, locally adapted varieties, old landraces and mixed populations play a more important role in organic than in conventional agriculture.

The development of low-input or non-conventional agricultural practices is also related to the diversification of public demands, in particular for organic farming and local products. These agricultural systems are based on varieties covering a wide range of genetic states and categories, for which the criteria of stability and homogeneity are not intrinsic qualities and are not necessarily required. Moreover, the shortcomings or unsuitability of conventional varieties with respect to the needs of organic farming has stimulated several PPB initiatives for organic farming. PPB varieties can be bred from diverse genetic resources using breeding methods that are in compliance with the IFOAM (International Federation of Organic Agriculture Movements) draft standards for organic plant breeding. Their main characteristics are the ability to adapt and co-evolve within the environment and with farmers' practices and needs.

The overarching objective of FSO was to contribute to the enlargement of the market of local varieties by setting up a science and marketing-based framework involving all relevant actors. To achieve these objectives, the consortium proposed a participatory approach of breeding and seed production in Europe to provide practical recommendations for the preparation of the directive to facilitate the marketing of seeds of landraces, conservation and amateur varieties.

Methodology

FSO has characterised stakeholder expectations through a survey, in the consortium's partners' countries and will describe the European 'variability' among the local features of landraces, conservation and amateur varieties. FSO has also illustrated the specified notions (e.g. local adaptation and the threat of genetic erosion) of the EU regulations on conservation varieties (Directive 98/95/EC and Directive 2008/62/EC for agricultural species). The countries involved in the project (Spain, France, Italy, Netherlands, Switzerland and the United Kingdom) represented the diversity of the situations in north and south Europe. The expertise has been supported by the partners, who are already involved in genetic resources, on-farm breeding and/or participatory plant breeding with farmers' networks using all kinds of landraces and local varieties. The market and/or the specific agricultural valorisation of these varieties were also represented by several partners, either by organic research or farmer organisations (FR, IT, NL, CH), either by networks for peasant seeds (ES, FR). The international expertise was provided by IIED (UK) who are involved in participatory action research in developing countries.

FSO studied methodologies for on-farm maintenance and breeding through a trial involving three countries (FR, IT, NL). Participatory on-farm research has recently been developed in Europe. The partners (researchers and farmers' organisations) are pioneers in participatory organic plant breeding in their countries (FR, IT, NL, ES, CH). Their experience in on-farm maintenance and breeding has been shared and widened in common experimentation of the involved varieties. This experimental approach of landraces, conservation and amateur varieties has determined their features and quantified their evolution in a real context of on-farm breeding. FSO has established common concepts needed for the understanding of the evolution and the adaptation of the varieties bred on-farm.

FSO identified key technological and economic constraints in seed production and marketing in the existing European initiatives on production and marketing of landraces, conservation varieties and amateur varieties and then proposed the development of methodologies for seed production and marketing in a participatory innovation development approach, involving all relevant actors.

FSO integrated the results of the previous actions. For policy interest, we will manage several means to broaden the debate about policy propositions, which will be developed by the partners and invited experts. The international interest on seed regulation will also stimulate debate at IFOAM and FAO (Food and Agriculture Organisation of the United Nations) level. The opportunity of the General Assembly of IFOAM in Italy, planned in 2008, will be exploited. FSO will also reach out to the public and answer their questions on the need to preserve endangered agrobiodiversity and the growing interest in food quality and diversification. Several media (website, CD-ROM, Newsletter, etc.) will be conceived to reach a broad audience.

Main findings and outcomes (results) or expected results

In the framework of the Farm Seed Opportunities project, the research activities and the dissemination of the results were organised into four work packages.

WP 1: DETERMINATION OF STAKEHOLDER EXPECTATIONS

WP 1 contributed, on the one hand, to a better knowledge of the seed context in its diversity in Europe and, on the other hand, performed a thorough analysis of the current regulations. The terms 'landrace', 'local variety', 'traditional variety', 'conservation variety', 'peasant/farmers' variety' and 'population variety' are often used interchangeably, and one of the goals of FSO was to bring greater clarity to the definition of these categories with the goal of developing appropriate policies. We have also

Bocci, R., Chable, V. (2009), 'Farm Seed Opportunities: Seed regulation scenarios for Europe', *Breeding Diversity, Proceedings of the First IFOAM Conference on Organic Animal and Plant Breeding*, Santa Fe, New Mexico, United States, 25–28 August 2009, pp. 264–268.

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Pimbert, M. (2011), *Participatory Research and On-Farm Management of Agricultural Biodiversity in Europe*, IIED, London, United Kingdom.

Bocci, R., Chable, V., Kastler, G., Louwaars, N., 'Farm seed opportunities, recommendations for on-farm conservation in Europe', *Agrobiodiversity Conservation: Securing the diversity of Crop Wild Relatives and Landraces*, CABI.

illustrated the specific ideas, described in Directive 98/95/EC (e.g. local adaptation and the threat of genetic erosion).

The project characterised stakeholder expectations through a survey in the consortium's partner's countries. The expert survey among stakeholders of the marketing chain of conservation products was conducted to provide an overview of the types of stakeholders related to the subject of the project, and to report on stakeholder expectations of bringing biodiversity to the market/niche markets, including added value and volume. The report also aimed at providing stakeholder point of views on ethical aspects of breeding methods (e.g. GMO, hybrids v open pollinated varieties).

Partner institutions of five countries (Spain, France, Italy, Netherlands and Switzerland) conducted interviews with 33 experts from 27 organisations active in the marketing of conservation plant crops. The 101 questionnaires were returned and analysed at the Research Institute of Organic Agriculture in Frick, Switzerland. The most important findings were that most initiatives working with conservation varieties are rather small and still in a start-up phase; they work with highly motivated, but scarcely financed staff, and depend partly on funding from private or, most often, public donors. Marketing of conservation products has great opportunities and product launching is relatively easy and with minor economic risk. However, the profitability of the products is relatively low, due to small-scale economies. A majority of the marketing project focused on covering niche markets and tried to combine product marketing with sensitisation and the raising of awareness of the consumers of the problem of genetic erosion. Most initiatives try to place the products in the premium price segment and combine it with premium cultivation labels, such as organic production. Important factors of the marketing strategies are inner qualities, such as taste of the products and a high product image which can be clearly differentiated from mainstream products.

WP 1 analysed the matches and mismatches between the Directive on conservation varieties with current practice in the conservation and use of varieties and landraces that are not included in national (and EU) variety lists. This study, therefore, aimed at analysing whether the Directive may be considered a contribution to the conservation and continued on-farm use of a wider array of field crop varieties, or that the regulations may curtail current practise. The last aspect of WP 1 was the analysis of diversity issues in varieties that may not fall within the definition of 'conservation variety' developed through non-conventional breeding methods (e.g. multi-lines, populations/hybrids of non-inbred parents), and the concept of 'farmers' new varieties' derived from farmer breeding or participatory breeding initiatives.

WP 2: IMPROVING MAINTENANCE AND BREEDING

The first task established realised a first inventory which resulted in some 40 initiatives in 15 countries, which, after completion by FSO partners, resulted in additional initiatives. The initiatives were divided in five different groups: (i) farmer breeders; (ii) biodynamic breeders of landraces; (iii) seed producers; (iv) seed savers; (v) *in situ* conservation initiatives. The first three groups are involved in breeding, while the last two try to conserve landraces.

On-farm field experiments were conducted with several kinds of varieties, landraces, old varieties and new farmers' varieties, during the three consecutive years of the project (2007–09) with the objectives of assessing the evolution/adaptation over time and space of these varieties when they were moved from one environment to another. These experiments were carried out in the France, Italy and the Netherlands with 30 farmers.

A large experiment of 25 trials on four species (wheat, maize, bean and spinach) started in 2007 (or autumn 2006 for bread wheat) and lasted three years in the three countries. In 2009, an additional common trial was conducted on one site (Le Rheu experimental station) under an organic farming system. This allowed the comparison of all versions of the varieties that have been grown on-farm for two generations with the initial samples (or other reference samples). Each species underlined a specific aspect of plant breeding/on-farm conservation. For maize and spinach, mass selection was applied by the farmers which allowed characterisation of the effect of the farmers' selection and practices. For beans, various breeding strategies have been developed by the farmers illustrating the diversity in the way farmers interact with the varieties. For wheat, very little or no selection was applied by the farmers, which led to the assessment of the effect of natural selection/adaptation within each environment.

FSO's original and extensive experiment based on four crops and vegetable species allowed an accurate characterisation of varieties' evolution over time in response to drastic environmental changes and contrasted farmers' practices on-farm, to be obtained. Overall, after only 2–3 years of on-farm growing, evolution over time appeared significant for many traits assessed both on-farm and in-station. The significance and range of evolution depended on the varieties, the farmers' practices and farm environmental conditions, and the trait. Although lower, this trend was also found for modern DUS varieties. Yet, all varieties stayed distinct based on multivariate assessment. Bottlenecks and challenges in relation to seed regulation were identified and propositions for scenarios were made.

- Distinctiveness: Distinction among varieties using phenotypic observations (in the field or on harvested grains/material) was always possible. This was true even in the presence of strong

GxE interactions which modified phenotypes from one farm to another and even when varieties appeared heterogeneous. The landraces were more diversified than the varieties registered in the official catalogue.

- ▶ **Homogeneity:** The UPOV (International Union for the Protection of New Varieties of Plants) protocols define homogeneity as a percentage of 'off-type' plants; this seems difficult to apply in the case of landraces, population or new farmers' varieties. In the FSO experiment, measures on individual plants for each variety and in each trial were used to assess the level of homogeneity within each variety. For a few criteria (e.g. plant height for wheat), the varieties registered (official catalogue) were much more homogeneous than the landraces. However, for the majority of phenotypic traits measured, under on-farm conditions, the level of intra-varietal heterogeneity was comparable among landraces and modern varieties. Thus, based on the FSO experimental results, the standard of homogeneity as understood in UPOV and the official catalogue is not relevant and does not make sense when varieties are observed and described on-farm under organic or low-input conditions.
- ▶ **Stability in space:** A single initial variety, cultivated in contrasting environments (France/Italy/the Netherlands) could (i) perform differently depending on the environment (GxE interactions) and (ii) evolve in a different manner in each environment depending on environmental and cultural conditions in the course of only two years of differentiation. Landraces were neither more nor less 'stable' than modern varieties over the six farms in terms of GxE crossover interactions.
- ▶ **Stability in time:** In the common experiment at le Rheu in 2009 as well as in the on-farm experiments, we found that for most of the characteristics measured, phenotypic expression had changed. Thus, 2–3 years of cultivation in contrasting conditions appeared to induce variations in phenotypic expression, including the catalogue varieties. Despite these changes in quantitative traits, however, each variety remained distinct and recognisable. Some farmers explained that it takes 4–5 years for a landrace to adapt to the conditions on their farm; after this period, the population's performance stabilises for agronomic traits, even while it stays heterogeneous at the individual plant level. The length of this project did not allow the evaluation of this facet of phenotypic stability in farmers' fields, but this 'stability' (buffering capacity) due to diversity (not the same as the UPOV definition of stability) remains a major reason for using landraces. Utilisation of the UPOV criteria of homogeneity and stability therefore appears to us to be inappropriate for describing conservation varieties or any other variety cultivated in situ; only the distinctiveness criteria appears to be useful and is not called into

question by either the non homogeneity or the non-stability of these varieties.

- ▶ Limited geographical zone: Some landraces gave very good results, sometimes even superior results, for certain productivity traits outside their zone of 'origin' or 'natural adaptation'. Therefore, limiting cultivation of these varieties to a narrowly defined geographic zone would limit farmers' choice of, and access to, potentially interesting landraces and historic varieties. In addition, the reduction of permitted cultivation to a legally defined geographic zone for conservation varieties would increase genetic erosion in these varieties both by limiting population numbers and sizes and by limiting the range of environmental conditions to which the variety is exposed (thus impeding their evolutionary potential).
- ▶ Genetic erosion: The results of a study conducted on the dynamic management of wheat populations (INRA) showed that a network of on-farm sites can maintain the overall genetic diversity as long as the sites and cultivation practices are diverse (meta-population principles). Another study on the *Rouge de Bordeaux* variety, conserved in the French Peasant Seeds Network RSP, showed the complementary nature of *in situ* dynamic management and conservation in the national gene bank. While samples conserved in the gene bank only captured and maintained a small part (often a single genotype) of the diversity initially present in a landrace, the evolution and adaptation that can develop after many cycles of cultivation *in situ* in contrasting conditions permits the diversification and the maintenance of the evolutionary potential of a variety.

The last task provided an overview of innovative participatory methodologies and approaches that can be used in on-farm conservation and management of agricultural biodiversity in Europe. A final report summarising lessons learnt from FSO (and other) experience in participatory on-farm management of agricultural biodiversity was prepared. Particular attention has been paid to how — and under what conditions — participatory plant breeding and seed production can be more widely encouraged in Europe. The analysis was based on observations from the FSO project as well as other case studies and the wider literature.

In recent years, there has been a rapid expansion of new participatory methods and approaches in the context of Participatory Plant Breeding/Participatory Varietal Selection (PPB/PVS) and, more generally, in agricultural research and development. These have drawn on many long-established traditions that have put participation, action research and adult education at the forefront of attempts to emancipate disempowered people. Effective use of these participatory methodologies often depends on the existence of platforms that bring relevant actors together to mobilise capacity for social learning, negotiation and col-

lective action for research into the management of agricultural biodiversity. Platforms range from farmer networks to farmer field schools and/or project partnership, as in the case of FSO. For both scientific and technological research, as well as the evaluations of PPB/PVS research products and impacts, a suite of methods for participatory inquiry can be combined in different sequences. Recommendations were made to the EU on how to improve the design and management of projects on participatory plant breeding, participatory varietal management, and other innovative methodologies in Europe.

WP 3: IMPROVING SEED PRODUCTION AND MARKETING

FSO made an inventory of farmers' practices in seed production and investigated the quality of the seed. The results of analytical purity (according to ISTA standards) for wheat are satisfactory, with most lots meeting the EU norm of 98 %. For maize and beans the purity is almost always near to 100 %. It was observed, however, that many farmers lack the possibility to clean their seed properly. Seed cleaning equipment and drying facilities are expensive, so farmers sometimes do this collectively. In the case of farmers producing flour or bread from their harvested grain, they are aware that it is of great importance to clean the grain properly in order to protect consumers from poisonous weed seeds or contaminants such as ergot.

The germination of a seed lot is expressed as the percentage of normal seedlings. In maize, but also in wheat and spinach, the germination results were mostly above the minimum norm. There is a difference between seeds from the trials and seeds produced by farmers for their own use. This is due to the set-up of the experiments, in which farmers participating in the trials harvested the plants as they were without further selection, allowing genetic drift to occur. This was how some farmers perceived the nature of the experiments: others selected within the plant population. As a result, the quality of the seed produced and replanted in the FSO experiments was quite variable. The seeds of maize and spinach also met the minimum norm in most cases, unlike beans, a notoriously difficult species to produce.

Here, we have to make some observations. Producing well-germinating bean seeds is more difficult than for most other vegetable species. This is due to the nature of the seed, having high oil and protein content, their size, their vulnerability, their natural enemies, etc. So therefore the EU norm has been put at 75 % in order not to have shortages of seed. This is also the reason why many (amateur) farmers normally plant three or four seeds in one hole, to compensate for non-germinating seeds. The initial seeds given to these farmers apparently already contained diseases, making it almost impossible to produce good seeds. Surprisingly, and maybe due to selection by the farmers, the crops in years 2 and 3 looked much healthier.

The object of the seed health test is to determine the health status of a seed lot (ISTA 2010). This is done by estimating the presence of pathogens present on or in the seeds. These pathogens may or may not give rise to disease development in the field, very much depending on the genetic background of the seed (tolerance or resistance), the environmental conditions during crop establishment and growth, and the crop management used. Disease management is an important aspect of crop growing and equally important for low-input and organic agriculture. In order to have the best possible performance, it is important to start with seed that is free of pathogens as far as possible.

For wheat, the majority of farmers produced lots with a low infection level. The test results (with and without hypochlorite) indicate that it is necessary to take extra measures, such as specific seed treatments, for example, the use of natural plant products or hot water treatment to remove or neutralise the inoculum. The presence of *Fusarium*, but especially of *Nigrospora*, is problematic because of the production of mycotoxins. A hypochlorite treatment on grain for food purposes is undesirable, however. It is important that farmers are aware of this problem. Indeed, the farmers who are using the grain for producing bread which they sell directly to consumers take particular care when handling the grain for that purpose.

For beans, the present results (of both germination and seed health) have been obtained from the trials and it must be acknowledged that many farmers are actually specialised in wheat growing, not in bean seed production. Moreover, the initial seed given to these farmers apparently already contained diseases, making it almost impossible to produce good seeds. Surprisingly, and maybe due to selection by the farmers, the crops in years 2 and 3 looked much healthier. This is in part corroborated by the virus and bacteria analyses of later years. This demonstrates the difficulties encountered in bean production. Farmers are aware of this, and some specialise in bean production, while others stay away from it. Beans are recognised as a species that requires special skills and attention.

The conclusion was that farmers are able to produce seeds up to EU standards. Seed production needs special skills, and farmers are using their networks to improve these. Projects like FSO are needed to generate exact figures and to provide guidelines for future activities. The presence of diseases on grains needs special attention. Part of the analysed seed samples came from the WP 2 trials which aimed to assess the adaptation process of varieties when they are moved from one environment to another. These were not representative of the farmers' usual procedure for seed management. Yet, this protocol has allowed the impact of this environmental change on crop performance as well as on seed quality to establish.

WP 4: INTEGRATION, DECISION MAKING SUPPORT AND OUTREACH

One of our objectives was to share partners' view and outcomes with other experts and stakeholders from countries not included in the project and particularly southern countries. This exchange took place during the Marseille International Conference in October 2009. The methodology adopted was to have an in-depth discussion during the International Conference, specifically about the impact of different seed laws on on-farm conservation and participatory plant breeding. The results of this task have been integrated in the Deliverable 4.6 'Set of recommendations about on-farm conservation strategies'. The need to have an exchange of experiences between different countries was confirmed during the International Conference. In fact, only through this sharing of knowledge and experiences was possible to develop innovative ways for on-farm conservation. This aspect could also be useful for future projects dealing with plant genetic resources conservation and breeding.

We analysed the possible links between plant genetic resources (PGR) conservation (one of the aims of the new rules on conservation varieties) and marketing tools for the so-called biodiversity produce. Indeed, one of the activities pointed out by the Global Plan of Action for the sustainable use of PGR is 'Developing new markets for local varieties and diversity rich products'. The development of instruments geared toward a sustainable use of PGRFA (Plant Genetic Resources for Food and Agriculture) includes appropriate relationships with the market and strategies for the valorisation of the produce.

One task produced a report on the analysis of relevant cases studies on the role of innovative market promoting the sustainable use of agrobiodiversity with a collection of case studies from Spain, Italy, France and the Netherlands aiming to show the link between conservation, use and valorisation. Particular attention was paid to the impact of innovative marketing on local varieties and cultural diversity. Particular emphasis was also paid to the link between geographical indications and plant genetic resources conservation, finding a bridge between the different tools and policies developed by the European Union. A survey pointed out that many GIs included in the EU catalogues are based on local varieties that are not listed in the official catalogue of varieties. It means that, at least from a legal point view, the seed of these varieties should not be commercialised or traded. On the other hand, we found that GI legislation could fit very well with the new directive on conservation varieties, at least for some of our case studies: the former protecting and valorising the market of the produce, the latter the market of the seeds. It was a qualitative analysis, but it could be useful for suggesting future connections between seed laws and niche markets of biodiversity produce. In fact, in our literature survey, we found very few studies on the link between the conservation of PGR and geographical indications.

The central task was the analysis of the varieties cultivated in Europe and the *proposition of legislative scenarios, which should take into account all kind of these varieties*. FSO found that space is missing in Europe for non-uniform and non-stable varieties, mainly population varieties, or farmers' varieties, which could be very relevant for the maintenance of food tradition and organic and low-input farming systems. We have collected and integrated the output from previous WPs and deliverables. The preliminary outcomes were submitted to experts. FSO reports painted a broad picture of the variety and seed situations in Europe. The first and foremost result is that **Europe is still full of diversity**, at cultural, environmental, climatic and farming level. Even if the formal system tends to impose its norms and modernisation through regulations, it fails to answer to the diversity of the European farming systems. For that reason, many farmers — mainly in alternative farming systems — don't find the seed they want through the formal seed system.

Traditional (or 'informal') seed systems still remain and innovation appears within these systems, based usually on traditional or local varieties. Even if agricultural modernisation has changed the landscape of Europe in the last 40 years, non-marketable seeds still have their place in agriculture from the economic point of view (Deliverable D.4.4 'National survey on the role of innovative markets'). FSO found that alongside the dominant conventional agricultural practices, a different agriculture strongly connected to *terroir* (a French word that refers simultaneously to the soil, climate and cultural values of an area) has been preserved and is now re-emerging in Europe. This alternative agriculture is based on different varieties to conventional agriculture, varieties with strong local adaptation. **Moreover, locally adapted varieties, old landraces and mixed populations play a more important role in organic than in conventional agriculture.** In addition, quality aspects linked to specific regional or handcrafted products are generally important in alternative agricultural systems, and are often responsible for the preservation of local varieties.

Finding a right balance between formal and informal seed systems within the European context should be one of the objectives of a regional strategy for on-farm conservation of plant genetic resources for food and agriculture. Such a strategy will also concretely address the implementation of Article 6 on sustainable use of PGR in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). We remind readers that this article is mandatory for Contracting Parties and concerns all crops and not only to these listed in Annex I, as, for example, in the case of the Multilateral System.

Moreover, it will ease the debate on farmers' rights at regional and international level due to the fact that many actions included in Article 6 are also in strict relation with Article 9. The promotion of the use of local varieties and underutilised species can be considered a way of protecting of

traditional knowledge (Article 9.2(a)). Increasing farmers' options through participatory plant breeding could be considered a non-monetary benefit sharing measure (Article 9.2(b)). Therefore, an integrated on-farm strategy that includes informal seed systems and their varieties should consider the promotion of Participatory Plant Breeding (PPB) strategies to help farmers fulfil their needs: helping farmers to access the genetic resources and broadening the range of available species are all actions aiming to bring compensation in the farmers' favour. For this reason, Article 9.2(b) can be considered close to Articles 6.2(b)–(d) concerning research promotion, participatory plant breeding and farmers' access to the genetic resources. Finally, promoting diversified agricultural systems (Article 6.2(a)) through policies that support informal seeds system will enhance farmers' role on seeds exchange, reuse and selling in agreement with Article 9.3.

In this framework, the on-farm strategy should allow the presence at nearby markets (local market or direct selling) of the varieties identified by FSO and, at the same time, the means to avoid creating opportunities for the diffusion of poor quality varieties on commercial markets. To this goal, the role of networks or associations could be a key element in order to set up a bridge between formal and informal seed systems. The latter, as already pointed out, is a specific system based on social norms: trust, reputation and reciprocity govern it. Therefore, enhancing the role of social networks could improve the quality of the informal seed system. In this regard, the directives on conservation varieties open a new interesting possibility, for the first time allowing organisations to have a role within seed legislation (Article 34 of Directive 2009/145/EC ⁽³⁾ and Article 21 of Directive 2008/62/CE). Specific attention should be paid to monitoring the process of notification to the Commission of the recognised organisations.

Finally, we would like to stress the importance of such a strategy, not least because 'it is impossible to replace farmers' seed systems completely and it would be unwise to try. Farmers' seed systems provide an important component of food security, a vital haven for diversity and space for further evolution of PGR' (FAO, 2009).

Since the directives on conservation varieties have already been published, we will only summarise the limits of their applicability. For the population varieties and farmers' varieties we will make suggestions.

Potential applications

Our results may find applications at several levels:

3 Commission Directive 2009/145/EC of 26 November 2009 providing for certain derogations, for acceptance of vegetable landraces and varieties which have been traditionally grown in particular localities and regions and are threatened by genetic erosion and of vegetable varieties with no intrinsic value for commercial crop production but developed for growing under particular conditions and for marketing of seed of those landraces and varieties, OJ L 312, 27.11.2009, p. 44.

- ▶ our propositions are the basis for further discussions to support seed regulation evolutions; the stakeholder and expert consultations show the difficulties in implementing the seed regulations on the 'conservation varieties';
- ▶ our experimentation pointed out the great potential for evolution of the cultivated populations over a short period; interest in adapting them to different environments is particularly valuable for organic agriculture.

Innovation contribution

Our work has formed the basis for the evolution of scientific and legislative support to all the activities which promote seed production and breeding on-farm. The lack of adapted varieties on the market has encouraged farmers and scientist to organise participatory plant breeding.

Conclusions

The objectives of the project were reached: definition of the concepts, description of the diversity in matter of variety, seed system, and agricultural system in Europe.

For the future, efforts are to be continued; some topics have been taken in hand by SOLIBAM (Strategies for Organic and Low-Input Breeding and Management) 2010–14:

- ▶ the discussion about our propositions and their coherence with other regulations will be pursued with relevant actors such as scientists and policymakers (at national and European levels);
- ▶ the mechanisms of adaptation are too precise from a genetic and epigenetic point of view; this approach is undertaken with landraces and farmers' populations trialled during FSO project;
- ▶ the diversity of situations and needs is considered in SOLIBAM, in which the diversity of processes and organisation for the creation of new varieties for organic agriculture are tested and compared.

There remain other scientific areas which need specific support: our observations on the matter of seed health of beans suggested a question about the role of microorganisms and their diversity in the process of adaptation of the plants; the pioneers of organic agriculture pointed out the great importance of the life in the soil to promote the good health of the culture. Furthermore, recent publications have shown the role of viruses in the evolution of living beings. Further research is necessary to better understand what the role of disease is in the adaptation process and thus help farmers involved in PPB activity.

Economic analysis of certification systems for organic food and farming

Acronym:
CERTCOST

Project No:
207727

EU contribution:
EUR 2.73 million

Duration:
39 months

Start date:
1.9.2008

End date:
30.11.2011

Framework programme:
FP7 (seventh framework programme)

Instrument:
Small/medium-scale focused research project

Project website:
<http://www.certcost.org/> (active)

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Summary

CERTCOST aims at combining the experience and knowledge of researchers and small and medium-sized enterprises to analyse how organic certification systems are implemented. Moreover, this project proposes to estimate all relevant expenditures or transaction costs for different certification systems along the organic food supply chain. Using data on consumers' recognition and willingness to pay for different organic logos and trademarks, the project will analyse benefits of certification. And finally, the project will recommend to the European Commission, national competent authorities, and private actors how to make organic certification more efficient and cost-effective.

The project has shown that the implementation of the organic certification systems in different European countries varies substantially — and to a degree that sometimes impedes comparison and quantitative analysis. A further study and development of organic certification would be highly desirable in order to make further scientific contributions to a reliable, coherent and cost-efficient organic certification system.

Problem

With the ongoing growth of the organic sector and the spread of organic production across the EU, the field of organic certification has become a maze of competing labels and logos. This diversity reflects the specific conditions in different regions and countries, but can also lead to confusion for producers and consumers, as well as create a variety of costs. It is imperative to conduct a comprehensive economic analysis of the variety of existing certification systems and their impact on the internal European market for organic food.

Background and objectives

The overall objective of this project is to provide research-based recommendations to improve organic food certification systems in Europe in terms of efficiency, transparency and cost-effectiveness. This is likely to strengthen the competitiveness of the European organic food sector because it will reduce incidence of non-compliance and as a result increase consumers trust.

The overall objective will be broken down into the following key objectives.

1. To provide baseline information on the organic certification systems and standard-setting procedures within the EU and associated European countries (Switzerland and Turkey). This includes a database on key data, a review of relevant international regulations, an overview on publicly available prices, an estimate of the size of the certification sector, and a further development and refinement of the existing theoretical and conceptual framework for the economic analysis of organic certification systems (Work Package 1 (WP 1)).
2. To analyse the implementation of organic certification systems and to assess all relevant expenditure and transaction costs for different certification systems along the organic food supply chain, in various regions of the EU, as well as Switzerland and Turkey (WP 2).
3. To investigate the main benefits of certification systems, both qualitatively and quantitatively, in terms of image, consumers' recognition, and willingness to pay for different organic logos and trademarks with their underlying production standards and certification procedures in various regions of the EU, as well as in Switzerland and Turkey (WP 3).
4. To develop and apply economic models that:
 - (a) improve risk-based certification systems; and
 - (b) allow costs of certification systems to be related to the gained benefits (WP 4).
5. To develop recommendations to the European Commission, national competent authorities, and private actors how to make organic certification more efficient and cost-effective. These recommendations will serve as a basis for optimising the current certification system in the European Union (Reg. EC 834/2007) and Switzerland (SR 910.18) (WP 5).
6. To include stakeholders' views in the assessment of organic certification systems and to share the project results with them and the public (WP 6).

Methodology

The project structure represented in Figure 1 closely follows the objectives outlined above: each work package addresses one of the objectives. However, there is a clear link between the objectives and thus between the work packages.

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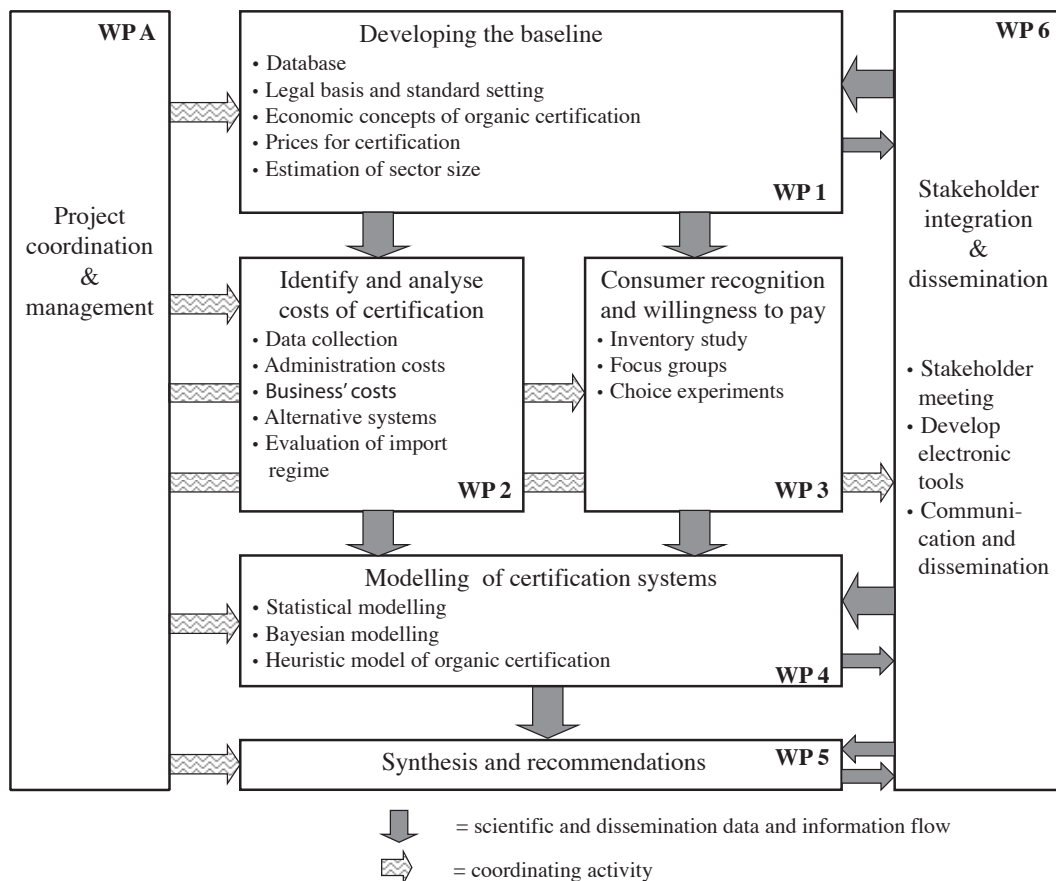


Figure 1: Overview of project work packages

Based on the framework developed in WP 1 to structure the description of the organic farming certification systems, the total expenditures and transactions costs will be identified and quantified for different fields and levels of certification in the following work package (WP 2). WP 3 deals with consumer perceptions of standards and labels. Using the information and data collected in these work packages, statistical and heuristic models will be developed in WP 4 for the elaboration of recommendations to increase the efficiency of organic certification schemes. WP 5 then draws recommendations and WP 6 comprises the involvement of stakeholder input and dissemination of project results to important stakeholders and the public.

Main findings and outcomes (results) or expected results

The following are the main results achieved so far.

- ▶ A new user-friendly database on actors involved in the certification chain in 19 European countries (including Turkey) is publicly available online (<http://www.organicrules.org>).
- ▶ The most important European and international legislation that set the framework for organic certification has been reviewed in the public report *The European regulatory framework and its implementation*.
- ▶ Economic theory is applied to organic food products, including a glossary of certification terms and a presentation of the formation of the organic certification system. This is conveyed in the public report *Concepts of Organic Certification*.
- ▶ The control and certification bodies' records are particular heterogeneous with regard to (i) the kind and level of detail of data which is gathered and stored electronically and (ii) the format and structure of how the data is recorded. This is shown in a public report on the availability of inspection data from five EU and two non-EU countries, which has been prepared for Commission Services and other programme participants — *Organic certification in selected European countries*.
- ▶ To increase the efficiency of the system, a better coordination and cooperation among control bodies is required. This is suggested in a CERTCOST survey on administrative costs.
- ▶ A market inventory shows that the three most frequent kinds of organic certification logos occurring on products across the study countries are national governmental logos, logos of farmers' associations and their umbrella organisations, and logos of certification bodies.
- ▶ There are only a few significant price differences in each country between products of different certification schemes. This is revealed in a CERTCOST analysis.
- ▶ A Focus group study revealed: in all study countries, the participants' knowledge of organic standards was generally low. Most of the participants in Italy, Turkey and the United Kingdom had no preference for any particular standard or logo, whereas in the Czech Republic, Denmark, Germany and Switzerland, some or more people stated a preference for products of a particular certification scheme.
- ▶ There are statistically significant differences between control bodies with regard to control and sanction behaviour. This is shown in an exploratory analysis of supervision data of the German organic system.

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- ▶ Intensive communication with stakeholders has taken place, which has generated implications for the project schedule and project work.
- ▶ Electronic communication tools for internal and external communication, project management and dissemination have been developed, including the CERTCOST newsletter.

EXPECTED FINAL RESULTS AND THEIR POTENTIAL IMPACT AND USE

The project will contribute to greater efficiency of the certification system, better regulation, and increase in the competitiveness of the European organic farming sector by:

- ▶ providing important knowledge on the certification sector, which is not currently available;
- ▶ evaluating suggestions and promising examples;
- ▶ investigating the regulatory requirements on inspection frequency and the relative efficiency of different certification approaches allowed by the EU;
- ▶ providing a framework of economic thought specially adapted to the organic certification sector;
- ▶ estimating the costs of the different types of certification system involved;
- ▶ a thorough scientific analysis of non-compliance and reasons thereof;
- ▶ a better understanding of consumers' view on market differentiation by means of standard-setting and logos within the organic sector;
- ▶ systematic feedback from stakeholders on the new import regulation and a number of other aspects of the system;
- ▶ contributing to a decrease in certification cost;
- ▶ indicating potential risk factors in the certifying process to implement risk-based certification;
- ▶ enhancing the trust of the European consumer in the European certification system;
- ▶ developing sophisticated tools to enhance the efficiency within the certification business;
- ▶ providing, for the first time, sound information on consumers' perception of differentiated, organic logos, which can be used for marketing purposes.

Potential applications

Project results will be, and already are, used and applied by different stakeholders in the organic certification sector: Certification bodies, competent authorities, the European Commission.

Innovation contribution

The overall approach of the project is innovative, as little research has been done on the issue of organic certification. Methodological innovations include contributions to risk-based certification systems by Bayesian Belief Networks and different econometric models.

Conclusions

The project is currently in its final phase. Many project objectives have already been reached and it is foreseeable that the final outcome of the project will be as foreseen. Baseline knowledge on the organic certification sector has been established and a number of different aspects of the systems have been thoroughly investigated. The project showed specifically that the implementation of the organic certification systems in different European countries varies substantially — and to a degree that sometimes impedes comparison and quantitative analysis. A further study and development of the organic certification would be highly desirable in order to make further scientific contributions to a reliable, coherent and cost efficient organic certification system.

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Focus on food consumers in the Balkans

Acronym:

FOCUS-BALKANS

Project No:

212 579

EU contribution:

EUR 2 614 110

Duration:

36 months

Start date:

1.10.2008

End date:

30.9.2011

Framework programme:

FP7 (seventh framework programme)

Instrument:

Specific International Cooperation Actions (SICA)

Project website:

<http://www.focus-balkans.org> (active)

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Summary

The general objective of the FOCUS-BALKANS project is to improve competencies and understanding in the field of consumer food science in the Western Balkans Countries (WBC). The scientific results of the research will make an important contribution to the public health and consumer protection and to the achievement of the objectives within the FP7. The specific objectives are to develop a network of universities, institutes, high schools, consumer organisations, NGOs and private enterprises active in the field of food consumer science that are able to develop joint-research activities and to gain a better understanding of food consumers in the WBCs, with a focus on products with positive nutritional properties (fruits and health/diet foods) and/or sustainability (organic and traditional food products).

Formal training sessions will be organised for key research organisations in the WBCs to enable them to become familiar with state-of-the-art methodologies, practical techniques and theories. The training activities, organised in each WBC, target a wide range of organisations from the public and private research sectors, NGOs and consumer associations. Six regional training meetings will be designed by the project partners and associated organisations. Four studies on niche markets plus one quantitative survey will systematically be conducted by WBC organisations as a mechanism for learning-by-doing. Two open seminars will bring together a wider spectrum of stakeholders including food supply chains representatives and policymakers. Altogether, these actors will be invited to participate in the 'Balkans Network for Food Consumer Science', which will seek to stimulate regional and interdisciplinary cooperation. The research, training and networking activities are intimately interlinked and will have strong synergies.

Problem

Food consumption has a considerable impact on the health and the well-being of the citizens of south-eastern Europe. Understanding consumer behaviour is also an important requirement for the food industry which must be market-oriented and respond appropriately to changes in domestic and international demand.

However, despite the importance of understanding food-consumer behaviour regarding food, WBCs lack the appropriate infrastructure. The relatively weak public research sector, including universities and scientific institutes has been slow to react to changes and reform curricula. One of the reasons is that academic and research institutions have not

renewed their key staff after the establishment of democratic regimes. Professors and scientists are often unable to speak foreign languages and, therefore, unable to access a wide part of the knowledge accumulated worldwide. Science in the WBC has remained very descriptive, with little analysis and a lack of orientation towards applicable results. In general, funding from international agencies has been modest. Another weak spot is the limited cooperation between institutes. While many research issues, including food science, require multidisciplinary approaches, most scientists continue to work in an isolated manner. This situation is fostered by scarce financial public resources for science resulting in harsh competition between research organisations. New consumer associations that have progressively replaced the state-led agencies need to gain experience and expertise. In addition, in the perspective of the regional Free Trade Agreement covering all Balkans countries, these associations need to consolidate regional cooperation and networking.

Background and objectives

In the Western Balkans Countries (WBCs), the lack of data and models of food consumption and trends hinders our understanding of important changes that are currently occurring in food markets. Indeed, these countries are recovering from the crisis of the 1990s and seeking to manage the transition to more market-based economies. In addition, all entities of the former Yugoslavia have in different ways progressed towards European integration. The obvious consequence of the transition to market-oriented systems is that the new driver is the consumer instead of the state.

Additionally, the strong long-lasting links between the productive sector and the state disappeared with the collapse of the old socio-economic apparatus. As a result, the control and information functions of the state have become much weaker. Directly linked with consumer issues and food safety, this weakness has also resulted in state agencies often becoming distrusted by the population regarding the control and dissemination of information.

While the overall economic situation has improved in almost all the countries, gaps between vulnerable social groups and the wealthiest population segments of the WBC continue to increase. As a result, food markets have become more differentiated with the demand for quality and safety standards varying substantially, partially as a result of differences in purchasing power. Nevertheless, whilst improvements in dietary patterns have contributed to the reduction of mortality in many western European countries, the dietary habits of the populations of some WBC remain less favourable.

The average life expectancy is 73 years for all the WBCs with the exception of Croatia (76 years). In comparison, the EU-15 statistics show

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80 years. Can this difference be explained by the difference in diet? The ample evidence of a north-east to south-west gradient of mortality across the Balkans would validate this assumption. Indeed, both within individual countries and in the region as a whole, adult mortality is lower in the south-west and higher in the north-east.

Information on food availability and dietary patterns in the WBC is limited. This information is essential for the development of food policies designed to ensure sufficient food supply and improved human health and well-being. While health is closely linked to incomes, regional anomalies are apparent. For example, despite a better socio-economic situation, in the Vojvodina region, average life expectancy over the last 15 years has always been two years lower than central Serbia where cardiovascular diseases are less frequent. Moreover, the high use of animal products, such as pork meat and dairy products, is likely to have negative implications for the health of the Balkans population. While, over the last years, new fat-free and light products offered by the agro-industry have met a growing demand, this phenomenon is largely restricted to the main urban centres.

Another new trend is a growing interest in organic food. After having first appeared in the main urban centres, specialised small groceries are now spreading to medium-sized towns. However, in many countries, the absence of accredited bodies impacts negatively on the costs of certification. As a consequence, virtually no product is certified for domestic markets. These circumstances considerably hinder the development of the domestic organic market. However, the extent of these trends and the underlying consumer motivations remain unclear and non-quantified. One of the main reasons for this is the weakness of public research and educational organisations. The future of the agriculture and food industry in the Balkans depends on the producers' ability to understand market trends and to take into account the consumers' needs. Consumer science related to food has evolved rapidly during the last decade (see progress beyond the state of the art). This period coincides with the crisis of 1990s embodied for many of the WBC by wars, social tensions and sanctions. These events isolated WBC researchers from the international scientific community and prevented them from upgrading their knowledge and approaches.

This project focuses on the important challenge of filling knowledge gaps and rebuilding networks. The general objective of the FOCUS-BALKANS project is to improve competencies and understanding in the field of food consumer science in the Balkans countries. This will result in a stronger participation of WBC scientists in projects related to food consumer science and an increased number of publications related to food consumer science in the WBCs in consumer science other scientific journals. The project beneficiaries aim to be active in food consumer science in their country and region.

The specific objectives are to:

- ▶ develop the competences and understanding of public organisations, private enterprises and NGOs in the WBCs regarding food consumer science (training);
- ▶ develop a network of universities, institutes, high schools, consumer organisations, NGOs and private enterprises active in the field of consumer science related to food (networking);
- ▶ gain a better knowledge and understanding of WBC food consumers, with a focus on products with positive nutrition properties (health alleged food and fruits) and/or sustainability (organic and traditional food products).

The training part of the programme will provide the participants with:

- ▶ a theoretical basis for understanding food consumer science;
- ▶ understanding of cutting-edge methods in the field of food consumer science;
- ▶ up-to-date market data, resulting from a learning-by-doing approach which will provide participants with a pool of relevant data about market structure and opportunities, consumer trends and habits in three different niche markets: organic food, regional food, dietetic food and in one of the major commodity market related to human health (fruits).

The project will result in effective relationships and exchanges between the WBC beneficiaries, methods and the understanding and appropriation of methodologies, specification of the scope of each research project, production of different methodologies and a good overview of all the aspects for the realisation of a consumer survey.

The networking part of the programme is conceived as a way of facilitating the exchange of knowledge between consumer organisations and farmers, producers, processors and retailers. This should result in the development of a tight network between the public institutions and private enterprises that are stakeholders in the use and generation of consumer food research (e.g. farmers, producers, processors and consumer organisations). This network will provide a framework for both (a) developing appropriate supply chain policies and strategies based on an understanding of consumers' preferences and market opportunities and (b) improving the efficiency of nutrition and health policies.

It will result in the mobilisation and information of the main stakeholders active in fields related to food consumer science all over the WBCs. The research part of the programme should lead to enhanced local co-operation and technical competence.

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Selected publications:

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Papers in preparation

Giraud, G., 'Traditional Food Products and Consumers: a Cluster Analysis over Western Balkans Countries', target journal: *European Review of Agricultural Economics*.

Amblard, C., Estève, M., 'Tradition Food Products seen from Western Balkans Consumers', target journal: *Food Policy*.

Mardon, J., 'Are Consumers of Traditional Food Products Healthy Concerned in WBC?', target journal: *European Journal of Public Health*.

Mardon, J., 'Food Consumption Driven by Health Concerns in WBC', target journal: *South East European Journal of Economics and Business*.

Stojanović, Z., Sijtsema, S., Amblard, C., Estève, M., 'Health Concerns of Western Balkans Consumers: a Cross-comparison of 36 Food-related FGs', target journal: *European Journal of Public Health*.

Sijtsema, Siet J.; Zimmermann, Karin; Miljan Cvetković; Zaklina Stojanović; Igor Spiroski; Ružica Butigan, Boban Mugosa, Jasna Milošević, Magali Estève, Cristina Mora, Jure Pohar, 'Consumption and perception of processed fruits in the Western Balkans Region', target journal: *LWT—Food Science and Technology*.

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Barjolle, D., Eynaudi, D., Mardon, J., Giraud, G., Milošević, J., Laniau, M., 'Understanding the motives for high traditionnal food consumption in the Balkans Countries'

Jasna Milošević, Iris Žeželj, 'Consumers of functional food in Western Balkans: nutritional knowledge, food choice motives and impulsiveness in food consumption', possible journals: *Apetite*, *Food Quality and Preference*.

Zaklina Stojanović, Radmila-Dragutinović Mitrović, 'Regulated and unregulated functional food markets — A case study in Western Balkans Region', target journals: *Food Policy*, *Journal of Agricultural and Food Economics*, *Journal of Food Policy Marketing*, *Food Economics*.

Delphine Eynaudi, Pascal Bernardoni, 'Signification of traditional products in the WBCs', Publication SYAL, Editor specialised in human science and books for university (geography, sociology, development) in Greece.

The project will develop an analysis of the drivers and determinants of food consumption behaviour in the WBCs on the basis of collaboration between EU and south-eastern European universities and SMEs, with the involvement of consumer organisations, which will act as main players for the diffusion of the results. The research will entirely be part of the knowledge acquisition process: the market and consumer studies (inquiries, data collection and process and synthesis) will be conducted mainly by actors in the WBCs with strong support from senior experts within the consortium. In terms of skills and knowledge related to food consumer science in the WBCs, the WBC project beneficiaries will be familiar with the different variables influencing food perception and will make available data on consumer behaviour towards specific food groups. It will result in the publication of the project's main findings, through reports, leaflets, brochures, articles and a list of publications.

Methodology

SCOPE	METHOD	ILLUSTRATION
Market study	In-depth interviews with experts	Health claim products
Motives of consumption	Consumer focus groups	Fruits
Future trends and challenges in a niche food market	Delphi method	Organic
Consumers' preferences	Conjoint analysis	Traditional products

Main findings and outcomes (results) or expected results

The relationships and exchanges between the WBC beneficiaries are effective and the general methods are understood. The scope of each research area is specified and the different methodologies are produced after each training (T2 to T6). All the aspects of the realisation of a consumer survey are covered.

The website is live and regularly updated, and databases available on the website are regularly updated. Participation of (some) beneficiaries in other common initiatives has started and the main stakeholders are mobilised and informed. One leaflet informing about the project has been distributed.

The main findings to be published in food science and/or on consumer journals include:

- ▶ qualitative and quantitative data on consumer behaviour and market trends;
- ▶ identification of variations between food consumer groups (segmentation of the Balkans population);
- ▶ new methods and tools in food consumer science adapted to the Balkans.

Potential applications

In terms of progress to be made, the FOCUS-BALKANS project foresees the development of courses or seminars in food consumer science in local universities as well as the involvement of PhD students in the topic.

In terms of networks, the consortium expects an increased number of collaborations related to food consumer science to start outside the project and an increased number of common publications, joining different disciplinary approaches.

Regarding concept and global awareness, the project will make available results and information on the consumer behaviour and market trends identified within the project, it will increase contact between public health bodies and citizens and highlight the issue of cross-compliance between nutritional, economic and agricultural policies in the WBCs.

Conclusions

In Western Balkans Countries, food supply chains can be relatively short for products originating in small-scale farms, but an increasing number of intermediaries take part in the commercialisation of food products in formal supply chains. The supply chain usually includes at least four main stages:

- ▶ **the farm level** — includes farmers and upstream industries;
- ▶ **processing** — could be very short or very long depending on the type of product, on-farm transformation is widespread as well as industrialised processing;
- ▶ **selling** — by the retailers who will distribute and advertise the population about the products;
- ▶ **consumption level** — the act of buying; the main actor is then the consumer, acting for different reasons (intra-individuals determinants and sensory characteristic of the products) and pressures (society also called interpersonal determinants).

In very short supply chains, all steps can take place on the farm or within the local communities.

Along these chains, there are actors (farmers, industry for transformations, retailers, consumers) but also outsider stakeholders who have the possibility to impact and modify the actual chain at different levels, for example, policymakers, universities and researchers, agricultural schools or other types of educational systems, health institutes and all types of associations such as consumers protection associations.

SUMMARY OF THE KEY FINDINGS AND NEEDS FOR FURTHER RESEARCH REGARDING ORGANIC FOOD

Compared to developed European markets and the other western markets in the organic food sector, the WBC markets are relatively young and very small.

THE MARKET

Committed market actors, farmers associations, stakeholders in rural development and environmental protection, consumer associations and policymakers act in favour of the expansion of the organic sector.

In the last 20 years, organic production was often available but was not officially called 'organic production'. During the last 10 years, market actors and their associations, but foreign market actors and policymakers as well often pushed the evolution of the sector with regard to different aspects:

- ▶ official regulation: in most WBCs, national laws give a framework to the production and marketing of organic products: the legal framework is often adapted to the model of EU regulations;
- ▶ certification: in all WBCs, domestic or international certification bodies control the organic production and guarantee the respect of the domestic law and/or of international standards.

PRODUCTION

As a consequence of these two elements of a sound framework (legal framework, certification), production has risen in all countries. Wild product collection plays an important role in the overall organic raw material production, mostly dominating the agricultural production. Furthermore, plant production is more significant than animal production.

SUPPLY CHAIN

Supply chains are generally short, with much direct selling on the domestic market. The best developed supply chains, with intensive and

high-quality processing industry, are to be found in the export-destined sectors.

CONSUMERS

Generally speaking, regarding all the food markets in the WBCs, there is a growing interest by the consumers in buying organic food products but there is no clear image of organic and the willingness to pay more is strictly limited. Mainly in rural areas, but generally as well, organic products compete with traditional and artisanal farm products.

RECOMMENDATIONS

Barrier	Options for policy and stakeholder action
Farm level	Lack of available organic commodities

Economic and organisational risk for the farmers Policymakers

- ▶ Organise producers in associations and cooperatives
- ▶ Encourage regional production basins, foremost for milk, cereals, vegetables and beef and meat
- ▶ Subsidies for converting and/or maintaining organic agriculture
- ▶ Extension service for farmers
- ▶ Know-how transfer at regional, national and international level
- ▶ Creation of networks
- ▶ Availability of input and specific technology
- ▶ Transparency and accessibility of labelling schemes
- ▶ Transparent and sustainably high commodity prices
- ▶ Market access and marketing conditions

Education

- ▶ Teaching and training on organic production, quality management, marketing
- ▶ Teach organic farming in schools and universities
- ▶ **Processing level** Lack of domestic processing

Lack of domestic supply chains Supply chain

- ▶ Encourage vertical link-up with agriculture on the one side and distribution on the other
- ▶ Strategic positioning of processing units in the production centres
- ▶ Encourage cooperation between sectors

Education

- ▶ Teaching and training on organic food processing, resourcing, quality management and marketing

- ▶ Industry associations, know-how transfer from conventional to organic
- ▶ Market intelligence services, market research
- ▶ Teach organic processing in schools and universities
- ▶ Benchmarking studies
- ▶ Teach organic supply chain management in agricultural schools and in the Faculties of Agriculture in universities

Consumption level Lack of domestic consumer demand Policymakers

- ▶ Clarify labelling and certification

Consumers associations

- ▶ Enhance trust and knowledge about organic
- ▶ Provide online information

Research

- ▶ Market research
- ▶ Consumer research

RESEARCH NEEDS FOR THE FUTURE

Research on organic products and their market is needed at every stage of the supply chain.

At the farm level, deficiencies have been noticed which still prevent the farmers from converting to organic farming. The following concrete research questions should be tackled not only by universities but also agricultural research institutes and even farmers themselves (being the ones who know and deal with their local agro-system every day).

- ▶ What are farmers' motivations and barriers to convert (or not to convert) to organic farming?
- ▶ What are the organisational, structural, societal, etc., challenges?
- ▶ What are efficient ways of informing farmers?
- ▶ How can transaction effort be reduced (information, teaching and training, quality control, marketing)?
- ▶ How to cooperate horizontally?
- ▶ What are the tendencies in production?
- ▶ What is the development of WBC organic production?
- ▶ What species, varieties and breeds are needed for organic agriculture and husbandry in the WBCs?
- ▶ What adaption of agriculture techniques is necessary?

For this topic research, supply chain analysis or SWOT analysis could be used but also production statistics (acreages, yields, herds, etc.) and research on species, varieties, breeds, techniques and technology.

At the processing and distributing level, the point of view of experts, sector by sector, cross-sector and SWOT analysis could be possible approaches to answer the following research issues.

- ▶ How to link local production to local distribution?
- ▶ How to reduce transaction costs in information uptake, innovation, supply, quality control and marketing?
- ▶ What information and innovation is needed?
- ▶ Which organisational structures are in favour of organic processing?
- ▶ How to link local production and processing?
- ▶ How to cooperate/communicate vertically?

At the consumption level, qualitative research on motivations and barriers towards organic food consumption should be reinforced and integrated with quantitative research on attitudes and behaviour. There is a need to better understand general consumption trends and efficient ways of information uptake by consumers.

Indicators for biodiversity in organic and low-input farming systems

Acronym:

BIO-BIO

Project No:

227161

EU contribution:

EUR 2 999 614

Duration:

42 months

Start date:

1.3.2009

End date:

31.8.2012

Framework programme:

FP7 (seventh framework programme)

Instrument:

Collaborative Project — small or medium-scale focused research project (CP-FP)

Project website:

www.biobio-indicator.org

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Abstract

In iterative interaction with stakeholders, the BioBio scientists identified and tested candidate indicators on 195 farms in 12 case-study regions across Europe. The findings led to a core set of eight indicators for habitat diversity, four indicators for species diversity (vascular plants, bees, spiders, earthworms), three indicators for genetic diversity of crops and livestock, and eight indicators for farm-management practices. The indicator set has been tested for redundancies, and correlating indicators have been removed. It is applicable across Europe and for major farm types, i.e. field crops and horticulture, grazing livestock, mixed farming, permanent crops (olive groves, vineyards).

The BioBio indicator set complements other indicator systems (IRENA, SEBI):

- ▶ State indicators are emphasised (the actual status of agricultural biodiversity);
- ▶ Indicators operate at farm scale (rather than at plot, landscape or national scale). Farms are the operational units for decision-making by farmers, administrators and policy-makers.

The cost of implementing the indicator set on a farm depends on its size and complexity. For a farm of 85 hectares and eight different habitat types, the effort amounts to 15 working days and EUR 1 000, mainly for the identification of the species. 0.25 % of European Union expenditure on the Common Agricultural Policy would suffice to implement a biodiversity monitoring on 50 000 farms across Europe. The information thereby obtained would allow to evaluate the effects of the 'greening' of the CAP, of agri-environmental schemes, and to better target agricultural policies towards the Aichi 2020 biodiversity goals.

Applications were tested beyond Europe in Tunisia, Ukraine and Uganda. The BioBio approach proved feasible, but would require adaptations to the countries in question.

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Replacement of sulphur dioxide (SO₂) in food keeping the Same quality and shelf life of the products

Acronym:

SO2SAY

Project No:

226930

EU contribution:

EUR 2 995 468

Duration:

40 months

Start date:

1.5.2009

End date:

31.8.2012

Framework programme:

FP7 (seventh framework programme)

Instrument:

Collaborative Project — small or medium-scale focused research project
CP-FP

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Abstract

As of today, there are many foodstuffs (including beverages and wine) where sulphites are used as antioxidant and preservative agents. Examples where sulphites are used include dried fruits, some kinds of fruit juices, seafood and convenience food (especially containing potatoes). But, sulphite-containing agents are suspected of causing some damage to health and they are blamed for some allergies.

The aim of the project is not to find a universal replacement for sulphite-containing agents for all foodstuffs, but to develop tailor-made solutions for the following foodstuffs: dried fruits; wine and beverages; convenience food (especially containing potatoes); package and processing.

For each line of products, special expert groups were established. These expert groups chose three to five products for detailed research. While these groups are working on additives, the focus of the group 'Package and processing' is on solutions within the process. This could be the environment where the process takes place but also solutions within packaging are possible. The process of research is closely linked with legislation and sensory evaluation: this should guarantee clean products, referring to the marketability and their sensory properties.

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Data network for better European organic market information

Acronym:

OrganicDataNetwork

Project No:

289376

EU contribution:

EUR 1 498 844

Duration:

36 months

Start date:

1.1.2012

End date:

31.12.2014

Framework programme:

FP7 (seventh framework programme)

Instrument:

CP-TP

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Abstract

The Data network for better European organic market information (OrganicDataNetwork) project aims to increase the transparency of the European organic food market through better availability of market intelligence about the sector to meet the needs of policymakers and actors involved in organic markets.

This overall objective will be broken up into key objectives:

1. bring together stakeholders and bodies actively involved in organic market data collection and publication and review the needs of end-users with respect to organic market data;
2. provide an inventory of relevant private and public bodies that are involved with the collection, processing and dissemination of organic market data in Europe;
3. classify existing methods of organic market data collection and develop criteria for quality improvement of available data;
4. collect, store in a common format, and provide access to currently available data on organic markets in Europe;
5. develop and test common methodologies to assess the consistency of national data, with special reference to available data on trade flows;
6. test innovative approaches to improve the data collection and market reporting in six case study regions;
7. disseminate project results and develop recommendations including a code of practice for organic market data collection and network beyond the conclusion of the project.

To achieve these objectives, OrganicDataNetwork has partners from 11 countries that collect, publish and analyse such data. This network will closely cooperate with the EC, Eurostat and the statistical offices of Member States, using existing structures for collecting and processing data on the organic market and stimulating the development of new systems by adapting existing models. The partnership will act as a co-ordinating centre between stakeholders, and will result in a proposal for the establishment of a permanent network to achieve collaboration on statistical issues regarding the organic market.

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Chapter 3

Sector development support

Introduction

The Organic Sector Development Research Review

*Christopher Stopes, President
IFOAM EU Group*

Organic food and farming has shaped production systems and markets, responding to the environmental and social challenges we face whilst meeting the demands of consumers, citizens and policymakers. The sector has pointed the way towards better food and farming, balancing production and consumption and enabling cultural diversity to be more fully expressed.

This catalogue provides an overview of the organic food and farming research and development supported by EU research programmes. As such, it gives a snapshot of some key research fronts involving collaboration between a wide range of research organisations throughout Europe. From a research and development perspective, it seems self-evident that organic food and farming is fit for purpose as a component of the European Innovation Partnerships. The organic sector can help meet the goals of Horizon 2020 and, consequently, is in a good place to help deliver the Europe 2020 strategy for smart, sustainable and inclusive growth.

Smart because organic farmers and food producers use innovative and forward-looking methods that respect ecological limits and work with natural systems. **Sustainable** because organic farming has a low environmental impact, is resource-efficient, protects and enhances biodiversity and provides the 'public goods' to meet key challenges: low climate change impact, clean air and water, and fertile soils. **Inclusive** because organic food and farming enables quality-driven markets, hence contributing to rural development programmes.

The EU Commission and the Member States are advised by the Standing Committee on Agricultural Research (SCAR) on strategic research orientations. The recent foresight exercise has revealed the underlying importance of 'sufficiency oriented research'. They highlighted the key research needs and priorities:

- ▶ Agro-ecological approaches;
- ▶ Eco-efficiency of food supply;
- ▶ Support for innovative consumption practices;
- ▶ Sustainable intensification (low-input/high-output systems);
- ▶ Participation of civil society and with farmers in on-farm research;

- Diversification of primary production.

Since 2007, the Technology Platform Organics (TP Organics) has involved the organic sector in a 'bottom-up' approach to define a research strategy for organic food and farming. In 2010, a prioritised implementation action plan to deliver the research and innovation for the organic sector continued to flourish. The TP Organics' proposals centre on three goals that match the areas highlighted by the SCAR, fit the goals of Horizon 2020 and thus can be incorporated into the European Innovation Partnership:

- Empowerment of rural areas;
- Eco-functional intensification;
- Food for health and well-being.

Eco-functional intensification is a new area of agricultural research that aims to harness beneficial activities of the ecosystem to increase productivity in agriculture, thus enabling the control of weeds, pests and diseases and promoting health and welfare in organic livestock by focusing on good husbandry and disease prevention. Health and well-being of citizens builds on the range of initiatives to reconnect consumers and producers, and uses a whole food chain approach to improve sustainable consumption of natural, authentic and culturally diverse foods.

This chapter provides details of 27 research projects supported through the EU research framework programmes. It shows a diverse range of initiatives aimed at delivering technology-based solutions, enhanced know-how as well as social and organisational innovations that will, together, improve the performance of organic food and farming systems in Europe. This will help spread the organic model of food and farming that responds to the challenges facing the EU in the area of agriculture and food production. The diverse and innovative research activities described in this publication can help organic systems push food and farming towards sustainability, quality and low risk technologies. Organic farms and food businesses have become creative living laboratories for smart and green innovations. The organic sector has already generated a multitude of useful new practices for sustainable agriculture useful both within and outside the organic sector and it will generate more.

The development of new technologies and their applications raises a number of important questions about impact on people, society and markets. The fifth framework programme (FP5) and the Quality of Life work programme confirmed the importance of such activities having to harmonise scientific progress and social expectation. At that time, the research priorities were very much reflected in sector-related projects such as ESLOCO, Blight-MOP, WECOF, CONVERSION, EUROTATE, MICRO-N-FIX, STOVE, INTERCROP and SAFO in protecting biodiversity, strategies of weed control in organic farming, development of a model-based deci-

sion support system to optimise nitrogen use in horticultural crop rotation across Europe, microbial fixation, seed treatments, weed control, but also in the livestock sector, sustaining animal health and food safety in European organic livestock farming.

In FP6, one of the priority thematic areas was research on food quality and safety. The objective was to develop lower input farming systems in agriculture and aquaculture based on systems such as integrated production and organic agriculture. It emphasised the use of innovative technologies for improved transformation processes delivering safer, healthier, nutritious, functional and varied foodstuffs and animal feed, which respond to consumer expectations. Influenced by the consumers' orientation which required healthy, safe and high-quality food, the food production systems were tending towards those which are more sustainable, more environmentally and welfare friendly, and which have lower requirements for inputs. Following the 'farm-to-fork' approach, research on production methods aimed to meet these consumer requirements.

Nine projects have been launched: one of the projects initiated in 2003, three started in 2004, two in 2005 and 2006, and one in 2007. Although they are also quite wide in scope, they can be regrouped under the following categories:

Plant research:

- ▶ Replacement of copper fungicides in organic production of grapevine and apple in Europe (REPCO)
- ▶ Enhancement and exploitation of soil biocontrol agents for bio-constraint management in crops (2E-BCAs in Crops)
- ▶ Environmental friendly food production system: requirements for plant breeding and seed production (ENVIRFOOD)
- ▶ Innovative wet-sowing technology in the ecological agricultural and farming community (ECOWETSOW)
- ▶ Increasing fruit consumption through a transdisciplinary approach delivering high-quality produce from environmentally friendly, sustainable production methods (ISAFRUIT)

Livestock research:

- ▶ Science and society improving animal welfare in the food quality chain (Welfare Quality®)
- ▶ Assessing arthropod predation on parasitized hosts in organic and conventional farming systems (P-P INTERACTIONS)
- ▶ Bees in Europe and Sustainable Honey Production (BEE SHOP)
- ▶ Improving the quality of pork and pork products for the consumer: development of innovative, integrated, and sustainable food production chains of high quality pork products matching consumer demands (Q-PorkChains)

The current seventh framework programme for research and technological development is built on the European knowledge-based bio-economy by bringing together science, industry and other stakeholders to exploit new and emerging research opportunities that address social, environmental and economic challenges: the growing demand for safer, healthier, higher quality food and for sustainable use and production of renewable bio-resources; the increasing risk of epizootic and zoonotic diseases and food-related disorders; threats to the sustainability and security of agricultural, aquaculture and fisheries production; and the increasing demand for high-quality food, taking into account animal welfare and rural and coastal contexts and response to specific dietary needs of consumers.

For land-based biological resources, special emphasis is placed on low-input and organic production systems, improved management of resources and novel food and feeds, and novel plants (crops and trees) with respect to their composition, resistance to stress, ecological effect, nutrient and water use efficiency, and architecture.

The projects selected under this framework programme clearly have strong interdisciplinary approaches. The LowInputBreeds project from 2009 studied the development of integrated livestock breeding and management strategies to improve animal health, product quality and performance in European organic and low-input milk, meat and egg production, while in the SOLIBAM project from 2010, strategies for organic and low-input integrated breeding and management for crops are considered. Other projects which started last year or this year include NUE-Crops (Improving nutrient efficiency in major European food, feed and biofuel crops to reduce the negative environmental impact of crop production), OSCAR (Optimising Subsidiary Crop Applications in Rotations), LEGUME-FUTURES (Legume-supported cropping systems for Europe), MultiSward (Multi-species swards and multi-scale strategies for multifunctional grassland-based ruminant production systems), and PURE (Pesticide Use-and-risk Reduction in European farming systems with integrated pest management) and visibly tackle research on low-input agriculture. The same can be noted in the livestock sector by the project SOLID (Sustainable Organic and Low-input Dairying). The BEE DOC (Bee health: identification of emerging honeybee pests and diseases and re-emergence of pathogens and explaining the intimate mechanisms and the reasons for increased honeybee mortality) project tackles a very recent problematic issue which heavily affects the sector with strong connotation on organic agriculture.

Many of these projects embody multidisciplinary approaches and rely on the active engagement of producers in programmes of on-farm research and demonstration. But this work does not stop here — the TP Organics' implementation plan outlines a long list of priority projects. The projects reviewed in this catalogue are an important start, but it is essential that

that the support from Europe, national governments as well as from the sector itself for organic research and innovation projects continues into the future for the benefit of Europe's citizens, consumers, farmers, and our environment. Organic food and farming can transform relationships in the food supply chain and open up new possibilities that are within the limits of available resources.

Scientific and technological innovation based on a fundamental understanding of natural ecological systems is at the heart of the development of modern food and farming systems. Organic production is no exception to this central truth, and indeed the organic sector is founded on this view. With increased knowledge of the workings of natural systems, the needs of animals and the place of humans in the food chain, we can build less environmentally damaging, more effective and more socially just farming for the future. This is not backward looking, but is fully a part of the concept of the knowledge-based bio-economy of the future — one that respects nature and all of life on this planet, reducing environmental footprints in an economically viable and socially responsible manner.

Protecting biodiversity through the development of environmentally sustainable locust and grasshoppers control

Summary

The Centre for Agricultural Bioscience International (CABI) carried out research in southern Europe seeking to reduce the risk of environmental damage caused by chemical pesticides in controlling locusts. CABI scientists have initiated and led a project to develop an environmentally sustainable alternative — Green Muscle™ — based on the naturally occurring fungus, *Metarhizium anisopliae* var. *acridum*, which kills insects.

During this study, because the locust populations were very low in Spain and Italy at the time, the project focused on a medium-scale trial in La Serena against, predominantly, the Italian grasshopper, *Calliptamus italicus*.

Although pretreatment populations were quite low, this study was able to show significant population reductions in the field relative to controls, with overall efficacy comparable to a chemical insecticide check. This is the first demonstration of population in the field in Spain and confirms that *Metarhizium* can provide effective control.

Problem

Current chemical-based locust control operations in Europe have a potentially negative impact on the environment. The use of chemical insecticides can lead to chronic and acute health and environmental problems and is not a long-term, sustainable solution.

Background and objectives

OBJECTIVES

The main objective of the project was to reduce the environmental impact of current chemical-based locust control operations in Europe through the development of a new environmentally sustainable strategy based on the safe and effective use of a mycoinsecticide (a biological pesticide based on a naturally occurring fungal disease that is specific

Acronym:

ESLOCO

Project No:

QLK5 1999-01118 CM

EU contribution:

EUR 741 188

Duration:

45 months

Start date:

1.2.2000

End date:

31.10.2003

Framework programme:

FP5 (fifth framework programme)

Instrument:

NA

Project website:

<http://www.esloco.org> (no longer active, see <http://www.cabi.org>)

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to locusts and grasshoppers). Within this, sub-objectives for the second year of the project were to:

- ▶ demonstrate the performance of the mycoinsecticide in a number of field trials against Moroccan locust in Spain, and in lab-based bioassays and semi-field trials in Italy;
- ▶ continue studies to determine the environmental risks and benefits of the mycoinsecticide, specifically considering effects on key non-target organisms, including the indigenous microbial community;
- ▶ conduct ecological studies and continue development of a model to predict mycoinsecticide performance at different times and places and develop optimum use strategies for the mycoinsecticide;
- ▶ conduct microbiological research and provide technical support to a commercial company to produce the mycoinsecticide including the design and testing of an industrial-sized cyclone unit for extraction of fungal conidia from the solid production substrate;
- ▶ provide support to the producer and commercial supplier to provide the necessary guidance and information on regulatory matters to obtain product registration;
- ▶ engage key stakeholders (e.g. plant protection officers and relevant local and national authorities) through workshops and participatory trials to address the current lack of understanding and knowledge of biopesticide properties, benefits and use;
- ▶ improve capacity for utilising microbial control products through participation in an international initiative to define appropriate data and methodologies for the harmonisation of registration requirements for microbial pesticide products in Europe.

Main findings and outcomes (results) or expected results

Locust populations in Spain were very low and it was not possible to conduct any large-scale field trials during the 2002 season. The only efficacy work possible for this region was a medium-scale trial in La Serena against, predominantly, the Italian grasshopper, *Calliptamus italicus*. Although pretreatment populations were quite low, this study was able to show significant population reductions in the field relative to controls, with overall efficacy comparable to a chemical insecticide check. This is the first demonstration of population in the field in Spain and confirms that *Metarhizium* can provide effective control.

The first field test was performed in Italy with a 1ha trial conducted against Moroccan locust. Numerous technical difficulties were encountered and, even though there was good product viability, no effects of *Metarhizium* were detected. This suggests major problems during application. In addition, control populations suffered massive mortality

making any comparisons difficult. In spite of these poor results, the trial provided useful experience for the Italian partners.

Studies on environmental impacts focused on a range of factors including interactions between *M. anisopliae* var. *acridum* and indigenous fungal pathogens, potential for competition between pathogens and genetic and phenotypic stability of *M. anisopliae* var. *acridum*. This research generally points to the fact that *M. anisopliae* var. *acridum* is unlikely to displace native pathogens and that it is very stable with little chance of local adaptation or change after introduction. The other main activity on environmental impacts formed part of the field trial in Spain where use of a toxic standard (Malathion) allowed direct comparison of the impact of chemical and biological treatments on non-target invertebrates. The results were striking in showing that the biopesticide had no detectable effect on non-target taxa, whereas Malathion caused significant reductions in non-targets for the duration of the one-month study.

The remaining ecological studies focused on understanding the thermal ecology of the target locusts and grasshoppers, and how temperature influences the speed of kill of the mycoinsecticide and the resistance of the hosts. Work continued on the development of a predictive model to assess the expected rate of decline of a locust population in the field after a spray application of the mycoinsecticide. These models have now been used as a basis for a use strategy for the mycoinsecticide (i.e. defining where and when, on average, the mycoinsecticide is likely to provide effective control).

More efficacy data was collected in the field in Spain, despite low population levels of locust. This data was submitted to the regulatory authorities. The Green Muscle™ registration dossier and experience with the use of this exotic isolate in Spain have been used at two expert consultations organised by the FAO (Food and Agriculture Organisation of the United Nations) as contributions to the harmonisation of regulatory processes for biopesticides worldwide.

Potential applications

This project alongside CABI's research work in West Africa, has revolutionised the understanding of biological pesticides using fungi and led to major scientific advances in understanding how to use fungi effectively for pest control.

Innovation contribution

CABI scientists initiated and led a project to develop an environmentally sustainable alternative to chemical insecticides to control locusts. Known as Green Muscle™, this product is based on a naturally occurring fungus, *Metarhizium anisopliae* var. *acridum*, which kills insects.

Conclusions

By meeting the scientific, technical and demonstration objectives of the programme and establishing a new biocontrol technology and capacity in Europe, the project will deliver an overall reduction in environmental contamination caused by current locust and grasshopper control operations. Additionally, through the associated advances in evaluation methods, production technologies and regulatory procedures, it will also increase the scope for exploiting microbial diversity in sustainable management of other pests and diseases in Europe.

Development of a systems approach for the management of late blight in EU organic potato production

Summary

Potato is a major cash crop in many European organic farming businesses. Compared to conventional production yields, organic production yields are estimated to be 30–40 % lower, even when copper is used to delay blight development in crops. Copper fungicides are estimated to extend the growing period by 2–4 weeks. This is estimated to result in 10–40 % higher yields compared to crops not protected with copper. Yield reductions greater than 10–20 % resulting from the prohibition of copper fungicides could threaten the profitability of organic potato production and/or the entire organic farming businesses in many EU countries.

The Blight-MOP project developed, evaluated and/or integrated the use of more resistant varieties, preventative management methods and alternative treatments to maintain potato yields and quality at levels currently obtained with the use of copper fungicides. The project focused on adapting integrated blight control strategies to local potato management systems and rapid dissemination of results to stakeholders.

Problem

Late blight is the most serious disease affecting potato production in Europe. It spreads rapidly and can devastate an entire crop. The Blight-MOP project was launched in March 2001 to develop a comprehensive approach for the management of late blight in organic potato production across Europe. This was largely in response to the proposed complete ban of copper-based fungicides in organic farming — until then, the most effective way of treating late blight in crops grown according to organic standards.

Background and objectives

An initial objective of the Blight-MOP study was to establish what the state of organic potato production in the EU was, which anti-blight strategies organic farmers were using and how effective they were. In view of the proposed ban on copper, the project specifically wanted to find out to what extent copper sprays were used and what impact a complete ban would have on yields in particular and on the viability of organic potato farming in general.

Acronym:

Blight-MOP

Project No:

QLK5-CT-2000-01065

EU contribution:

EUR 3.83 million

Duration:

56 months

Start date:

1.3.2001

End date:

31.12.2005

Framework programme:

FP5 (fifth framework programme)

Instrument:

RTD project

Project website:

<http://research.ncl.ac.uk/nefg/blightmop/> (active)

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The main objective of the project was to test how other preventative strategies and alternative treatments could be combined to develop an optimal system for the control of blight in organic farming systems. Factors such as the regional climate, variety of potato, soil management and crop protection strategies were studied.

Methodology

Standard questionnaire-based semi-structured interview methods for farmer/expert survey carried out in studies under Objective 1.

The main approach used in studies under Objective 2 included field trials using factorial, dose-response and 'additive' experimental designs. These were complemented by molecular, physiological and biochemical analytical tests where appropriate.

A large proportion of field trials was carried out using farmer-participatory approaches to increase the industry relevance on field experiments and to support rapid dissemination and technology transfer.

Main findings and outcomes (results) or expected results

OBJECTIVE 1

CURRENT STATE OF ORGANIC POTATO PRODUCTION AND LATE BLIGHT CONTROL IN EUROPE

Growth in organic potato production

In all participating countries, the area of organic potato production had grown between 1998 and 2000. This was not the case for conventional potato production. There were, however, great variations between countries in the area increase for organic potato production. The area growth for production of organic potatoes was still smaller than that for other organic crops. Further expansion of organic potato production was considered likely, but profitability was expected to decrease.

Yield

There was a large difference between countries in terms of organic potato yield as well as between different farms in any one region. Conventional potato yields were higher than organic yields in all participating countries except Norway. In the other six countries, organic yield was between 50 and 80 % of conventional yield. Some organic farmers could improve efficiency and yield by adopting existing strategies.

Varieties used

Organic growers did not grow as wide a range of varieties as conventional growers, and chose cultivars for robustness and acceptance on the market.

Price

Farm gate prices were higher for organic potatoes than for conventional potatoes, but varied from country to country.

Consumer preferences

In deciding which organic product to buy, consumers rated production practices highest, then price, variety and taste. Processors looked for process quality and variety in organic potatoes.

Farmers' opinions

There were differences of opinion amongst farmers regarding the profitability of the industry. Most farmers were primarily motivated by environmental factors, food quality and other philosophical considerations.

Effects of blight

Outbreaks of blight between 1996 and 2000 varied greatly from region to region. In some countries, not all farmers had losses while in others, more than 70 % of farmers had losses with every outbreak.

Defoliation

In the Netherlands, foliage had to be destroyed at 5 % infection stage as this is a statutory requirement.

Copper fungicides

The use of copper-based sprays varied greatly from country to country, largely according to variations in legal stipulations. In Scandinavian countries, copper-based sprays were not allowed at all while, in some countries, they were limited and, in other countries, not limited until 2001 when the EU limit was set at 8 kg/ha/year. Where farmers could use copper, they generally did. Some also tried alternative products, but with little success. A ban on copper-based fungicides while there are no effective alternatives for the treatment of blight could destabilise organic potato production.

OBJECTIVE 2**EVALUATION OF DIFFERENT PREVENTATIVE MANAGEMENT STRATEGIES AND ALTERNATIVE TREATMENTS****FINDINGS AND CONCLUSIONS REGARDING THE USE OF OTHER METHODS AND TREATMENTS****Varieties**

Planting resistant varieties would be the single most effective strategy against blight. A ban on copper would stimulate the uptake of resistant varieties, leading to a drastic reduction in foliar and tuber blight. Development and widespread adoption of more varieties would take time. Uptake would also depend on market preferences.

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Alternating rows of varieties

The virulence and aggressiveness of the blight pathogen may be controlled by planting highly resistant varieties and desirable but less resistant varieties in alternating rows. Success is more likely when the pressure of blight outbreak is low. Practical problems may present for fertilisation and harvesting of different varieties.

Mixing varieties in the same row

Pathogen control may be better when up to four varieties are mixed within rows, but practical problems regarding harvesting and separation of varieties are bigger. This strategy could be effective on a smaller scale. The disease is unlikely to be suppressed more than expected for the average resistance of the mixed varieties. When planting susceptible yet highly desirable varieties mixed with less desirable yet highly resistant varieties, the success of the susceptible varieties may be improved.

Intercropping

Crops of a different species planted between fields or rows of potatoes should provide barriers against the spread of blight spores. Taller crops such as wheat should be better than clover, but yield may be affected by competition between species. Bigger plot size should decrease the effects of blight. Plots planted perpendicular to the wind, with grass-clover as an intercrop, enjoyed the greatest reduction in blight during trials.

Planting earlier

Earlier planting leads to earlier tuber bulking, which may secure a yield before blight attacks. This strategy is already widely used.

Chitting/pre-sprouting seed tubers

Chitting causes tubers to bulk earlier, which may secure a yield before blight attacks. The strategy requires extra labour and is already widely used.

Defoliation

Removing infected foliage by burning with a propane gas burner kills the blight spores, but the cost of gas and use of fossil energy are problematic. Flailing is less effective, but still better than doing nothing when foliage is infected with blight. No gas is required when flailing.

Management of soil fertility

Optimal fertilisation does not have direct effects on blight, but does improve yield and the general vitality of plants. The availability of manure is a factor. Weather and rotation practices also affect nutrient availability to the crop.

Rotation

The position of the potato crop in the rotation cycle has no effect on blight, but yield is affected through nutrient supply from the preceding

crop. However, the optimal position for potatoes in the rotation cycle may not be optimal for other crops.

Volunteer removal

Pigs can be used to remove volunteer tubers which are a source of blight inoculum, but pigs are not available on all farms and may cause damage to soil structure.

Planting density

Very low planting density reduces late blight, but because of adverse effects on tuber size grading lies outside normal commercial limits and is therefore not a feasible option.

Irrigation

To improve yield and tuber quality, drought should be avoided through irrigation, but long periods of leaf wetness should be avoided to prevent the spread of blight infection. Yield and quality can be improved on many farms, but water for irrigation purposes is not available to all.

Compost extracts

This method is not yet developed enough for practical applicability. It is not clear which compost feedstocks and methods of preparing extracts should be used, or how often and at what concentration the extracts should be used.

Foliar sprays and microbial inocula

There has been success in some crops but there is no conclusive demonstration of effectiveness against blight under field conditions.

Microbial antagonists and plant extracts

Spraying antagonists and plant extracts was effective up to 70 % in glasshouse trials and 45 % in semi-field trials, but had little effect under field conditions.

Application equipment

Underleaf spraying equipment and air-assisted sprayers both gave a more uniform cover, especially for copper-based fungicides. High equipment costs and labour requirements are the biggest limitations.

Alternative sprays

Within the range of organic regulations, no effective products were found.

Copper fungicides

Spraying lower dosages (2 kg/ha/year) of copper fungicides can be widely practiced. Significant reduction in dosages showed only slight reductions in protection against blight.

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Potential applications

A range of management practices and treatments developed/evaluated in the Blight-MOP project can be immediately applied in farming practice. Practices which were shown to positively affect crop performance and/or blight control include: (a) use of resistant varieties; (b) chitting; (c) early planting; (d) effective fertilisation and irrigation regimes; (e) crop rotation; (f) defoliation; and (g) use of copper sprays.

Organic growers will have to identify individual strategies or combinations of strategies that are applicable to their specific circumstances and develop methods of using these strategies for optimal gain. This is most likely to lead to improved crop performance because of better blight control, and/or better growth and higher yields, and/or lower costs.

Innovation contribution

The main innovation delivered by the project is the provision of a toolbox for the integrated management of potato blight that can be used by farmers in different areas of the EU.

Blight-MOP activities also defined in detail the *Phytophthora infestance* race and virulence spectrum found in organic potato crops in different regions of the EU. This information will contribute to the development of innovative late blight-resistance management strategies in organic and low input potato production systems.

Conclusions

The project achieved its main aims/objectives by providing improved blight management protocols/strategies for the organic and low-input farming industry.

The use of resistant varieties was clearly identified as being the most promising approach for the eventual replacement of copper fungicides. However, resistance against late blight is often transient, due to the development of new pathogen strains that can overcome the resistances/tolerance in existing varieties.

The main research identified by the project is the need to maintain a continuous breeding effort for varieties with more stable blight tolerance/resistance to late blight, especially with respect to early varieties. A main conclusion from the project is that such breeding effort should involve selection in the context of organic agronomic practice to optimise later performance in organic and other low-input systems.

Strategies of weed control in organic farming

Summary

A crop's competitiveness against weeds is determined by agronomic factors, including variety choice, as well as soil and climatic conditions that influence the growth and development of both crop and weeds. The WECOF approach focused on high crop competitiveness to control weeds in organic winter wheat. This has been shown to be successful under a wide range of environmental conditions. In most of the core and variety trials, weed growth was kept to a manageable level by the overall site-specific farm strategy combined with the establishment of competitive crop stands. Consequently, the WECOF strategy was designed to reduce the need for any additional mechanical control measures. Although only one of many aspects in a combined weed control strategy, competition for light can play an important role on weed management.

Problem

Concern about potential increases in weed populations without the use of herbicides has limited the conversion from conventional to organic farming (Bond and Grundy, 2001). Consequently, weed management is an important part of organic farming, reducing yield loss, minimising harvesting losses and grain contamination and limiting the build-up of the weed seed bank in the soil (Beveridge and Naylor, 1999; Davies and Welsh, 2002).

Background and objectives

The aim of the WECOF project (Strategies of Weed Control in Organic Farming) is to improve the efficiency of weed control in organic farming. The model crop is winter wheat. A primary objective is to optimise the natural competitiveness of winter wheat in reducing weed growth, and thus reduce the need for direct weed control.

A core experimental programme is focusing on plant morphological and crop architectural characteristics to increase the competitive ability of the crop for light. A series of core trials have been established in Germany, Poland, Scotland and Spain comparing plant structure through the use of different varieties and crop architectural factors by using different sowing row widths and directions. Variety trials have been established in Scotland with constant row width and sowing direction to give more detailed varietal comparisons in terms of shading ability. The aim is to identify key characteristics of winter wheat morphology, which can increase shading ability, in order to assist breeders in selecting suitable cultivars for organic farming.

Acronym:
WECOF

Project No:
QLK5-CT-2000-01418

EU contribution:
EUR 2 272 190

Duration:
48 months

Start date:
1.10.2000

End date:
30.9.2004

Framework programme:
FP5 (fifth framework programme)

Instrument:
NA

Project website:
<http://www.uni-bonn.de/wecof/> (active)

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Drews, S., Juroszek, P., Neuhoﬀ, D., Köpke, U. (2004), 'Optimierung der Beschattungsfähigkeit von Winterweizen als Unkrautkontrollmaßnahme', *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* (Journal of Plant Diseases and Protection), Sonderheft XIX, pp. 545–552.

Drews, S., Juroszek, P., Neuhoﬀ, D., Köpke, U. (2004), 'Optimierung der Beschattungsfähigkeit von Winterweizen als Unkrautkontrollmaßnahme', *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* (Journal of Plant Diseases and Protection), Sonderheft XIX, pp. 545–552.

Juroszek, P., Drews, S., Neuhoﬀ, D., Köpke, U. (2004), 'Effects of organic fertilisers on the development of weeds and winter wheat', *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* (Journal of Plant Diseases and Protection), Sonderheft XIX, pp. 611–618.

Furthermore, in Poland, laboratory and field experiments have investigated the allelopathic potential of sunflower and buckwheat residues to reduce germination, emergence and growth of different weed species. In Germany, field trials on photocontrol weed germination to reduce emergence of light-sensitive weed species after light-less soil disturbance (night-time tillage and sowing) are carried out. Data of all WECOF experiments will be evaluated through analysis of variance and principle component analysis to identify key factors involved in weed control. Moreover, the economic efficiency of the tested weed control methods will be analysed, both at the microeconomic (farm) and the macroeconomic (society) level. The elaborated strategies will be integrated into a Decision Support System (DSS) to assist advisers and farmers in selecting site-specific strategies for effective weed control. Recommendations delivered by the DSS will be checked in field trials on pilot farms.

Methodology

Field experiments under organic farming conditions, demonstration trials, modelling and development of a DSS.

Main findings and outcomes (results) or expected results

Clear varietal differences in weed suppression were determined. Row width had a more pronounced effect than sowing direction on weed growth. The most competitive cultivar generally had a higher ground cover, leaf area index, plant height and a planophile leaf inclination thus increasing light interception. The use of a narrow row width resulted in a higher crop ground cover and increased shading ability of the crop. Two years' results suggest that narrow row width seems to be the optimal spacing to increase the shading ability of the crop. In many varieties, it was detectable that crop ground cover and weed ground cover had an inversely proportional relationship. Thus, crop ground cover is likely to be a key character in defining a crop ideotype suitable for efficient weed suppression.

In case of low pressure, weeds in organically grown winter wheat stands can often sufficiently be controlled just by using a narrow sown competitive cultivar. In two out of three field trials, mechanical weed control had no significant effect on grain yield, although ground cover was significantly reduced. Results suggest that the growth of some weed species can be reduced by increased crop competition. For example, in one trial, the number of loose silky bent (*Apera spica-venti*) panicles overtopping the wheat was significantly reduced in varieties with high shading ability (cv. Pegassos).

In another trial, ground cover of chickweed (*Stellaria media*) was significantly decreased by using a competitive variety. However, there are also results suggesting that weed species with high competitive abilities cannot sufficiently be controlled using indirect weed control methods only. These

species include climbing weeds such as hairy tare (*Vicia hirsuta*) or perennial weeds like whitetop (*Cardaria draba*). Beside weed species composition, other site specific factors such as the climate and weather conditions also influence the outcome of indirect weed control methods. Dry weather conditions in spring strongly favour crop competitive ability, because crop plants have better access to water and nutrients due to a deeper rooting system. Therefore, weed competitive ability in trials carried out in central Spain under dry soil conditions often failed to reach critical levels. Experiments on photocontrol suggest that effective weed control in organic farming with night-time tillage alone is not possible. Nevertheless, the germination of some weed species like *Chenopodium album*, *Lamium* species and *Veronica hederifolia* was light- dependent in several trials, suggesting that the emergence of these weed species can be reduced by photocontrol.

Experiments on allelopathy showed that there is considerable potential for using sunflower cover crop mulch to decrease weed pressure in following winter wheat. Laboratory trials clearly showed that water extracts of sunflower leaves (cv. Lech) significantly reduced seed emergence and subsequent growth of a wide range of weed species. The physiological reasons for the inhibition of germination and growth were extensively studied indicating that allelopathic compounds extracted from sunflower leaves mainly affect plant water balance. First field trials have confirmed the weed suppressing effect of sunflower mulch. It is expected that a DSS can integrate an option for using sunflower cover crops in certain crop rotations.

A first draft of a Decision Support System (DSS) has been developed. The DSS is based on a script compiler that is able to produce Internet pages, on which the inquiry and the subsequent evaluation can be carried out automatically. The user of the DSS only has to open the program file that is directly linked to common Internet programs. The specific advantage of this technique is the possibility for the user to update the DSS online. The basic principle of the DSS consists of a questionnaire, where farmers have to enter all relevant data of site-specific aspects such as climate and soil type and other farming management practices such as crop rotation. Furthermore, the user has to provide the DSS with information of the weed species composition and weed species abundance of the field site and with data about the weed control management system (e.g. type of mechanical weed control method used). Once the user of the DSS has entered all relevant data, an automatic evaluation tool will run, based on an 'if/then' decision tree that integrates the current knowledge derived from own results, results of literature and the knowledge of experts.

Suitable ideotypes are presented in the *WECOF Plant Breeders Manual*, which provides a guide to improve the competitiveness of new varieties. They need to be more robust in both plant establishment under contrasting conditions and in ability to produce as high as possible number of shoots per plant: either through tiller production or tiller retention. Certain key characteristics are generally desirable in plant breeding programmes

Juroszek, P., Drews, S., Neuhoﬀ, D., Köpke, U. (2004), 'Einfluß verschiedener Umweltbedingungen auf die Wirksamkeit der Nachtbodenbearbeitung gegen Unkräuter', *Mitteilungen Gesellschaft für Pflanzenbauwissenschaften*, 16, pp. 115–116.

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Ciarka, D., Gawronska, H., Malecka, M., Gawronski, S. W. (2004), 'Allelopathic potential of sunflower roots and root exudates', *Advances of Agricultural Sciences Problem Issues*, 496, pp. 301–313.

Bernat, W., Gawronska, H., Janowiak, F., Gawronski, S. W. (2004), 'The effect of sunflower allelopathics on germination and seedling vigour of winter wheat and mustard', *Advances of Agricultural Sciences Problem Issues*, 496, pp. 289–299.

Bernat, W., Gawronska, H., Gawronski, S. W. (2004), 'Physiological effects of allelopathic activity of sunflower on mustard', *Advances of Agricultural Sciences Problem Issues*, 496, pp. 275–287.

Topp, C. F. E., Davies, D. H. K., Hoad, S., Maskell, P. (2004), 'Modelling cereal ideotypes for optimising weed suppression in organic farming', *Organic farming: Science and practice for profitable livestock and cropping*, BGS/AAB/COR, Harper-Adams, April 2004 (A. Hopkins), BGS Symposium No 37, p. 256–259.

Golis, A., Gawronska, H., Gawronski, S. W. (2004), 'Weeds' responses to allelopathics derived from buckwheat (*Fagopyrum esculentum* Moench), submitted to *Crop Protection* (accepted).

Golis, A., Gawronski, S. W., Gawronska, H. (2004), 'Allelopathic activity of buckwheat against on quackgrass growth and development', *Advances of Agricultural Sciences Problem Issues*, 496, pp. 315–324.

Golis, A. (2004), 'Ocena zdolności allelopatycznej gryki zwyczajnej *Fagopyrum esculentum* Moench' (Evaluation of the allelopathic activity of buckwheat *Fagopyrum esculentum* Moench), PhD thesis, Department of Pomology and Basic Natural Sciences in Horticulture, Faculty of Horticulture and Landscape Architecture, Warsaw Agricultural University, Warsaw, Poland, pp. 112 (in Polish).

Davies, D. H. K., Hoad, S., Maskell, P., Topp, K. (2004), 'Looking at cereal varieties to help reduce weed control inputs', *Proceedings Crop Protection in Northern Britain 2004*, February 2004, Dundee, United Kingdom.

for organic wheat varieties to improve weed suppression. These are discussed in the Plant Breeders Manual and include besides the general aims of high grain yield, high baking quality and disease resistance:

- ▶ good establishment ability;
- ▶ high tiller production or tiller retention;
- ▶ high ground cover — initially through a highly prostrate habit to achieve early canopy closure, or if in an erectophile type then through a high leaf area index, either from high shoot production and/or large leaf size;
- ▶ balancing a lack of planophile growth habit and other ground cover characteristics with increased plant height or vice versa;
- ▶ targeting high leaf area index through tiller production or large leaves.

Potential applications

Farmers and advisers can use the DSS for teaching purposes, as most systems, but also for practical weed control.

Innovation contribution

New criteria for wheat ideotypes with respect to weed control were developed and included in a breeder manual.

Conclusions

The objectives of the project were fulfilled. Key issues have been published recently in *Weed Research* and in a chapter in an upcoming book on breeding for organic agriculture. The following are the conclusions from the paper published in *Weed Research*.

'Although strongly supported by evidence, the approach of weed competition encounters several limitations from the practical point of view. First and foremost variety choice in organic winter wheat production is a complex and hierarchically structured decision procedure. Main determinants of variety choice include purpose of use, yield performance and resistance to a range of fungal diseases such as brown rust (*Puccinia recondita*) that may negatively affect yield performance and grain quality. It is evident that the consideration of all these aspects already limits the availability of suitable varieties. Future breeding programmes for low input agriculture however could consider these issues.'

(Drews, S., Neuhoﬀ, D., Köpke, U. (2009), 'Weed suppression ability of three winter wheat varieties at different row spacing under organic farming conditions', *Weed Research*, 49, pp. 526–533.)

Development of a model based decision support system to optimise nitrogen use in horticultural crop rotations across Europe

Abstract

Most fresh vegetable production within Europe relies heavily on large inputs of fertiliser or organic nitrogen (N) sources to maintain the yield and quality of produce. Field vegetable crops often use N inefficiently and leave large residues of N in the soil after harvest, which can cause damage to soil, water and aerial environments.

This project will provide growers and policymakers with a decision support system for N management and rotational planning to optimise N use efficiency and economic sustainability in both conventional and organic systems of vegetable production across Europe.

This will help Member States to:

- (a) minimise hazards to the environment (Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources) by adopting consistent approaches to improve efficiency of nitrogen use for different production systems and climatic regions of Europe;
- (b) optimise production of quality crops while enhancing the economic sustainability of horticultural production.

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Acronym:

EU-Rotate_N

Project No:

QLK5-CT-2002-01100

EU contribution:

EUR 6 897 000

Duration:

48 months

Start date:

1.1.2003

End date:

31.12.2006

Framework programme:

Quality of Life (fifth framework programme)

Instrument:

Research Technological Development and Demonstration activities (RTD)

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Microbial fixation of atmospheric nitrogen for staple food crops

Abstract

The heavy use of inorganic fertilisers in arable farming has led to serious environmental problems. Organic farming methods require inputs of large volumes of organic material and yields do not compete with conventional farming. This project will research and develop new N-fixing bacterial inoculants for cereal crops which can substitute inorganic fertilisers or add value to organic fertilisers. inoculants are established for legumes, but no equivalent for non-legumes is available. Some recently discovered strains do interact with cereal plants, but they are vulnerable to high losses during storage and application. The project will isolate and test new strains as well as researching various delivery modes, including compost and microencapsulation, which will improve the survival of the bacteria during storage and application.

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Acronym:

MicroNFix

Project No:

QLK5-CT-2002-00791

EU contribution:

EUR 4 554 918

Duration:

48 months

Start date:

1.10.2002

End date:

30.9.2006

Framework programme:

Quality of Life (fifth framework programme)

Coordinator:

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Seed Treatments for Organic Vegetable Production

Acronym:

STOVE

Project No:

QLK5-CT-2002-02239

EU contribution:

EUR 1 697 664

Duration:

43 months

Start date:

1.3.2003

End date:

30.9.2006

Framework programme:

FP5 (fifth framework programme)

Instrument:

NA

Project website:

<http://stove.jki.bund.de/> (active)

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Summary

The efficacy ⁽¹⁾ of physical seed treatments and combined results from laboratory, greenhouse and field experiments (depending on pathosystem) are shown in Tables 1 and 2.

Table 1: Summary of physical seed treatments

Treatment	Cabbage/ <i>A. brassicicola</i>	Carrots/ <i>A. dauci/radicina</i>	Parsley/ <i>S. petroselin</i>
Hot water ⁽¹⁾	+++	+++	+++
Aerated steam	+++	+++	+++
Electron treatment ⁽¹⁾	++	+++	++

Treatment	Lamb's lettuce/ <i>P. valerianellae</i>	Beans/ <i>C. lindemuthianum</i>	Peas/ <i>A. pisi</i>
Hot water ⁽¹⁾	+++	+++	—
Aerated steam	+++	+++	—
Electron treatment ⁽¹⁾	+++	++	—

Treatment	Cabbage/ <i>X. campestris</i>	Carrots/ <i>X. hortorum</i>
Hot water ⁽¹⁾	+++	+++
Aerated steam	+++	++
Electron treatment ⁽¹⁾	++	++

Key: — = none; + = poor; ++ = moderate; +++ = high (similar to or better than the chemical thiram; no chemical standard for bacterial pathogens).

⁽¹⁾ Treatments not always optimally adapted to the respective seed lots.

Table 2: Efficacy ⁽¹⁾ of selected non-physical seed treatments (results mainly from greenhouse experiments, unless stated otherwise)

Treatment	Category ⁽²⁾	Use rate per 10 g seed/ inoculum used ⁽³⁾	Cabbage/ <i>A. brassicicola</i>	Carrots/ <i>A. dauci radicina</i>	Parsley/ <i>S. petroselinii</i>
BA 2552	FM	300 µl	++	+ (F)	+++ (F)
FZB 24	FM	100 mg	+	—	—
Serenade	FM	100 mg	++	—	++
Mycostop Mix	FM	50 mg	++	+ (F)	++
IK 726	EM/FM	CP/100 mg	+	++ (F)	+
E 183	EM	CL		+	
G 12	EM	CL	+	+	+
SLU 2	EM	CL	++	—	—
SLU 3	EM	CL	++	+	++
SLU 4	EM	CL		+	
SLU5	EM	CL	++	++ (F)	—
RG 68	EM	CL	+	+	—
MSA 35	EM	CL	++	—	+
T.v. 69039	EM	CP	++	+	+
R 11	EM	CL	—	<i>n.t.</i>	-
M 29	EM	CL	++	—	+
M 8	EM	CL	—	—	—
Thyme oil	PP	(0.1–1 %)	++	++ (F)	+++ (F)
Milsana	PP/RI	1 %	++	+	+
Tillecur	PP	130 mg	+	+	+
Thiram	CH	variable	+	+++ (F)	+++ (F)

Treatment	Lamb's lettuce/ <i>P. valerianellae</i>	Beans/ <i>C. lindemuthianum</i>	Peas/ <i>A. pisi</i>	Cabbage/ <i>X. campestris</i>	Carrots/ <i>X. hortorum</i>
BA 2552	+	+	—	<i>n.t.</i>	<i>n.t.</i>
FZB 24	—	++	—	<i>n.t.</i>	<i>n.t.</i>
Serenade	—	++	—	<i>n.t.</i>	<i>n.t.</i>
Mycostop Mix	+	—	—	<i>n.t.</i>	<i>n.t.</i>
IK 726	—	++	+	<i>n.t.</i>	<i>n.t.</i>
E 183					
G 12	—	++	—	<i>n.t.</i>	<i>n.t.</i>
SLU 2	—	—	—	<i>n.t.</i>	<i>n.t.</i>
SLU 3	+	—	—	+	—
SLU 4					
SLU5	—	—	—	<i>n.t.</i>	<i>n.t.</i>
RG 68	—	++	—	<i>n.t.</i>	<i>n.t.</i>
MSA 35	—	++	—	<i>n.t.</i>	<i>n.t.</i>
<i>T.v.</i> 69039	—	+	—	<i>n.t.</i>	<i>n.t.</i>
R 11	<i>n.t.</i>	++	—	<i>n.t.</i>	<i>n.t.</i>
M 29	—	<i>n.t.</i>	<i>n.t.</i>	<i>n.t.</i>	<i>n.t.</i>
M 8	—	++	—	<i>n.t.</i>	<i>n.t.</i>
Thyme oil	+	++	++	—	—
Milsana	—	+	—	—	—
Tillecur	++	++	—	<i>n.t.</i>	<i>n.t.</i>
Thiram	++	++	+	<i>n.t.</i>	<i>n.t.</i>

Key: — = none; + = poor; ++ = moderate; +++ = high (similar to or better than the chemical thiram; no chemical standard for bacterial pathogens); (F) = efficacy also observed in field. (*n.t.*) = not tested

(¹) List of treatments with efficacy in at least one of the tested pathosystems.

(²) EM = experimental microorganism; FM = formulated microorganisms; PP = plant derived product; RI = resistance inducer; CH = chemical standard.

(³) CP = Petri dish culture; CL = shake culture.

Problem

Due to the difficulty in organic farming of producing pathogen-free seeds, and the lack of simple, effective non-chemical methods for seed sanitation, a substantial part of the seed used by European organic vegetable growers is still derived from conventional production. This will be strongly restricted after 2003 (Council Regulation (EEC) No 2092/91 ⁽¹⁾).

In March 2003, the EU project 'Seed Treatments for Organic Vegetable Production' (QLK5-2002-02239: STOVE) was initiated. The project was aiming to improve the available, non-chemical methods for the control of seed-borne vegetable pathogens and to develop new methods which are acceptable to organic farming.

Background and objectives

The overall long-term aim of the project is the reduction in existing obstacles to the production of healthy crop starting material for organic farming, in support of Regulation (EEC) No 2092/91. More short-term specific objectives are the evaluation and optimisation of existing methods and development of new methods for the control of seed-borne diseases in vegetable crops for organic farming. The following specific objectives will be fulfilled by the project.

- ▶ Objective 1: Optimisation/adaptation of existing physical methods for the treatment of seeds of different vegetable crops
- ▶ Objective 2: To test the suppressive activity of microorganisms, plant extracts and resistance-inducing agents against seed-borne pathogens and to evaluate their effect on plant growth
- ▶ Objective 3: Comparison of the effect of the three physical seed treatment methods, microorganisms and resistance inducing agents regarding efficacy against seed-borne pathogens and seed vitality
- ▶ Objective 4: Combinations of the physical seed treatment methods with seed treatments of natural origin (microorganisms, plant extracts, resistance inducing agents)

Methodology

The main methodology used was efficacy trials performed in the greenhouse and in the field using naturally infected vegetable seeds

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¹ Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1–15.

Selected publications:

Groot, S. P. C., Birnbaum, Y., Rop, N., Jalink, H., Forsberg, G., Kromphardt, C., Werner, S., Koch, E. (2006), 'Effect of seed maturity on sensitivity of seeds towards physical sanitation methods', *Seed Science and Technology*, 34, pp. 403–413.

Schmitt, A., Krauthausen, H.-J., Kromphardt, C., Jahn, M., Koch, E. (2006), 'Physikalische und biologische Saatgutbehandlung gegen *Alternaria* sp. an Möhre: Resultate von Gewächshaus- und Feldversuchen', *Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft*, 400, p. 339.

Koch, E., Kromphardt, C., Jahn, M., Krauthausen, H.-J., Schmitt, A. (2006), Untersuchung physikalischer und biologischer Saatgutbehandlungsverfahren für Feldsalat und andere Gemüsearten, *Mitteilungen aus der Biologischen Bundesanstalt für Land- und Forstwirtschaft*, 400, p. 339.

Schmitt, A., Koch, E. (2006), 'Gesundes Saatgut für den Öko-Anbau', *Gemüse*, 3/2006, pp. 18–20.

Koch, E., Schmitt, A. (2007), 'Saatgutbehandlung ohne Chemie', *Gemüsebau Praxis*, 14(3), pp. 7–8.

Koch, E., Schmitt, A., Jahn, M., Kromphardt, C., Krauthausen, H.-J., Roberts, S., Wright, S., Amein, T., Forsberg, G., Tinivella, F., Gullino, M. L., Wikström, M., van der Wolf, J., Groot, S., Werner, S. (2007), 'Evaluation of seed treatment methods for organic vegetable production', *IOBC-WPRS Bulletin*, 30(6), p. 17.

Wright, S. A. I., Amein, T., Forsberg, G. et al. (2007), 'Behandling av köksväxtfrö', *Viola: Potatis och Grönsaker*, 20 pp., 32–33.

Groot, S. P. C., Birnbaum, Y., Kromphardt, C., Forsberg, G., Rop, N., Werner, S. (2008), 'Effects of activation of germination processes on the sensitivity of seeds towards physical sanitation treatments', *Seed Science and Technology*, 36, pp. 609–620.

Main findings and outcomes (results) or expected results

The expected achievements are:

- ▶ information on the biological potential and methodology of combinations of physical seed treatments with disease suppressive and/or growth promoting agents of natural origin;
- ▶ identification of such combinations resulting in additive or complementary activity compared to the single methods.

It is expected that the optimised physical seed treatments as well as their combination with non-physical methods developed in this project also have economic potential in integrated vegetable production.

Potential applications

Seed treatment of vegetable seeds in organic and conventional production. The project has contributed greatly to the further development of the aerated steam seed treatment technology which is now marketed under the name 'Seedgard'.

Innovation contribution

Knowledge on the use and efficacy of new seed treatment technologies, mainly the method of electron seed treatment and aerated steam treatment and the use of plant extracts and microorganisms for control of seed-borne pathogens.

Conclusions

The overall conclusions of the project are as follows.

- ▶ The outcome of seed treatment projects is fundamentally dependent on the availability of infested seed lots. *In vitro* results on the level of seed infection do not necessarily reflect the usefulness of the particular seed lot for greenhouse work. Work was not possible on all pathosystems planned: Oomycete pathogens were not included due to lack of suitable seed lots.
- ▶ Not all pathosystems are equally amenable for use in model systems. If disease symptoms of a certain pathogen can only be seen under field conditions (e.g. parsley/*Septoria*; bacterial diseases), laborious field trials or transmission experiments have to be carried out. In cases where pathogen control can be determined via emergence or symptoms on plants, greenhouse trials demonstrated clear effects (e.g. carrots or brassica/*Alternaria*, lamb's lettuce/*Phoma*, bean/*Colletotrichum*).

- ▶ Inclusion in the experiments with fungal pathogens of a chemical standard (thiram) — although STOVE is a project for organic farming — proved to be very helpful and can be recommended for further work.
- ▶ In almost all cases, the treatments could be better differentiated under controlled conditions compared to the field. In the field, it appeared that treatments could be better differentiated under less favourable conditions, when emergence in the controls was low.
- ▶ From the extension point of view, it is obvious that field experiments in projects for organic farming should be made on organic land. However, based on the results obtained in the field experiments with carrots (2004 and 2005 on conventional fields, 2006 on organic land) there is no reason to suspect that the outcome of seed treatment trials differs in the two situations.
- ▶ In all pathosystems, effective alternative control treatments were identified, with efficacy comparable to that of thiram. This applies, for example, to *Alternaria* on cabbage and carrots, *Sep-toria* on parsley, *Phoma* on lamb's lettuce and *Colletotrichum* on bean, while *Ascochyta* on peas and the bacteria were particularly difficult to reduce to acceptable disease levels.
- ▶ Best results were obtained with the physical seed treatment methods. The success with these methods is largely dependent on the selection of the right treatment parameters, because even seed lots of the same cultivar may differ in physiology (e.g. due to differences in maturity). This implies that intensive optimisation is required in order to guarantee a safe treatment and viability of seeds.
- ▶ It could be shown that immature or pre-germinated seeds are more sensitive to hot water and aerated steam treatment than mature seeds.
- ▶ Aerated steam appeared to be the most effective method, but hot water and electron seed treatment may still be similarly effective if they are optimally adapted to the respective seed lot.
- ▶ Disease control activity could also be demonstrated for some of the alternative seed treatment agents. Their activity was usually more specific and lower than that of the physical methods. However, due to the given time frame, the alternative agents could not be optimised (e.g. the microbials in terms of fermentation, formulation and number of CFU/seed) which may have improved their efficacy. It should also be noted that most of the seed lots used had greater infestation levels than usually encountered under practical conditions. For these 'normal' seed lots, the effective alternative seed treatments may be sufficient.
- ▶ Effects on plant growth by the biological treatments appeared in some trials but could not be demonstrated in experiments with non-infested seed.

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- ▶ The effective alternative agents are suited for situations with low seed infection, especially in greenhouses, and in combinations with physical methods. It may even be an advantage with respect to seed vitality to combine a lower (safe) intensity physical treatment with a biological one. The alternative agents may also provide some activity against soil-borne infections which physical seed treatments alone do not have.
- ▶ Overall, the STOVE project has been a successful project, in which many of the objectives were reached. It demonstrates that for most of the important seed-borne pathogens leading to vegetables diseases, effective non-chemical seed treatments exist. Most of them are developed enough to be used in practice.

Intercropping of cereals and grain legumes for increased production, weed control, improved product quality and prevention of N-losses in European organic farming systems

Abstract

Organic farming is increasing in Europe. However, the production of cereals and protein crops (pea, beans, etc.) needs to be increased in organic farming to fulfil the requirement for organic feed and food in Europe from 2005. Intercropping, which is the simultaneous growing of two or more crop species on the same land, can contribute to this overall goal.

The objective of this multidisciplinary project is to determine the potential for intercropping in European organic farming. In field pot and on-farm experiments in four European countries we will determine: the intercrop yield advantage and stability; new intercropping designs; multiple nutrient use; monitor effects on weeds and diseases; and determine the effects of intercropping on the quality of products for food and feed. A simulation model will be developed to model grain legume-cereal intercrops. The project is expected to contribute to an increased use of intercropping and the associated beneficial effects, such as environmentally friendly produce.

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Acronym:
INTERCROP

Project No:
QLK5-CT-2002-02352

EU contribution:
EUR 4 041 831

Duration:
41 months

Start date:
1.1.2003

End date:
31.5.2006

Framework programme:
Quality of Life (fifth framework programme)

Instrument:
Research Technological Development and Demonstration activities (RTD)

Coordinator:
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Sustaining Animal Health and Food Safety in Organic Farming

Acronym:

SAFO

Project No:

QLK5-CT-2002-02541

EU contribution:

EUR 750 096

Duration:

42 months

Start date:

1.3.2003

End date:

31.8.2006

Framework programme:

Quality of Life (fifth framework programme)

Instrument:

Coordination of research actions

Coordinator:

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Abstract

In Europe, organic livestock production has experienced rapid growth in the past decade. Common EU standards for organic animal production were implemented only some 18 months ago (Council Regulation (EC) No 1804/1999 of 19 July 1999 supplementing Regulation (EEC) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock product). There is a strong need to harmonise the standards under widely different circumstances in order to ensure food safety and animal health.

The proposed project will provide a network where consumer and policy-maker concerns about food safety and animal health is addressed in existing and emerging EU countries in the field of organic livestock production. Through workshops, standard development, creation of networks and forums for researchers and stakeholders, this three-year project will facilitate, coordinate, integrate, communicate and discuss research in the field with special emphasis of harmonisation between existing and emerging EU countries.

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Replacement of copper fungicides in organic production of grapevine and apple in Europe

Acronym:

REPCO

Project No:

501452

EU contribution:

EUR 1.94 million

Duration:

48 months

Start date:

1.11.2003

End date:

31.10.2007

Framework programme:

FP6 (sixth framework programme)

Instrument:

Specific Targeted Research Project

Project website:

<http://www.rep-co.nl> (no longer active)

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Summary

The objective of the REPCO project was to contribute to the replacement of copper fungicides in organic agriculture by new measures for control of downy mildew (*Plasmopara viticola*) in grapevine and scab (*Venturia inaequalis*) in apple. Both major European organic crops strongly depend on copper fungicides. Permitted amounts will be reduced stepwise in the years ahead (Council Regulation (EEC) 2092/91, Annex II ⁽¹⁾) to avoid environmental risks. In European countries where copper fungicides are already out of use, the production of organic apples suffers severe economic problems because of insufficient scab control.

Potentiators of resistance, organic-based fungicides and biocontrol agents have been screened and evaluated in grapevine and apple. The risk of pathogen evolution during use of novel control measures has been estimated to enable the development of sustainable strategies. Effects of crop management practices in organic agriculture on overwintering of *V. inaequalis* were assessed. Novel disease control measures and knowledge have been integrated into organic management systems. 'Pipeline' products already under development elsewhere have been included and, where necessary, optimised in their use.

The implementation by end-users and industries qualified for the commercialisation of project findings has strongly been emphasised. Small and medium-sized enterprises (SMEs) as project partners have ensured a strong link between end-users and research. At the end of the project, several compounds and biocontrol agents were delivered to qualified industries for the development of products for use in organic agriculture. Additionally, knowledge of integrated use of control measures was delivered to organic growers.

The project results thus strongly support EU policies to replace the use of copper fungicides in organic agriculture in the near future.

1 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1–15.

Problem

In European organic agriculture, multiple applications of copper fungicides are common in grapevine for the control of downy mildew (*Plasmopara viticola*) and in apple for the control of scab (*Venturia inaequalis*). Economical viable production of these organic crops strongly depends on the use of copper.

Council Regulation (EEC) No 2092/91 on organic farming allows for the application of a maximum level of copper per hectare per year which was reduced after the beginning of 2006. Due to their unfavourable ecotoxicological characteristics, copper-containing fungicides should be replaced by novel control measures acceptable in organic farming and sustainable agriculture. The availability of novel tools will allow the development of ecologically sound and economically viable forms of agriculture as set out in Agenda 2000 and, consequently, support the implementation of the policy of the European Commission.

Background and objectives

The objective of the project was to contribute to the replacement of copper fungicides in European organic agriculture by studying and developing new organic-based fungicides and potentiators of resistance, new biocontrol agents and new integrated management systems for disease control of *Plasmopara viticola* in organic grapevine and *Venturia inaequalis* in organically grown apple.

Methodology

The following experimental work was carried out.

- ▶ Collection of candidate compounds for control of *Plasmopara viticola* and *Venturia inaequalis* and risk assessment of each compound
- ▶ Screening of potentiators of resistance and fungicides for control of *P. viticola* on leaf discs in the laboratory, on seedlings in the glasshouse and in the vineyard
- ▶ Integration of control measures for downy mildew control in French and Italian vineyards
- ▶ Assessment of selection pressure of control measures and forced evolution in *P. viticola*
- ▶ Assessment of *P. viticola* on vines grown in cultivar mixtures
- ▶ Screening of potentiators of resistance and fungicides for control of *V. inaequalis* in apple under controlled conditions and in the orchard
- ▶ Assessment of integrated use of selected products for scab control in apple production
- ▶ Dissemination of knowledge in growers' trials in apple orchards

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Selected publications:

Bengtsson, M., Wulff, E., Lyngs
 Jørgensen, H. J., Pham, A., Lübeck, M.,
 Hockenhull, J. (2009), 'Comparative
 studies on the effects of a yucca extract
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 cropro.2011.02.031.

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 Vibeke Bengtsson, M., Eznar, E.,
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 'New composition for control of foliar
 diseases in *Rosaceae*', International Patent
 Application: P76089EP00.

- ▶ Collection and screening of antagonists on seedlings for biological control of apple scab
- ▶ Development of mass production and prototype biocontrol products and field testing during summer epidemics of apple scab
- ▶ Enhancement of degradation of overwintering apple leaves to reduce the ascospore potential of scab (*V. inaequalis*) by leaf treatments stimulating degradation and earthworm activity

Main findings and outcomes (results) or expected results

- ▶ Potential of more than 130 potentiators of resistance and fungicides for control of downy mildew assessed in screening experiments in grapevine
- ▶ Potential of more than 100 potentiators of resistance and fungicides for control of scab assessed in screening experiments in apple
- ▶ Potential of 40 potentiators of resistance and fungicides for control of downy mildew assessed in 14 field experiments in grapevine
- ▶ Potential of 40 potentiators of resistance and fungicides for control of scab assessed in 18 field experiments in apple
- ▶ Novel potentiators of resistance against *P. viticola* found in grapevine
- ▶ Novel use of several plant extracts found highly effective against *V. inaequalis* in apple
- ▶ More than 200 candidate antagonists assessed for their potential to control apple scab
- ▶ One novel antagonist selected with high potential effectiveness against *V. inaequalis* and suitable for commercial product development
- ▶ Stimulation of leaf degradation and reduction of *V. inaequalis* ascospore production by applications of vinasse demonstrated
- ▶ Selection pressure of control measures and forced evolution in *P. viticola* in grapevine known
- ▶ Complex microbial interaction in apple leaves characterised

Potential applications

REPCO produced exploitable knowledge on the use of several potentiators of resistance or organic-based fungicides in organic production of grapevine or apple. Such novel products showed promising activity against downy mildew of grapevine (*Plasmopara viticola*) and/or apple scab (*Venturia inaequalis*) and may have a potential for the control of other plant diseases. An antagonistic isolate for effective control of apple scab has been found as well. In part, exploitable knowledge has been protected by patent applications to facilitate the commercial development of plant protection products by industries.

REPCO evaluated a substantial number of formulated or non-formulated products obtained by 60 industries and 10 scientific institutes. REPCO partners had agreements with such industries or scientific institutes and knowledge on test products has, on the basis of agreements, been exchanged directly between REPCO partners and the respective industries or scientific institutes so that this knowledge can be exploited. In other cases, knowledge is available for industries on request and/or has been published and thus is available for exploitation by industries.

Innovation contribution

All the main findings contributed to the development of innovative plant protection methods for organic farming. A high level of innovation was achieved by REPCO research: six patents or other IPR protection applications were submitted during or after the project period to support a commercial exploitation of novel project results.

Conclusions

REPCO successfully contributed to the development of new measures for control of downy mildew (*Plasmopara viticola*) in grapevine and scab (*Venturia inaequalis*) in apple and thus achieved the overall goal to contribute to the replacement of copper fungicides in organic agriculture. Some of the new measures found during the REPCO project have to be further developed by industry: relevant information has been provided. The efficacy of the new measures may not be sufficient as stand-alone applications and the combined use of different measures has to be explored. Furthermore, the use of the new disease control measures has to be integrated into copper-free cropping systems which also include the control of diseases not yet targeted by the new measures.

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Köhl, J. A. (2009), 'Novel micro-organisms controlling plant pathogens', International Patent Application under PCT: WO 2009/078710 A1.

Matasci, C. L., Gobbin, D., Schärer, H.-J., Tamm, L., Gessler, C. (2008), 'Selection for fungicide resistance throughout a growing season in populations of *Plasmopara viticola*', *Eur J Plant Pathol.*, 120, pp.79–83.

Matasci, C. L., Jermini, M., Gobbin, D., Gessler, C. (2010), 'Microsatellite based population structure of *Plasmopara viticola* at single vine scale', *Eur J Plant Pathol.*, 127, pp. 501–508.

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Improving the quality of European citrus and fruit by developing Medfly SIT technology so it can be widely applied in Europe

Acronym:

CLEANFRUIT

Project No:

506495

EU contribution:

EUR 2 367 303

Duration:

36 months

Start date:

1.1.2004

End date:

31.12.2006

Framework programme:

FP6 (sixth framework programme)

Instrument:

Specific Targeted Research Project (STP)

Coordinator:

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Abstract

The project aims to develop safer, higher quality food by implementing improved crop protection systems based on the increased use in Europe of Sterile Insect Technique (SIT). SIT is based on the mass production and release of sterile male insects which mate with wild females, preventing the production of offspring, and causing the pest population to crash.

Medfly is a major pest of several key crops in Europe, notably citrus. Use of Medfly SIT in California, Florida, Mexico, Central America and Chile has shown SIT to be cost-effective, environmentally sound and a sustainable alternative to chemical insecticides. In Europe, the main control method remains chemical insecticide spraying. Feasibility studies and small-scale SIT trials show SIT can be used effectively in European fruit production though technical and practical obstacles hinder its widespread use. European commercial culture, geography and the citrus industry structure is different from, for example, the USA.

SIT requires specific adaptations and improvements to be widely adopted in Europe. By replacing chemical insecticides, SIT reduces chemical residue levels in food. By effective control of the pest, it reduces impacts on the food chain. By encouraging biodiversity, it supports tourism and alternative land use, and other biological control programmes. By controlling quarantine pests, it supports exports. Of the biological methods available, SIT has the greatest potential to improve the quality of fruit production in Europe (EU Standing Committee on Plant Health, 2001).

Three main advances are needed to enable the widespread adoption of SIT in Europe: (i) development of decentralised production based on egg-shipping technology; (ii) development of field-release technologies more suitable for Europe; (iii) dissemination of tools and knowledge enabling local organisations to adopt SIT. A consortium of SIT experts will develop technical/scientific tools and measures to address these issues.

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Enhancement and exploitation of soil biocontrol agents for bio-constraint management in crops

Acronym:

2E-BCAs in Crops

Project No:

1687

EU contribution:

EUR 2.3 million

Duration:

36 months

Start date:

1.1.2004

End date:

31.12.2006

Framework programme:

FP6 (sixth framework programme)

Instrument:

Specific Targeted Research Project

Project website:

No longer active

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Summary

The main objective of the project was to improve the efficacy of some of the already available, or the most promising, biocontrol microorganisms (such as *Fusarium*, *Trichoderma* or *Coniothyrium* sp.) in vegetable crops. Cabbage, tomato, carrots and lettuce were particularly targeted for the biological control of diseases such as those caused by *Sclerotinia*, *Fusarium* or *Pythium* spp., or parasitic and perennial weeds, such as *Orobancha* sp. and *Cirsium arvense*.

The studies of the genetic and physiological enhancement strategies, the ecological fitness of the agents, the production, formulation and application methods, the integration with other organisms and with control methods, and assessing their quality and the risk of release into the environment, have all made a contribution to improving the efficacy of fungal biocontrol agents, and to their wider use on a European level, providing new and important tools to support the production of safer and healthier foods.

Problem

Among all the living organisms that can attack crops causing qualitative and quantitative reductions in production, those living in the soil, such as plant pathogens and weeds are among the worst and more difficult to control by traditional tools and strategies. It is thus necessary to use pesticides, raising issues of food safety and the need to find alternatives.

Soil-borne plant pathogens responsible for damping off, crown and root rots, and wilt represent a major problem of plant protection in many open-field and greenhouse vegetable crops. **Parasitic weeds** such as *Orobancha* spp. attack nearly all vegetables, legumes and sunflowers from southern Europe to the Balkans and Russia, the Middle East and North Africa. **Perennials weeds** are among the most troublesome weeds to manage. For example, *Cirsium arvense* is considered one of the world's worst weeds.

Control strategies for the above pest problems include the application of soil fumigants such as methyl bromide, which is one of the most effective and widespread (but extremely expensive) practices used to

control soil pests. Recent regulations have meant it has been phased out totally since 2005 due to negative environmental effects. In many crops, no real alternatives to methyl bromide have been found. Other fumigants are expensive and generally less effective than methyl bromide for conventional agriculture and cannot be used in organic farming.

Other control strategies such as soil solarisation could be possible, but have environmental and temporal constraints. Seed treatments with conventional fungicides provide some initial protection against soil pathogens but this is not effective for a long enough period in heavily infested soils. None of the fungicides allowable in organic agriculture are very effective on soil-borne pathogens.

No traditional control methods have been effective for *Orobanche* spp., which are not usually amenable to control by persistent selective herbicides. Furthermore, as these weeds attach to crop roots, they cannot be controlled mechanically. Perennial weeds are difficult to control using traditional methods, because they cannot usually be removed mechanically and because they often require repetitive chemical treatments. None of the few herbicides allowable in organic agriculture control perennial or parasitic weeds.

Background and objectives

BIOLOGICAL CONTROL — A POTENTIAL SOLUTION

Examples of biocontrol agents follow, it was these examples that were the targets for enhancement in this project.

Coniothyrium minitans is an efficient mycoparasite of important plant pathogenic fungi, including *Sclerotinia* and *Sclerotium*. This organism has been used successfully in glasshouse and field experiments to control *Sclerotinia* diseases of a number of crop plants and a commercial product has been registered in seven European countries, Mexico and the United States. The major constraints of its wider use in agricultural practice are the limited knowledge of its ecology, and the scant information on its physiology and genetics, preventing attempts at strain improvement. Fungi of the genus *Trichoderma* are among the more bio-effective pesticides and are applied against fungal diseases. Regardless of the obvious potential, there are some problems that limit the development and application of these biopesticides, such as the lack of strains for every disease, very effective and correctly formulated preparations, a limited availability of basic information needed for further product registration (including sufficient knowledge of the mechanisms of action and interaction with other biocontrol agents), enough efficacy tests for the geographic areas in the countries where the product has to be registered, and methods for monitoring the production of possibly mammalian toxic metabolites produced by some of these fungi.

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Selected publications:
Research papers

During the three years of the project, 16 research papers in which the EU contribution was acknowledged were published — almost all of them appeared in international journals.

Book Chapters

Four book chapters related to, and acknowledging the project, were prepared.

Posters

Thirteen posters showing the activities carried out within the project were displayed at International Conferences.

Conference presentations

Twenty-eight oral presentations were held at international and national congresses, during which the research activities carried out by partners in the project or the general aims of the project were presented.

Non-pathogenic *F. oxysporum* strains were developed as biocontrol agents, showing several modes of action contributing to their biocontrol capacity, such as competition for nutrients in the soil, competition for infection sites on the root, trigger plant defence reactions, inducing systemic resistance. Several strains of non-pathogenic *F. oxysporum* have good efficacy in many trials but, as with other biocontrol agents, there is a lack of consistency. Despite isolation of many promising pathogenic organisms that could be useful for the control of parasitic weeds, none has received continual widespread use. Two very promising strains, *F. arthrosporioides* and *F. oxysporum*, were isolated in Israel from juvenile *O. aegyptiaca* plants, and also attacked *O. ramosa* and *O. cernua*, and very promising strains were isolated also in Italy.

Perennial weeds in arable farming are ideal targets for biological control. In organic farming systems, biological control of perennials, especially *Cirsium arvense*, would reduce the number of time-consuming and expensive mechanical treatments. *Phomopsis cirsii*, *Ramularia cirsii* and *Septoria cirsii* were chosen as promising candidates in systematic field surveys. Several virulent pathogens have been isolated by the partners but their efficacy has to be better evaluated and improved.

Methodology

Taking into account that many microorganisms were considered in the project, many different biotechnological, molecular, physiological and applicative approaches were chosen. Nine work packages were defined, each dealing with the solution to the overall problem on a continuum, from bettering the organisms while elucidating the genetic and physiological underpinnings of virulence (and lack thereof), to perfecting the culture, formulation and application technologies, to finally testing efficacy and food quality, following logical phases.

This multiplicity of expertise, tasks, microorganisms and approaches allowed the planning of a very interactive project that made a substantial contribute to the enhancement and application of biocontrol agents. Each group worked not only on the organisms on which it had already accumulated a high level of knowledge, but their expertise was also made available for the enhancement of other microorganisms. Each partner worked in collaboration with several partners, on more than one task and on more than one organism.

Considering the microbes studied in the project: four partners were involved with *Coniothyrium* studies, five with *Trichoderma*, four with antagonistic *Fusarium* and six with perennial or parasitic plants. Considering the different work packages, from two to six partners (mostly four or five) were involved in each work package.

Each working group involved experts in mycology, physiology, biotechnologies, molecular biology, chemistry, weed and crop science, allowing highly multifaceted work plans. A continuous flow and exchange of materials, strains, technologies and protocols was created within sub-packages, making it possible to formulate an organic and integrated work scheme that reached most of the planned objectives.

Main findings and outcomes (results) or expected results

Work package 1: Efficacy enhancement through the knowledge of genetic characters

- ▶ Changes in enzyme production and gene expression by biocontrol agents during infection of the host were identified
- ▶ Biocontrol agents at the molecular level for identification and environmental monitoring were characterised
- ▶ Pathogenicity genes were identified
- ▶ Mating-type genes in biocontrol strains to improve mycoherbicide efficacy were characterised and utilised
- ▶ Potentially hyper-virulent strains for mycoherbicide use were selected and manipulated

Work package 2: Physiological enhancement

- ▶ Molecules involved in the activation and stimulation of biocontrol process in *Trichoderma* and other mycoparasitic fungi were identified
- ▶ Improvements were made in essential amino acids to enhance the virulence of mycoherbicides, including the induction of hyper-virulence by reducing the free calcium available to weed defences
- ▶ More efficacious pathogens to perennials and the production of toxic metabolites with herbicidal properties were selected

Work package 3: Ecological fitness

- ▶ The population dynamics of biocontrol agents in different soil types was studied
- ▶ The effect of environmental factors on the population dynamics of biocontrol agents in soil was studied
- ▶ Population dynamics of biocontrol agents in the rhizosphere was considered
- ▶ Ecological fitness under field conditions was studied

Project website

The World Wide Web has become a major information channel and indispensable to producers of information, particularly in scientific and technical domains, for publishing online. The official website of the project was realised and published on the net a few months after the beginning of the project. It contained details of the aim of the project, background on the partners involved, programme, activities, results obtained, etc. It was updated on a regular basis but is no longer active; its content, however, will be made available on another website.

Project brochure

A brochure of project was prepared in 5 000 copies and distributed to each partner. It worked as a calling card for presentation to influential readers, such as European policymakers, national and local authorities, potential partners, investors, industrial end-users, technology licensees and media representatives. It provided an overview of the consortium, highlighting the reputation/strengths of individual partners; it reviewed the background and technological rationale for undertaking the initiative and indicated the planned results, emphasising the scale of breakthrough/innovation expected to be achieved.

Work package 4: Environmental impact of biocontrol agents

- ▶ Molecular markers to recognise the biocontrol agent strains after their release into the soil were identified
- ▶ Interactions of biocontrol agents with soil microorganisms were studied
- ▶ A method to detect non-target effects of microbial application to soil by characterising the structure of the microbial communities was developed and validated
- ▶ Specially labelled *Trichoderma* strains acting as anti-fungal biocontrol agents, while visualising the antagonistic interactions with pathogens and other soil microorganisms, was monitored
- ▶ The effect of the biocontrol agent *Coniothyrium minitans* on microbial communities following introduction into soil was determined
- ▶ Interactions of biocontrol agents with plants were studied
- ▶ The host range of selected strains of pathogenic fungi on *Cirsium arvense* was determined to ensure that the potential biocontrol agents have no undesirable off-target effects
- ▶ Transgenic markers were used to follow the movement of a root-colonising organism that attacks parasitic *Orobanch*e spp. and ascertain its persistence in soil, especially when the organism is applied at a point source as an asporogenic mutant, with or without mitigator genes tandemly-linked to hyper-virulence genes

Work package 5: Production and formulation

- ▶ A suitable culture medium was selected for the production of the fungal colony-forming unit (CFU) using an appropriate fermentation technology
- ▶ The most suitable growth conditions were evaluated
- ▶ The best technology to separate the CFU from the fermentation product was selected
- ▶ The most suitable methods and conditions for the formation of the produced CFU were evaluated
- ▶ The shelf life of the formulated products was determined

Work package 6: Application methods

- ▶ The compatibility of irrigation systems with the application of living microbial agents was evaluated
- ▶ Application technologies of wild-type and modified *Fusarium* mycelial formulations in the laboratory and greenhouse for the control of *Orobanch*e were compared
- ▶ Application technologies for mycoherbicides for the control of *Cirsium* sp. in the laboratory and greenhouse were compared
- ▶ The ability of phytotoxins to prevent irrigator clog by weed roots was evaluated

- ▶ Application technologies of biocontrol agents to seeds were developed

Work package 7: Field efficacy

- ▶ Consistent and reliable effects from the selected microbial control organisms on clones of *Cirsium arvense* and *Sonchus arvensis* under field conditions in different parts of Europe were obtained
- ▶ The best application technologies for pathogens of weeds with different irrigation methods as a new option for applying mycoherbicides to the soil were ascertained
- ▶ The best application technologies for *Fusarium* mycelial-based mycoherbicides in a small-scale field experiment were ascertained
- ▶ The best application technologies to enhance the efficacy under field conditions of novel fungal biocontrol agents and bioactive molecules on major plant pathogens on lettuce and tomato were ascertained

Work package 8: Integration

- ▶ Mixtures of cell-wall-degrading enzymes were produced by biocontrol strains of *Trichoderma* to increase the efficacy of various biocontrol agents and the effect of chemical fungicides
- ▶ The compatibility of *Coniothyrium minitans* and *Trichoderma* for the control of *Sclerotinia sclerotiorum* in lettuce; glasshouse trials on the integrated use of these two major biocontrol agents were carried out
- ▶ The compatibility and efficacy of weed pathogen-phytotoxin mixtures for enhanced biocontrol was assessed
- ▶ The biocontrol efficacy of microbial-inoculant combinations against soil-borne pathogens of vegetable crops and enhanced compatibility of strains of *Trichoderma*, non-pathogenic *F. oxysporum* and *Pseudomonas* spp. was tested

Work package 9: Assessment of crop quality

- ▶ The content of antioxidant components (vitamin C, lycopene and phenolic compounds), sugars, organic acids and the mineral content of tomato berries obtained using biocontrol methods versus those obtained using traditional methods of crop protection was compared

Potential applications

Growing concern over the presence of chemical residues in the food chain, the evolution of fungicide-resistant strains of plant pathogens

and herbicide-resistant weeds, the loss of registration of some of the more effective pesticides or their phasing out, have generated an interest in the development of alternatives to synthetic agrochemicals that are both effective and economically feasible. Sales of organic products have increased dramatically in recent years in Europe, and organic farming is the fastest growing sector of agriculture and an important point in the EU agri-food policy. There is an increasing interest in the biological control of plant diseases, pests and weeds as an environmentally friendly practice to be used in conventional, low-input agriculture and organic farming. However, there are some disadvantages in the use of biological over chemical control: these must be overcome to increase biological use on horticultural, forest and field crops in diverse habitats. Research has shown that the results of biological control are sometimes inconsistent and less satisfactory than chemical control. In many cases, biocontrol agents are too specific or, under some environmental conditions, slow-acting. The overall objective of the project was the enhancement of the performance of biocontrol agents to offer a reliable alternative to chemical control of plant diseases and weeds.

The public, even if open to organic farming practices and desiring healthy and safe methods for food production, may be worried about the risk of release into the environment of microbes that could have environmental side effects on non-target organisms. An important part of the project was dedicated to developing methodologies for the assessment of the environmental impact of biocontrol agents, by producing specific primers to recognise them after release into the soil; constructing methods for labelling biocontrol agents for tracking their movement; assessing the impact on microbial populations of biocontrol agents introduced into soil; and designing methods for containment and mitigation.

Commercialisation of biocontrol agents has been slow due to the lack of consistency and efficacy of the microorganisms used. An important part of the project was devoted to the synergistic integrated use of more than one microorganism, or their integration with microbial bioactive metabolites. This part of the project supplied innovative data on the production of mixtures of cell-wall-degrading enzymes by *Trichoderma* strains optimised for synergistic antimicrobial activity in combination with living biocontrol agents and chemical fungicides; the determination of the compatibility of two major biocontrol agents for the control of *Sclerotinia* in lettuce and protocols for joint application; the ecological fitness and biocontrol efficacy of wild strains of biocontrol agents resistant to inhibitory metabolites produced by other biocontrol agents

Innovation contribution

Companies, local authorities and end-users require consistent efficacy of products when they are used, and the endpoint of the project was to help in producing effective biocontrol agents. A whole package was

devoted to the assessment of field efficacy, evaluating the best methods of application to experimental fields in different environmental conditions. The methodologies and the knowledge developed during the project could be easily adapted to other needs, further widening the public and scientific interest. Considering that the agents studied in the project could potentially be applied on several other crops with respect to those considered into the project, the supply of microbes to other vegetable growers could increase the information on the efficacy of biocontrol agent treatments, and would wider the consumer audience and their confidence in strategies of microbial biocontrol.

Conclusions

The objectives of the projects were mostly reached. Considerable research and efforts are still necessary in these fields in order to obtain products ready to be introduced to the market.

Science and society improving animal welfare in the food quality chain

Acronym:

Welfare Quality®

Project No:

506508

EU contribution:

EUR 14.6 million

Duration:

68 months

Start date:

1.5.2004

End date:

31.12.2009

Framework programme:

FP6 (sixth framework programme)

Instrument:

IP

Project website:

<http://www.welfarequality.net> (active)
<http://www.welfarequalitynetwork.net> (active)

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Summary

The primary objective of the thematic priority 'Food Quality and Safety' is to improve the health and well-being of European citizens through ensuring a higher quality of food. In a 'fork to farm' approach it is recognised that consumers' perception of food quality is not only determined by overall nature and safety but also by the welfare status of the animal from which it was produced. Thus, animal welfare is part of an overall 'food quality concept'.

Furthermore, the fact that improving an animal's welfare can positively affect numerous aspects of product quality (e.g. reducing the occurrence of tough or watery meat, bruising, abnormal eggshells), pathology (e.g. alleviating fear reduces the potential development of pathological anxiety) and disease resistance (e.g. decreasing the immunosuppressive effect of chronic stress and the need for antibiotics) also has a direct bearing on food quality and safety.

Within the Welfare Quality® project, leading European groups with the most appropriate specialist expertise are integrated to build on European research strengths and to realise important societal and policy objectives. Our research programme is designed to develop European standards for on-farm welfare assessment and product information systems as well as practical strategies for improving animal welfare.

Considerable effort is focused on analysing and addressing the perceptions and concerns of principal stakeholders (public, industry, government and academia) and providing appropriate feedback. Educational and media initiatives, web-based platforms, etc., further enhance societal involvement.

Transparency of the product quality chain requires visibility of production processes and an understanding of how they affect welfare; the key is to link animal husbandry practices to informed animal product consumption. This demands reliable on-farm welfare monitoring systems enabling assessment of welfare status and the standardised conversion of welfare measures into accessible and understandable information, thereby addressing concerns and allowing clear marketing and profiling of products.

Development of innovative, species-specific, practical strategies for improving animal welfare will minimise the occurrence of harmful behav-

joural and physiological states, improve human-animal relationships, and provide animals with safe and stimulating environments.

Finally, implementation of the welfare assessment and product information systems as well as the welfare improvement strategies identified here will support the development of husbandry systems and genotypes offering different facets of animal welfare, thus contributing to the diversification and societal sustainability of farm animal production in Europe.

Problem

There were many and very diverse groups, factors, circumstances and developments that have been influential in driving and guiding the Welfare Quality® project. Specifically, four factors have been particularly crucial: citizens, production chains, the European Union and scientists.

European citizens consider farm animal welfare of increasing significance and they demand guarantees and transparent information

During the last decades of the 20th century major changes took place in animal production (Blokhuis et al., 1998). Production intensified enormously and farms became highly specialised (Porcher, 2001). This development led to a huge increase in the number of animals per farm and to striking increases in actual production. Furthermore, housing conditions and management practices changed profoundly with increased mechanisation and other technological developments. Animal production became increasingly industrialised, with quantity often taking precedence over quality.

Over the years, cultural, attitudinal and commercial barriers hampered constructive communication between farmers and the people who ultimately eat what is produced. The activities of consumer groups and animal protectionists and, more recently, the effects of crises such as swine fever, BSE, foot-and-mouth disease and avian influenza have led to people becoming increasingly aware that animal production is more than just an industry. Issues such as animal welfare, food quality, food safety and the environment have assumed much greater importance for the public (consumer concerns).

Farm animal welfare is now clearly an important issue for ordinary people across Europe and there is clear demand for higher animal welfare standards (see *Eurobarometer*, 2005; 2007; Kjærnes et al. (2008)).

The general interest in animal welfare is also reflected in a widespread demand for information across Europe. However, this demand varies significantly across different countries and largely reflects differences in primary production, processing and distribution as well as govern-

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ance structures and public discourse. Moreover, information demand often seems to reflect a general interest rather than one that is apparent through purchase choice (Kjærnes et al. (2008)).

The production chain focuses more and more on delivering good animal welfare as an important attribute of total food quality

In general, farmers consider animal welfare as an important aspect of farming (Bock, these proceedings) and they are very motivated to take good care of their animals. Farmers also realise they have to deal with a market where people are concerned about the welfare of production animals and they acknowledge that these concerns have to be taken into account. There is broad recognition that conditions that harm animal welfare can negatively affect production and also damage specific quality aspects thereby jeopardising profitability.

Farmers are in favour of an objective standardised system of assessing animal welfare that could be used all over Europe and preferably worldwide (Bock, these proceedings). But, they are also worried about the costs of welfare assessments, welfare improvements and more stringent regulations. They are also anxious about who will bear such costs.

Producers, retailers and other food chain actors increasingly recognise that consumer concerns for good animal welfare represent a business opportunity that could be profitably incorporated in their commercial strategies (Roe and Buller, 2008). Animal welfare is increasingly used, particularly by retailers, as a component of product and supply chain differentiation (Eurogroup for Animals, 2007). Such differentiation (and creation of markets) may be based on an 'overall' high welfare level or be related to specific welfare aspects; it might or might not be 'bundled' with other product characteristics such as those referring to 'environment', 'global warming' or 'sustainability'.

In general, animal welfare is increasingly used as an important attribute of an overall conception of 'food quality' (Blokhuys et al., 1998; Buller et al., 2007).

The European Union's endorsement of the European Research Area

At the Lisbon European Council in March 2000, the European Research Area (ERA) was endorsed as a central component of the process of developing a knowledge-based economy and society in the EU. It was recognised that the issues at stake and the challenges associated with the technologies of the future, require European research efforts and capacities that are integrated to a far greater extent than at present. As such, the ERA has become the reference framework for research policy issues in Europe. The European Union promotes the ERA objectives and strengthens the scientific and technological basis of the Community

through the framework programmes (FP) for research, technological development and demonstration activities.

These FPs stimulate the creation of large collaborative projects and networks of excellence. Such integrated efforts aim to mobilise a critical mass of European research and development resources and skills and to better integrate research capacities across Europe.

THE COMMITMENT OF SCIENTISTS

Animal welfare science is relatively young and can be traced back to the 1960s with behavioural and physiological sciences being the most dominant areas of research (Blokhuys et al. (2008)). The science area is developing and expanding through the efforts of a growing number of committed researchers. Nowadays, the approach to the issue is clearly multidisciplinary and involves many different specialisations such as biology, psychology, ethology, biotechnology, veterinary and animal sciences, and social sciences.

Animal welfare is a subject of fierce debate in society and researchers in this area are often asked to contribute to the debate. Policymakers also often draw upon these experts to provide the science base for animal welfare regulations (e.g. through scientists' contributions to opinions of the European Food Safety Authority, EFSA).

Current developments in animal welfare research also clearly indicate that researchers respond to the ongoing public discourse and policy-making needs and that they shift their priority topics accordingly. Some examples of such topics are positive welfare indicators, detailed animal-based descriptions of farming practices, socio-economic information and technical decision support (Keeling, presentation at EFSA Scientific Forum, November 2007).

Background and objectives

The vision of the Welfare Quality® project was to accommodate the above drivers and to respond to their diverse requirements. Transparency of the product quality chain in relation to animal welfare is considered a major requirement. The latter involves visibility of production processes to all stakeholders (public, industry, government, etc.) and a quantification of how these processes affect animal welfare (Blokhuys et al., 1998).

Welfare Quality® therefore set out to deliver reliable, science-based, on-farm welfare assessment systems for poultry, pigs and cattle as well as a standardised system to convey welfare measures into easy to understand product information.

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Selected publications:

Blokhuys, H. J., Veissier, I., Miele, M., Jones, R. B. (2010), 'The Welfare Quality® project and beyond: safeguarding farm animal well-being', *Acta Agriculturae Scandinavica, Section A — Animal Science*, 60, pp. 129–140.

Boivin, X., Gilard, F., Egal, D. (2009), 'The effect of early human contact and the separation method from the dam on responses of beef calves to humans', *Applied Animal Behaviour Science*, 120, pp. 132–139.

Bokkers, E. A. M., Leruste, H., Heutinck, L. F. M., Wolthuis-Fillerup, M., van der Werf, J. T. N., Lensink, B. J., van Reenen, C. G. (2009), 'Inter-observer and test-retest reliability of on-farm behavioural observations in veal calves', *Animal Welfare*, 18, pp. 381–390.

Botreau, R., Veissier, I., Perny P. (2009), 'Overall assessment of cow welfare: strategy adopted in Welfare Quality®', *Animal Welfare*, 18(4), pp. 363–370.

Canali, E., Keeling, L. (2009), 'Welfare Quality project: from scientific research to on-farm assessment of animal welfare', *Italian Journal of Animal Sciences*, Vol. 8 (Supplement 2), pp. 900–903.

Dalmau, A., Fàbrega, E., Velarde, A. (2009), 'Fear assessment in pigs exposed to a novel object test', *Applied Animal Behaviour Science*, 117, pp.173–180.

It was also recognised that a large European effort in the area of animal welfare should also include research designed to identify practical ways of solving some of the main welfare problems in current animal production. Therefore, Welfare Quality® initiated appropriate studies in important areas — handling stress, injurious behaviours, lameness, temperament, etc.

In our view, an integrated European approach provides a firm basis for the harmonisation of assessment and information systems. It is also considered extremely relevant for the provision of transparent consumer information and for marketing and trade.

Thus, although the original goals have evolved as results emerged and opportunities arose, the main objectives still stand:

- ▶ to develop a standardised system for the assessment of animal welfare;
- ▶ to develop a standardised way to convey measures into animal welfare information;
- ▶ to develop practical strategies/measures to improve animal welfare;
- ▶ to integrate and interrelate the most appropriate specialist expertise in the multidisciplinary field of animal welfare in Europe.

Methodology

In a truly integrated effort, Welfare Quality® combined analyses of consumer/citizen perceptions and attitudes with existing knowledge from animal welfare science and thereby identified 12 areas of concern that needed to be adequately covered in the assessment systems.

To address these areas of concern, it was decided to concentrate on so-called performance measures that are based on measuring the actual welfare state of the animals in terms of, for example, their behaviour, fearfulness, health or physical condition. Such animal-based measures reflect the effects of variations in the way the farming system is managed (role of the farmer) as well as specific system-animal interactions (Figure 1). Relevant resource- and management-based measures are also included.

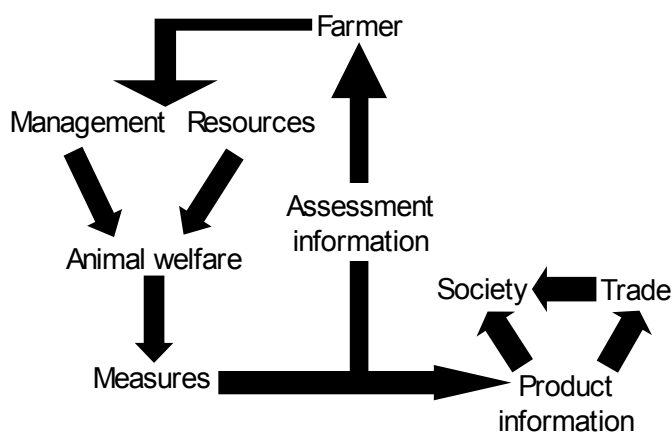


Figure 1: Diagrammatic representation of the measuring and information systems (adapted from Blokhuis et al., 2003)

Clearly, such an integrated, standardised assessment procedure could also provide an invaluable tool for testing and evaluating new housing and husbandry systems as well as new genotypes before they are allowed onto the market. By identifying potential risks, such monitoring would play a critical preventative role.

In the vision of Welfare Quality®, the feedback of the detailed outcomes (assessment information) of the measures to the farmer is a very important basis for the on-farm welfare management. Together with expert advice, such information can support the farmer's efforts to further improve the welfare of the animals. To support this process, Welfare Quality® also developed a so-called information resource which gives farmers and advisers access to background information, causal factors and possible improvement strategies for identified welfare problems.

Welfare Quality® also conducted detailed studies of producers, distribution systems and consumers in six European countries (France, Great Britain, Italy, the Netherlands, Norway and Sweden), and more modest studies in a seventh (Hungary). Significant national differences were found in, for example, how farm animal welfare is considered and regulated. On the basis of these analyses, different strategies for the implementation of the Welfare Quality® results were considered. These scenarios were characterised by the market situation, regulatory arrangements, the focus on welfare among experts and in public discourse, issues of trust, division of responsibility for farmed animal welfare, market forces, etc.

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Main findings and outcomes (results) or expected results

The Welfare Quality® project progressed very well and many results and deliverables were produced. Some of our major achievements are briefly mentioned below.

THE PRINCIPLES AND CRITERIA OF GOOD WELFARE

Considering the diverse range of backgrounds and expertise in the project, it was a major achievement to reach firm agreement on the principles and criteria for good welfare. The logic inherent in them (i.e. that they represent the whole range of animal welfare concerns in a way that is acceptable to a wide range of stakeholders) could be a major breakthrough for future developments in animal welfare. The fact that the 12 criteria can be combined into four principles for ease of dissemination, as well as the fact that each criterion can be subdivided into many separate indicators, also contributed to the effectiveness of assessment. This logical approach to welfare assessment is an important advance in animal welfare science.

COMPLETION OF THE WELFARE ASSESSMENT MODELS (THE INTEGRATION METHODOLOGY) FOR ANIMAL WELFARE

A major objective of Welfare Quality® was to propose harmonised methods for the overall assessment of animal welfare on-farm and at slaughter that are science-based and meet societal concerns. Since welfare is a multidimensional concept, its assessment requires measures of many different aspects.

Welfare Quality® was the first project to formulate a sound way of integrating scores from different measures into an overall welfare assessment. The combination of subjective assessments with mathematical approaches already developed in other disciplines strengthens the validity of the methodology. That it can be used in practice and via a website greatly increased the likely impact of this achievement. Our formal evaluation model transforms the data on animals or their environment into value scores that reflect compliance with the 12 criteria and four principles of good welfare (see above). Each farm is then allocated to one of four welfare categories: excellent, enhanced, acceptable and not classified.

COMPLETION OF THE SOFTWARE CHAIN TO MANAGE DATA FROM WELFARE ASSESSMENT

The Welfare Quality® assessment protocols generate numerous data that must be processed in order to produce an overall assessment of farms or slaughterhouses, according to the scoring models developed in the project.

A software chain was created to ease the collection of data on farms (the application for dairy cows was developed for use on a laptop or tablet PC), a database to store all data collected for all animal types, and a software module for the calculation of welfare scores (at criterion, principle, and overall levels). Interactive web pages (<http://www1.clermont.inra.fr/wq/>) show the assessment procedures (including descriptions of measures and calculation of scores) and the results (per animal type and country) can be displayed on the website. Farmers can then access their own results (at measures, criterion, principle or overall levels) and welfare improvement strategies can be simulated.

THE 'PROTOCOL' DOCUMENTS

The 'protocol' documents for assessing welfare in cattle, pigs and poultry were developed with the assistance of NEN, the Dutch Standards setting body. This process combined the work of the many researchers and research institutes involved to create the 'first' overall assessment scheme for farms and abattoirs using animal-based outcomes and originating from such a broad international consensus. Although the protocols require practical refinement and application in commercial settings, they are a very positive and important output of the Welfare Quality® project. The protocols are freely available and many have already been distributed to interested parties.

INTEGRATION

Specific activities in the project brought together many of the different research teams via 'integration meetings' and activities held throughout the project's lifetime and in different institutes across Europe. These meetings aimed to mix and connect social and animal scientists and stakeholders. Such integration has been a challenging, interesting, illuminating, informative and productive part of the overall work of Welfare Quality®.

TRAINING PROGRAMME(S) FOR STOCKPERSONS

Research by Welfare Quality® scientists identified several key attitudes and beliefs amongst farmers that have a large effect on the animals' reactions and welfare. This knowledge was used to design a training programme (Quality handling) to: improve animal handlers' technical knowledge with regard to animal welfare and the animals' perception of the human; to develop knowledge on husbandry practices and systems; and to positively influence the attitudes of EU farmers' towards handling livestock. This programme describes the following aspects:

- ▶ how animals' fear responses to humans vary between farms;
- ▶ how fear of humans can adversely affect productivity and ease of handling;

Turner, S. P. Roehle, R., D'Eath, R. B. Ison, S. H., Farish, M., Jack, M. C., Lundeheim, N., Rydhmer, L., Lawrence, A. B. (2009), 'Genetic validation of post-mixing skin injuries in pigs as an indicator of aggressiveness and the relationship with injuries under more stable social conditions', *Journal of Animal Science*, 87, pp. 3076–3082.

Windschnurer, I., Boivin, X., Waiblinger, S. (2009), 'Reliability of an avoidance distance test for the assessment of animals' responsiveness to humans and a preliminary investigation of its association with farmers' attitudes on bull fattening farms', *Appl. Anim. Behav. Sci.*, 117, pp. 3–4, 117–127.

- ▶ how animals perceive their environment;
- ▶ how to build a positive human-animal relationship;
- ▶ how to improve the stockpersons' attitudes and behaviour towards the animals;
- ▶ how to maintain the above improvement when the stockpersons return to the farm after training.

FACT SHEETS

Several glossy fact sheets describing selected results were produced by members of Welfare Quality® working with a journalist. These were widely disseminated and proved to be extremely popular. Each fact sheet is available in five languages (English, French, Italian, German and Spanish). The fact sheets were advertised in the Welfare Quality® Update newsletters and they are now available on the Welfare Quality® website.

The following fact sheets had been produced by the end of the project.

- ▶ Principles and criteria of good farm animal welfare
- ▶ Consumer concerns about animal welfare vary widely in Europe
- ▶ Marketing Farm Animal Welfare
- ▶ Towards a Welfare Quality® Assessment System
- ▶ The Overall on-farm Animal Welfare Score
- ▶ Reducing Lameness in Dairy cows
- ▶ Preventing Lameness in Broiler Chickens
- ▶ Reducing Social Stress in Cattle in Feed Bunks
- ▶ Reducing Aggression in Pigs Through Selective Breeding
- ▶ Improving Piglet Survival
- ▶ Reducing stress in farm animals by improved human-animal relationships

A POPULAR WEBSITE

The Welfare Quality® project and its results continued to receive substantial attention not only from Europe, but from all over the world. The Welfare Quality® website, the backbone of our communication strategy received about one million hits in the period May–December 2009! The visitors were often of European origin, but there was also a huge interest from Australia, Canada, China, Japan, New Zealand and the United States. There were over 500 000 extensive page views, by at least 55 000 unique visitors, with each visitor viewing an average of nine pages. Many of the articles and fact sheets we produced were downloaded very frequently, and from November 2009, the Welfare Quality® assessment protocols for cattle, pigs and poultry can be ordered online.

The active dissemination of results through our E-zine, demonstrator activities, through CORDIS and AlphaGallileo also drew considerable attention from stakeholders and agricultural journalists in Europe. For ex-

ample, the press release on the fact sheet 'Improving Piglet Survival' (in five languages) was read by 765 European journalists.

FINAL STAKEHOLDERS' CONFERENCE IN COLLABORATION WITH THE SWEDISH GOVERNMENT

The final Stakeholders' Conference of Welfare Quality® was organised (8 and 9 October) in collaboration with the Swedish Government during Sweden's EU presidency. This ensured a very high profile for the Conference and clearly contributed to the dissemination of the final results to a wide range of stakeholders, including policymakers in Member States. The conference was attended by almost 300 people from 31 different countries of which 12 were outside the EU.

STAKEHOLDER INVOLVEMENT

The perceived success of Welfare Quality® is not only dependent on the quality of its science but also on the uptake of its findings, particularly the welfare assessment and information systems and the welfare improvement strategies. In this respect, the growing and active involvement of stakeholder organisations and individuals was a major advance. Not only were some stakeholders (farmers, breeding companies, retailers, etc.) involved in the research but others provided valuable input via the project's Advisory Committee. Welfare Quality® also generated the European Animal Welfare Platform, a multi-stakeholder project committed to safeguarding and progressing farm animal welfare by identifying welfare risks, best practices and R & D priorities. Similarly, a follow-on proposal (WelPro) features substantial stakeholder participation. The very fact that these projects and proposals involve NGOs, major companies in the animal production sector and leading researchers is an achievement in itself. It shows that the efforts of the Welfare Quality® project have helped to raise the profile of farm animal welfare as an issue of commercial as well as societal relevance.

Potential applications

Welfare Quality® assessment protocols: The Welfare Quality® project has created protocol documents for pigs, cattle and poultry.

- ▶ Welfare Quality® (2009), *Welfare Quality® Assessment protocol for poultry* (broilers, laying hens), Welfare Quality® consortium, Lelystad, Netherlands, ISBN/EAN 978-90-78240-06-8
- ▶ Welfare Quality® (2009), *Welfare Quality® Assessment for pigs* (sows and piglets, growing and finishing pigs), Welfare Quality® consortium, Lelystad, Netherlands, ISBN/EAN 978-90-78240-05-1

- Welfare Quality® (2009), *Welfare Quality® Assessment for cattle*, Welfare Quality® consortium, Lelystad, Netherlands, ISBN/EAN 978-90-78240-04-4

Organisations have expressed interest in receiving training in the application of these protocols in practical situations such as state regulatory work or certification activity. Training in these protocols will involve activities based in both the classroom and farm (and slaughterhouse) and the use of training and resource material derived from the Welfare Quality® project. Training may involve payment to the institutes and individuals providing the training.

SOFTWARE TO MANAGE DATA ON ANIMAL WELFARE

Welfare Quality® designed a programme to help in recording welfare data on farms. A database where all data collected on farms or at slaughter to assess the welfare of animals are stored was designed. Welfare scores are automatically calculated. The system can be consulted online (<http://www1.clermont.inra.fr/wq/>) and provides an explanation of welfare measures and calculated scores, statistics, individual results (restricted access), and simulation of improvements. This software will be essential for the further implementation of the Welfare Quality® protocols. A pan-European database should be produced either in the context of the future Welfare Quality® network or the European Network of Reference Centres on animal welfare proposed by the commission.

TRAINING AND MOBILITY

The methodology developed in the Welfare Quality® project's training and mobility horizontal activity was included in the subcontractor APEC's mission. It is now proposed to other project leaders in order to strengthen the training of young researchers.

TRAINING COURSE 'QUALITY HANDLING'

The partners of WP 3.1 have designed and tested a training course for pig, poultry and cattle stockpersons. This training course involves an interactive DVD and written instruction materials. Potentially, this training course can be offered to interested parties by the WP 3.1 partners, at cost price.

Innovation contribution

A major innovation of the Welfare Quality® animal welfare assessment system is that, for very good reasons (Blokhuys et al., 2003), it focuses more on animal-based measures (e.g. related to condition, health aspects, injuries, behaviour, etc.) than most existing approaches which largely concentrate on design or management-based (e.g. size of cage or

pen, flooring specifications, etc.) characteristics. Of course, this does not mean that resource-based or management-based factors are ignored in Welfare Quality®; many of these are important features. A particular attraction of the animal-based measures is that they show, as it were, the 'outcome' of the interaction between the animal and its environment (housing design and management) and this outcome is assessed by the Welfare Quality® assessment system. Of course, the farmer should use the information from this assessment and target specific aspects where animal welfare might be improved. And the factors that the farmer can control and improve are obviously design and management-based. This is why Welfare Quality® puts a lot of effort into establishing mechanisms to provide feedback and detailed assessment information to the farmer and to developing practical strategies to support the farmer in their attempts to improve animal welfare.

Conclusions

At present, most welfare parameters applied in the Welfare Quality® project are measured by an assessor during a farm visit. This is obviously a time-consuming effort and there are inevitably quite extensive time lags between consecutive visits. Moreover, assessors need extensive training to reliably assess the different parameters, and there are biosecurity risks associated with farm visits. The automatisisation of (some of) the measuring would be of great help in solving some of these problems (ETAG, 2009).

The field of automated recording of animal-based parameters is relatively new. Some electronic tools are currently available to farmers (e.g. individual recognition in dairy cattle and sows at the concentrate feeder, automatic weighing of broiler chickens). But, most of these tools and the associated research efforts focus on specific research goals (often developed for laboratory animals) or production-related parameters, rather than welfare parameters. The available technology is not yet ready for on-farm use and the expertise seems to be fragmented (ETAG, 2009).

Welfare Quality® focused on developing the relevant criteria and parameters and there were only very limited possibilities to look into the automatisisation of measures. However, one project within Welfare Quality® successfully developed a prototype for automatic assessment of foot pad lesions in broilers (De Jong, 2008). The system was developed in collaboration with the industry and is based on existing video imaging techniques used to monitor aspects of carcass classification. Another recent example in broiler chickens is the automated measuring of high gait scores (poor walking) using optical flow statistics derived from flock movements recorded on video or CCTV (Dawkins et al., 2009).

Essentially, automated recording through the exploitation of new techniques may increase the feasibility of large scale animal welfare assessment.

Welfare Quality® established a range of implementation strategies and tools to support the effective use of the assessment outcomes. In this way, the project itself creates a good basis for consolidation, implementation and further development of the results. However, Welfare Quality® as an integrated and collaborative structure will cease to exist. To ensure the best conditions to support the application and implementation of the Welfare Quality® results and the maintenance of the assessment systems, there is an urgent need for an independent and respected body to manage and maintain the welfare assessment and product information systems as well as support instruments and tools.

Scenario analyses within Welfare Quality® (Ingenbleek et al., 2009) stressed the importance of establishing a body or an institution to facilitate the implementation of a harmonised animal welfare assessment system. Such an institution would have strategic responsibilities for developing a common vision on how to support and manage the implementation of harmonised assessment systems for the various species. Moreover, in other contexts (e.g. sustainability), the need for new kinds of institutions to coordinate policy and guide innovation and development in industry was highlighted (Lundvall et al., 2002).

The roles of such an institution could include the following (Ingenbleek et al., 2009).

- ▶ A supporting role in stimulating adoption of the assessment system among farmers and businesses, and a management role once adopted. Here, one can think of advisory services, training and support packages to help individual farmers, farmer organisations, or farmer-retailer groups, as well as quality assurance checks to ensure that the system is used correctly. The increasing amount of animal welfare data that will become available will help to develop these support products and services and the resulting database will be a valuable future resource that would need to be managed responsibly.
- ▶ A scientific role, updating the assessment measures and systems with the latest scientific insights as well as incorporating societal views, and facilitating research using the above mentioned animal welfare database.
- ▶ A level-setting role, turning the system into a measuring scheme against which farms, farming systems and brands and products can be benchmarked.
- ▶ A legitimising role, in ensuring that the system has a solid acceptance basis among stakeholders in society, both within animal interest groups and beyond, and with the wider group of stakeholders concerned with sustainable development.

Environment friendly food production system: requirements for plant breeding and seed production

Summary

The general objective of ENVIRFOOD was to bring together the plant breeders, seed producers, and specialists in variety testing from the Baltic countries (Estonia, Latvia and Lithuania) and organic agriculture experts from Denmark, the Netherlands and Switzerland to facilitate the exchange of knowledge and expertise between conventional and organic plant breeding, variety testing and seed production. The main impact of ENVIRFOOD was to ensure the successful implementation of Council Regulation (EEC) No 2092/91 ⁽¹⁾, Council Regulation (EC) No 1257/1999 ⁽²⁾ and Commission Regulation (EC) No 1452/2003 ⁽³⁾ in the Baltic States.

The central event of the project was the four-day seminar. Compiled reports about specific requirements, achievements, problems and prospects of organic crop breeding, variety testing, seed production in the EU in general and in the Baltic States in particular are published in the Proceedings of the Seminar/CD-ROM 'Environment friendly food production system: requirements for plant breeding and seed production' (http://www.orgprints.org/5190/01/ENVIRFOOD_2005.pdf).

Problem

EU directives and regulations define organic farming systems as an important condition for stabilising ecological situation in agriculture.

A specific cereal-breeding programme for organic farming in the Baltic States did not exist. The cereal research for organic plant breeding was fragmented — it was undertaken separately in each of the Baltic States.

Acronym:

ENVIRFOOD

Project No:

7003

EU contribution:

EUR 80 000

Duration:

12 months

Start date:

1.10.2004

End date:

30.9.2005

Framework programme:

FP6 (sixth framework programme)

Instrument:

Support Actions (SSA)

Project website:

No

Coordinator:

Prof. Ina Belicka
State Stende Plant Breeding Station
 Department of Plant Breeding
 Dizstende Stende PBS
 Talsi District
 LATVIA
 E-mail: stende.selekcija@apollo.lv

Partners:

None

- 1 Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs, OJ L 198, 22.7.91, pp. 1–15.
- 2 Commission Regulation (EC) No 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidelines and Guarantee Fund (EAGGF) and amending and repealing certain Regulations, OJ L 168, 26.6.1999, pp. 80–102.
- 3 Commission Regulation (EC) No 1452/2003 of 14 August 2003 maintaining the derogation provided for in Article 6(3)(a) of Council Regulation (EEC) No 2092/91 with regard to certain species of seed and vegetative propagating material and laying down procedural rules and criteria relating to that derogation, OJ L 206, 15.8.2003, pp. 17–21.

Selected publications:

http://www.orgprints.org/5190/01/ENVIRFOOD_2005.pdf

<http://www.orgprints.org/5705/>

<http://www.orgprints.org/5709/>

<http://www.stendeselekcija.lv>

<http://www qlif.org/index.html>

<http://www.eco-pb.org>

The Baltic States began state variety testing under organic farming conditions in 2004. An appropriate methodology for this work had not yet been established.

The certified organic seed market did not exist in the Baltic States.

There was a lack of information for breeders on how to improve the nutritional value of (organically grown) cereals.

The situation in the food sector of the Baltic States indicates that there was a wide spectrum of organic agricultural products available, but they represented only a small portion of the total food product market. Consumers were not sufficiently informed about the merits of organic production. Potential entrepreneurs, including scientists, were not sufficiently informed about products and concept development and on how to take their product to market.

ENVIRFOOD's chief goal was to help the Baltic States implement the EU regulations in the organic farming.

Background and objectives

There were three general objectives of ENVIRFOOD.

1. To bring together plant breeders and seed producers of the Baltic countries (Estonia, Latvia and Lithuania) for discussion and exchange of knowledge and expertise between conventional and organic breeding and seed production and its role on the safety food production.
2. To work out a programme for collaboration in plant breeding, variety testing and seed production for organic/low-input agriculture and producing plants with a chemical composition corresponding to healthy food production.
3. Discuss capacity-building and the creation of a 'critical mass of human resources' in the field of environment-friendly food production to promote participation in the activities of FP 6.

There were five specific activities towards those objectives.

ORGANIC PLANT BREEDING

To compile information about the achievements, problems and prospects of organic cereal breeding in the Baltic States and in the EU overall, and develop a network for organic cereal breeding in the Baltic States, establishing cooperation with other Member States of the EU for successful integrating researchers of the Baltic States into the European Research Area and to share, discuss and disseminate the information.

ORGANIC VARIETY TESTING

Analysing the current variety testing system for adoption and implementation of recommendations regarding organic farming by 2006 in the Baltic States: share, discuss and disseminate the analysis.

ORGANIC SEED PRODUCTION

Analysis of the organic seed production area at national and EU level according to Regulation (EC) No 1452/2003 in order to provide development towards the certified organic seed market in the Baltic States: share, discuss and disseminate the analysis.

ORGANIC FOOD AND FEED QUALITY

Critical evaluation of organic food quality and safety of the primary producers of raw material to ensure integration of plant breeding and seed production in the total food chain: share, discuss and disseminate the evaluation.

EXPOSITION OF ORGANIC FOOD PRODUCTS

Organising an exposition of the diversity of organically farmed products to demonstrate the results of organic management practices for different types of food and how to market them.

Methodology

The means to achieve the objectives were the following activities:

- ▶ collection and editing of information;
- ▶ meetings of the advisory board;
- ▶ publication of the abstract book/CD-ROM;
- ▶ delivery of lectures from key speakers (who have already devoted their great experience to the problems of organic farming);
- ▶ reports of the representatives of each Baltic State about the problems and prospects on plant breeding, variety testing and seed production of organic farming;
- ▶ poster session;
- ▶ round-table workshop-discussions;

Main findings and outcomes (results) or expected results

The seminar was attended by at least 60 persons. Information about requirements, achievements, problems and prospects of plant breeding, organic variety testing, seed production, organic food and feed quality in the Baltic States and in the EU regarding organic farming was com-

piled and disseminated to 250 addresses (CD-ROM) plus 150 addresses (book). The attitude of consumers to organic products was established.

During ENVIRFOOD, seminar plant breeders, agronomists and seed producers of the Baltic States as well as some individuals from other EU countries with experience in organic agriculture were provided with a platform for discussion and the exchange of knowledge and expertise between conventional and organic plant breeding and seed and food production.

A network among breeders, researchers, and seed and food producers in the Baltic States was established based on the exchange of previous results from national research and achievements. Unexploited knowledge of researchers of the Baltic States was transferred and expanded into the European Research Area.

Potential applications

The main user groups of ENVIRFOOD results are plant breeders, specialists of variety testing centres and seed certification services, and seed producers.

A knowledge of the European experience helped plant breeders and scientists to determine precisely the main objectives of the national organic breeding programme. For organic and low-input agriculture, it was important to develop official variety testing (the Value for Cultivation and Use test, VCU) to take into account new traits tested under environmental conditions with limited or no synthetic inputs. The organic seed sector in the Baltic States was under establishment and needed further development. The exposition of marketed organic products showed the results of organic management practices for different types of organic food and successful marketing by small and medium-sized enterprises.

The realisation of the ENVIRFOOD project established the programme for further collaboration in plant breeding, variety testing, seed production for organic agriculture, establishing close contact with food producers.

Innovation contribution

ENVIRFOOD helped the Baltic States implement EU regulations on organic farming and facilitated the development of organic farming: in the Baltic States, organic production has increased.

According to statistics in 2010, organic farms constitute 9 % of total agricultural land in Latvia and 10.5 % in Estonia. In Latvia, biological certified fields constitute 166 334 ha (seven years before, this figure was 43 899 ha). The total number of organic farms is 3 620 (compared to 352 seven years before), with average size of farms being 46 ha.

Using ENVIRFOOD experience, new scientific project applications were submitted regarding organic plant breeding. Currently, in Latvia, the project 'Development, improvement and implementation of environmentally and sustainable crop breeding technologies' (No 2009/0218/1DP/1/1/1/2/0/09APIA/VIAA/009) is being realised (2009–12). The project is co-financed by the European Social Fund (ESF).

Conclusions

The general objective of ENVIRFOOD was reached. The project brought together plant breeders, seed producers, specialists of variety testing in the Baltic countries (Estonia, Latvia and Lithuania) and organic agriculture experts from Denmark, the Netherlands and Switzerland to facilitate the exchange of knowledge and expertise between conventional and organic plant breeding, variety testing and seed production.

In the Baltic States, organic farmers are using varieties bred in conventional agriculture at the present time. For the development of varieties suitable for organic agriculture, it is necessary to initiate the purposeful development and selection of varieties just for organic agricultures with specific criteria for plant morphological and physiological traits selection and assessment: financial support is needed for this work.

Assessment and improvement of the existing methods used in testing of VCU are necessary, and traits essentially significant in organic farming conditions are to be included in this assessment.

Innovative wet-sowing technology in the ecological agricultural and farming community

Acronym:
ECOWETSOW

Project No:
513195

EU contribution:
EUR 722.338

Duration:
30 months

Start date:
15.6.2005

End date:
14.12.2007

Framework programme:
FP6 (sixth framework programme)

Instrument:
Horizontal research activities involving SMEs

Coordinator:
Agromiljo AS
Judaberg
Finnoy
NORWAY
E-mail: agrom@agromiljo.no

Abstract

The proposed project is focused on the farming and agricultural sector within which there are 135 000 farms concentrating on ecological agriculture and 20 700 SMEs in their supply chains. Ecological agriculture has, to date, only reached 2.0 % of the target of 10 % of cultivated land in the next decade. There are great challenges to increase competitiveness and meet customers' demand, including access to methods and equipment that increase efficiency, enable cost reductions and thus increase competitiveness.

The global market for sowing and manuring/fertilising machinery was worth approximately EUR 3.1 billion in 2002, and is growing at a constant 4.7 % per year, but a substantial number of all sowing and/or manuring/fertilising machinery are imported into Europe from the USA. In addition, the 135 000 EU ecological farmers face increasing competition from the steady growth in import of seed and corn from low-cost countries.

Agriculture ranks among the most hazardous industries. Farmers are at high risk of fatal and non-fatal injuries, work-related lung diseases, noise-induced hearing loss, skin diseases, and certain cancers (brain, lip, and skin cancer). The total consumption of fertiliser in Central Europe is more than 5 million tonnes and increasing and the total consumption of pesticides in the EU-15 is more than 320 tonnes of active substance.

Agriculture is the main source for 'man-made' nitrogen oxide (N_2O) — this being a very potent greenhouse gas as well as having high ozone depletion potential. The farmers and the agricultural community and industry in Europe face great challenges to meet customers' growing demand for ecological products and to react to the increasing scepticism with regard to the use of chemicals and genetic manipulated products in the agricultural sector.

Several European Commission initiatives are addressing these issues including Council Regulation (EEC) No 2092/91 on organic production of agricultural products and Agenda 2000.

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Assessing arthropod predation on parasitized hosts in organic and conventional farming systems

Acronym:

P-P INTERACTIONS

Project No:

515216

EU contribution:

EUR 120 724

Duration:

17 months

Start date:

1.4.2005

End date:

31.8.2006

Framework programme:

FP6 (sixth framework programme)

Instrument:

IEF

Project website:

http://www.uibk.ac.at/ecology/forschung/arthropod_predation.html.
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Summary

Worldwide insect pests cause pre- and post-harvest crop losses between 20–50 %. Insect natural enemies play a key role for pest control in organic farming systems; however, relatively little is understood regarding the trophic relationships within the natural enemy community and their effect on the level of biological control. The proposed project addressed this lack of knowledge by assessing arthropod predation on parasitized and unparasitized hosts by using, for the first time, a molecular approach.

The project work followed a two-step approach.

1. Establishing a DNA-based method for detecting parasitoids within their hosts as well as host and prey DNA within predators that have eaten parasitized hosts.
2. Screening of field-collected hosts for parasitoid DNA to determine parasitism rates and screening of field-collected predators to assess predation on unparasitized and parasitized hosts.

The DNA-based techniques developed within this fellowship allowed the detection of parasitoids at a high specificity and sensitivity: parasitoids could be detected within their hosts from the egg stage onwards. Furthermore, it was possible to verify consumption of parasitized hosts by invertebrate predators with diagnostic polymerase chain reaction (PCR) by amplifying both host and parasitoid DNA.

A novel multiplex PCR system was developed to screen field-collected cereal aphids simultaneously for seven parasitoid targets within one PCR. New insights into aphid-parasitoid interactions could be gained by screening > 1 000 aphids collected within an experimental wheat field. For example, the red coloured morph of the cereal aphid *Sitobion avenae* seems to suffer less from parasitoid attack than the green coloured ones.

Based on the parasitism rates of the field-collected aphids, another multiplex PCR system was developed to screen predators from the wheat field for aphid and parasitoid consumption. The data showed that generalist predators disrupt interactions between parasitoids and their aphid hosts although the levels at which predators feed on aphids and para-

sitoids seem to vary significantly between predator taxa. Despite regularly feeding on aphids, linyphiid spiders and carabids such as *Trechus quadristriatus* may, through direct and coincidental predation on primary parasitoids, diminish the potential of the parasitoids to control aphids. Our results suggest that taxon-specific trophic interactions between predators, pests and parasitoids need to be considered to obtain a better understanding of the mechanisms which determine the success of conservation biological control measures. Moreover, this study provides a blueprint for future work on using molecular tools to study complex interactions in both agricultural crops and natural ecosystems.

Within this Marie-Curie Fellowship, a novel molecular approach to analysing complex trophic interactions was developed, evaluated, and applied to a pest-natural enemy system providing an important proof of concept for further research looking at the effects of predator-parasitoid interactions in organic plant production.

Besides the scientific project outputs, the fellow received training in various scientific skills at the host institution and was able to network with outstanding researchers for future collaborative projects, thus strengthening the European research area.

Problem

Organic farming systems rely heavily on biological control to regulate pest populations. Organic systems are also known to harbour a greater diversity of species and increased densities of natural enemies compared to their conventional counterparts. However, it remains to be understood whether the greater diversity and abundance of natural enemies translate into enhanced pest control ecosystem services. Central to this question is the functional understanding of these communities. Here, food web interactions play a key role, but they are notoriously difficult to analyse under field conditions. In this fellowship, we aimed at developing molecular approaches to overcome this hurdle and to examine food web interactions in aphid-parasitoid-generalist predator communities under natural conditions. The new insights gained by this approach will allow us to better understand how food web interactions affect the control of agricultural pests and contribute to further develop conservation pest control, particularly in organically farmed systems.

Background and objectives

In the project, as it developed, there were two main objectives.

1. To establish a molecular method for detecting parasitoid DNA within aphid hosts as well as in predators that have eaten parasitized hosts.

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None

Selected publications:

Traugott, M., Bell J. R., Raso L., Sint D., Symondson, W. O. C., 'Generalist predators as enemies of aphid parasitoids', under review at *Journal of Applied Ecology*.

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King, R. A., Read, D. S., Traugott, M., Symondson, W. O. C. (2008), 'Molecular analysis of predation: a review of best practice for DNA-based approaches', *Molecular Ecology*, 17, pp. 947–963.

Traugott, M., Symondson, W. O. C. (2008), 'Molecular analysis of predation on parasitized hosts', *Bulletin of Entomological Research*, 98, pp. 223–231.

2. To screen field-collected aphids and predators for DNA of parasitoids and to test the predators for aphid consumption.

Methodology

Diagnostic PCR assays were developed allowing us to detect parasitoid DNA in aphid hosts as well as to detect DNA of both parasitoids and aphids in generalist predators which had consumed parasitized aphids. Parasitism and feeding experiments were carried out to test and evaluate the molecular protocols.

Field-collected aphids and generalist predators were screened for aphid and parasitoid DNA to track aphid-parasitoid-predator food web interactions during the establishment of the aphid population in a wheat field.

Main findings and outcomes (results) or expected results

We found that both the levels of multiparasitism and hyperparasitism were low in primary parasitoids. This suggests that the primary parasitoids effectively parasitize the aphids. However, we found that generalist predators disrupt interactions between parasitoids and their aphid hosts although the levels at which predators feed on aphids and parasitoids seem to vary significantly between predator taxa. Despite regularly feeding on aphids, linyphiid spiders and carabids may diminish the potential of the parasitoids to control aphids. These results suggest that taxon-specific trophic interactions between predators, pests and parasitoids need to be considered to obtain a better understanding of the mechanisms which determine the success of conservation biological control measures. This is especially relevant to organic farming systems, which usually harbour a greater diversity of natural enemies, but this does not necessarily mean that natural pest control is any less important to conventionally farmed crops.

Potential applications

Our findings demonstrate the functional complexity inherent to these communities and indicate which routes of research need to be taken to further develop conservation biological control in speciose organic systems.

Innovation contribution

New molecular methodologies allowed us to overcome major hurdles to the effective tracking of trophic interactions within species-rich invertebrate communities under field conditions, and provide important insights into the functioning of insect pest-natural enemy interactions in organically farmed crops.

Conclusions

Our major objectives were achieved and, in many respects, surpassed. Our results suggest that taxon-specific trophic interactions between predators, pests and parasitoids need to be considered to obtain a better understanding of the mechanisms which determine the success of conservation biological control measures in organic crop systems. Moreover, this work provides a blueprint for future work on using molecular tools to study complex interactions in organically farmed agricultural crops.

Future research should generate replicated food webs which are temporally and spatially highly resolved to further improve our understanding of food web interactions in organically farmed land. The hypotheses which can be generated from these trophic data should be tested in manipulative field experiments.

Bees in Europe and Sustainable Honey Production

Acronym:

BEE SHOP

Project No:

22568

EU contribution:

EUR 1.86 million

Duration:

42 months

Start date:

1.3.2006

End date:

31.8.2009

Framework programme:

FP6 (sixth framework programme)

Instrument:

Specific Targeted Research Project

Project website:

http://www2.biologie.uni-halle.de/zool/mol_ecol/bee-shop/index.html (active)

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Summary

BEE SHOP, a European strategic research project, is a network of 10 leading European honeybee research groups in honey quality, pathology, genetics and behaviour as well as selected beekeeping industries, which all share the common interest in promoting Europe's high standards for honey quality.

The prime goal of BEE SHOP is to reduce potential sources of honey contamination due to both foraging contaminated nectar and chemotherapy of honeybee diseases.

Problem

Honey is among the oldest food products of mankind and beekeeping is deeply rooted in every European culture. Numerous European and national regulations control honey quality. Yet, in an environment with increasing pollutants, honey runs high risks of becoming chemically polluted. In addition, a broad spectrum of chemicals is used to treat honeybee diseases, further contaminating honey with sometimes highly toxic compounds.

Background and objectives

The prime goal of BEE SHOP is to reduce potential sources of honey contamination due to both foraging contaminated nectar and chemotherapy of honeybee diseases. BEE SHOP is a network of 10 leading European honeybee research groups in honey quality, pathology, genetics and behaviour as well as selected beekeeping industries, which all share a common interest in promoting Europe's high honey quality standards.

Methodology

BEE SHOP applied a multifactorial approach including: (i) the development of tools to assess honey quality and authenticity; (ii) the study of antimicrobial properties of plant and bee-derived compounds; (iii) the assessment of variance among pathogen virulence and transmission and resistance in the honeybee; (iv) the mapping of major genes in honeybees controlling disease susceptibility to allow for marker-assisted breeding programmes; (v) the screening of European honeybee races and populations for their disease resistance potential; and (vi) assess-

ment of whether aversive learning can be a tool to control the foraging behaviour of honeybees.

Main findings and outcomes (results) or expected results

BEE SHOP has enhanced the knowledge of honeybee diseases and developed a number of new tools and ideas for further research. A monograph of the summarised BEE SHOP results will be published by Nova Science (Behrens, D., Moritz, R. F. A. (eds) (2011), *Bees in Europe and Sustainable Honey Production* (BEE SHOP): *Results of a pan-European Research Network*, Nova Science Publishers, New York, US (in press)).

Potential applications

Exploitable results, defined as knowledge having a potential for industrial or commercial application in research activities or for developing, creating or marketing a product or process or for creating or providing a service, were not foreseen and have not been developed within the BEE SHOP network. All other results are free to use by the apicultural industry and open to the public.

Innovation contribution

BEE SHOP contributed to innovative research on honeybees by disseminating the acquired knowledge in numerous scientific publications as well as publications for the general public, oral presentations on conferences and seminars, schooling of extension specialists and interviews in the public media.

Conclusions

Although most of the scientific aims were reached by the BEE SHOP network, some routes were found to be more difficult or less rewarding than expected. However, a number of findings which were initially not implemented in the work plan arose from alternative studies or as unexpected side results. The joint results of BEE SHOP are about to be published in detail as a book (Behrens, D., Moritz, R. F. A. (eds) (2011), *Bees in Europe and Sustainable Honey Production* (BEE SHOP): *Results of a pan-European Research Network*, Nova Science Publishers, New York, US (in press)).

Based on the experience of the BEE SHOP network, future research strategies have been developed to address open questions in continuative scientific networks (e.g. BEE DOC). These networks will include newly available methods (e.g. Next-generation-sequencing) and focus on pathogens which were not included in BEE SHOP (e.g. *Nosema*).

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SELECTED PUBLICATIONS

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Jaffé, R., Moritz, R. F. A. (2010a), 'Beekeeping and the conservation of native honeybees in Europe', in Settele, J., Penev, L., Georgiev, T., Grabau, R., Grobelnik, V., Hammen, V., Klotz, S., Kotarac, M., Kuhn, I. (eds), *Atlas of Biodiversity Risk*, Pensoft Publishers, Moscow, pp. 182–183.

Jaffé, R., Moritz, R. F. A. (2010b), 'Mating flights select for symmetry in honeybee drones (*Apis mellifera*)', *Naturwissenschaften*, 97 (3), pp. 337–343.

Jaffé, R., Dietemann, V., Allsopp, M. H., Costa, C., Crewe, R. M., Dall'Olio, R., De la Rúa, P., El-Niweiri, M. A. A., Fries, I., Kezic, N., Meusel, M. S., Paxton, R. J., Shaibi, T., Stolle, E., Moritz, R. F. A. (2010), 'Estimating the density of honeybee colonies across their natural range to fill the gap in pollinator decline censuses', *Conserv Biol.*, 24 (2), pp. 583–593.

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Locke, B., de Miranda, J., Forsgren, E., Fries, I. (2010), 'Effects on virus infection dynamics following removal of mites (*Varroa destructor*) from honey bee colonies', *Apidologie* (submitted).

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Increasing fruit consumption through a transdisciplinary approach leading to high-quality produce from environmentally safe, sustainable methods

Abstract

ISAFRUIT is an Integrated Project (IP) aiming to improve the health of the European community by increasing fruit consumption. Increased consumption can be achieved through consumer satisfaction: ISAFRUIT aims to better fulfil the consumer preferences and expectations with regard to the quality, safety, convenience and availability of fruit and fruit products at the point of sale.

Consumer-linked sciences are therefore the starting point of ISAFRUIT, providing input to other RTD activities. In addition, ISAFRUIT wants to increase consumers' awareness of the health effects of fruit while also researching human health effects of fruit consumption. The fruit species used as models are apples and peaches/nectarines. Activities on quality and health effects as well as on the convenience of processed fruit will stimulate consumer interest in a wide range of healthy products.

The proposed research on sustainable production methods including organic and integrated production will not only increase the safety of fruit, but also have positive effects on the European environment. The control of fruit quality throughout the supply chain from the point of sale to the farm is covered in various work packages. Genetics and implementation of new varieties is included, considering the long-term perspectives for the environment as well as to cope with the characteristic preferences of consumers that currently hardly eat any fruit.

The ISAFRUIT IP is built on seven pillars:

1. Consumer-driven and responsive supply chain;
2. Fruit and human health;
3. Improved appeal and nutritional value of processed fruit;
4. Quality, safety and sustainability — improved pre-harvest chain management;

Acronym:
ISAFRUIT

Project No:
016279

EU contribution:
EUR 13 797 773

Duration:
57 months

Start date:
1.1.2006

End date:
30.9.2010

Framework programme:
FP6 (sixth framework programme)

Instrument:
Integrated Project (IP)

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5. Quality, safety and sustainability — improved post-harvest chain;
6. Genetics of fruit quality and implementation of better fruit cultivars;
7. Knowledge management.

ISAFRUIT consists of a management committee, project and pillar coordinators, an SME-committee, a scientific group and the General Assembly.

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Improving the quality of pork and pork products for the consumer: development of innovative, integrated, and sustainable food production chains of high quality pork products matching consumer demands

Acronym:

Q-PorkChains

Project No:

36245

EU contribution:

EUR 14.5 million

Duration:

60 months

Start date:

1.1.2007

End date:

31.12.2011

Framework programme:

FP6 (sixth framework programme)

Instrument:

IP

Project website:

<http://www.q-porkchains.org> (active until October 2014)

Summary

The quality of pork and pork products has become a complex and dynamic theme involving the total pork chain from fork to farm with a multitude of interacting aspects related to peoples' demand as consumers, and the demands of people as citizens and producers for economic and environmental sustainability. The European Union's self-sufficiency and leading position in the global market for pork and pork products is challenged by Brazil, Canada, China, and the United States. The need to develop innovative, integrated, and sustainable food production chains of high-quality pork products matching consumer demands is being addressed by the present project, Q-PorkChains.

The strategy of the project is to develop and test advanced and multidisciplinary approaches for the identification, characterisation, prediction, and control of the quality of pork and pork products in different stages of the pork chain in diverse production systems. The project will explore, in six RTD modules, the development potential of different aspects of the pork chain: consumer and citizen behaviour and preferences; on-farm production systems; product development; integration and sustainability within the pork chain; new biology for quality control; and the development of prediction models for quality, safety and animal welfare.

Furthermore, three horizontal modules include activities to ensure innovation through: active participation of SMEs and larger industries in pilot research and demonstration chains; dissemination of knowledge and technology through education and training from academic to vocational level and SME networking; and professional management of the consortium and its relations.

Q-PorkChains is a highly multidisciplinary and integrated project which will apply the latest advances in genomics and biology in a quality con-

text defined by consumer and citizen preferences and will provide research results, innovation and breakthroughs that will strengthen the competitiveness of a sustainable European pork sector.

Problem

Pork and pork products are an important part of the diet in the EU. In several Member States, the proportion of pork is more than 50 % of all meat consumed. On average, each consumer in the former EU-15 consumed 43 kg of pork in 2000, which is 46 % of the total meat consumption. Pork and pork products are also important in the new Member States; for example, the consumption in Poland in 2000 was 48 kg per inhabitant and in Hungary, 42 kg per inhabitant. The EU produces more than one fifth of the world production of pork, which makes pork production an important socio-economic factor in the EU. Other major producers in the world market are Brazil, Canada, China and the United States, for which the expectations in October 2004 were that the production would increase in 2004 and 2005, while the EU expectations were a slight decline in the production in the same period of time.

Dramatic changes in the international market over the past decade and the fact that consumers are becoming increasingly sophisticated, demanding, and powerful requiring high standards regarding quality, safety, diversity, and healthiness of foods together with aspects related to environmental, ethical, and animal welfare issues in the production of meat. The meat quality concept is now to be considered a complex, dynamic and multivariate property of meat, which is influenced by multiple interacting factors, including the conditions under which the meat is produced. In this way, concepts such as sustainable, organic, and wholesome have evoked a positive response in the production of meat, as these from a consumer and political point of view, are consistent with the demanded quality. Consequently, emphasis on the quality aspects and sustainability (environmental and economic) in the production of pork and pork products to ensure added value in the European pork chain are of high priority in the EU to maintain and strengthen the position as one of the key producers in the world.

Background and objectives

The objective of the project is to develop and test advanced and multi-disciplinary approaches for the identification, characterisation, prediction, and control of the quality of pork and pork products in different stages of the pork chain in diverse production systems

Main findings and outcomes (results) or expected results

In Q-PorkChains, an extensive inventory on diversity of pork chains in Europe was performed based on several case studies in various European

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Selected publications:

Nijhoff-Savvaki, R., Trienekens, J., Omta, O. (2009), 'De Groene Weg: The organic pork chain in the Netherlands', Trienekens, et al. (eds), *European Pork Chains; consumer-oriented production and distribution*, Wageningen Academic Publishers, Wageningen, Netherlands. pp. 157–178.

Trienekens, J., Petersen, B., Wognum, N., Brinkmann, D. (2009), *European pork chains: Diversity and quality challenges in consumer-oriented production and distribution*, Wageningen Academic Publishers, Wageningen, Netherlands, ISBN 978-90-8686-103-3.

countries (Germany, Greece, Spain, France, the Netherlands and Hungary). The rationale for the selection was to include three large-scale producing countries (Germany, Spain and France), a large-scale exporting country (the Netherlands), and one relatively new EU Member State (Hungary). Two countries outside Europe (China and South Africa) were included in the inventory representing the largest producer of pork in the world and a developing country. The results of the inventories contributed to the analysis of quality management systems, inter-organisational information systems, forms of collaboration in the chain, logistics and environmental systems, performance and innovation in a number of European pork chains. The outcome of this research is published in the book *European pork chains*, Trienekens et al.).

One of the case studies was the Dutch organic pork chain. The case study gives an overview of size (2.3 % sales on the Dutch market) and structure of the sector. About 50 independent farmers have formal contracts with a slaughterhouse. The majority of organic pork meat slaughtering and processing is done by a company of Vion Food Group, De Groene Weg. Quality certification is performed by the SKAL association. In the last decade, the Dutch organic pork sector has enjoyed modest yet sustainable growth. The major player in the Dutch organic pork sector is De Groene Weg (<http://www.degroeneweg.nl>), established in 1981, and, since 2004, owned by the Vion Food Group. Approximately 1 300 pigs are slaughtered per week, which are sold to consumers on the national and international market as pre-packed organic meat and organic bacon. The meat is marketed through De Groene Weg's own store and other retail and export outlets, and is branded as Bio+ (own label of De Groene Weg) or with private labels from national and international partner retailers. To highlight how the organic pork supply chain differs from conventional pork supply chains the governance forms applied, information systems, quality assurance, and management system, are discussed in Nijhoff-Savvaki et al. (2009).

Innovation contribution

Four innovation groups can be identified: product, process, market and organisational innovations.

De Groene Weg focuses on processing methods for ready-to-eat products. Process innovations in breeding involve the use of molecular genetics. Continuous innovation in production processes is performed to meet legislative requirements for animal welfare, health and environmental issues. Market innovations in breeding include a focus on market-oriented production with emphasis on meat quality and animal welfare. Organisational innovations focus on formalising relations with suppliers and developing long-term relationships with retailers.

Conclusions

The Dutch organic pork sector has experienced modest sustainable growth. De Groene Weg has been mainly responsible for this development. This project concludes that although the Dutch organic pork sector is in its pioneering stage, it has growth potential. The sector still lags behind other European countries; however, if organic production and sales continue to develop, and if environmental pressures affecting conventional production systems continue, organic pig farming will have a chance of realising steady growth. Strict internal control and certification related to social issues are required, which should lead to the further strengthening of the image of organic pork products.

Development of integrated livestock breeding and management strategies to improve animal health, product quality and performance in European organic and low- input milk, meat and egg production

Acronym:

LowInputBreeds

Project No:

222623

EU contribution:

EUR 6 million

Duration:

60 months

Start date:

1.5.2009

End date:

31.4.2014

Framework programme:

FP7 (fifth framework programme)

Instrument:

RTD project

Project website:

<http://www.lowinputbreeds.org/> (active)

Summary

The LowInputBreeds project aims to develop integrated livestock breeding and management strategies to improve animal health, product quality and performance in European organic and low-input milk, meat and egg production through research, dissemination and training activities.

Problem

Almost without exception, breeding goals in livestock production in recent years have been dominated by the demands of intensive systems striving for higher yields. As a result of progress in animal breeding, today's dairy cows, pigs and poultry especially are capable of high outputs but only if supported by high nutritional and veterinary inputs. Under organic or low-input management product quality, health, welfare and fertility deteriorate with modern genotypes. Unfortunately, reduced-input systems are in the minority and do not justify sufficient demand by breeding companies to address their needs. They either attempt to minimise the negative impact on high-demand animals or are using traditional unimproved breeds — neither of which is ideal.

Background and objectives

It is increasingly recognised that breeding priorities differ between high and low-input systems and the latter tend to be neglected. Recent studies (e.g. the FP6 IP QualityLowInputFood (<http://www.qlif.org>)) found that livestock breeds (and breeding systems) developed for high-input conventional production lack, specifically:

- (i) 'robustness' traits required for optimum performance in organic and low-input (e.g. extensive outdoor grazing and free-range) production systems; and

- (ii) product quality traits (including nutritional, sensory and animal welfare related quality parameters) that are demanded from the organic and low-input sector.

However, very little R & D has covered breeding concepts, methods and programmes focused on the needs of organic and other low-input systems. The LowInputBreeds project will focus on developing:

- (i) 'robustness' (e.g. resistance to biotic and abiotic stress factors, survival of young animals, longevity, fertility);
- (ii) 'product quality' traits (including ethical qualities related to animal welfare and environmental impact related traits) that have a higher priority in organic/low-input compared to high-input conventional systems.

The project has four main science and technology objectives.

1. Develop and evaluate innovative breeding concepts for five live-stock production systems (dairy cows, dairy and meat sheep, pigs and laying hens) and design species-specific breeding strategies for different macroclimatic regions in Europe.
2. Integrate the use of improved genotypes with innovative management approaches including improved diets, feeding regimes and rearing systems. This will focus on issues (e.g. mastitis and parasite control, animal welfare problems) where breeding or management innovations alone are unlikely to provide satisfactory solutions.
3. Identify potential economic, environmental, genetic diversity/plasticity and ethical impacts of project deliverables to ensure they conform to different societal priorities and consumer demands/expectations and are acceptable to producers.
4. Establish an efficient training and dissemination programme aimed at rapid exploitation and application of project deliverables by the organic and low-input livestock industry.

Methodology

The project covers six major livestock production systems (dairy cows, beef, dairy and meat sheep, pigs and laying hens). Each of the four species is the focus of individual sub-projects (SPs 1–4) which are further divided into work relating to (a) animal breeding approaches and (b) complementary husbandry necessary to achieve the project goals in situation where breeding alone will not suffice. A fifth work package considers the environmental and economic impact of innovation generated in these technical studies along with the dissemination of findings and training early years' researchers in some of the techniques being employed.

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SP 1 addresses major problems identified for organic and low-input DAIRY COWS: mastitis, poor fertility, milk quality and the environmental impacts of organic and low-input systems. There are three work packages as follows.

- ▶ Developing within breed selection to improve animal health, product quality and performance traits; comparing genome-wide and traditional quantitative-genetic selection
- ▶ Cross-breeding strategies to optimise the balance between robustness and performance traits; comparing cross-breeds with pure-bred Holstein Friesian genotypes
- ▶ Design of optimised breeding and management systems for different macro-climatic regions of Europe; model-based multi-criteria evaluation with respect to performance, animal health and welfare, product quality and environmental impact

SP 2 aims to improve the performance, animal health and welfare, and product quality in organic and low-input MILK and MEAT SHEEP production, focusing on sheep breeding in Mediterranean or Alpine mountainous conditions. The main issues addressed are the animals' ability to overcome abiotic (extremes in temperatures and poorly balanced diets) and biotic (internal parasites and mastitis challenges) stress and maintaining milk and meat quality. Work will be carried out in the following work packages.

- ▶ Developing within breed selection to improve abiotic and biotic stress resistance and performance traits; comparing marker assisted and traditional quantitative-genetic selection systems for functional traits
- ▶ Improved endoparasite management strategies based on integrating:
 - o feed supplementation with tannin-rich forages; with
 - o strategic use of clean pastures; and/or
 - o the use of parasite-tolerant breeds.
- ▶ Strategies to improve lamb meat quality based on optimising;
 - o tannin-rich feed supplements;
 - o grazing regimes; and/or
 - o the use of stress-tolerant breeds.

SP 3 on PIGS considers piglet survival in outdoor, organic and free-range production traits, tolerance of abiotic stress (particularly heat stress) and maintaining quality in pig meat. This will be carried out in three work packages.

- ▶ Developing a 'flower' breeding system to improve pig survival and robustness related traits in small populations; comparing the performance of breeds from 'flower' and conventional breeding systems.

- ▶ Management innovations (gilt rearing and lactation systems) on mothering ability of sows as well as pre- and post-weaning diarrhoea and loss of piglets.
- ▶ Effect of traditional, improved and standard hybrid pig genotypes and feeding regimes on carcass, meat and fat quality in heavy pigs used for premium, regional pork products.

SP 4 on LAYING HENS addresses animal behaviour problems (e.g. feather pecking, smothering, nesting behaviour and associated mortality rates), diseases and parasites, ethical questions relating to male chick and old hen disposal and egg quality, with work carried out in three work packages.

- ▶ Developing a 'farmer participatory' breeding systems to improve productivity, health and welfare and egg quality related traits; comparing standard with farmer participatory breeding systems
- ▶ Effect of, and interactions between genotypes, feeding regimes, 'welfare-friendly' moulting protocols and prolonged use of layers on performance, animal health and welfare
- ▶ Effect of, and interaction between, laying hen genotypes and management innovations on egg quality

Main findings and outcomes (results) or expected results

At the time of writing, the first report had been submitted at 18 months and, although work is in progress as planned, most studies are ongoing with few findings ready for publication. Some provisional findings, however, are available.

DAIRY COWS

- ▶ Although the accuracy of genomic selection is greater for high heritability traits such as milk yield, the expected benefits, in terms of relative gains in accuracy of estimated breeding values, are likely to be greater for traits of low heritability such as those related to fertility
- ▶ The addition of Bronopol preservative to milk has little impact on fatty acid determination meaning that routine milk recording samples could potentially be used to identify cows showing superior fatty acid profiles.

SHEEP

Sainfoin was effective in parasite control in pre-lambing ewes, reducing the faecal egg output by about 70 % compared to forage without tannins. However, this effect was transient, disappearing within two weeks

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Butler, G., Stergiadis, S. (2011), 'Suitability of Bronopol preservative treated milk for fatty acid determination', *Journal of Dairy Research*, 78(2), pp. 220–225.

Dedeurwaerdere, Tom (2011), 'Evaluating Resource Use in Low Input Systems', paper at the First LowInputBreeds Symposium on Ethical Consideration in Livestock Breeding, Wageningen, Netherlands, 15 and 16 March 2011.

Edwards, Sandra (2011), 'Ethical Problems and Breeding Goals: Pigs', paper at the First LowInputBreeds Symposium on Ethical Consideration in Livestock Breeding, Wageningen, Netherlands, 15 and 16 March 2011.

Jensen, Karsten Klint (2011), 'Ethical Concerns in LowInputBreeds', paper at the First LowInputBreeds Symposium on Ethical Consideration in Livestock Breeding, Wageningen, Netherlands, 15 and 16 March 2011.

Maurer, Veronika; Heckendorn, Felix (2010), 'Internationale Projekte rund ums Schaf' (Projets internationaux dans le secteur ovin), *forum* (5/2010), pp. 16–18.

Maurer, Veronika; Heckendorn, Felix (2010), 'Projets Internationaux dans le secteur ovin' (Internationale Projekte rund ums Schaf), *forum* (5/2010), pp. 19–20.

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Maurer, Veronika (2011), 'Comment peut-on juguler les verminoses?', *Aviculture Suisse*, 2011, pp. 1–3.

Maurer, Veronika (2011), 'Quelle est la meilleure pondeuse plein-air?', *Aviculture Suisse*, 2011, p. 1.

Maurer, Veronika (2011), 'Wie kann man die Verwurmung eindämmen?', *Schweizerische Geflügelzeitung*, 2/11, 2011, pp. 14–16.

Maurer, Veronika; Zeltner, Esther; Zivile, Amsler; van Niekerk, Thea; Leenstra, Ferry; Reuvekamp, Berry; Bestman, Monique (2011), 'Auf der Suche nach der besten Freilandhenne', *Schweizerische Geflügelzeitung*, 2/11, 2011, pp. 17–19.

after the end of feeding. Tannin-rich concentrates fed at this time were not effective at reducing egg output.

- The timing of pasture access for lambs in Sicily was found to influence meat quality: lambs restricted to grazing during the mornings only were found to have higher levels of indole in carcass fat compared to those with access to pasture in the afternoons or throughout the day, and the latter had a healthier fatty acid profile compared to housed lambs or those with restricted access to grazing.

PIGS

- Sow productivity and carcass quality of traditional breeds appear unsuitable for the commodity pork market; however, for niche markets, meat quality of these breeds adds value. Additionally, the dark skin of many traditional breeds offers greater resistance to sunburn and might be an advantage in hotter climates.
- Heat stress tolerance can be measured by reproductive performance identified in a large data sets (100 000 records) collected on farms in Spain and Portugal. For farrowing rate, heat stress heritability ranges from 0.02 to 0.05.

LAYING HENS

- Farmer workshops in the Netherlands and Switzerland identified an 'ideal hen' for low-input systems with lower peak production and higher eating capacity, relative to modern hybrids, and also showing an absence of smothering behaviour and feather pecking: many participants described the ideal hen mentality as 'optimistic', 'not stupid', 'bold and assertive'.
- A data set of 276 free-range and organic poultry units in France, the Netherlands and Switzerland shows a wide range of genotypes used with clear differences in flock and farm size and housing system between the three countries. Production was similar, except for organic flocks in the Netherlands which had lower egg production and higher mortality. Across countries and production systems, white hens and mixed flocks (in Switzerland) perform relatively well in contrast to silver hens that showed higher mortality and more poorly feathered birds.

Potential applications

The success of the LowInputBreeds project will help to reduce production problems and improve animal health and welfare in European organic and low-input production systems, while improving the quality of milk, meat and eggs for consumers. Many findings could also be of benefit to livestock systems currently relying on high inputs. As pressure on prices

for feed, fertiliser and other resources increase on the world stage, many of these intensive units tending to question high inputs.

Innovation contribution

The LowInputBreeds project is expected to make a significant contribution towards the main impact expected from topic KBBE-2007-1-3-07 which is to *stimulate organic and low-input livestock production by enabling logical, regionally adapted breeding strategies to be developed that are compatible with sustainable production, high product quality and organic principles.*

This will be achieved by supporting the development and integrated use of:

- ▶ novel livestock genotypes selected for performance, robustness (health, stress) and product quality traits needed in the organic and low-input sector; and
- ▶ agronomic innovations that improve low-input management systems with respect to sustainability, product quality and conformity with organic principles.

To maximise its impact, the project will develop breeding and management innovations for six major livestock systems (dairy cows and beef cattle, dairy sheep, lamb meat, pork and laying hen production systems).

Conclusions

The project is ongoing.

Strategies for organic and low-input integrated breeding and management

Acronym:
SOLIBAM

Project No:
245058

EU contribution:
EUR 6 million

Duration:
54 months

Start date:
1.3.2010

End date:
31.8.2014

Framework programme:
FP7 (seventh framework programme)

Instrument:
Large collaborative project

Project website:
<http://www.solibam.eu/> (active)

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Summary

The SOLIBAM project's overall objective is to develop specific breeding approaches linked to management practices to improve the sustainability, the quality and performance of crops adapted to organic and low-input systems, in their diversity in Europe and taken into account the 'small-scale farms' in Africa.

To achieve this overall objective, SOLIBAM will:

- (i) identify traits specific for adaptation to low-input/organic conditions over a wide range of different agro-climatic conditions in Europe;
- (ii) quantify the effects and interactions of breeding and management innovations on crop nutritional, organoleptic and end-use quality;
- (iii) develop efficient phenotyping, genotyping and molecular tools to monitor heritable variation during the selection process; molecular analysis of the functional polymorphism will increase accuracy in breeding methodologies and better monitoring of genetic diversity and adaptation along generations and will improve the understanding of the adaptive phenomena;
- (iv) develop the use of within-crop diversity to cope with current and increasing variation in organic and low-input agriculture;
- (v) design, develop and test innovative arable and vegetable cropping systems based on the integration between a high level of diversification in crop management and the use of genetically diverse populations or varieties;
- (vi) compare the effectiveness of different breeding strategies under conventional, low-input and certified organic farming conditions to set up optimal breeding strategies for the production of varieties suitable for organic and low-input farming taking into account the traits which are avoided in conventional breeding;
- (vii) develop methodologies of farmers' participatory research in the context of low-input and organic farming.

Conduct a multi-criteria evaluation of the environmental, food quality, cost and profit margin impacts under different price premium scenarios for the breeding and management innovations resulting from SOLIBAM in order to identify farm business, consumer demand and legislation-related issues that are likely to influence their adoption.

Problem

Performance of current high-input agricultural systems relies on intensive production based on high fossil energy consumption and large-scale use of plant protection products and fertilisers. The growing consumer demand for healthy food with diversified organoleptic qualities, as well as the increasing awareness of the need to preserve endangered environments, natural and agricultural diversity while limiting greenhouse gas emissions and resource use, stimulates organic and low-input production. In order to increase sustainability of production systems and to preserve the environment, alternative methods of production must be encouraged; these include organic and low-input production.

It has long been recognised that low-input and organic farming systems require crop genotypes that are specifically adapted to the higher environmental variability typical of these systems and that modern-bred genotypes are often unsuited for use under these conditions. This becomes more urgent in a time of climate destabilisation. Unfortunately, the crop varieties used in the high-input systems are often not adapted to organic and low-input production methods. But with Commission Regulation (EC) No 1452/2003 ⁽¹⁾ in force, the organic sector is not only striving for organically produced seeds from conventional varieties, but is also urging for breeding and management strategies for better adapted varieties.

Background and objectives

The potential of genetic diversity at the crop level for stabilising low-input farming systems and to enable adaptation to environmental changes is recognised theoretically, but is far from being used in practice. The genetic diversity of crops is a fundamental resource for adaptation and, therefore, crucial for the stability of food supply. A crop's ability to productively exploit its environment depends on many adaptive features, which are controlled by multiple genes, interacting among themselves and with the environment and other plants in a complex way. Breeding strategies developed should thus make use of the genetic diversity of crops and involve modern molecular methods to help understand and manage the diversity.

SOLIBAM's overall objective is to develop specific and novel breeding approaches integrated with management practices to improve the performance, quality, sustainability and stability of crops adapted to organic

Partners:

Institut National de la Recherche Agronomique (INRA)
FRANCE

Associazione Italiana per l'Agricoltura Biologica (AIAB)
ITALY

The Organic Research Centre, Elm Farm (ORC)
UNITED KINGDOM

Institut Technique de l'Agriculture Biologique (ITAB)
FRANCE

Technical University of Munich (TUM)
GERMANY

Instituto de Tecnologia Quimica e Biologica (ITQB)
PORTUGAL

Agencia Estatal Consejo Superior de Investigaciones Cientificas/Instituto de Agricultura Sostenible (CSIC/IAS)
SPAIN

Escola Superior Agraria de Coimbra (ESC)
PORTUGAL

Agricultural Research Institute of the Hungarian Academy of Sciences (ARI HAS)
HUNGARY

Scuola Superiore Sant'Anna, Pisa (SSSUP)
ITALY

University of Perugia (UNIPG)
ITALY

Agroscope (FDEA-ART)
SWITZERLAND

Institute of Food and Resource Economics (ACPH)
DENMARK

INRA Transfert (IT)
FRANCE

University of Pisa (UNPI)
ITALY

¹ Commission Regulation (EC) No 1452/2003 of 14 August 2003 maintaining the derogation provided for in Article 6(3)(a) of Council Regulation (EEC) No 2092/91 with regard to certain species of seed and vegetative propagating material and laying down procedural rules and criteria relating to that derogation, OJ L 206, 15.8.2003, pp. 17–21.

Crop breeding companies

Saatzucht Donau — cereal breeding
(Donau)
AUSTRIA

Gautier Semence — vegetable
breeding (Gautier)
FRANCE

Agrovegetal — legume breeding
(Agrovegetal)
SPAIN

Arcoiris — vegetable breeding
(Arcoiris)
ITALY

**Institutions from African ACP
countries and international
organisations**
**International Center for Agricultural
Research in the Dry Areas**
(ICARDA)
INTERNATIONAL

**Coordination Nationale des
Organisations Paysannes du Mali**
(CNOP)
MALI

Mekelle University (MU)
ETHIOPIA

Selected publications:

Chable, V., Goldringer, I., Wolfe, M., Barberi, P., Kovacs, G., Grando, S., Rakszegi, M., Ostergard, H., Bocci, R. (2010), 'SOLIBAM, Strategies for Organic and Low-Input Breeding and Management, a European programme (2010–14)', *Proceedings of the EUCARPIA Conference, Breeding for resilience: a strategy for organic and low-input farming systems?*, Paris, France, 1–3 December 2010.

and low-input systems, in their diversity across Europe and taking into account small-scale farms in Africa.

Methodology

SOLIBAM is identifying specific traits or combinations of traits for adaptation to low-input/organic conditions over a wide range of different agro-climatic conditions in Europe and Africa. Three types of complementary approaches are undertaken:

- (i) the identification of innovations and specific needs for crop management and plant breeding from the fields and the stakeholders;
- (ii) the identification of specific traits (and their combination) and how they can be measured in different farming systems and for different markets; and
- (iii) the assessment of the concept of variety performance in a broader sense through stability, adaptability, robustness and the evolutionary processes.

Knowledge from genomics, quantitative genetics, population genetics and epigenetic approaches is associated to phenotyping under different organic and low-input crop management systems for some cases. Contrary to the usual approaches, where association between molecular markers and phenotypes are developed in specific designs optimal for their detection, we are relying on concrete experiments designed for the development of populations or improved varieties with regard to various organic or low-input systems (plant breeding scheme x crop management) developed throughout SOLIBAM. We are analysing responses at different molecular levels in populations submitted to organic and low-input conditions.

SOLIBAM is exploiting crop diversity in breeding to improve yield and quality traits in different pedoclimatic conditions of Europe and sub-Saharan Africa. We are:

- (i) assessing early-stage adaptation and selection of populations under organic and low-input management;
- (ii) assembling a wide range of diversity in populations, mixtures and landraces and will compare the performance of the differing levels of diversity in a wide range of environments; and
- (iii) creating new features in species by assembling several populations with specific product qualities and agronomical performances.

For all trials, the main objective is to compare the performance of strategies in terms of yield, quality and the other main prioritised characteristics.

Innovative cropping systems based on the optimum use of diversity by taking into account the genotype and management components together have been designed. We are evaluating innovative cropping systems based on higher species and/or variety diversity (cover crops, intercropping, and all the linked cultural techniques) in a wide range of environments in Europe and Africa. Breeding actions will be performed on associated species to increase their co-adaptation. These trials are highlighting the feasibility of using cropping system diversification as a strategy to improve crop yield, crop quality traits, and the overall sustainability of the systems. Specifically, it is expected that the inclusion of legumes in association with arable and vegetable crops and that diversifying cropping systems will increase diversity-driven agroecological services that have consequences for agronomically important outcomes such as increased crop yield, yield stability, weed suppression and soil fertility.

Specific attention will be paid to arbuscular mycorrhizal fungal (AMF) communities, which are an important component of soil fertility in organic and low-input systems, facilitating crop nutrition through symbiosis. The composition and diversity of AMF communities is expected to vary upon crop rotation, management intensity, plant abilities and soil conditions.

SOLIBAM is comparing the effectiveness of different breeding strategies under conventional low-input and organic farming conditions to set up optimal breeding strategies for the production of varieties suitable for organic and low-input farming taking into account the traits which are usually disregarded in conventional breeding. We will find a suitable way to continuously release new varieties to all possible market types of organic and low-input farming over a wide range of different agro-climatic conditions in Europe and sub-Saharan African countries.

During the development, two different breeding systems have been considered: the first is for self-pollinating species; the second for open-pollinated species. The possible benefit of 'mainstream' conventional breeding from the developed organic breeding methods and varieties has been taken also into consideration.

SOLIBAM is developing participatory plant breeding approaches to answer to key adaptation bottlenecks of organic and low-input agriculture. Farmers, users and researchers are full partners in the development of new methodologies and technological innovations, with full decision-making power in planning, implementation, monitoring, and evaluation. We are associating plant breeding and crop management (PPBM) in several agroecological conditions to best adapt genotypes to environments. ICARDA, which initiated PPB in Syria 20 years ago, will share its experience with European and African partners.

As both genetic and agronomic factors may affect the nutritional, organoleptic and end-use quality of crops grown under low-input and organic conditions, we are quantifying the effect of breeding and agronomic innovations developed under SOLIBAM on crop quality. The organoleptic quality is assessed through different complementary ways: hedonic tests with a large panel of consumers and sensory analysis from trained juries. Physicals and chemicals tests complete this approach and will assess nutritional and end-use qualities.

The impacts of the innovative breeding and management strategies on (a) environmental sustainability (climate change, soil, water, biodiversity); (b) resource use (energy and materials); (c) food supply system structures (local/regional/global markets, resource/consumer driven); and (d) cost structures, for example price premiums achieved in the market for 'added value' (environmental/biodiversity/resource efficiency and/or product related quality attributes) are assessed.

The sustainability of the SOLIBAM strategies will be assessed at (i) the cropping system, (ii) the farm, and (iii) the food supply system, that is from farmer to consumer (including technical and legal aspects of non-conventional varieties developed on-farm). Our approach is to study a number of cases demonstrating the variation in organic and low-input farming and food supply systems in the involved countries from a life cycle perspective.

Finally, SOLIBAM will make a discerning analysis of the research and technical outputs and results of the project and will assure their dissemination and transfer among the following groups: (i) breeders; (ii) organic and low-input farmers; (iii) policymakers; (iv) consumers; (v) NGOs; and (vi) scientists. This will ensure that the outcomes of the project will enlarge the breeding and crop management concepts for organic and low-input agricultures. Technology transfer and dissemination (TTD) activities will be implemented for the dissemination of knowledge and technologies on variety selection and seed multiplication in the African ACP countries.

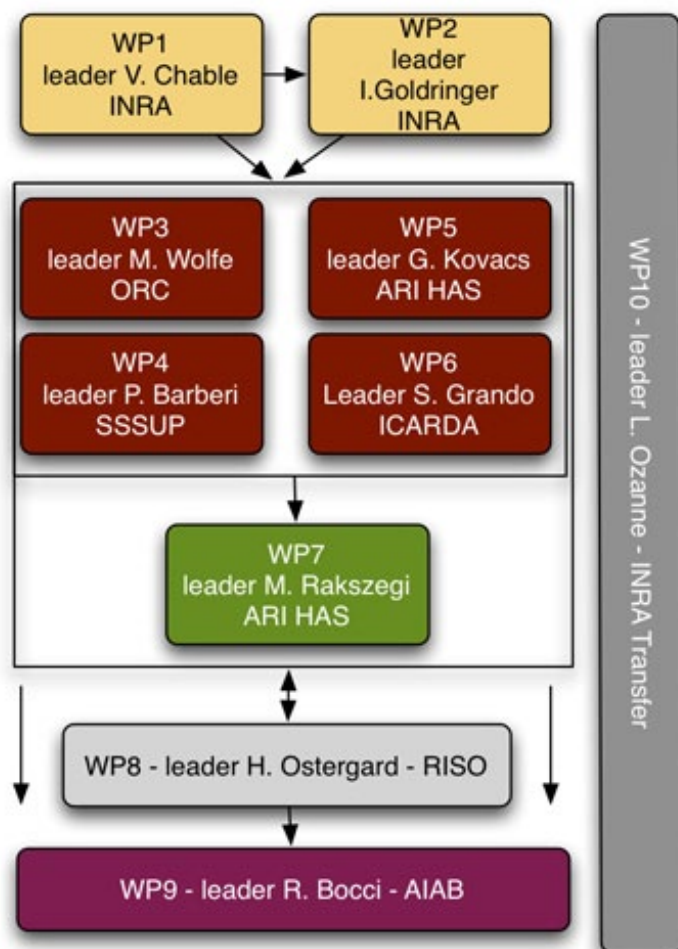


Figure 1: SOLIBAM work plan

Main findings and outcomes (results) or expected results

SOLIBAM was launched in March 2010. The partners are developing specific breeding methodologies linked to management practices to improve the sustainability, the quality and performance of crops adapted to organic and low-input systems, in their diversity in Europe and Africa.

The SOLIBAM strategy is based on examples in several species (wheat, barley, maize, faba beans, beans, tomato, cabbage, broccoli), which represent most plant breeding situations. Within the 4.5 years of the project, besides the improvement of methodological processes, breeding plant populations will be created for breeders and farmers involved in PPBM programmes.

SOLIBAM has already proposed a range of traits for the considered crops. At the end of the project, it will offer a global approach to the selection criteria for a wide range of species and will gather from all the experiments, the relative interest of each trait (nutritional and organoleptic quality, pest and disease resistance, competitiveness against weeds, nutrient use efficiency, stable and acceptable yields, and tolerance to abiotic stress) or the combination of several traits in the diversity of the considered situations. SOLIBAM is integrating the quality criteria at the beginning of the breeding process and the crop management interaction.

Potential applications

SOLIBAM trials are representative of the main European agro-ecosystems and farming systems of Europe; therefore, the proposed strategy at the end of the project will be easily adapted in different farming conditions and environments. We are referring to breeding and management methodologies that will fully take into account the need of organic and low-input farmers as users of the new varieties. This approach that will integrate the principle of participatory research will provide new tools for breeding for organic and low-input agriculture.

SOLIBAM will also suggest policy recommendations in order to enlarge the legal position for varieties adapted to organic and low-input agriculture developed during the project.

Innovation contribution

People often point out the weakness of organic and low-input agriculture, due to the currently insufficient productivity and stability of the yields (especially of intensive cash crops) and quality. The innovative breeding and management for organic agriculture and low-input systems developed by SOLIBAM — especially low-input fertilisation and pest management, diversified crop rotation and farm activities, higher genetic diversity of crops — aims to enhance the nutritional and organoleptic quality, on the one hand, and performance and its stability, on the other hand, for a range of cereals, legumes and vegetable crops in different pedoclimatic conditions of Europe and sub-Saharan Africa.

Diversity within crops is in conflict with the seed laws and in particular DUS (distinctness, uniformity and stability) testing for variety registration. SOLIBAM will pursue policy recommendations for a legal environment for the certification and commercialisation of 'varieties' that do not fit DUS and conservation varieties (Commission Directive 2008/62/EC ⁽²⁾),

2 Commission Directive 2008/62/EC of 20 June 2008 providing for certain derogations for acceptance of agricultural landraces and varieties which are naturally adapted to the local and regional conditions and threatened by genetic erosion and for marketing of seed and seed potatoes of those landraces and varieties, OJ L 162, 21.6.2008, p. 13.

Commission Directive 2009/145/EC ⁽³⁾) criteria. These recommendations will be based on the work done in the EU project FarmSeedOpportunities (FSO) (FP6 SSP-CT-2006-044345). SOLIBAM will also provide policy recommendations for new rules for the protection of varieties (IPRs) balancing Plant Breeders Rights (PBRs) and Farmers' Rights (FRs). In the case of PPB, there is a need for negotiations among the different actors involved in the innovation process, and the rights over newly developed varieties should be considered more as collective individual.

Conclusions

SOLIBAM has just started so it is impossible to have any conclusions at this point moment on the issues analysed in the various work packages. But, based on the experience of the first year, it is possible to say that having a large partnership in terms of partners, countries and types of stakeholders (scientific institutions, farmers' associations, breeding companies, etc.) involved will be the key element of the success of the project.

³ Commission Directive 2009/145/EC of 26 November 2009 providing for certain derogations, for acceptance of vegetable landraces and varieties which have been traditionally grown in particular localities and regions and are threatened by genetic erosion and of vegetable varieties with no intrinsic value for commercial crop production but developed for growing under particular conditions and for marketing of seed of those landraces and varieties, OJ L 312, 27.11.2009, pp. 44–54.

Sustainable organic low-input dairying

Acronym:

SOLID

Project No:

266367

EU contribution:

EUR 5 955 858

Duration:

60 months

Start date:

1.4.2011

End date:

31.3.2016

Framework programme:

FP7 (seventh framework programme)

Instrument:

Collaborative Project (CP)

Project website:

<http://www.solidairy.eu> (active)

Coordinator:

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Summary

Organic and low-input dairy farming systems are increasingly noted for delivering multifunctional benefits to the agricultural industry and society but technical and economic constraints prevent their widespread adoption. The SOLID project will deliver an innovative toolbox of novel methodologies that will contribute to the competitiveness of the dairy industry and increase the effectiveness with which these benefits are delivered.

SOLID facilitates the use of breeds and feeding strategies to maintain productivity, improve animal health and welfare while meeting the market requirement for high-quality milk. A multidisciplinary team comprising academic and stakeholder (SME) partners from across Europe, encompassing dairy cows and goats, will identify and apply novel strategies at the farm level and throughout the supply chain. Innovative science and models, combined with a participatory approach, will tackle practical issues, and assess competitive sustainability and integration across a range of scales and geographical contexts.

Proteomics combined with genotyping and calorimetry will be used to characterise and quantify dairy cow and goat breed adaptation to organic and low-input systems. Given the reliance of such systems on forage, SOLID will develop novel and sustainable feed resources and design a decision-support model to optimise the management of on-farm forage supply.

Life cycle assessment tools will assess environmental sustainability of grassland-based multifunctional dairy systems. Analysis of the supply chain from fork to farm will quantify the acceptability of new strategies and enhance collaboration. An integrated assessment tool and socio-economic modelling will assess innovations on farms and along supply chains, and will predict the impact of more widespread adoption of low-input practises. Effective knowledge dissemination and exchange activities will target key stakeholder groups ensuring exploitation of outputs at animal, farm, region, sector and European levels.

Problem

In the rapidly changing environment in which Europe's agri-food industries must prosper, new knowledge-based farming systems are required that are profitable at a farm level, produce competitive food products required in the market place, are environmentally sustainable and are energy efficient (SCAR, 2008). In dealing with the challenges facing agri-

culture such as climate change and biodiversity loss, the multifunctional potential of agricultural systems is now as important as productivity for a sustainable future for European agriculture.

Background and objectives

Organic and low-input farming systems have developed in spite of the past emphasis of agricultural sciences on improving productivity and performance. Grasslands (both permanent and temporary), as a low-cost feed source for ruminants, are essential components of organic and low-input production. Grasslands have many functions, not just food production: they also provide an essential regulatory function in our global environment and form an integral part of our cultural heritage (Kemp and Michalk, 2007). Grasslands play an important role in the delivery of different ecosystem services, such as the conservation of biodiversity, soil protection and the regulation of nutrient cycling, including the sequestration and storage of carbon (Sousanna et al., 2009).

Particularly in mountain and alpine regions, grassland and ruminant production systems help to preserve the landscape and play a large role in the rural economy and community stability, providing cultural services such as recreation, tourism and landscape provision. These systems also promote a clean, animal welfare-friendly image for ruminant production and there is currently increased consumer interest in site-specific and origin labelled products using local flora of various sensory characteristics to produce dairy products (Scollan et al., 2008). The nutritional properties of dairy products in particular from grassland and forage-based systems are also of significant importance (Butler et al., 2008; Scollan et al., 2008). The increased awareness of the productivity, benefits and functions of organic and low-input dairy systems has resulted in these systems receiving much attention as more sustainable methods of farming.

The objective of SOLID is to support developments and innovations in organic and low-input dairy systems to optimise competitiveness for a sustainable and profitable dairy industry in Europe, whilst at the same time (i) maximising the potential of these systems to deliver environmental goods and enhance biodiversity and (ii) optimising economic, agronomic and nutritional advantages for the development of innovative and sustainable organic and low-input dairy systems and supply chains.

Methodology

To reach the objective defined above, SOLID will specifically:

1. actively involve stakeholders (organic and low-input dairy farmers, farmers' groups, advisors and processors) in a coordinated participatory approach to identify research needs, engage producer innovation in the development and implementation of re-

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AUSTRIA

Università Politecnica delle Marche
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Agrifood and Biosciences Institute
UNITED KINGDOM

Maa Ja Elintarviketalouden
Tutkimuskeskus
FINLAND

Aristotelio Panepistimio
Thessalonikis
GREECE

JRC-IPTS
SPAIN

Eigen Vermogen van het
Instituut voor Landbouw en
Visserijonderzoek
BELGIUM

Agencia Estatal Consejo Superior de
Investigaciones Cientificas
SPAIN

Institutul Național de Cercetare —
Dezvoltare Pentru
Biologie si Nutritie Animala
ROMANIA

AgResearch Limited
NEW ZEALAND

Service ICAR SRL
ITALY

Organic Milk Suppliers Cooperative
Ltd
UNITED KINGDOM

Institute of Organic Training and
Advice Ltd
UNITED KINGDOM

Leibniz-Zentrum fuer
Agarlandschaftsforschung
GERMANY

Calon Wen Organic Milk Cooperative Ltd
UNITED KINGDOM

Istituto per la Certificazione Etica ed Ambientale
ITALY

Agricultural Dairy Cooperative of Anogia Proodos
GREECE

Juvan Luomu OY
FINLAND

Wim Govaerts & Co
BELGIUM

Federacion Andaluza de Asociaciones de Ganado Caprino De Raza Pura, Cabrandalucia
SPAIN

Thise Mejeri A.m.b.A.
DENMARK

SC Agro-Solomonescu SRL
ROMANIA

search projects, and to assess stakeholder-led novel strategies at the farm level and along the supply chain;

2. quantify the advantages of a number of contrasting genotypes which are perceived to be 'adapted to organic and low-input dairy production systems', in comparison to conventional genotypes, characterise and, where possible, improve metabolic balance, health and welfare status and milk quality and investigate the physiological background of adapted and non-adapted genotypes of dairy cows in organic and conventional low-input systems and the genetic background of dairy goats in low-input conventional systems only;
3. identify and develop novel and sustainable feed resources, especially those which are currently underutilised — this will include the development of a decision-support model to optimise the management of on-farm feed supply;
4. develop a knowledge platform to assess environmental sustainability, using tools based on Life Cycle Assessment (LCA), of diverse multifunctional dairy systems including regional and local chains and dairy chains originating outside Europe;
5. identify the broad range of expectations of low-input and organic dairy farming and food systems (e.g. food quality, animal welfare, environmental and economic performance) along the whole supply chain (fork to farm) and assess the acceptability of novel strategies developed in SOLID given these expectations; the project will also develop optimal strategies to enhance collaborative behaviours in the supply chain to increase the uptake of innovations developed within SOLID;
6. evaluate the competitiveness of existing organic and low-input dairy farms and any novel strategies developed; utilising a simple Integrated Assessment (IA) tool for the rapid assessment of competitive sustainability of organic and low-input dairy farms and develop novel strategies and determine the wider impact of more widespread adoption of novel strategies developed within SOLID in contrast to further intensification of milk production within the EU through farm and sector modelling;
7. disseminate knowledge to key stakeholder groups (dairy farmers, milk processing/animal industry, consumers, NGOs, scientists and policymakers) through a participatory framework that will allow exchanges between researchers and major stakeholders and increase the awareness of the major challenges and solutions in organic and low-input dairy systems.

Main findings and outcomes (results) or expected results

- SOLID WPs 1, 2 and 3 perform the technological development of novel strategies for organic and low-input dairy production within the project: WP 2 and WP 3 using innovative scientific ap-

proaches and WP 1 using a participatory approach involving SME partners.

WP 2 will build on a network of existing experiments on dairy breed suitability and 'robust' dairy animals by SOLID partners in Austria, Finland and Northern Ireland (cows) and Greece and Spain (dairy goats) with the aim of quantifying the level of adaptation of these breeds compared to 'conventional breeds' in organic and low-input systems: animal health and welfare assessment protocols will be developed and used as indicators of breed adaptability.

Field experiments (WP 3) will be used to develop and evaluate novel feeds and feeding strategies, alongside the multi-functional potential of systems which provide these feeds (e.g. agro-forestry).

On-farm research projects (WP 1) will be carried out on a total of 17 farms across eight countries in collaboration with stakeholder and science partners in WP 2 and WP 3. Science partners within WP 2 and WP 3 will assist with experiment design for the on-farm studies and additional samples (forage, soil, milk quality, biomarkers) from WP 1 will be collected and fed into WP 2 and WP 3 tasks.

- SOLID WP 4, 5 and 6 perform the evaluation of novel strategies developed in WPs 1, 2 and 3 from an environmental, supply chain and socio-economic perspective. Tools, based on modelling and indicator calculation, for an integrated environmental assessment of dairy products in a chain perspective will be developed in WPs 4, 5 and 6.

The toolbox of WP 4 is a prerequisite for the systematic sustainability assessments of the selected dairy chains that are investigated in the project (WPs 1, 2 and 3) and to evaluate the environmental impacts of the novel strategies and innovations developed in WPs 1, 2 and 3. The competitiveness of SOLID will be assessed in WP 6 using existing models and indicators and data derived from WPs 1, 2, 3, 4 and 5. An integrated assessment will bring together environmental and socio-economic aspects of SOLID in collaboration between WPs 4, 5 and 6, and utilised through WP 1.

- Participatory approaches such as focus groups, case studies, on-farm experiments and stakeholder workshops will form an integral part of SOLID to identify constraints and novel strategies (WP 1) which will be evaluated in WPs 4, 5 and 6; for evaluating the assessment tools (WPs 4 and 6) which will be used to evaluate the strategies developed in WPs 1, 2 and 3; for eliciting supply chain member input (WP 5), which will feed into the overall socio-economic evaluation of novel strategies (WP4 and 6); and for disseminating and evaluating the overall outcomes of SOLID (WP 7).

Potential applications

The research to develop novel strategies conducted in WPs 1, 2 and 3, the evaluation of SOLID and novel strategies conducted in WPs 4, 5, 6 and effective dissemination in WP 7 will enable policy recommendations to be made regarding the potential of organic and low-input dairy systems to meet the multifunctional needs of agriculture in Europe.

Innovation contribution

- ▶ WP 1: The aims of this work package are to actively involve farming stakeholders (organic and low-input dairy farmers, farmer groups, advisors) and stakeholder partners in the project in a co-ordinated participatory approach; to identify research needs; to engage producer innovation in the development and implementation of research projects; to assess stakeholder-led novel strategies at the farm level and to contribute stakeholder perspectives to other work packages.
- ▶ WP 2: This work package will contribute to an improvement in the competitiveness of organic and low-input dairy production systems by focusing on an assessment of potential advantages of robust, adapted dairy breeds over conventional genotypes in terms of health, welfare and milk product quality, thus gaining a better understanding of the physiological background of the metabolic and health status and milk quality of dairy cows and goats in low-input systems.
- ▶ WP 3: Considering the importance of internal feed resources in driving the competitiveness and sustainability of organic and low-input systems, the availability and the nutritional value of potential novel feed components will be examined. This will include the evaluation of novel feedstuffs and novel agro-forestry systems which can be used to buffer forage feed supplies.
- ▶ WP 4: Specifically, the following objectives are to develop and apply tools based on Life Cycle Assessment (LCA) to produce conventional and novel indicators for environmental sustainability assessment of diverse multifunctional dairy systems (process approach); to identify the sustainability hot spots in important low-input and organic dairy chains (system approach); to integrate the LCA approach to other sustainability indicators used in chain approaches and to analyse the eco-efficiency and sustainability gains from innovations at the farm and chain level (policy approach).
- ▶ WP 5: This work package will identify the broad range of expectations for innovation in management practices and adapted breeds along the whole low-input and organic dairy farming supply chain (fork to farm); to assess the acceptability of novel strategies (developed in WP1, 2 and 3) along the whole supply chain given the differing expectations, with special consideration

to consumer acceptance and preferences, and the sustainability of supply chain management practices and to identify optimal strategies to enhance collaborative behaviours in dairy low-input and organic supply chains in order to introduce acceptable innovations enhancing competitiveness and sustainability along the whole supply chain.

- ▶ WP 6: This work package will develop a methodology for defining and classifying low-input dairy farms and to identify the direct and indirect factors that have led to the sustained profitability of high performing organic, low-input and conventional dairy farms; develop a simple Integrated Assessment (IA) tool for the rapid assessment of competitive sustainability of organic and low-input dairy farms through WP1 and as a tool for the development of novel strategies; utilise a farm-scale modelling tool for the appraisal of novel strategies on typical dairy farm types and as a dissemination tool at extension level and determine the impact of more widespread adoption of novel strategies developed within the SOLID project in contrast to further intensification of milk production within the EU through modelling.
- ▶ WP 7: In this work package, a participatory framework will be created that will allow structured and continuous dialogue between partners and the stakeholders to ensure that the project meets the needs of the end-users; organise national and regional advisory and scientific workshops and a final conference to enhance the relevance of the research to end-users; agree on future research, technology and implementation strategies and disseminate results to the intended end-users; and secure exploitation of innovations from the project through the provision of innovative training elements (E-learning), dissemination material and demonstration activities.

Conclusions

The project is ongoing; there are no conclusions available at this point in time.

Bees in Europe and the decline of honeybee colonies

Acronym:

BEE DOC

Project No:

244956

EU contribution:

EUR 2 993 million

Duration:

36 months

Start date:

1.3.2011

End date:

31.3.2013

Framework programme:

FP7 (seventh framework programme)

Instrument:

CP

Project website:

<http://www.bee-doc.eu/index.php>
(active)

Coordinator:

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Summary

The BEE DOC project comprises a network of 11 partners from honeybee pathology, chemistry, genetics and apicultural extension aiming to improve the colony health of honeybees. BEE DOC will empirically and experimentally fill gaps in the knowledge of honeybee pests and diseases, including 'Colony Collapse Disorder', and quantify the impact of interactions between parasites, pathogens and pesticides on honeybee mortality.

Specifically, BEE DOC will show how interactions affect individual bees and colonies in different European areas for two model parasites (*Nosema* and *Varroa* mites), three model viruses (Deformed Wing Virus, Black Queen Cell Virus and Israel Acute Paralysis Virus) and two model pesticides (thiacloprid and t-fluvalinate). BEE DOC will use transcriptome analyses to explore host-pathogen-pesticide interactions and identify novel genes for disease resistance.

BEE DOC will specifically address sublethal and chronic exposure to pesticides and screen how apicultural practices affect colony health. BEE DOC will develop novel diagnostic screening methods and develop sustainable concepts for disease prevention using novel treatments and selection tools for resistant stock. BEE DOC will be linked to various national and international ongoing European, North and South American colony health monitoring and research programmes, which will not only ensure pan-European but also global visibility and the transfer of results to apicultural practice in the world community of beekeepers.

Problem

Unfortunately, beekeeping is a declining industry and recent decades have seen a constant drop in both managed honeybee colonies and beekeeping activities in most EU Member States. Most beekeepers are either hobbyists or part-time operators, with a rapidly ageing demography. On top of this, wild or feral bee colonies are also rapidly declining due to human land use, poisoning, diseases and parasites. In monetary terms, these losses of honeybee colonies in the EU alone result in a significant direct damage exceeding EUR 400 million per year for the apicultural industry. One of the principal reasons for the decline in managed honeybee colonies, and of beekeepers, is extensive and unpredictable colony death. While for small-scale hobbyist beekeepers this can be discour-

aging enough to abandon the hobby, for (semi)-professional operators, this is a crucial limitation to business planning and expansion. Moderate and predictable losses can be accommodated and planned for; however, extensive and uncontrollable losses make beekeeping as a profession, with the heavy investment in material and equipment, an enterprise at permanent risk of bankruptcy. This financial uncertainty also limits recruitment of a new generation of beekeepers, especially to the professional ranks. It is these colony losses that this project aims to address.

The most recent event of colony losses is the well-publicised Colony Collapse Disorder (CCD) that devastated the honeybee industry across the United States in 2006 and 2007 and the Rhine valley bee poisoning case of 2008. Whereas the causes of the colony deaths became rapidly clear for the Rhine valley poisoning and similar cases in France and Italy, and appropriate actions could be taken to prevent future accidents, the causes of CCD are still ambiguous or inconclusive. This uncertainty prevents the development of rational approaches to managing colony losses and encourages ad hoc remedies and blanket prophylactic application of chemical treatments against pathogens or parasites, whether present or not. Such practices are also encouraged by the inadequate diagnostic tools and procedures for disease treatment.

Typically, the apiculturist identifies symptoms at the colony level, and then starts diagnostic procedures to identify the disease and initiate a treatment. Yet, when clinical symptoms appear at the colony level, diagnosis often comes too late to save or cure the colony. Consequently, there is a clear need for fast, reliable, sensitive and cheap diagnostic tools that alert the beekeeper to potential problems before colony level symptoms appear.

Background and objectives

Treatments typically rely on chemicals, which are administered to target pathogens before colony collapse is inescapable. The development of such treatments is based on searching for chemicals that are toxic to the pathogen, but harmless to the honeybee. However, so far, any chemical treatment for a honeybee disease, even if successful at the colony level in the short term, has not eradicated diseases at the population level, particularly if the pathogen has a high transmission rate and a high infectivity. As illustrated by the present apicultural reality, any chemotherapy of honeybee colonies immediately leads to an obligate contamination of honey and ultimately, even more worrying, to resistant pathogens. Moreover, the dramatic colony losses of the past decade suggest that treatments aimed only at a single pathogen may, in principle, fall short in curing colonies altogether if the interactions between various pathogens are the main drivers of colony death.

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Methodology

Field trials, behavioural observations, molecular analysis, genetic analysis, genomics, immunological assays, proteomics.

Main findings and outcomes (results) or expected results

BEE DOC will develop novel diagnostic screening methods and develop sustainable concepts for disease prevention using novel treatments and selection tools for resistant stock.

Potential applications

Improving honeybee health and beekeeping using sustainable methodologies and techniques.

Innovation contribution

Analysing the combined effects of multiple stressors on honeybees and honeybee health. Exploration of novel treatment methods relying on sustainable resources like bee, plant and microbial products.

Conclusions

The project has just started.

Selected publications:

Moritz, R. F. A., de Miranda, J.,
 Fries, I., Le Conte, Y., Neumann, P.,
 Paxton, R. J. (2010), 'Research strategies
 to improve honeybee health in Europe',
Apidologie, 41: 227–242.

Improving nutrient efficiency in major European food, feed and biofuel crops to reduce the negative environmental impact of crop production

Summary

Concerns about the overuse and long-term sustainability of chemical fertilisers has led to an interest in improving our understanding of the agronomic and genotypic potential for improved efficiency of fertiliser use in crop production. In the NUE-CROPS project, a range of classical (QTL identification, association genetics) and innovative (gene expression profiling using proteomics, metabolomics and transcriptomics) techniques will be used to identify genetic markers for nutrient use efficiency (NUE) in four key European field crops (maize, wheat, oilseed rape and potato).

These markers will allow for more rapid selection of varieties with NUE traits. Improved varieties will be tested with agronomic innovations to significantly reduce fertiliser use and associated negative environmental impacts of crop production, while maintaining or improving crop yield and quality. The project is expected to result in the development of new, improved NUE varieties for the four focus crops, as well as the identification of the most useful agronomic strategies to improve NUE. In addition, the project training and dissemination activities will facilitate transfer of knowledge to the industry, and result in the development of a new generation of scientists able to approach future challenges in food production, using a range of innovative strategies.

Problem

Based on the current predictions for increases in world population and the growing demand for renewable sources of energy in the future, it will be essential to maintain and/or improve yields of the main staple food, feed and potential biofuel crops such as wheat, oilseed rape, potato and maize. However, it is widely accepted that such increases must be achieved with reduced environmental impacts, especially with respect to nutrient pollution and energy use/greenhouse gas emissions.

Current levels of crop production are reliant on high inputs of nitrogen (N) and phosphorus (P) fertiliser. The use of N fertiliser is associated with

Acronym:

NUE-CROPS

Project No:

222645

EU contribution:

EUR 6 million

Duration:

60 months

Start date:

1.5.2009

End date:

30.4.2014

Framework programme:

FP7 (seventh framework programme)

Instrument:

Collaborative Project (Large-scale integrating project (IP))

Project website:

<http://research.ncl.ac.uk/nefg/nuecrops/>

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(a) high levels of non-renewable energy use, (b) greenhouse gas emissions (e.g. CO₂, N₂O) that cause climate change and (c) eutrophication of fresh water and marine ecosystems. Every year in Europe, 11 Mt reactive N (of 91 Mt globally) is introduced into the environment as mineral fertiliser. Phosphorus fertiliser use is also a major concern since the currently known global P deposits may be depleted within 50 years and since P run-off from agricultural land contributes significantly to eutrophication, especially in freshwater ecosystems.

In the context of these issues, the NUE-CROPS project brings together crop breeders, agronomists, and environmental scientists to address the challenge of maintaining or increasing crop yields, while reducing fertiliser use and damage to the environment. The past 20 years have seen the field of genomics (proteomics, metabolomics, transcriptomics) develop at a rapid pace. In the NUE-CROPS project, genomics tools will be used to identify molecular markers for rapidly screening plant populations for NUE traits. Improved varieties will be tested using innovative crop production techniques to minimise losses of N and P and maximise crop use of these valuable nutrients. This interdisciplinary approach has a high probability of delivering varieties and crop production systems that will maximise N and P use efficiency by the crop.

Background and objectives

The NUE-CROPS project was designed to address the growing challenge of producing food and energy crops in a world with a rapidly increasing population, and a declining resource base. This situation demands new approaches to crop production utilising NUE varieties in combination with innovative agronomic approaches, to maximise the uptake and utilisation of plant nutrients, especially N and P.

The following are the overall objectives of the NUE-CROPS project.

1. 1. Develop NUE varieties of four major European crops (wheat, oilseed rape, potato, maize) for different macro-climatic regions. This will be based on:
 - (a) classical QTL identification methods;
 - (b) association genetics approaches;
 - (c) gene expression profiling (and where appropriate proteomic, metabolomic analyses and/or analytical transformation analyses); and
 - (d) whole plant physiological studies.

R & D activities will focus on the four major crops species, but deliverables from studies with model plants/crops (*Arabidopsis*, *Brassica rapa*, barley) will be used as 'genetic bridges' for the genetically complex crops wheat and oilseed rape.

2. Integrate NUE-CROPS with innovative management approaches (e.g. improved fertilisation regimes, rotational designs, winter cover crop use, and tillage systems). This will be based on:
 - (a) field experiments to evaluate the impact of NUE crops under contrasting agronomic scenarios; and
 - (b) the construction/validation of models/algorithms for nutrient budgeting/precision farming systems.
3. Establish an efficient training and dissemination programme aimed at rapid exploitation and application of project deliverables in commercial crop production.

Methodology

The NUE-CROPS project is divided into five R & D sub-projects, as well as a management/coordination sub-project and a training and dissemination sub-project. Four of the R & D sub-projects (one for each crop) will utilise the following techniques to elucidate the relationships between phenotypic traits associated with nutrient use efficiency, and the genetic markers for these traits. Approaches used will include:

- (i) classical quantitative trait loci (QTL) identification approaches based on simultaneous phenotyping and genotyping of populations developed from parents with contrasting NUE or associated traits;
- (ii) association genetics approaches which allow phenotypic characters and molecular marker data from unrelated lines and varieties to be linked;
- (iii) genetic 'bridging' approaches for crops with complex genetics (wheat and oilseed rape); this will be based on utilising and transfer knowledge obtained with model systems (barley, *Arabidopsis* and *Brassica rapa*);
- (iv) gene expression profiling (and, where appropriate, proteomic and metabolomic analyses) of genotypes with high and low NUE exposed to contrasting fertilisation regimes; and
- (v) whole plant physiological studies.

Sub-project 5 focuses on the integration of breeding and agronomic innovations to improve NUE. In this sub-project, information from the four crop-specific sub-projects will be analysed. In addition, SP 5 experiments will involve:

- (i) detailed assessment of crop genotypes with distinct levels and/or mechanisms of NUE within the context of different rotational, fertilisation and/or production system scenarios using established long-term, factorial field experiments; and
- (ii) the construction and validation of models/algorithms for nutrient budgeting and precision farming systems that consider varietal differences in *nutrient uptake and acquisition, storage*

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and utilisation of fertilisers when calculating fertiliser recommendations for commercial crop production systems.

The training and dissemination sub-project will focus on rapid transfer of new knowledge to the industry, and the training of young scientists who are equipped with the skills to develop efficient systems of crop production in an increasingly resource-limited world.

Main findings and outcomes (results) or expected results

In the first 18 months of the project, field trials have been established using a range of varieties under contrasting nutrient supply conditions, and in a range of environments. This has allowed the investigation of variety, nutrient supply and environment effects, and the interactions among these factors. Mid-season and harvest data has been collected, including whole plant and grain/tuber samples. The efficiency of N uptake by the whole plant, and the efficiency of the utilisation of N for production of grain or tubers, has been calculated. In-depth studies of the components of N use efficiency will be used to link phenotypes, N use efficiency traits, and molecular markers.

Key findings to date include the following.

- ▶ Clear environment x variety interactions for the yield of barley varieties (used as a model for wheat), with differences in ranking between the northern United Kingdom and the south. This confirms that varieties vary in their yield responses to nitrogen supply depending on their environment.
- ▶ Hydroponic studies of maize using N efficient and inefficient lines with varying rates of nitrate supply have shown that plant height, root length and density of lateral roots differs between the tested lines. One phenotype, an increased density of lateral roots, could be associated with the introgressed SL region on chromosome 8. Thus, a QTL-linked root trait was identified to be further used for QTL characterisation and fine-mapping.
- ▶ Researchers in the Netherlands have designed an ecophysiological model to describe the genotype x environment interaction effects on canopy cover dynamics in potato. The model describes three phases of canopy development using five parameters that define the three phases. Work is ongoing to validate and test this model in the field.

Future activities will include the continued development of an integrated approach to the management of NUE in four major European crops. This will be coupled with a programme of dissemination to the scientific community and early-stage researcher training.

Potential applications

The NUE-CROPS project will result in the identification of key molecular markers associated with nutrient use efficiency in four of the major crops in Europe. These markers can be used to hasten the selection process for improved varieties by allowing for pre-screening of a large number of genotypes, thereby shortening the time between the start of a breeding programme, and the production of varieties for commercial release.

The linking of molecular markers with phenotypic traits may also contribute to improvements in the efficiency of crop breeding for other desirable traits (e.g. high protein content in grains, short straw length, high harvest index, etc.).

The incorporation of phenotypic traits linked to NUE into soil N dynamics models will further increase the precision of model predictions for losses and gains of N at the field scale. These models can then be used for further simulations and the development of cropping systems with optimised NUE *in silico*.

The NUE-CROPS project uses a truly interdisciplinary approach to solve the problem of low fertiliser use efficiency in modern crop production systems. Geneticists, molecular biologists, crop scientists, soil scientists, and mathematical modellers will all work together to tackle this multi-faceted problem. This approach is transferable and can be adapted to help solve a range of other agricultural problems in the future.

Innovation contribution

The linking of scientists from a range of disciplines within the NUE-CROPS project is innovative and will contribute to the development of new solutions to the challenge of low NUE in modern crop production. In this project, molecular biologists will work in collaboration with crop scientists working at the field scale. This will help the molecular biologists to put their science into the context of field production. Likewise, it will help crop scientists to recognise the value of new tools in genomics to better understand the underlying mechanisms behind crop responses observed in the field. Analysis of the results from similar experiments conducted under a range of pedoclimatic conditions across the EU will also improve understanding of the importance of environment x genotype interactions in determining the expression of crop traits.

Conclusions

The project is ongoing.

Optimising Subsidiary Crop Applications in Rotations

Acronym:
OSCAR

Project No:
289277

EU contribution:
EUR 2 998 654

Duration:
48 months

Start date:
1.4.2012

End date:
31.3.2016

Framework programme:
FP7 (seventh framework programme)

Instrument:
CP-TP

Coordinator:
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Abstract

There is a need to improve sustainability in farming systems particularly through soil care and improvement, but not at the expense of productivity. One approach is to focus on a comprehensive advance in conservation tillage. This will be developed from improved ways of integrating subsidiary crops (SC) as living or dead mulches or cover crops with the main crops in rotation so as to simultaneously improve crop nutrition, health, and productivity. The SC will deliver multiple ecological services by increasing the duration of soil cover in the rotation overall while increasing species diversity, minimising the use of tillage and agrochemicals, enhancing biological N fixation and soil C content, and both reducing water demand in dry climates and improving soil workability in wetter climates.

The research will draw on a wide range of previous and ongoing EU and related projects and will be based on 11 coordinated field experiments in different climatic regions together with three long-term experiments in Europe and Brazil. These experiments will all be assessed for economic and ecological impact including the often neglected issue of legume root health. Breeding companies and manufacturers of agricultural equipment from all regions of interest will be involved in finding adapted solutions for the different environments by extending the range of potentially useful plant species and by developing appropriate machinery to promote adoption in practical agriculture. The potential for useful chemical extraction from the existing and novel SCs will also be investigated.

A central deliverable will be a database-supported 'Cover Crop and Living Mulch Toolbox' and Decision Support Tool which will encourage multilingual stakeholder exchange and dissemination during and beyond the lifetime of the project so as to capture farmer experience. The results of the project as a whole will be of use for, and improve sustainability in, low-input, organic and conventional farming systems.

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Legume-supported cropping systems for Europe

Abstract

This research will deliver knowledge and technology for the optimisation of the use of legumes in European agricultural systems and promote the partnerships needed to support the public policy outcomes sought. By integrating the consortiums' extensive set of existing field case studies, modelling and knowledge base, the project will test, validate and deliver novel cropping systems. This network of 18 case studies, in 12 countries, will be the focus of interaction with farmers, SMEs, other businesses, and policymakers.

Outputs will include system-optimised cropping plans for each pedoclimatic region, input into existing farm-planning tools, local on-farm demonstrations, a socio-economic analysis that will enable local economic assessment of cropping systems, and an ecological assessment of the effects of relevant farming system changes on greenhouse gas and nitrogen budgets, biodiversity and soil health from the farm to the continental scale. A book on legume-supported eco-efficient farming systems covering all aspects of the use of legumes in Europe will be published.

The research is planned around the appreciation of how nitrogen fertilisation and the production and use of plant protein lie at the heart of many of the global, regional and local environmental challenges arising from agriculture. The project will take a novel strategic approach to knowledge interaction and delivery, in order to enhance and pool existing knowledge platforms and databases. It will then deliver the results into the farming community, commercial use, and policy practice beyond the life of the project.

The project will facilitate wide access to new and existing knowledge and technologies and it will promote awareness of the role of legumes in the development of sustainable supply chains and consumption patterns. All research results and products will be put in the public domain, and partnership with all the agents of change, including policymakers, will be a key element of the work.

Acronym:

Legume Futures

Project No:

245216

EU contribution:

EUR 2 999 981

Duration:

48 months

Start date:

1.3.2010

End date:

28.2.2014

Framework programme:

FP7 (seventh framework programme)

Instrument:

Collaborative Project — small or medium-scale focused research project (CP-FP)

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Multi-species swards and multi-scale strategies for multifunctional grassland-based ruminant production systems

Acronym:

MultiSward

Project No:

244983

EU contribution:

EUR 2 997 595

Duration:

48 months

Start date:

1.3.2010

End date:

28.2.2014

Framework programme:

FP7 (seventh framework programme)

Instrument:

Collaborative Project — small or medium-scale focused research project (CP-FP)

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Abstract

MultiSward will support developments and innovations in grassland production and management throughout the diversity of European farming systems, pedo-climatic and socio-economic conditions. It will enhance regulating and support services from grasslands at the farm and landscape levels whilst improving the competitiveness of grassland-based ruminant production systems. This will be achieved by a concerted use of diversity: multi-species swards, diversity of plant communities at the farm and landscape levels and diversity of production systems at the landscape level.

To reach this goal, MultiSward will:

1. define the roles and utility of grassland from economic, agronomic and environmental perspectives and determine stakeholders' requirements and expectations with respect to multifunctionality in EU countries;
2. assess the performance of multi-species swards (MSS) in terms of plant productivity and animal nutrition over a range of environments and determine the most appropriate mixtures according to the soil and climatic conditions;
3. optimise the role of MSS in the provision of regulating and supporting services and maintaining a high level of biodiversity;
4. design and evaluate innovations in grazing and animal management (including animal genetics) to enhance the sustainability and competitiveness of grassland-based ruminant production system;
5. provide adequate evaluation tools (indicators and models) to assess ways of combining high production efficiency with optimal provision of regulating and support services from grasslands at the farm to regional levels;
6. identify and analyse the effects of socio-economic and policy scenarios supporting grassland development or inducing grassland replacement by annual crops in order to support the design of future policies;

7. disseminate knowledge to key stakeholders through a participatory framework that will allow exchanges between researchers and key stakeholders and increase awareness of grassland-based systems

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Pesticide Use-and-risk Reduction in European farming systems with integrated pest management

Acronym:

PURE

Project No:

265865

EU contribution:

EUR 8 999 828

Duration:

48 months

Start date:

1.3.2011

End date:

28.2.2015

Framework programme:

FP7 (seventh framework programme)

Instrument:

CP-IP

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Abstract

To meet both the worldwide demand for food security and new environmental needs, agriculture must increase food production and quality while decreasing its ecological footprint. Ensuring sustainability and competitiveness with reduced pesticide inputs is a major challenge.

The PURE project will provide integrated pest management (IPM) solutions and a practical toolbox for their implementation in key European farming systems (annual arable and vegetable, perennial, and protected crops) in which the reduction of pesticide use and better control of pests will have major effects. PURE will exploit recent advances in emerging technologies, plant-pest-enemy interactions, soil and landscape ecology and pest evolution to feed IPM solutions with innovative diagnostic and decision support systems, physical devices and bio-products, strategies for ecological pest regulation and improved durability of control methods.

For each selected farming system, PURE will combine existing methods with new tools and technologies into novel IPM solutions addressing the biological, agronomical and economical diversity in Europe. IPM solutions will range from easy-to-adopt combinations of tactical control methods to more ambitious solutions involving strategic changes at farm level. PURE will test the efficacy, practicability and relevance of IPM solutions under the agro-ecosystems and farming conditions of the main broad European regions by on-station and on-farm experiments and will perform a comparative assessment of their environmental, economic and social sustainability. By jointly involving researchers and the key actors of pest management (farmers, advisors, policymakers and actors in the food supply chain) in design and assessment, PURE will facilitate the adoption of these innovative IPM solutions.

PURE will thereby contribute to reducing the risks to human health and the environment and the dependence on pesticides and will facilitate the implementation of the pesticides package legislation.

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European Commission

A decade of EU-funded, low-input and organic agriculture research (2000-2012)

Luxembourg: Publications Office of the European Union

2012 — 284 pp. — 17.6 x 25.0 cm

ISBN 978-92-79-26540-2

doi:10.2777/19796

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The publication summarises 49 research projects on low-input and organic agriculture, co-funded by the European Commission under the 5th, 6th and 7th Framework Research Programmes, conducted or started in the period 2000 – 2012.

The catalogue aims to present the basic data of the different projects and also, where possible, the results. Structured as three main chapters under large collaborative, policy support and sector development projects, it could be a valuable data source for stakeholders, researchers and policy makers.

The publication is complemented by a number of highly valuable contributions from policy makers and distinguished scientists.

The decade of organic research funding was built on major contributions by Danièle Tissot, Lina Lapinskaite and Gudrun Bauer.

Studies and reports



ISBN 978-92-79-26540-2



9 789279 265402

doi:10.2777/19796