Vision for an Organic Food and Farming Research Agenda 2025

Food, Fairness and Ecology

2nd draft[1], 26 March, 2008

Prepared by Urs Niggli, Anamarija Slabe, Otto Schmid, Niels Halberg and Marco Schlüter

IFOAM Regional Group European Union (IFOAM EU Group)
Rue du Commerce 124
1000 Brussels
Belgium
Tel.: +32 2 7352797
Fax: +32 2 735 73 81
E-mail: info@ifoam-eu.org
Internet: www.ifoam-eu.org

International Society of Organic Agriculture Research (ISOFAR)
c/o Institut für Organischen Landbau (IOL)
Katzenburgweg 3
53115 Bonn
Germany
Tel.: +49 228 735616
Fax: +49 228 735617
E-mail: Info @isofar.org
Internet: http://www.isofar.org

[1] This is the 2nd draft made public. The 1st draft was submitted to consultation on 10 November, 2007. This 2nd draft integrates the results of the stakeholder consultation (10 November to 15 December 2007), the comments reported from the IFOAM EU conference on 4 and 5 December, 2007 and the comments taken at an open stakeholder meeting at biofach (Nuremberg), 24 February, 2008.

With input of:
Alex Beck, Büro Lebensmittelkunde & Qualität (D)
Andrea Ferrante, AIAB (I)
Andreas Biesantz, Demeter International (B)
Anna Bieber, FiBL (CH)
Anna Maria Haering, University of Eberswalde (D)
Anton Pinschof, FNAB (F)
Arnd Spahn, EFFAT (B)
Birgit Dittgens, Federal Agency for Agriculture and Food (D)
Camilla Mikkelsen, IFOAM-EU Group (B)
Chris Koopmans, Louis Bolk Institute (NL).
Christian Waffenschmid, Coop (CH)
Christophe David, ISARA-Lyon (F)
Els Wynen, Eco Landuse Systems (AU)
Grete Lene Serikstad, Bioforsk (NO)
Heidrun Moschitz, FiBL (CH)
Helga Willer, FiBL (CH)
Henning Hoegh Jensen, SOAR / University of Copenhagen (DK)
Ina Pinxterhuis, Wageningen University (NL)
Iris Lehmann, Federal Agency for Agriculture and Food (D)
Jacques Neeteson, Wageningen University (NL)
Johannes Kahl, University of Kassel (D)
Johannes Nebel, farmers committee in the Danish Agricultural Research Centre for Organic Farming (DK)
Kirstin Brandt, University of Newcastle (UK)
Laszlo Radics, Corvinus University Budapest (HU)
Lawrence Woodward, The Organic Research Centre (UK),
Manon Haccius, Alnatura (D)
Marco Bosco, Unibo (I)
Maria Finckh, University of Kassel (D)
Matthias Stolze, FiBL (CH)
Mette Stjernholm Meldgaard, IFOAM World Board (DK)
Nic Lampkin, University of Wales (UK)
Per Baumann, EuroCoop (B)
Salvatore Basile, AIAB (I)
Stefan Dabbert, Hohenheim University (D)
Stefan Lange, Federal Agency for Agriculture and Food (D)
Susanna Padel, University of Wales (UK)
Ulrich Hamm, University of Kassel (D)
Ulrich Koepke, Bonn University (D)
Victor Gonzalves, SEAE (E)
Vonne Lund, National Veterinary Institute (NO)
William Lockeretz, Tufts University (USA)
Winfried Schäfer, MTT Agrifood Research (FIN)

Table of Contents

1 Preface ... 4

2 Executive summary ... 5

3 Introduction ... 8

4 Current situation of organic agriculture ... 9

4.1 ORGANIC AGRICULTURE IN THE EU ... 9
4.2 ORGANIC PRODUCTION IN THE CONTEXT OF EU POLICY ... 12
4.3 ACTION PLAN FOR ORGANIC FOOD AND FARMING ... 13
4.4 RESEARCH ... 13
4.4 METHODOLOGICAL APPROACHES OF SYSTEM ORIENTED AGRICULTURAL AND FOOD RESEARCH ... 14

5 Agriculture and food production challenged by global problems and changing food trends. ... 17

5.1 SUSTAINABLE MANAGEMENT OF FINITE RESOURCES WHILE MAINTAINING GLOBAL FOOD SECURITY ... 17
5.2 SUPPLY OF HIGH QUALITY FOOD AND INCREASED TRANSPARENCY OF FOOD CHAINS ... 18

6 Organic agriculture and food production in the context of the global challenges and changing food trends ... 20

6.1 STRENGTHS OF ORGANIC AGRICULTURE ... 20
6.1.1 ENVIRONMENT AND ECOLOGY ... 20
6.1.2 SOCIO-ECONOMIC IMPACTS ... 23
6.1.3 FOOD QUALITY AND SAFETY ASPECTS ... 25
6.2 WEAKNESSES OF ORGANIC AGRICULTURE ... 27
6.2.1 PRODUCTIVITY GAP ... 27
6.2.2 GLOBAL WARMING POTENTIAL OF FOOD PRODUCTION ... 28
6.2.3 ORGANIC CERTIFICATION DOESN'T CHECK FOR ECOLOGICAL GOODS AND SERVICES 28
6.2.4 FAIRNESS TO ALL: THE HIGH PRICE OF ORGANIC FOOD ... 28

7 A vision for 2025: strategic research priorities to address the big challenges of the European and global society ... 30

7.1 ETHICAL VALUE SYSTEM FOR GUIDING TECHNOLOGY DEVELOPMENT AND INTEGRATION OF STAKEHOLDERS AND CIVIL SOCIETY INTO INNOVATION. ... 31
7.2 VIABLE CONCEPTS FOR THE EMPOWERMENT OF RURAL ECONOMIES IN A REGIONAL AND GLOBAL CONTEXT ... 33
7.3 EFFICIENT APPROACHES TO ECOLOGICAL INTENSIFICATION. ... 36
THE ECOLOGICAL CHALLENGES ... 36
7.4 HIGH QUALITY FOODS – A BASIS FOR HEALTHY DIETS AND A KEY FOR IMPROVING THE QUALITY OF LIFE ... 39
THE FOODS CHALLENGES ... 39

8 Sustainable agro-ecosystems and human well-being ... 42

1 Preface

Research is an important tool to find solutions for the key problems of the society, to develop innovation and to ensure growth, employment and competitiveness of the EU economy. Therefore, the EU sets up 'Framework programmes' (FPs) as main financial tools through which the European Union supports research and development activities covering almost all scientific disciplines. The currently running FP7 (2007 to 2013) bundles all research related EU initiatives together under a common roof in order to reach the above mentioned aims.

Organic food and farming systems are a promising and inventive way to contribute to the challenges of the EU in the area of agriculture and food production. Organic production has offered dynamically growing markets and has created employment for more than a decade now. On the other hand, it delivers public goods in terms of environmental protection, animal welfare and rural development. Furthermore, the innovation produced by the organic sector has considerably driven general agriculture and food production towards sustainability, quality and low risk technologies.

Therefore, it would be of common interest to invest into organic food research in order to improve and further develop the system of organic production. So called technology platforms have proven to be a powerful instrument to bring together a wide range of stakeholders identifying research priorities of a sector. Technology platforms are industry-led while also involving the financial world, public authorities, the research community and civil society. Their potential is well-acknowledged by the EU institutions.

There are about 30 different TPs, but so far, there is no one that deals with agriculture, in general, or with organic food and farming and public goods, in particular. This lack was pointed out even by the European Commission at the conference "TOWARDS FUTURE CHALLENGES OF AGRICULTURAL RESEARCH IN EUROPE" in Brussels, 26-27 JUNE 2007. Zoran Stančič, deputy Director General of DG Research said: “The technology platforms and the SCAR Working Groups have shown their capacity to break-down research challenges to specific fields covering the 4 Fs: Food, Feed, Fibre and Fuel. In some areas, however, we are lacking appropriate platforms, for example in public goods oriented research or organic agriculture.”

Consequently, the IFOAM EU Group, representing the organic sector, initiated in close cooperation with ISOFAR a process for drawing up a vision for innovative research activities for organic agriculture and food systems with a strong focus on providing public goods.

The first step in this endeavour was a Vision Camp held in Hagenthal-le-Bas, France, in June 2007. More than 30 farmers, processors, retailers and scientists discussed different scenarios for agriculture and food systems in the year 2025, positioned the organic industry within that context and debated concepts that would answer the big challenges of the future. The Vision Camp in France was the basis for the first draft of the Vision Paper. After an internal consultation round of the expert group, the paper was subject of a two-month public consultation, including a discussion at the IFOAM EU Organic Congress in Brussels, December 2007. This consultation was open to stakeholders outside the organic sector to ensure a transparent process and to broaden the legitimacy of the vision.

The current re-drafted 2nd version of the research vision is a result of the received input and will be open for an electronic consultation which started on March 26 and will end on April 25, 2008. A further elaborated version will be discussed at the EU stakeholder forum inMay.

Parallel to this process, a Technology Platform focussing on sustainable food systems and public goods titled 'Food, Fairness and Ecology" will be established. In addition to the IFOAM EU Group and ISOFAR, various other organisations have already committed themselves to the TP: European Environmental Bureau [EEB], the European Federation of Food, Agriculture and Tourism Trade Unions [EFFAT], the European Council of Young Farmers [CEJA] and the Foundation for Future Farming. Currently, discussions with further interested organisations are underway. The participation of the industry (processing and trade companies, machine industry) will be directly targeted.

The secretariat of the Technology Platform will be hosted at the IFOAM EU Group office in Brussels. The platform will have an official framework, a work structure and work flow. Members of the organic agriculture movement, the scientific community and the wider civil society will be asked to contribute as volunteers to the work of the TP. A research concept and a research action plan will be the final outcome of this ambitious endeavour. The platform will be officially launched in May 2008.

The Technology Platform will bundle the research priorities which have to be communicated directly to the EU institutions. It will showcase the huge innovation provided by organic food and farming research, innovation that is to the benefit of the whole European society and will help to identify research priorities.

2 Executive summary

For organic food and farming, research is one of the most important tools for its further development and spreading. It is thus important that the EU research programme is adequately supporting organic food and farming research.

This Vision Paper has been prepared on the basis of discussions and results of a Vision Camp organised by the IFOAM-EU group in France (June 2-3, 2007) and is supposed to be a starting point for the development of a long-term strategic research agenda as well as an action plan for its implementation. The fast growing organic industry is willing to better promote its specific research needs and to facilitate smart solutions for rural development, sustainable resource use as well as quality foods and healthy diets.

Organic agriculture and organic foods represent a fast growing sector of the European economy; it is one of the most promising "lead markets". The EU is in a leading position in research and knowledge transfer, in the legal and regulatory frameworks for the organic industry, in food processing, certification, trade (important as well as exports) and in consumption. In order to maintain a leading position in an innovative political and economic field, research activities are crucial.

General needs and trends in our society will considerably increase the opportunities for organic foods, especially as characteristics like ‘ecologically produced’, ‘credible’, ‘high quality’ and ‘fair’ will become more important among consumers. On the other hand, global problems such as ‘growing food demand’, ‘climate shock’, ‘energy crisis’, ‘water scarcity’, ‘unsustainable resource use, biodiversity loss and environmental degradation’ (only to name the most important ones) will challenge and change agriculture in the next 25 years.

Strengths and weaknesses of currently practiced organic food and farming are identified in this paper. Organic agriculture matches best the multifunctional goals consumer and civil society expect from agriculture. It is a very sustainable method of natural resources use with only minor environmental problems and with many positive effects on the diversity of the landscape, the farms, the fields and the species. Ethical values like welfare vis-à-vis humans and animals are high on the agenda and participation of stakeholders and individual responsibility is high along the food chain. It is especially suited to the empowerment of local economies without falling back into trade barriers. As characteristics of high quality food and reasonable eating/nutrition are inherent to organic foods (e.g. fresh or only slightly processed, authentic in terms of taste, structure, ingredients and processing aids), organic nutrition is a beacon for modern lifestyle and nutrition.

This paper developed four visions for agricultural and food research, which will bring both, the organic industry and our society forward and will considerably contribute to a sustainable European way to economic wealth and well-being of its citizens.

The vision for the future role of organic agriculture and organic food systems in the European society encompass:

> Ethical value systems for guiding technology development and integration of stakeholders and civil society into innovation.

> Viable concepts for the empowerment of rural economies in a regional and global context.

> Efficient approaches to ecological intensification.

> High quality foods – a basis for healthy diets and a key to improving the quality of life.

The nowadays concept of organic agriculture and foods already contributes to these visions. Nonetheless, research activities based on agro-ecological and socio-economic understanding and analyses, on empowering stakeholders in decentralised knowledge and expert systems, on novel and smart technologies in crop and livestock breeding, on robot, information and location technologies and on other appropriate technologies will considerably increase the relevance of organic agriculture and foods in the disruptions and instabilities European and international agriculture will face in the next decades, as a result of changing eating patterns, increased food, feed, fibre and energy crop demand, climate change and increasing malnutrition in developed and emerging economies. Many research ideas are already outlined in this paper in order to meet the vision for organic food and farming.

It is planned to use this vision paper as a source for the development of a strategic research concept and agenda which will consequently lead to a research action plan for the organic industry and research community. For this purpose, a Technology Platform ‘Food, Fairness and Ecology’ will be launched in 2008 in order to facilitate and structure the debates among the industry and the scientific community.

3 Introduction

Organic food and farming is a constantly growing sector in the EU and globally. It produces high quality foods (certification of organic foods is a EU quality scheme and well spread globally) and provides numerous others public benefits, especially those in the area of environment, management of natural resources and viability of rural areas.

Organic farming receives a high level of support in Europe; organic farmers are entitled to agri-environmental payments for implementation of their agricultural practice. This support is expressed even more importantly by the constant increase in the number of consumers that buy organic foods in spite of higher prices for organic products.

Due to the evidence for the good environmental performance of organic farming and the trust in organic foods, there are high expectations of organic farming for the future. The overall aim towards greater sustainability that is characteristic of organic farming is in line with the need for improvement of sustainability in all European agriculture. In relation to this, organic farming has a good capacity to respond to the big challenges the European Union and the world are facing today, both in the area of environment (mitigation of and adaptation to climate change, incl. water and soil management and protection) as well as in the area of food (a need for sustainable production of high quality foods), rural development and animal welfare.

Furthermore, organic production is a leading market for high quality and high value foods. Agriculture Commissioner Fischer Boel underlined on different occasions that the future of EU agriculture lies in the production of high quality food, and that quality will be the key to a strong European food sector. Here, organic food can be the spearhead and example for such kind of quality schemes in production as well in certification.

In this context it has to be considered that EU organic production competes with both conventional food and global organic food production. Therefore, its competitiveness highly depends on innovation, novel appropriate technologies and scientific evidence of its superior qualities.

A thriving, innovative organic food and farming research would be one of the most important tools for ensuring that these high expectations and opportunities can be fulfilled. Organic farming has been characterised by innovation in agricultural methods; here, the most important aspect has been the systems approach within the concept of naturalness, which is the key approach in research on organic agriculture. Many new solutions, in the form of products as well as in practices and research methodology, have been developed on the basis of this approach. Innovation is taking place also in organic food processing, where the demands for naturalness, high quality, environment friendly production and safety of foods have to be fulfilled at the same time. Yet the needs and capacities for improvement, with the help of dedicated organic food and farming research, are high and current support does not reflect them enough.

This paper is intended to show the way towards a European organic food and farming research agenda that will help to meet the big challenges of the next twenty years.

4 Current situation of organic agriculture

4.1 Organic agriculture in the EU

The growing demand of consumers for organic food and the consequent increase in organic production led to the introduction of Council Regulation (EEC) 2092/91 in 1991.

Currently, the organic industry is one of the most rapidly expanding sectors of the food industry in many European countries. Based on the data provided by Padel et al. (2008)[2] it can be assumed that, in 2006, the European organic market grew by more than 10 percent, and that it was worth approximately 14 billion €. In many established European Markets (such as Germany and the UK) demand is growing considerably faster than supply.

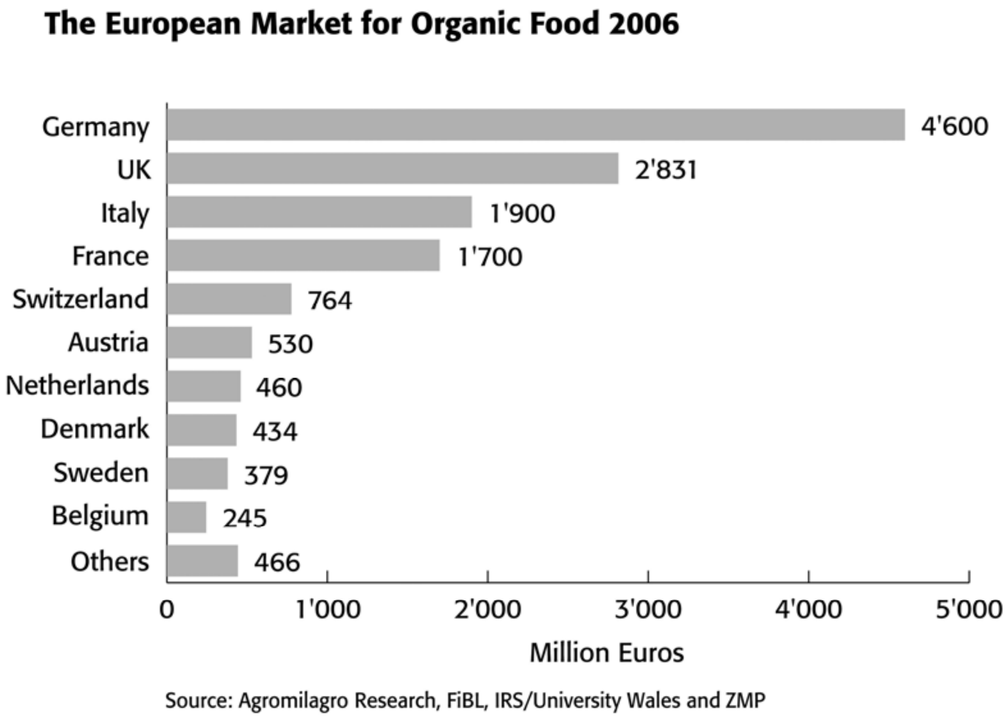


Figure 1: The European Market for Organic Food 2006 (Padel et al., 2008; Graph FiBL)

However, there are considerable differences in trends between the countries. In 2006, in most old member states, production accounted for up to 13 % of the total agricultural land[3]; more

---

[2] Susanne Padel, Aleksandra Jasinska, Markus Rippin, Diana Schaack and Helga Willer (2008): The European Market for Organic Food in 2006. In: Willer/Yussefi-Menzler and Sorensen (Eds.) (2008): The World of Organic Agriculture. Statistics and Emerging Trends 2008. IFOAM, Bonn, and FiBL, Frick

[3] Llorens Abando, Lourdes and Elisabeth Rohner-Thielen (2007) Different organic farming patterns within EU-25. An overview of the current situation= Statistics in focus, 69/2007, Eurostat, Luxemburg, Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-07-069/EN/KS-SF-07-069-EN.PDF

than 6.8 million hectares were under organic management in the EU (7.4 million hectares in the whole of Europe).

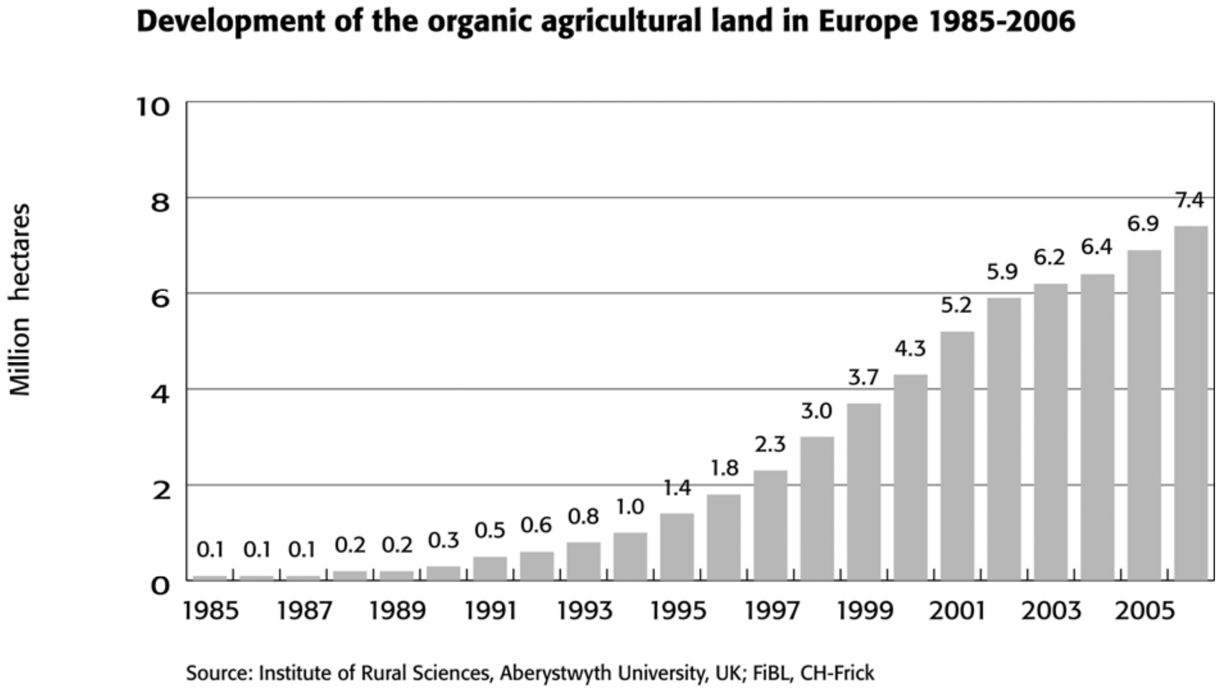


Figure 2: The development of the organic land area in Europe (Willer/Yussefi-Menzler/ Sorensen 2008; Graph FiBL)

Consumption of organic food is 4.5 to 5.5% of the total food market in countries such as Denmark, Austria and Switzerland. However, while the organic land area has also expanded rapidly in many new EU member states as well as candidate and potential EU candidate countries with annual growth rates of up to 100%[4], consumption levels have remained very low in these countries (< 1%).

Organic farming is supported in most European countries in the context of rural development programs[5]. Most EU27/EEA states have implemented area payments to support conversion to and (in most cases) continued organic production, with Bulgaria and Romania due to introduce support. However, payment rates, eligibility conditions and requirements vary considerably between countries[6]. In 2003, the average organic farming area payment was highest (€404/ha) in Greece, reflecting the then focus on high value crops, and lowest in the United Kingdom (€36/ha) reflecting low per ha payments on high areas of grassland. The EU15 av-

[4] Llorens Abando, Lourdes and Elisabeth Rohner-Thielen (2007) Different organic farming patterns within EU-25. An overview of the current situation= Statistics in focus, 69/2007, Eurostat, Luxemburg, Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-07-069/EN/KS-SF-07-069-EN.PDF

[5] Council Regulation (EC) No 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD), Available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32005R1698:EN:NOT

[6] Tuson J. und Lampkin, N. H. (2006): D2 report detailing national and regional OF policy measures in EU states and Switzerland. EUCEEOFP project deliverable to European Commission. Aberystwyth: University of Wales. Unpublished.

erage was €185/ha. In the new CEE member states, the highest level of average area payment in 2004 was provided by Lithuania (274 €/ha), followed by Slovenia with 243 €/ha. Compared with the initial year of organic farming support, the highest level of average area payment was noticed in Slovenia (226 €/ha) and the lowest level in Latvia (21 €/ha), followed by Estonia (28 €/ha), Lithuania and Poland (both 29 €/ha).

.The need for further development of the sector has led to the elaboration of a new EU Council regulation (EC) No 834/2007 on organic production and labelling of organic products that should come into force in 2009[7]. This regulation does include also principles of organic farming, to a large extent as developed by IFOAM, the International Federation of Organic Agriculture Movements.

Table 1: Organic Agriculture in the European Union 2006 (EU 27)

Country	Organic agricultural area (ha)	Share of total agricultural area	Number of Organic farms
Austria	361'487	13.03%	20'162
Belgium	29'308	2.12%	783
Bulgaria	4'692	0.17%	218
Cyprus	1'979	1.31%	305
Czech Rep.	281'535	6.61%	963
Denmark	138'079	5.33%	2'794
Estonia	72'886	8.79%	1'173
Finland	144'558	6.42%	3'966
France	552'824	2.00%	11'640
Germany	825'539	4.85%	17'557
Greece	302'256	7.59%	23'900
Hungary	122'765	2.88%	1'553 (2005)
Ireland	39'947	0.95%	1'104
Italy	1'148'162	9.04%	45'115
Latvia	175'109	9.44%	4'095
Lithuania	96'696	3.46%	2'348
Luxemburg	3'630	2.81%	72
Malta	20	0.20%	10
Netherlands	48'424	2.49%	1'448
Poland	228'009	1.55%	9'187
Portugal	269'374	7.32%	1'696
Romania	107'582	0.77%	3'033
Slovak Republic	121'461	5.76%	279
Slovenia	26'831	5.53%	1'953
Spain	926'390	3.73%	17'214
Sweden	225'385	7.06%	2'380
UK	604'571	3.79%	4'485
Total*	**6'859'499**	**3.98%**	**179'433**

[7] 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. Available at http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_189/l_18920070720en00010023.pdf

4.2 Organic production in the context of EU policy

The overarching strategy of the EU is described in the Lisbon Strategy, initiated by the Heads of State and Government in 2000 to make the European Union the most competitive and dynamic knowledge-based economy in the world by 2010, and refocused at the 2005 Spring Summit[8] on increasing growth and creating jobs. Agriculture based on sustainable organic and low external input food and farming systems can contribute significantly to achieving the aims of the Lisbon Strategy. Consumers demand foods produced in an ecological and environmentally sound way, with respect for animal welfare, and in an authentic quality. Besides, many consumers want to know where their food comes from. This food and farming concept provides great chances for economic growth and stability especially in rural areas. Though, the economic potential is not limited to farms, and also includes the whole area of tourism, services, education, crafts, trades and SMEs.

The sustainable management of biological resources is the underlying principle of European land, forest and marine management defined in many policy papers of the EU. It is, of course, the fundament of the Common Agricultural Policy, implemented in the pillar 1 and pillar 2 measures of the Community. At the Gothenburg Summit 2001, the European Council adopted the EU strategy for sustainable development and added an environmental dimension to the Lisbon process for employment, economic reform and social cohesion[9].

In July 2002, the European Community adopted the Sixth Environment Action Programme[10], which establishes the environmental priorities for the European Union for the next ten years. Within the Framework of the action programme, four priority areas for urgent action were outlined: Climate Change (1), Nature and Biodiversity (2), Environment and Health and Quality of Life (3), Natural Resources and Waste (4). The implementation of these actions includes the preparation of seven thematic strategies such us soil, sustainable use of pesticides and sustainable use of resources.

In the area of biodiversity, the EU Community committed themselves to halt the loss of biodiversity by 2010. In a follow up of the 1998 EU biodiversity strategy, the European Union reconfirmed its commitment to the 2010 target during several official meetings. In 2006, the European Commission published its Communication "Halting the Loss of Biodiversity by 2010"[11].

---

[8] Spring summit 2005, http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/84335.pdf

[9] Göteborg European Council 2001, PRESIDENCY CONCLUSIONS http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/ec/00200-r1.en1.pdf

[10] DECISION No 1600/2002/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 22 July 2002, Sixth Community Environment Action Programme, http://europa.eu.int/eurlex/pri/en/oj/dat/2002/l_242/l_24220020910en00010015.pdf

[11] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2006:0216:FIN:EN:PDF

In the beginning of 2006, the Commission adopted the "Action Plan on the Protection and Welfare of Animals 2006 to 2010"[12]. In the five main areas of actions, applied research on animal protection and welfare is highly prioritized.

4.3 Action plan for organic food and farming

In order to foster organic farming and the organic food supply chain in particular, a European Action Plan for Organic Food and Farming was established in 2004 and the specific benefits not only for the environment, but also for public health, social and rural development and animal welfare were underlined. Among the 21 actions listed, action N°7 is to 'strengthen research on organic agriculture and production methods"[13]. In the Commission Staff Working Document of June 2004, the significance of new technologies and improved information exchange and suitable technology transfer to farmers for any policy aimed at developing the organic sector was stressed. Improved vertical o-operation between science, applied research, advisory services and farmers as well as horizontal synergies between Member States were identified as approaches bringing progress. The Commission document also raised major obstacles of the processing and distribution industry where different technologies are required and expensive separation and tracking systems are needed, obstacles to be addressed by interdisciplinary food chain research activities.

4.4 Research

Research has a crucial role in further progress and spreading of organic food and farming. Until the 1980s it was mainly carried out by private research institutes. In 1982, the first universities took organic farming on their curricula, in the 1990s, the first EU-funded projects on organic farming contributed to a better co-operation of researchers on organic farming on a European level, and a growing number of national state research institutes became involved in organic farming projects.

Many national action plans include special programs for organic farming research e.g. the Federal Organic Farming Scheme (BOEL) in Germany (launched in 2002) and the Danish Research Centre for Organic Farming (DARCOF) in Denmark (running since 1996). With the ERA Net project CORE Organic the cooperation among funding agencies of research programmes has increased, and a joint call of the 11 countries involved was launched in 2006 with a common pot of at least 3 million €. The total national funding for organic food and farming research in these 11 countries was 54 million Euros in 2005.

Since the mid 1990s, several organic farming research projects have been funded under the framework programmes of the European Commission.

[12] http://europa.eu.int/comm/food/animal/welfare/com_action_plan230106_en.pdf

[13] European Commission, 2004: European Action Plan for Organic Food and Farming http://ec.europa.eu/agriculture/qual/organic/plan/comm_en.pdf

- > Under the 5th framework programme 11 organic farming projects were funded with a total sum of 15.4 million Euros (without national co-funding).
- > Under the 6th framework programme 9 organic farming projects were funded with a total sum of 22.1 million Euros (without national co-funding).
- > Under the 7th framework programme, two organic farming projects have been selected for funding in the first and second call. (a small collaborative project and a research project for SME-associations). Four new topics related to organic food and farming are listed in the calls for 2008 and 2009.

More relevant policy-related research work is also done by the Joint Research Centre (JRC).

4.4 Methodological approaches of system oriented agricultural and food research

Fundamental science and applied research are crucial drivers for improving productivity, quality, safety and sustainability of agriculture and food production. Organic agriculture makes no exception as it is **not** some kind of traditional production technique preserving a bygone era of pre-industrialised and small holder agriculture. In fact, the rationale of organic agriculture and food production is the sustainable use of natural resources and the respect for the inherent value of living beings, humans and non-humans alike[14]. Organic standards and regulations are set as a code of conduct for the actors in agriculture and food production facilitating the practicability of the rationale. They are neither conservative nor impeding scientific progress, they are updated regularly and continuous learning is inherent. Learning is triggered by insights achieved by disciplinary natural sciences, complex ecosystem research, socio-economic analyses and traditional knowledge which has made farmers competitive in local contexts for centuries. Therefore, research activities are crucial in order to fully reveal the potential of organic agriculture and food production for a sustainably organized society.

The rationale of organic agriculture and food production has also effect upon **how** research addresses problems, seeks solutions and chooses methods. **Long-term** observations of the impacts of production techniques on landscape, on agro-ecosystems and natural habitats, on farm economy and on macro-economy and society are especially sought in the organic scientific community, like in most environmental sciences. Most recent research on improving the performance and competitiveness of the organic production technique also emphasised the ecological footprints of the products, the impact on the resource use and the preference of consumers[15]. Such approaches imply a shift from a multidisciplinary to an **interdisciplinary research culture** in order to find trade-offs and to strengthen complexity and sustainability.

---

14 Jaber, D. (2000) Human Dignity and the Dignity of Creatures. Journal of Agricultural and Environmental Ethics, Volume 13, Number 1 / March 2000, Springer Netherlands, p. 29-42.

15 See e.g. the Integrated Project Improving quality and safety and reduction of costs in the European organic and “low input“ food chains funded by the Commission, associated countries and member states within the 6th Framework (www.qlif.org).

Although the majority of organic research has remained quite ‘conventional’[16], more interdisciplinary research themes have become short-listed and funded in recent programs[17]. Several long-term-comparison trials such as the DOK trial in Switzerland[18] or the Rodale trial in Pennsylvania (USA)[19] reveal substantial differences in the physical, chemical and physiological properties of the soil-ecosystems depending on the cropping and farming measures taken over longer periods. This differentiation in the soils influences considerably soil food web functioning, mineralization of nutrient elements and pathogen dynamic. Therefore, to have the ‘real’ contextual framework is crucial in organic research, otherwise specific problems cannot be solved system-alike.

Organic researchers are increasingly aiming a shift from a multidisciplinary to an interdisciplinary or **transdiciplinary research culture** in order to find trade-offs and to strengthen complexity and sustainability in how they conduct their research[20]. The core idea of transdisciplinarity is that researchers, practitioners and stakeholders cooperate in order to address complex challenges of society and find feasible solutions. It is also a method (or a group of methods) which can deal with completely different kinds of knowledge and can integrate them such as quantitative, qualitative, tacit and indigenous knowledge. Beyond question, transdisciplinary ways of research offer huge opportunities for organic food and farming.

Indigenous knowledge - which is often scarcely documented (e.g. on genotype, phenotype, site, climate and management interactions of plants or animals) – is crucial for research in ecology and sustainability. This cognisance makes the role of farmers in organic research so outstanding. Decentralised systems adapt themselves faster than centralised ones to disruption and unpredictable changes which are projected in most climate change scenarios[21]. Decentralised adaptation relies not only on a high performance information system as concluded by the Standing Committee for Agricultural Research (SCAR)[21], but also on the use of the huge tacit knowledge of farmers and the rural population.

Another aspect of transdisciplinary research is that the actors bringing scientific insight into action participate from the very beginning in the projects. On-farm research is preferred in many of the existing organic research projects or programs although it is not suitable for all questions. This makes research more relevant and efficient. Farmers as subjects interact with

16 Lockeretz, W. (2000) Organic farming research, today and tomorrow. In: Alföldi, Th., Lockeretz, W. and Niggli, U.: The world grows organic. Proceedings of the 13th IFOAM Scientific Conference in Basel, 29 – 31 August, 2000, p. 718-721. Available at: http://books.google.ch/books?id=2hdlIfMhR8UC&printsec=frontcover&source=gbs_summary_r#PPP1,M1;

17 See e.g. the German Federal Organic Farming Scheme. http://www.bundesprogramm-oekolandbau.de

18 Mäder, P, Fliessbach, A, Dubois, D, Gunst, L, Fried P. and Niggli, U. (2002) Soil fertility and biodiversity in organic farming. Science 296, p. 1694-1697.

19 Pimentel, D., Hepperly, P., Hanson, J. Douds, D., Seidel, R. (2005): Environmental, energetic, and economic comparisons of organic and conventional farming systems. BioScience 55, S.573–582

20 Thompson Klein, J.; Grossenbacher-Mansuy, W.; Häberli, R.; Bill, A.; Scholz, R.W.; Welti, M. (Eds.) (2000) Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society. An Effective Way for Managing Complexity. A Birkhäuser Book, ISBN: 978-3-7643-6248-5, 332 p.r

21 ‘Fore sighting food, rural and agrifutures’ (FFRAF 2007) available at http://ec.europa.eu/research/agriculture/scar/pdf/foresighting_food_rural_and_agri_futures.pdf

technology and change it[22]. It should also contribute towards and increased transfer of knowledge from organic to general agriculture and vice versa.

However, all research in the area of organic farming should use 'fit for purpose' methods, recognising that some problems require holistic solutions whereas for others disciplinary sciences are best suited. It has to combine work undertaken in the practical context of organic farms with rigorous science[23].

[22] Alrøe, H.F. & Kristensen, E.S. (2002) Towards a systemic research methodology in agriculture: Rethinking the role of values in science. Agriculture and Human Values 19(1), 3–23.

[23] Watson et al (2006) Review: Research in organic production systems, past, present and future. *Journal of Agricultural Sciences* 146:1-19.

5 Agriculture and food production challenged by global problems and changing food trends.

5.1 Sustainable management of finite resources while maintaining global food security

Big global challenges such as an efficient and sustainable management of finite resources (fertile soils, water, biodiversity and genetic resources, energy, clean air), climate change and land use, the need for new energy sources, the globalisation of food supply and unequal market assess, changes in eating habits away from vegetable to meat based diets, livelihood in rural areas and rural exodus and especially food security will have a major impact on the development of agricultural production and human nutrition.

The SCAR foresight study[21] emphasised with the two major scenarios "Climate Shock" and "Energy Crisis" the strong dependency and vulnerability of European agriculture from inefficient resource use and environmental impacts which could end up in a disruption of conventional production systems. The 'Millennium Ecosystems Assessment"[24], initiated by UN organisations, World Bank, many civil society organisations and private and public donors, found a "substantial and largely irreversible loss in the diversity of life on Earth" as a consequence of the "growing demands for food, fresh water, timber, fibre and fuel", a development which will "substantially diminishes the benefits that future generation obtain from ecosystems." The Millennium Ecosystems Assessment report stressed the need for significant "changes in policies, institutions and practices" in order to "reversing the degradation of ecosystems while meeting increasing demands for their services".

In this context, organic agriculture will be strongly challenged as an option to enhance specific ecosystem services, to reduce negative trade-offs of food production and to maintain a sustainable productivity. Many techniques of organic agriculture exactly address these challenges and science and farmer based innovation might make major approaches of organic agriculture relevant for European and global food production to become sustainable.

The 4th scenario of the SCAR group ("cooperation with nature") at least seems to point exactly at the beneficially symbiotic relationship behind the organic principles.

---

[24] http://www.millenniumassessment.org/en/index.aspx

5.2 Supply of high quality food and increased transparency of food chains

Premium quality, ecology, fairness, authentic taste and credibility are big trends in the worldwide food industry[25,26,27,28]. Traditionally, Europe is well positioned to meet these trends and growth potentials.

In food labelling, completely different information on quality will be required by the majority of consumers in the near future:

- > the way how food is produced and processed,
- > the extent to which the environment, natural resources, biodiversity and livestock is taken care of,
- > the way how farmers and co-operatives are organised and how fair prices are,
- > food miles, energy use and GHG emissions of food production (ecological footprints).
- > the standards used for food chain management, quality assurance and certification,
- > different aspects of food taste qualities (authenticity, local qualities like 'terroir', differentiation of tastes).

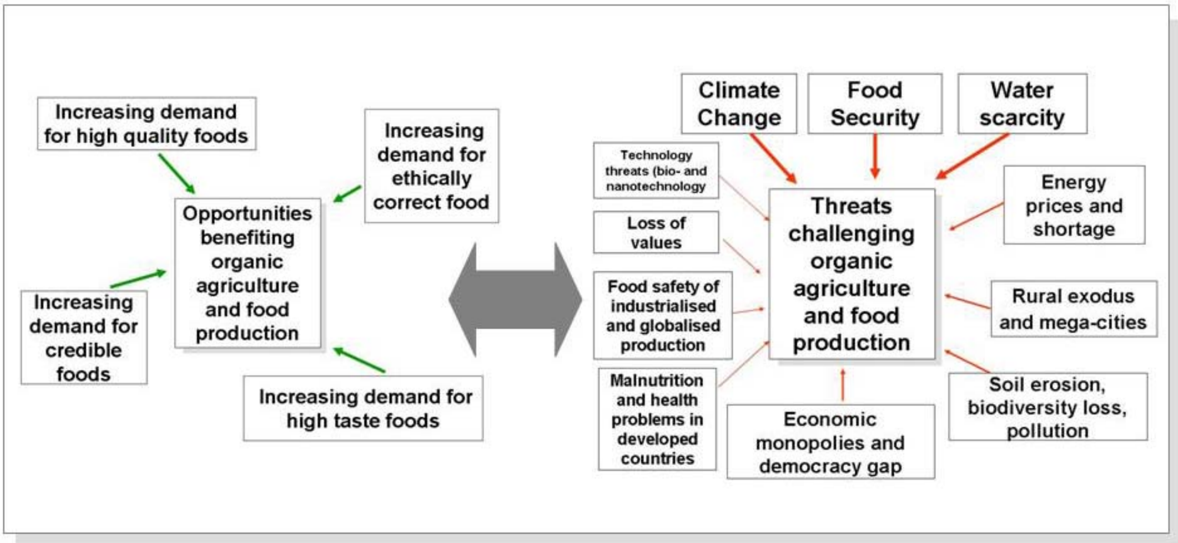


Figure 1: Future opportunities and challenges for organic agriculture and food supply chains (identified during a workshop of 30 organic agriculture experts and stakeholders in June 2007).

---

[25] CMA (2007): Trendstudie Food. Ernährungsinformation der CMA 02/2007. URL: http://www.cma.de

[26] Richter, Toralf (2008) Retailing organic food in Europe 2008: Latest trends in distribution channels and driving forces. BioFach Congress, Nuernberg, Germany, February 21 - 24, 2008.

[27] Midmore, P.; Wier, M. und Zanoli, R. (2006) Consumer attitudes towards the quality and safety of organic and low input foods. Report QLIF project. www.qlif.org

[28] Zanoli. et al (2004). The European Consumer and Organic Food OMiaRD Vol. 4. University of Wales, Aberystwyth (UK). 175p.

One of the scenarios developed in the foresight study for the Standing Committee of Agriculture Research (SCAR) in 2006 put emphasis on such changes among European consumers (see the scenario ‘We are what we eat”). This scenario highlights the advantages of research and technology which address the real needs and concerns of citizens respecting social, environmental and lifestyle processes and services.

Organic food systems are multi-functional and deliver many of the above mentioned goods and services. Therefore, the changes in consumer attitudes will offer excellent opportunities for the further growth of organic agriculture and organic food value chains. To meet these opportunities, innovation and careful progress is needed in organic food systems as well. Innovation and progress will be addressed in the strategic research agenda later in this paper.

6 Organic agriculture and food production in the context of the global challenges and changing food trends

6.1 Strengths of organic agriculture

6.1.1 Environment and ecology

Environmental and ecological benefits are among the strengths of organic farming – and the main reasons for consumers' preference for organic products. State support for organic farming in the context of agri-environmental programs is based on the evidence of environmental benefits, and the OECD does use the share of organically managed land as an indicator for the 'environment friendliness' of a country[29].

On the basis of long-term on-station comparisons (plot experiments), field and farm comparisons (pair, small and large sample comparisons) and on the basis of landscape comparisons and large-scale modelling of quantitative and qualitative data from habitats of conventional and organic farms, we have quite a comprehensive understanding of the ecological and environmental impacts of different farming systems:

Reduced pollution

Nitrogen leaching rates in organic arable fields were reduced by 35 to 65 % when compared to conventional or integrated ones (different European and US studies[30,31]). Herbicide and synthetic pesticide residues in soils, surface and ground water do not occur as their use is completely banned. In a 30-year field experiment in Switzerland, the active matter of sprayed pesticides in the organic arable crop rotation was only 10 % of that of the identical integrated and conventional crop rotations[32] (in the organic crop rotation, copper, plant extracts or biocontrol agents were used, in the integrated and conventional crop rotation herbicides and pesticides in compliance with IPM standards).

Biological and physical soil properties

Several European, US, Australian and African studies show higher organic matter content, higher biomass, higher enzyme activities, better aggregate stability, improved water infiltra-

---

[29] OECD (Organisation of economic Co-operation and Development) (2001) Environmental indicators for agriculture. Methods and results. Volume 3. OECD, Paris. Available at OECD http://www.biodiv.org/doc/reports/agro-oecd-chap-vi-en.pdf

[30] Drinkwater, L E, Wagoner, P and Sarrantonio, M (1998) Legume-based cropping systems have reduced carbon and nitrogen losses. Nature 396, 262-264.

[31] Stolze, M, Piorr, A, Häring, A and Dabbert, S (2000) The environmental impacts of organic farming in Europe. Organic farming in Europe, Volume 6, University of Stuttgart-Hohenheim, Stuttgart.

[32] Mäder, P, Fliessbach, A, Dubois, D, Gunst, L, Fried P. and Niggli, U. (2002) Soil fertility and biodiversity in organic farming. Science 296, p. 1694-1697.

tion and retention capacities and less water and wind erosion in organically managed soils when compared to conventionally ones[33,34,35,36,37,38,39.]

Most recent studies show that organic cropping with shallow ploughing is as good as no-till cropping at the prevention of soil erosion and the improvement of soil structure[40,41].

Biodiversity

Diversity is an inherent quality of organic agriculture. On farmer level, it is practised in the diversity of farm activities and in the field as diversity in the crops rotation. Organic farms cannot be operated in the long run with strongly simplified crop rotations. This is a phenomenon of conventional farms or of badly managed organic farms which usually cease to work organically after 4 or 5 years.

On field level, diversity is the result of the very specific organic fertilization, weed, disease and pest management techniques. Biodiversity is an important driving factor for the stability of agro-ecosystems[42.] The establishment of an organic production system needs to consider aspects such as landscape complexity to ensure that sufficient semi-natural landscape elements are present to serve as sources of natural enemies (e.g. planting hedges, sowing weed strips, installing beetle banks)[43]. Soil quality management (e.g. amendment with compost), tillage practices (e.g. conservation tillage), host plant resistance, crop rotation, and intercropping are important additional measures to lower risks of pest and disease outbreaks. It is therefore a crucial economic interest of organic farmers to enhance diversity on all levels because organic weed, pest and disease management would fail without a high diversity. Or-

---

[33] Edwards, S. (2007): The impact of compost use on crop yields in Tigray, Ethiopia. Institute for Sustainable Development (ISD). Proceedings of the International Conference on Organic Agriculture and Food Security. FAO, Rom. Obtainable under: ftp://ftp.fao.org/paia/organicag/ofs/02-Edwards.pdf Fliessbach, A and Mäder, P (2000) Microbial biomass and size-density fractions differ between soils of organic and conventional agricultural systems. Soil Biology & Biochemistry, 32 (6) 757-768.

[34] Fließbach, A., Oberholzer, H.-R., Gunst, L., Mäder, P. (2007): Soil organic matter and biological soil quality indicators after 21 years of organic and conventional farming. Agriculture, Ecosystems & Environment 118, 273-284.

[35] Marriott, E.E. and Wander, M.M. (2006) Total and Labile Soil Organic Matter in Organic and Conventional Farming Systems. Soil Sci. Soc. Am. J. 70, 950-959.

[36] Pimentel, D., Hepperly, P., Hanson, J. Douds, D., Seidel, R. (2005): Environmental, energetic, and economic comparisons of organic and conventional farming systems. BioScience 55, S.573–582

[37] Reganold, J, Elliott, L and Unger, Y (1987) Long-term effects of organic and conventional farming on soil erosion. Nature 330, 370-372.

[38] Reganold, J, Palmer, A, Lockhart, J and Macgregor, A (1993) Soil quality and financial performance of biodynamic and conventional farms in New Zealand. Science 260, 344-349.

[39] Siegrist, S., Staub, D., Pfiffner, L. and Mäder, P. (1998) Does organic agriculture reduce soil erodibility? The results of a long-term field study on loess in Switzerland. Agriculture, Ecosystems and Environment 69, 253-264.

[40] Teasdale, J.R., Coffman, Ch.B. and Mangum, R.W. (2007) Potential Long-Term Benefits of No-Tillage and Organic Cropping Systems for Grain Production and Soil Improvement. Agronomy Journal, VOL. 99, September – October 2007.

[41] Müller, M., Schafflützel, R., Chervet, A., Sturny, W.G., Zihlmann, U. (2007) Humusgehalte nach 11 Jahren Direktsaat und Pflug. Agrarforschung 14(09), 39.

[42] Altieri, Miguel A (1999) The ecological role of biodiversity in agroecosystems. Agriculture, Ecosystems and Environment 74, 19-31

[43] Zehnder, G., Gurr, G.M., Kühne, S., Wade, M.R., Wratten, S.D. and Wyss, E. (2007) Arthropod pest management in organic crops. Annual Review of Entomology, 52, 57-80.

ganic farming has shown to promote more species and abundance of organism groups than conventional farming[44,45], especially a greater species diversity and density of insects, plants, soil micro- and soil macro-fauna. Nonetheless, some taxa are not significantly affected[46, 47] and need special measures on organic farms as well. An over-riding determinant of biodiversity may be habitat diversity, rather than management practices.[48]

The potential of genetic diversity on crop level for stabilization of low input farming systems and for adaptation to environmental changes is theoretically understood but far from being practically used. Kotschi (2006) considered the genetic diversity of crops as a fundamental resource for adaptation and therefore crucial for the stability of food supply. As the resistance or robustness to environmental stress is a multi-genetic characteristics, the in situ conservation and on farm breeding is likely to be more successful than genetic engineering. There are many very small initiatives of plant and animal breeders in the context of organic farms all scattered around the world. These initiatives urgently need political, scientific and economic support.

Climate change

Organic farming techniques such as shallow ploughing, recycling of livestock manure onto arable cropland, composting techniques, integration of green manure, catch crops and cover crops as well as diversified crop sequences reduce soil erosion considerably and lead to increased formation of soil humus. Compared to stockless conventional systems, annual sequestrations rates between 400 kg and almost one ton of CO_2 per hectare have been measured.[49,50]

Higher soil organic matter contents as well as higher diversity on landscape, farm, field, crop and species level might help organic farmers to better adapt to locally and globally more unpredictable weather conditions.

The ban of nitrogen from fossil fuel and it's replacement by leguminous and organic nitrogen reduces $C0_2$ emissions considerably.

---

[44] Hole D.G., Perkins, A.J., Wilson, J.D., Alexander, I.H., Grice, P.V. and Evans, A.D. (2005) Does organic farming benefit biodiversity? Biological Conservation 122, 113-130.

[45] Bengtsson, J., Ahnström, J. and Weibull, A.-C. (2005) The effects of organic agriculture on biodiversity and abundance: a meta-analysis. Journal of Applied Ecology, 42, 261–269.

[46] Fuller, R.J., Norton, L.R., Feber, R.E., Johnson, P.J., Chamberlain, D.E., Joys, A.C., Mathews F., Stuart, R.C., Townsend, M.C., Manley, W.J., Wolfe, M.S., Macdonald, D.W and Firbank, L.G. (2005) Benefits of organic farming to biodiversity vary among taxa. Biology letters, 1, 431-434.

[47] Gabriel D and T Tscharntke. 2007. Insect pollinated plants benefit from organic farming. Agriculture, Ecosystems and Environment, 118, p 43-48.

[48] Weibull, A.-C., Östman, Ö. & Granquist, Å. (2003) Species richness in agroecosystems: the effect of landscape, habitat and farm management. Biodiversity and Conservation, 12, 1335–1355.

[49] Mäder, P, Fliessbach, A, Dubois, D, Gunst, L, Fried P. and Niggli, U. (2002) Soil fertility and biodiversity in organic farming. Science 296, p. 1694-1697.

[50] Pimentel, D., Hepperly, P., Hanson, J. Douds, D., Seidel, R. (2005): Environmental, energetic, and economic comparisons of organic and conventional farming systems. BioScience 55, S.573–582.

Water shortage

In organic farming, water use is likely to be more sustainable due to better rain infiltration and higher water retention rates[51,52.] In the Rodale experiment in Pennsylvania e.g., corn and soybean yields where highest in the organic plots in dry years. In a broad acre experiment in the province of Tigray in Ethiopia with several thousand farmers, yields could be increased through composting and organic farming mainly thanks to better water conservation capacities[53].

Fossil fuel shortage

Basically, organic agriculture is one of the few approaches to food production which strives for independency from fossil energy. Globally, 90 million tons of fossil nitrogen[54] or approx. 90 million tons of fuel (1 % of the global consumption) could be spared by a conversion to organic agriculture. In addition, many organic farms replaced fuel for tractors by agro-diesels.

6.1.2 Socio-economic impacts

Farm economy

On average profits of organic farms lay in the range of +/- 20% of the profits of the respective conventional reference farms[55]. Relative profits may vary substantially among farm types and regions. Particularly high profits can usually be found on mixed farms, whereas organic pig and intensive cattle fattening farms in particular are often less profitable under organic management due to high feeding costs and possible changes in the housing system[56,57].

Impact assessment of the 2003 CAP reform or other decoupling policies on the financial performance of organic farms indicate that that recent agricultural policy changes have been beneficial for organic farms[58,59,60].

---

[51] Siegrist, S., Staub, D., Pfiffner, L. and Mäder, P. (1998) Does organic agriculture reduce soil erodibility? The results of a long-term field study on loess in Switzerland. Agriculture, Ecosystems and Environment 69, 253-264.

[52] Lotter, D., Seidel, R. & Liebhardt, W. (2003): The Performance of Organic and Conventional Cropping Systems in an Extreme Climate Year. American Journal of Alternative Agriculture 18(3): 146-154.

[53] Edwards, S. (2007) The impact of compost use on crop yields in Tigray, Ethiopia. Institute for Sustainable Development (ISD). Proceedings of the International Conference on Organic Agriculture and Food Security. FAO, Rom. Obtainable under: ftp://ftp.fao.org/paia/organicag/ofs/02-Edwards.pdf

[54] IFA (2007) http://www.fertilizer.org/ifa/.

[55] Offermann, F. and H. Nieberg (2000) Economic performance of organic farms in Europe. University of Hohenheim, Stuttgart.

[56] Nieberg, H., F. Offermann and K. Zander (2007) Organic Farms in a Changing Policy Environment: Impact of Support Payments, EU-Enlargement and Luxembourg Reform. Organic Farming in Europe: Economics and Policy, Vol. 13. University of Hohenheim, Stuttgart.

[57] Jackson, A. and N. Lampkin (2005) Organic farm incomes in England and Wales 2003/04. Report, Institute of Rural Sciences, University of Wales Aberystwyth.

[58] Nieberg, H., F. Offermann and K. Zander 2007. Organic Farms in a Changing Policy Environment: Impact of Support Payments, EU-Enlargement and Luxembourg Reform. Organic Farming in Europe: Economics and Policy, Vol. 13. University of Hohenheim, Stuttgart.

The determinants of absolute profits are generally very similar to those of conventional agriculture[61]. Differences in yields, producer prices, total amount of direct payments received, variable and labour costs are most commonly mentioned as factors determining the differences in the financial performance of organic and non-organic farms[62,51,56].

Social impact

Higher demand for labour in organic farming generates more employment per farm[63,64]. This effect is often found to be associated with high value enterprises (e.g. horticulture) and/or on-farm retailing / processing[51,65].

There is some contested evidence that organic farming can enhance job satisfaction and happiness for farmer, family and workers. Organic farms may rely less on migrant labour but there is no requirement for or guarantee of this. Occupational health may be improved due to reduced exposure to agricultural chemicals, but this may be offset by effects of manual labour[61,66,67].

Organic farmers are younger, more educated, have a broader range of skills and engage in knowledge transfer activities. More women are engaged in organic farming and food[60,68,69,70].

Returns to labour on organic farms are similar or higher, where premium prices and support payments are high enough to compensate for reduced output and receipt of Pillar 1 payments.

---

[59] Schmid, E. and Sinabell, F. (2007) Modelling Organic Farming at Sector Level. An Application to the Reformed CAP in Austria . WIFO Working Papers, No.288. Österreichisches Institut für Wirtschaftsforschung, Vienna.

[60] Sanders, J. (2007) Economic impact of agricultural liberalisation policies on organic farming in Switzerland. Aberystwyth University. Aberystwyth.

[61] Fowler, S., S. Padel, N. Lampkin, H. McCalman and P. Midmore (1999) Factors affecting the profitability of organic farms. Aberystwyth: UWA, Institute of Rural Studies.

[62] Schulze Pals, L. (1994) Ökonomische Analyse der Umstellung auf ökologischen Landbau. Eine empirische Untersuchung des Umstellungsverlaufes im Rahmen des EG Extensivierungsprogramms. Landwirtschaftsverlag, Münster.

[63] Morison, D., R. Hine, and J.N. Pretty (2005) Survey and analysis of labour on organic farms in the UK and Republic of Ireland. International Journal of Agricultural Sustainability 3(1), 24-43.

[64] Lobley, M., M. Reed, A. Butler, P. Courtney and M. Warren (2005) The Impact of Organic Farming on the Rural Economy in England. University of Exeter. Centre for Rural Research, Exeter.

[65] Jansen, K. (2000) Labour, livelihoods, and the quality of life in organic agriculture. Biological Agriculture and Horticulture, 17 (3), 247-278.

[66] Shreck, A., C. Getz, and G. Feenstra 2006. Social sustainability, farm labor, and organic agriculture: Findings from an exploratory analysis. Agriculture and Human Values, 23 (4), p. 439-449.

[67] Cross, P., R.T. Edwards, B. Hounsome, and G. Edwards-Jones 2008. Comparative assessment of migrant farm worker health in conventional and organic horticultural systems in the United Kingdom. Science of the Total Environment, 391 55 - 65.

[68] Koesling, M., M. Ebbesvik, G. Lien, O. Flaten, P.S. Valle, and H. Arntzen 2004. Risk and Risk Management in Organic and Conventional Cash Crop Farming in Norway. Acta Agriculturæ Scandinavica Section C - Food Economics, 1 (4), 195-206.

[69] Schäfer, M. (Ed.) 2007. Zukunftsfähiger Wohlstand - der Beitrag der ökologischen Land- und Ernährungswirtschaft zu Lebensqualität und nachhaltiger Entwicklung, Marburg: Metropolis Verlag.

[70] Padel, S. 2001. Conversion to organic farming: a typical example of the diffusion of an innovation. Sociologia Ruralis, 41 (1), p. 40-61.

The combination of similar or fhigher incomes and employment contributes to rural economic development, which may be strengthened by added value activities such as direct marketing, processing and tourism, particularly if linked to organic food production. Higher farm incomes and positive farm development perspective can results in strengthening of the agricultural role for rural development[60,71],[72].

Organic farming initiatives can have a catalyzing effect for innovation in rural development[73,65,74]. There is anecdotal evidence that organic farming generally contribute to the quality of life in rural areas, diversification, strengthening of regional identity, landscape, cultural heritage and fosters links to rural tourism[75].

6.1.3 Food quality and safety aspects

Generally, consumer attribute positive qualities and characteristics to organic foods such as healthy, tasty, authentic, 'live up to its promise", local, highly diverse, fresh, low in the processing degree, whole food, natural, free from pesticides, antibiotics and GMO, low in nitrate contents, safe and certified and these are often interwoven with expectations of the production process, such as environmental impact or animal welfare[76]. This positive cognition is global and - although not backed up by real buying and eating behaviour – an asset for a further development of sustainable agriculture and food systems.

Several meta-studies[77a-h] confirm many of these quality claims. These meta-studies are coincident on organic products from plant origin concerning the following qualities[78]:

---

[71] Darnhofer, I. (2005) Organic Farming and Rural Development: Some Evidence from Austria. Sociologia Ruralis, p. 308-323 (4).

[72] Jackson, A. and N. Lampkin 2005. Organic farm incomes in England and Wales 2003/04. Report, Institute of Rural Sciences, University of Wales Aberystwyth.

[73] Schmid, O., J. Sanders, and P. Midmore (Eds.) 2004. Organic Marketing Initiatives and Rural Development, School of Management and Business, Aberystwyth.

[74] Hassink, J. and M. van Dijk, M. van (eds.) 2006. Farming for Health - Green-Care Farming Across Europe and the United States of America. Wageningen UR Frontis Series , Vol. 13, Springer.

[75] Brunori G. and A. Rossi 2000. Synergy and coherence through collective action: some insights from wine routes in Tuscany, Sociologia Ruralis, num. 4, Vol. 40, p. 409.

[76] Zanoli Zanoli, R. (Ed.) 2004. The European Consumer and Organic Food, Aberystwyth School of Management and Business, University of Wales.

[77a] Tauscher, B., G. Brack, G. Flachowsky, M. Henning, U. Köpke, A. Meier-Ploeger, K. Münzing, U. Niggli, K. Pabst, G. Rahmann, C. Willhöft & E. Mayer-Miebach (Koordination) (2003): Bewertung von Lebensmitteln verschiedener Produktionsverfahren, Statusbericht 2003. Senatsarbeitsgruppe «Qualitative Bewertung von Lebensmitteln aus alternativer und konventioneller Produktion», http://www.bmvel-forschung.de

[b] Velimirov, A. & W. Müller (2003): Die Qualität biologisch erzeugter Lebensmittel. Umfassende Literaturrecherche zur Ermittlung potenzieller Vorteile biologisch erzeugter Lebensmittel. Im Auftrag von BIO ERNTE AUSTRIA – Niederösterreich/Wien

[c] Heaton, S. (2001): Organic farming, food quality and human health. A review of the evidence. Soil Association, Bristol, Great Britain, 87 S.

[d] Woese, K., D. Lange, C. Boess & K.W. Bögl (1997): A comparison of organically and conventionally grown foods – results of a review of the relevant literature. Journal of the Science of Food and Agriculture 74: 281-293

[e] Worthington, V. (1998): Effect of agricultural methods on nutritional quality: A comparison of organic with conventional crops. Alternative Therapies 4, (1): 58-69

> Organic plant products contain markedly fewer value-reducing constituents (pesticides, nitrate); this enhances their physiological nutritional value.

> Organic plant products are just as safe as conventional products as regards pathogenic microorganisms (mycotoxins, coli bacteria).

> Organic plant products tend to have a higher vitamin C contents.

> Organic plant products tend to have higher than average scores for taste.

> Organic plant products have a higher content of health-promoting secondary plant compounds.

> Organic plant products tend to have lower protein contents.

Health claims are generally not substantiated by scientific research, even in cases where the organic production system provides inherent nutritional advantages (e.g. higher contents of bioactive compounds in fruits and vegetables [secondary metabolites[79,80,81,82,83,84,85,86,87,

---

[f] Alföldi, T., R. Bickel & F. Weibel (1998): Vergleichende Qualitätsuntersuchungen zwischen biologisch und konventionell angebauten Produkten: Eine kritische Betrachtung der Forschungsarbeiten zwischen 1993 und 1998. Interner Bericht, 32 S.

[g] Bourn D. & J. Prescott (2002): A comparison of the nutritional value, sensory qualities and food safety of organically and conventionally produced foods. Critical Reviews in Food Science and Nutrition 42 (1): 1-34

[h] Afssa (Agence Française de Sécurité Sanitaire des Aliments) (2003): Evaluation nutritionnelle et sanitaire des aliments issus de l'agriculture biologique. 236 S., http://www.afssa.fr (/publications/autre rapports/agriculture biologique).

[78] Summarized in Alföldi, Th., Granado, J., Kieffer, E., Kretzschmar, U, Morgner, M., Niggli, U., Schädeli, A., Speiser, B., Weibel, F and Wyss, G. (2006) Quality and Safety of Organic Products. Food systems compared. FiBL-Dossier N° 4, 24 pages, ISBN 978-3-906081-89-2.

[79] Weibel, F.P., R. Bickel, S. Leuthold & T. Alföldi (2000): Are organically grown apples tastier and healthier? A comparative field study using conventional and alternative methods to measure fruit quality. Acta Hort., 517(ISHS), 417-426.

[80] Brandt, K. & J.P. Mølgaard (2001): Organic agriculture: does it enhance or reduce the nutritional value of plant foods? Journal of the Science of Food and Agriculture 81: 924-931.

[81] Asami, D.K., Y.-J. Hong, D.M. Barrett & A.E. Mitchell (2003): Comparison of the total phenolic and ascorbic acid content of freeze-dried and air-dried marionberry, strawberry, and corn grown using conventional, organic, and sustainable agricultural practices. Journal of Agricultural and Food Chemistry 51: 1237-1241.

[82] Levite, D., M. Adrian & L. Tamm (2000): Preliminary results on contents of resveratrol in wine of organic and conventional vineyards. Proceedings of the 6^{th} International Congress on Organic Viticulture. Basel: 256-257

[83] Finotti, E., M. Antonelli, C. Beye, A. Bertone & G. Quaglia (2000): Capacita antiossidante di frutta da Agricultura biologica e convenzionale.

[84] Carbonaro M., M. Matterra, S. Nicoli, P. Bergamo & M. Cappelloni (2002): Modulation of antioxydant compounds in organic vs. conventional fruit (peach, Prunus persica L., and pear, Pyrus communis L.). J. Agric. Food Chem., 50 (19), 5458-62

[85] Hamouz, K., J. Lachmann, B. Vokal & V. Pivec (1999a): Influence of environmental conditions and way of cultivation on the polyphenol and ascorbic acid content in potatoe tubers. Rostlinna Vyroba 45 (7): 293-298. Hamouz, K., J. Cepl, B. Vokal, & J. Lachman (1999b): Influence of locality and way of cultivation on the nitrate and glycoalkaloid content in potato tubers. Rostlinna Vyroba 45 (11): 495-501.

[86] Ren H., H. Bao, H. Endo & T. Hayashi (2001): Antioxidative and antimicrobial activities and flavonoid contents of organically cultivated vegetables. Nippon Shokuhin Kagaku Kaishi, 48(4): 246-252.

[87] Adam, S. (2002): Vergleich des Gehaltes an Glucoraphanin in Broccoli aus konventionellem und aus ökologischem Anbau. Bundesforschungsanstalt für Ernährung (Hrsg.), Jahresbericht 2001.

[,88,89,90], or higher contents of fat-soluble vitamins or poly-unsaturated fatty acids in organic milk or meat[91,92,93,94]).

6.2 Weaknesses of organic agriculture

6.2.1 Productivity gap

Critics of organic agriculture emphasis the low productivity of organic agriculture, thus counteracting positive impacts of this method on the environment, on biodiversity and on climate change mitigation[95].

Recent meta-studies show that the productivity gap is widely overestimated. Under intensive production on favourite site and climate conditions, the organic agriculture yields vary between 60 and 90 % of conventional ones[96,97]. On marginal soils and unfavourable climate conditions, under permanent or temporary water stress and generally in subsistence agriculture, organic agriculture enhances food productivity considerably[98,99,100]. In fact, organic agriculture is a very productive form of agriculture pursuing consequently agro-ecological intensification strategies in order to increase and safeguard yields. The Green Revolution, although very effective at yield increase, was accompanied by tremendous negative impacts on the

---

[88] Gutierrez F., T. Arnaud T. & M.A. Albi (1999): Influence of ecological cultivation on virgin olive oil quality. JAOCS, 76: 617-621.

[89] Weibel, F., D. Treutter, A. Häseli & U. Graf (2004): Sensory and Health-related Quality of Organic Apples: A comparative Field Study over three Years using Conventional and Holistic Methods to Assess Fruit Quality. ECO-FRUIT; 11th International Conference on Cultivation Technique and Phytopathological Problems in Organic Fruit-Growing, LVWO, Weinsberg/Germany, Feb. 3-5, 185-195

[90] Tinttunen, S. and Lehtonen, P. (2001) Distinguishing organic wines from normal wines on the basis of concentrations of pgenolic compounds and spectral data. European Food Research and Technology 212, 390-394

[91] Jahreis, G., J. Fritsche & H. Steinhart (1997): Conjugated linoleic acid in milk fat: high variation depending on production system. Nutrition Research 17: 1479-1484.

[92] French, P., C. Stanton, F. Lawless, E.G. O'Riordan, F.J. Monahan, P.J. Caffrey & A.P. Moloney (2000): Fatty acid composition, including conjugated linoleic acid, of intramuscular fat from steers offered grazed grass, grass silage, or concentrate-based diets. Journal of Animal Science 78: 2849-2855

[93] Dewhurst, R.J., W.J. Fisher, J.K.S. Tweed & R.J. Wilkins (2003): Comparison of grass and legume silages for milk production. 1. Production responses with different levels of concentrate. Journal of Dairy Science 86: 2598-2611.

[94] Bergamo, P., E. Fedele, L. Iannibelli & G. Marzillo (2003): Fat-soluble vitamin contents and fatty acid composition in organic and conventional Italian dairy products. Food Chemistry 82: 625-631

[95] The Economist (2006) Good Food? Why ethical shopping harms the world. December 9th – 15th.

[96] Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Jahi Chappell, M., Avilés-Vázquez, K., Samulon, A. and Perfecto, I. (2007): Organic agriculture and the global food supply. Renewable Agriculture and Food Systems: 22(2); 86-108.

[97] Nieberg (2003) reference missing

[98] Pretty, J., Morison, J.I.L. and Hine, R.E. (2003) Reducing food poverty by increasing agricultural sustainability in developing countries. Agriculture, Ecosystems and Environment 95, 217-234.

[99] Edwards, S. (2007): The impact of compost use on crop yields in Tigray, Ethiopia. Institute for Sustainable Development (ISD). Proceedings of the International Conference on Organic Agriculture and Food Security. FAO, Rom. Obtainable under: ftp://ftp.fao.org/paia/organicag/ofs/02-Edwards.pdf

[100] Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Jahi Chappell, M., Avilés-Vázquez, K., Samulon, A. and Perfecto, I. (2007): Organic agriculture and the global food supply. Renewable Agriculture and Food Systems: 22(2); 86-108.

quality and magnitude of ecosystem services (fertile soils, biodiversity, water)[101], services which form the basis of future productivity. This decline hasn't been stopped yet in modern agriculture.

Organic agriculture bears a tremendous potential for further ecological intensification, beyond current standard setting and certification procedures. These potentials will be targeted in this research vision.

6.2.2 Global warming potential of food production

Difficult crops under high input conditions such as potatoes, rape seeds, some vegetables, grapevines etc. are not efficient enough protected against epidemic diseases by existing organic prevention and control measures. These crops, or more precisely the currently used varieties, have a higher global warming potential (GWP) per yield than conventional ones.

There are conflicting goals between animal ethology (e.g. free range systems for ruminants) and the reduction of methane emissions.

Restrictions of artificial inputs intended to safeguard the authenticity, the naturalness or the high quality of foods (e.g. synthetic amino-acids in animal feeds, genetically modified and optimised enzymes in food processing) might counteract very efficient energy utilization.

6.2.3 Organic certification doesn't check for ecological goods and services

Originally, organic food and farming was designed on the ban of technologies and substances hazardous in the environment, and the associated acute, subacute, and chronic health effects. Production and processing standards and the corresponding certification system effectively guarantee these qualities. Although the scientific evidence for many societal benefits of organic farming is overwhelming, these benefits are not assessed with indicators during the certification. The more specific problems the society wants agriculture to resolve, e.g. sequestration of CO_2 into soils, reduction of GHG during production, the promotion of birds and wildlife, the more important is an advanced certification systems using appropriate indicators.

This lack of indicators in the organic certification is also a weak point for claims on the analytical quality (desirable and undesirable compounds), nutritional value (like bioactive compounds etc.) and taste, freshness and careful processing. These qualities are often there but can not be guaranteed to the consumers.

6.2.4 Fairness to all: the high price of organic food

Higher farm prices are essential to main farm incomes but they can result in higher consumer prices, although supply/demand factors and supply chain efficiencies are also relevant. This can raise questions of affordability for low income households, but when seen in context of declining real prices for food (in real terms food prices fell by 75% between 1974 and

[101] http://www.millenniumassessment.org/en/index.aspx

2005[102]), in real terms current organic prices are comparable to conventional prices in recent decades, while overall incomes have risen.

IFOAM standards include social concerns, but there also is a paucity of social considerations in most organic standards[103]. Such ideals are strengthened where they are combined with Fair trade certification = the organic fair trade combination is often found on products from developing countries.

[102] http://www.economist.com/opinion/displaystory.cfm?story_id=10252015

[103] Lockie, S., Lyons, K., Lawrence, G. and Halpin, D. 2006. Going Organic. Mobilizing Networks for Environmentally Responsible Food Production. Wallingford: CABI Publishing.

7 A vision for 2025: strategic research priorities to address the big challenges of the European and global society.

So far, research projects and national framework programmes on organic agriculture have addressed technology gaps in organic agriculture and food production. This has been politically expedient and brought more producers and professional skills in order to satisfy unexpectedly fast growing consumer-driven markets.

In contrast, this paper raises a long-term perspective on sustainable food and farming practices based on i) the principles of organic agriculture, ii) scientific innovation and iii) best integration of indigenous knowledge of farmers.

The strategic research priorities particularly focuses on the inconsistencies between economy, ecology and social cohesion/harmony inherent in most concepts for sustainable agriculture and food production and proposes research activities and insightful learning concepts far beyond niches.

Agricultural and food research are systems sciences, predominantly applying interdisciplinary and trans-disciplinary methods and pursuing and learning from long-term impacts in complex contexts. These methodological specifications hold together the different dimensions of the strategic research agenda outlined on the following pages.

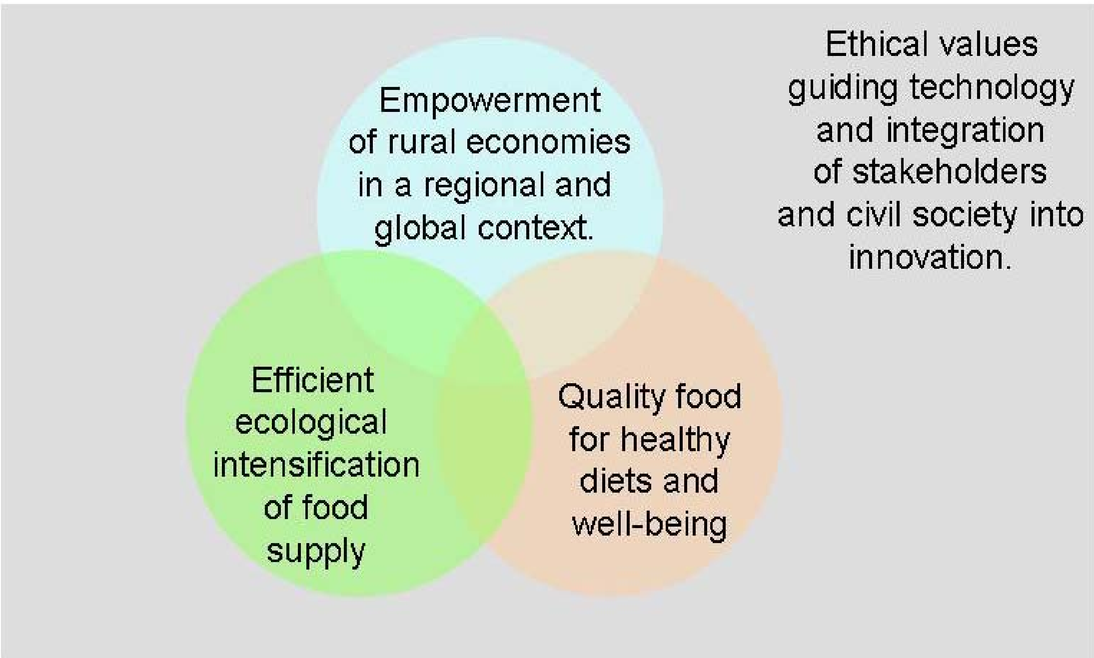


Figure 6: Vision for 2025: Strategic research priorities for food and farming research.

7.1 Ethical value system for guiding technology development and integration of stakeholders and civil society into innovation.

The societal challenges

The magnitude and diversity of problems and challenges outlined by foresight studies and various future scenarios (see chapter 5) indicate that agriculture and food production are based on distinctive ethical value systems and that scientific and economic feasibility is only one part contributing to societal decision making. This is especially true for rural development and decentralised food production, the quality of the landscape, the conservation of natural and agro-biodiversity, the sustainable use of natural resources as well as fair trade, green jobs and animal welfare.

Organic agriculture is strongly based on an ethical value system which is described by the underlying principles of health, ecology, fairness and care[104]. This value system provides a unique basis for developing complex assessment and decision tools and for modelling future sustainable food and farming systems in a practical context where stakeholders along the whole food chain can participate and where civil society is strongly involved into technology development and innovation.

Such assessment and decision tools also help organic agriculture to gain momentum in a science driven environment.

The competitive advantages of organic and sustainable agriculture and food production to address the societal challenges

The way how technology development and innovation in organic agriculture and food production is approached is characterised by a combination of unique (but not exclusive) features:

- Long-term effects of technology, innovation and human impacts in agro-ecological systems and socio-economic contexts are considered.
- The active participation of stakeholders, especially at farm level, is characterised by decentralised patterns of responsibility and decision making.
- The flow of information along the food chain and the effective management of knowledge, including tacit or indigenous knowledge, are high.
- The collective understanding for ecological circuits, finite resources and precaution as a principle in technology assessments is high.

[104] http://www.ifoam.org/about_ifoam/principles/index.html

Examples for research ideas:

- Development of suitable tools on how to best include ethical reflections and dialogue in decision-making.
- Identification of procedures on how ethical values and principles can be better operationalised in setting rules in the regulatory framework.
- Development of approaches how to successfully integrate people (farmers, industry, consumers, civil society) in the research programmes using participatory and action research methodology.
- Assessing novel technologies in the context of sustainable production and processing systems (marker assisted breeding techniques, nano-particles on inert surfaces in processing units *etc.*). Such assessments allow for the reduction of hazards to a minimum in complex natural, semi-natural and agro-ecological systems.
- Developing appropriate technologies that will be readapted to people and resilient to human error instead of training people to adequately respond to imposed technologies.
- Developing appropriate livestock technologies and practices that foster welfare and allow for ethological functions of farm animals while at the same time minimises environmental impacts.
- Adapting and optimizing information technologies along sustainable food supply chains in order to improve knowledge access and transfer.
- Transition management: learning and knowledge exchange in complex agricultural and food systems.
- Developing appropriate indicators and procedures in certification systems to monitor the delivery of public goods?

7.2 Viable concepts for the empowerment of rural economies in a regional and global context

The socio-economic challenges

The empowerment of local economies will be an important trend for European agriculture and food production and this may be linked with regional food chains (as opposed to or better in addition to the increased globalisation of food chains). Empowerment can be described as *"a critical integrating mechanism for bringing together the social, economic and institutional construction of power, both in and through rural (as well as urban) spaces. This is cross-cutting both vertically through supply chains and laterally through community and institutional interfaces"*[105]. Such an empowerment will concern both the producer and the consumer ends of the supply chain, both of which have been increasingly excluded from the active design of the food supply system.

Locally produced raw materials with specific qualities like 'terroir' and 'authenticity' will increase the diversity of European food in a considerable way (or will tie on the traditionally high diversity with cutting-edge technology) and will make the European agriculture, the food production and the tourism very competitive. Wellness, high quality food, locally processed foods from traditional recipes and geographical denomination will create jobs and wealth in rural areas and will add to their attractiveness. Local agriculture and foods will remain or again become essential for the culinary culture and the well-being of European citizens and will provide more direct relationship with consumers. New forms of cooperation, learning and negotiation will be developed, which build on and contribute to the participatory and value based research and development activities described under 7.1.

As a result, small and medium farm operations as well as producers from climatically, site-specifically or logistically less favourable regions will be able to find markets. This production will be taken up by innovative small and medium enterprises and will allow a considerable local economic value added. Specialised types of production may benefit from close collaboration and thus create synergy between the advantages of specialisation and benefits of diverse crop rotations in mixed productions. This will increase the diversity of foods.

Moreover, a diversification into multifunctional livelihoods and creation of green jobs will be an alternative and an additional value to the production of bulk commodities – conventional as well as organic ones - on the global market. The stakeholders participating in boosting local agriculture and food production will remarkably contribute to other sectors of the economy and to public services. An empowered agricultural sector will furthermore strengthen the local identity that radiates from the region. This, in turn promotes ecotourism, and rural areas will become very attractive for week-end commuters (and second-home city dwellers). This may again create potential for green jobs servicing the non-farming community.

---

[105] Marsden, T. (2004) The Quest for Ecological Modernisation: Re-spacing rural development and Agri-food Studies. Sociologia Ruralis, Vol 44, Number 2, April 2004.

The competitive advantages of organic and sustainable agriculture and food production to address the socio-economic challenges

In this growing trend towards an empowerment of local economies, organic agriculture will play an important role. It is a low-risk and high-value agriculture with an excellent tracking and tracing system and its principles and added value are easy to communicate to other actors and partners in rural areas.

Parallel to the strengthening of rural economies, agricultural activities in urban and suburban environments and contexts will become more important, either as learning and demonstration activities (farms and livestock holdings as ‘outdoor’ classrooms, farmers as experts for sustainability, nature and rural life) or as commercial activities (self-picking, urban agriculture and gardening). Such urban or peri-urban agriculture will be organic or nearly organic with closed nutrient cycles, ecologically improved habitats, biological plant protection, composting or free-range husbandry systems.

The specific techniques of organic agriculture and food production, especially low input fertilization and pest management, diversified crop rotation and farm activities, higher genetic diversity of crops and livestock as well as its specific processing methods (traditional, minimal and careful), enhance qualities like ‘authenticity’ and ‘terroir’ and tend to positively influence taste and sensory quality[84].

Organic and sustainable farming are a highly knowledge-based agriculture – high tech knowledge as well as indigenous - and are based upon the aptitude for autonomic decision making. These are crucial skills in locally complex contexts and in food scenarios characterized by unpredictability and disruption[21].

Organic and sustainable farming have taken up very early multifunctionality and have considerably influenced mainstream agriculture and food production due to partial improvements of quality and added-value characteristics (e.g. integrated farming, functional foods with scientifically substantiated health claims, very focussed ecological programs like no tillage agriculture, free-range programs for livestock, programs for the reduction of CO_2 emissions, conservation programs for birds and wildlife in conventional environments). This forerunner and pioneer role is very fruitful for the society and helps to adjust technology development and innovation. As conflicts will become bigger and trade-offs more difficult in agriculture and food production, truly multifunctional approaches as organic farming will offer relevant solutions or will be at least exiting learning fields

Examples for research ideas:

> Development of methods for assessing food systems in relation to the core principles of organic agriculture (health, ecology, fairness and care).

- Development of models for new economic and social forms of cooperation such as CSA (community-supported agriculture), local box-schemes, regional food webs, etc.
- Ecological, economic and social comparisons of models of regional co-operation and competition in agriculture.
- Potentials and consequences of localised and regionalised food systems including assessments of differences in diets and degree of satisfying consumers' demands across seasons.
- Creating a space for dialogue between all stakeholders such as consumers, producers, processors and other agents in the food supply chain.
- Assessing the social and economic implications of different models for fair trade.
- Development of localised and renewable energy production in rural areas including sustainability assessments of technology and social, economic and environmental impacts.
- Innovative forms of learning through communication and collaboration in global networks of actors in regionalised and local food chains.
- Methods for improved communication and sharing of values in global and long-distance food chains on the basis of negotiation between equal partners.
- Economical and social implications of different types of multifunctional livelihoods combining organic farming with green jobs related to nature protection, guiding, training in gardening etc.
- Documentation of social and economic impact on local and regional levels from different types of regionalised versus global food chains including quantification of the externalities.
- Assessing social sustainability, working quality and quality of life of supply chain actors.
- Modelling of different scenarios for Europe, such as high quality organic food, mass production of food, feed, fibre and fuel.
- Obstacles in international trade of organic food
- Conflicts and trade-offs of organic and sustainable agriculture in developed and developing countries (food security, domestic markets and exports, environmental and nature conservation policy, natural resource management). Impacts of increasing imports of organic food from developing countries on the economic development of developing countries (cost-benefit analyses).

7.3 Efficient approaches to ecological intensification.

The ecological challenges

There are 6 billion people living in the world today and although agricultural production has been intensified by all means (and with severe impacts on ecosystem services), still 850 million people are starving (FAO). The human population is projected by the UN to increase up to 9 million in 2050. If current trends of changing eating habits (towards meat and dairy diets; obesity and malnutrition, high proportions of wasted food), uneven production and distribution of foods as well as bad governance in many countries continued, a 50 % rise of global food production would be needed to secure food supply. Parallel to this tremendous increase of food production, a considerably redaction of negative impacts of agriculture on the environment, the ecosystem services and the use of non-renewable resources and energy will become a question of the survival of humans. These emerging conflicts show how important the societal, political and economic framework will be in order to reverse current trends (see societal and economic challenges under 7.1. and 7.2). Any successful strategy for the future development of European agriculture will have to find trade-offs between the different services agriculture is expected to deliver on the one hand, and legal or voluntary quality requirements with respect to environment, ecology and animal welfare on the other.

The competitive advantages of organic and sustainable agriculture and food production to address the ecological challenges

In this regard, organic agriculture represents a potential solution as it is one of the best developed multifunctional strategies in agriculture so far. On the other hands, there is a well recognised need to improve further the organic farming systems in order to secure both productivity and environmental sustainability. Therefore, organic agriculture is an excellent starting point for further research and development on sustainable agricultural productivity. It will be an efficient approach to an ecologically and environmentally sound intensification of farming systems in balance with ecological goods and services, nature protection, animal welfare and social objectives.

The weakness of organic agriculture, so far, is in its still insufficient productivity and stability of the yields. This may be solved by an appropriate "ecological intensification", i.e. via a better and more efficient use of natural resources, improved nutrient recycling techniques and agro-ecological methods for enhancement of diversity and health of soils, crops and livestock. Such development will build on the knowledge of stakeholders (using participatory methods developed under 7.1) and relies on powerful information and decision tools in combination with new research tools in biological sciences. Ecological intensification is characterised by co-operation and synergy between different components of agriculture and food systems with the aim of enhancing productivity and health of all components.

Ecological intensification is expected to find very efficient, completely new and powerful ways to secure sustainable food and bio-energy production and will build on i) improved use of nitrogen pools so far not or inefficiently exploited for food production and on using (but not wasting) ecosystem services like fertile soils, species diversity, genetic diversity of crops and livestock.

The most important approaches to improve efficiency are i) the clever integration of leguminous plants into cropping and ii) the better use the nitrogen (and other nutrients), which derive from livestock production. Scientists from Michigan University modelled the potentially available nitrogen pool from the integration of leguminous plants in arable cropping systems to be 60 % bigger than the current use of nitrogen produced with fossil energy – without reducing the food and feed production area[90].

Reducing again the separation of crop and livestock production, which often has resulted in soil degradation on croplands[106] and in nutrient excess in livestock operations with yet unsolved environmental problems, is another approach to better utilizing the nutrient elements in the excrements of 18.3 billion livestock animals (FAO statistics). In order to close again the cycles of macro- and micro-nutrients and organic matter, we shall need either new design of modern mixed farms or industrial livestock waste processing units, bringing the by-products back to cropland. New small-scale farm models, integrating livestock into cropland, would be a solution for many regions in Europe. As farm technology has completely changed during the last 25 years, such mixed farms of tomorrow would not resemble the old models and would match the requirements of modern entrepreneurship.

Other approaches to ecological intensification comprise the exploitation of eco-system services via clever habitat design[107], the use of novel smart breeding technologies (QTL, SNP etc), the combined use of sensor, GPS and information technologies, automatisation and robots and decentralised plant & animal breeding strategies with high adaptability and flexibility of varieties and breeds to environmental and climatic changes.

The ecological intensification is meant to secure the productivity and efficient resource use for the sake of environmental and economic sustainability but should not compromise food quality and human health benefits of consuming organic products. Therefore, care should be taken to avoid negative feed backs in the form of increased susceptibility to pests and diseases and reduced resilience. Agro-ecological and probiotic methods for prevention and control of pests and improvement of plant and soil health based on enhancement of agro-biodiversity will be widespread.

Examples for research ideas:

> Improved management of soil organic matter, soil micro-organisms for the improvement of nutrient supply, soil structure, soil moisture retention and soil health as well as pest and disease prevention.

---

[106] Bellamy, P.H, Loveland, P.J., Bradley, R.I., Lark, R.M. and Kirk, G.J. (2005) Carbon losses from all soils across England and Wales 1978 – 2003. Nature 437, 245-8

[107] Altieri, M. A., Ponti, L. and Nicholls, C. (2005) Enhanced pest management through soil health: toward a belowground habitat management strategy. Biodynamics (Summer) pp. 33-40.

- The development of **systems** (and not only plants and animals) which are drought-tolerant, nutrient autarkic and self-sufficient as well as resilient to pests, diseases as well as environmental and climate change.
- Better recycling of macro- and micro-nutrients and enhanced self-reliance in nitrogen supply through new farm and crop sequence design d through highly improved and reduced soil tillage techniques.
- Redesigned mixed farming systems with multiple objectives:
    - Improved nutrient and organic matter cycles and diversified production systems (multi-cropping, agro-forestry concepts, grassland etc.).
    - Integration of food and renewable energy and biomass production (e.g. integration of fodder crops for biogas production improving crop rotation, nutrient recycling and soil Carbon sequestration).
    - Development of innovative and competitive forms of collaboration between specialised farmers and enterprises (e.g. vegetable producers taking advantage of good crop rotations in livestock systems).
- Ecological habitat management as a key to more resilient and locally adapted farming systems (improved biodiversity through management at landscape, farm and field levels, crop rotation, buffer zones and diversified habitat in and around crops).
- New *on-farm* breeding concepts for livestock and crops, enhancing genotype-environment-management interactions and using smart breeding techniques like markers and genome-wide selection.
- Novel technologies in the context of sustainable farm design and management (automatisation and robots, sensors in crop and livestock management, GPS and information technologies).
- Assessments of resource use efficiency and emissions of greenhouse gasses and environmental impact of different agro-ecological methods and new farming systems.
- Cross-disciplinary assessments of trade-offs and synergies between ecological intensification methods and their impact on environment and food quality and the organic principles of health, ecology, fairness and care.

7.4 High quality foods – a basis for healthy diets and a key for improving the quality of life

The foods challenges

Nutritional malfunction have become wide-spread in Western societies as well as in emerging economies in all parts of the world. Childhood obesity is one of the most serious public health challenges of the 21st century[108]. Other diet-related diseases like for example cardiovascular diseases, diabetes, caries or food allergies affect the physical and mental ability of consumers.

Changes of the eating habits, caused by different economic, social, societal and individual factors, drive the demand for convenience foods, simplified and biased diets, fast food and low-price community catering in schools, canteens and nurseries. Knowledge how to produce and prepare food has decreased and there is a general alienation in the natural awareness of food[109].

Individual and social well-being strongly depend on both the quantity **and** quality of food we eat, the composition of the diets and how it is processed and prepared. The power to choose foods that meet the highest standards of ethics and craftsmanship, are a clear manifestation of every citizen's everyday's control of his life circumstances, the key prerequisite for a long and healthy life. Therefore, an improved quality of life is intricately linked with an increasing demand for foods (and other goods) of the highest standards. Due to this, the dietary awareness of consumers will considerably increase, also beyond classical themes like food safety, residues and basic nutritional needs, in particular if science succeeds to elucidate the role different aspects of food play for health: "we are what we eat".

The competitive advantages of organic and sustainable agriculture and food production to address the foods challenges

Organic foods are a synonym for 'high quality foods", since they are produced under most sustainable conditions. The organic processes of production are regulated and controlled by international, European and national standards. More over, organic foods are seen as exactly those foods which guarantee reasonable nutrition for children and adults. Organic foods are also perceived as tasty foods with structure and consistency, authentic foods without unnecessary processing. Organic foods also do not contain taste fortifiers with addictive potentials and do without processing technologies which delay satiety signals. Several studies indicate a positive effect of organic food e.g. on the immune system[110,111].

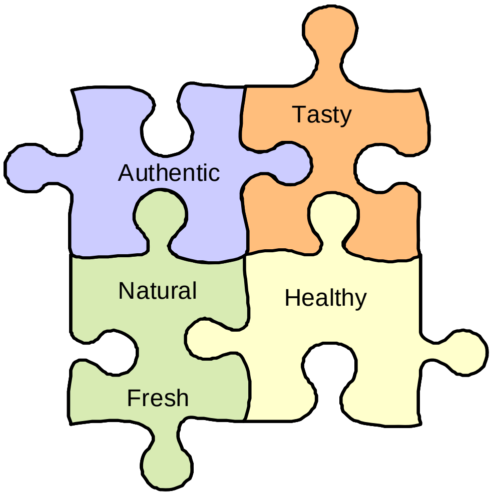
---

[108] http://www.who.int/dietphysicalactivity/childhood/en/index.html

[109] Eberle U., Hayn D. Rehaag R. Simshäuser U. (2006): Ernährungswende

[110] Huber, M (Ed.) (2007): Organic More Healthy? A search for biomarkers of potential health effects induced by organic products, investigated in a chicken model.

Organic means systemic in a way of the whole food chain approach as well as a systemic few on several quality indicators[112] to improve new production methods and technologies:



Buying and eating organic foods will become a basic component of modern eating culture as an integrated aspect of changes that will remarkably improve the quality of life. Furthermore it contributes to reduce public health costs. It will become standard in food and nutrition education and in schools, hospitals, geriatric institutions and public catering. Organic food culture has the potential to be the driving force behind a sustainable, natural and healthy lifestyle.

Food quality research includes a whole chain approach – from field to fork. Within the chain, the most critical steps which influence the quality of the food are identified and regulated. Based on this, authenticity as well as the naturalness of the products can be sustained. Because organic farming aims to support the consumer with vital and healthy food, process technologies are adapted according to the quality indicators. Health studies (e.g. feeding trials, intervention studies) have to be carried out. The design of these studies reflects the systemic approach of organic farming including the four principles of IFOAM.

Examples for research ideas:

> Improvement of systemic indicators for high quality organic food (e.g. freshness, naturalness, structure).

> Development and validation of methods testing organic food quality indicators.

> Development and validation of methods securing authentication of organic food.

---

[111] Kummeling I, Thijs C, Huber M, van de Vijver LP, Snijders BE, Penders J, Stelma F, van Ree R, van den Brandt PA, Dagnelie PC (2008): Consumption of organic foods and risk of atopic disease during the first 2 years of life in the Netherlands. Br J Nutr.;99(3):598-605

[112] Meier-Ploeger, A (2002): Quality of organic Food: Perception and Criteria. Elm Farm Research Centre (EFRC), Bulletin No. 60, 13 pp

- Improved and more consistent food quality in organic and low input plant and livestock production systems (through breeding and farm management techniques).
- Understanding the interaction of organic farming practices and food quality indicators.
- Technologies for securing organic food quality during transport and storage.
- Technologies for securing organic food quality in processing and packaging.
- Whole food chain quality and hazard analysis of critical control points in organic production.
- Regionality, biodiversity and consumption of organic food.
- Eating behaviour and consumer preference of organic food.
- Consumer perception of organic food quality indicators.
- Interactions between the eating behaviour, well-being & health of humans and the organic production systems.

8 Sustainable agro-ecosystems and human well-being

"The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services. Ecosystem services are the benefits people obtain from ecosystems. These include *provisioning services* such as food, water, timber, and fibre; *regulating services* that affect climate, floods, disease, wastes, and water quality; *cultural services* that provide recreational, aesthetic, and spiritual benefits; and *supporting services* such as soil formation, photosynthesis, and nutrient cycling" (quoted from the Synthesis Report from the Millennium Ecosystem Assessment[24]).

Among the different ecosystems, intensively managed **agro-systems** (arable land and land under permanent crops) represents some 11 percent (1.5 billion ha) of the globe's land surface[113] and **grassland**[114] some 40 % (5.4 billion ha) [115]. These figures underline the importance of the sustainable use and management of agricultural land for human well-being. Only very sustainable agro-**eco**-systems can provide all the services needed by future generations.

A sustainable approach to agriculture and food production means coping with trade-offs between ecosystem services while not reducing some of them in favour of others. With the vision "Food, Fairness and Ecology" we want to cope successfully with trade-offs relevant for human-wellbeing and global societal cohesion. The rationale behind organic agriculture is providing sufficient food and fibre while increasing *regulating* services (e.g. increasing the adaptive capacity of farming systems to climate change) and maintaining or restoring *cultural* (e.g. pleasant landscape) and *supporting* services (e.g. soil fertility). As human well-being strongly depends not only on the quantity of food but also on its quality and diversity, the vision also addresses food, nutrition and health aspects.

A long-term perspective is crucial when developing a sustainable food production. As long as most of the ecosystems services are not scarce, market economy and international politics and protocols will fail to adequately address the challenges. Therefore, an economizing use of natural resources is an ethically driven decision of well informed and independent citizens. In the context of sustainability, ethically farming, trading and consuming is an existential question for the human species[116].

Feeding a growing human population on equitable terms considerably reduced vitally important *regulating*, *cultural* and *supporting* ecosystem services. Organic farmers practise a pragmatically optimised equilibrium between the services the society expects agriculture to deliver. It is therefore an excellent starting point for truly sustainable food systems.

---

[113] http://www.fao.org/docrep/005/y4252e/y4252e06.htm

[114] UNESCO defines grassland as "land covered with herbaceous plants with less than 10 percent tree and shrub cover"

[115] http://www.fao.org/docrep/008/y8344e/y8344e05.htm

[116] Nick Clarke, Clive Barnett, Paul Cloke and Alice Malpass (2007) Globalising the consumer: Doing politics in an ethical register. Political Geography. Volume 26, Issue 3, p. 231-249.