TIPI VISION AND STRATEGY


TECHNOLOGY INNOVATION PLATFORM OF IFOAM – ORGANICS INTERNATIONAL

A Global Vision and Strategy for Organic Farming Research

February 10, 2016

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List of abbreviations

ABA	Brazilian Association of Agroecology
ACIAR	Australian Center for International Agricultural Research
ADB	Asian Development Bank
AfroNet	African Organic Network
ANSOFT	Asian Network for Sustainable Organic Farming Technology
ARNOA	Asian Research Network of Organic Agriculture
ASA	American Society of Agronomy
ASEAN	Association of Southeast Asian Nations
ASTI	Agricultural Science and Technology Indicators
AU	African Union
BARI	Bangladesh Agriculture Research Institute
BOAN	Bangladesh Organic Agriculture Network
CAP	Common Agricultural Policy
CAPSA	Center for Alleviation of Poverty through Sustainable Agriculture
CATIE	Tropical Agriculture Research and Higher Education Centre
CAZRI	Central Arid Zone Research Institute
CEOA	Centre of Excellence for Organic Agriculture
CCFD	Terre Solidaire
CGIAR	Consultative Group on International Agricultural Research
CMS	Cytoplasmic Male Sterility
CORE Organic	Coordination of European Transnational Research in Organic Food and Farming Systems
CO_2	Carbon Dioxide
CRRA	Centre Régional de Recherche Agronomique, Mali
CSA	Community Supported Agriculture
DOA	Department of Organic Agriculture
DOK trial	Biodynamic-Bioorganic-Conventional Agricultural Trial
EC	European Council
ECO-PB	European Consortium for Organic plant breeding
EIP-AGRI	European Innovation Partnership for Agricultural Productivity and Sustainability
EU	European Union
EOA	Ecological Organic Agriculture
EOAI	Ecological Organic Agriculture Initiative
ERA-Net	European Research Area Network
FAO	Food and Agriculture Organization of the United Nations
FARA	Forum for Agricultural Research in Africa
FiBL	Research Institute of Organic Agriculture
GFAR	Global Forum for Agriculture Research
GIZ	German Federal Enterprise for International Cooperation
GIZ IS	GIZ International Service
GMO	Genetically Modified Organisms
GOAN	Ghanaian Network of Organic Agriculture
GTZ	German Technical Cooperation
GOMA	Global Organic Market Access
HAL	Horticulture Australian Limited
HIVOS	Dutch Humanist Institute for Cooperation
HNV	High Nature Value
IAASTD	International Assessment of Agriculture Sciences and Technology for Development
IP	Integrated Production
IARI	Indian Agricultural Research Institute
ICAR	Indian Council of Agricultural Research
ICOA	Inter-American Commission for Organic Agriculture
ICROFS	International Centre for Research in Organic Food Systems
ICT	Information and Communication Technology
IFAD	International Fund for Agricultural Development
IFOAM	International Federation of Organic Agriculture Movements (Today: IFOAM - Organics International)
IFOAM EU	International Federation of Organic Agriculture Movements European Union
IFPRI	International Food Policy Research Institute
IICA	Inter-American Institute for Cooperation on Agriculture (IICA
IITA	International Institute of Tropical Agriculture
INTA	National Institutes for Agricultural Research
IOL	Institute of Organic Agriculture, University of Bonn, Germany
IRRI	International Rice Research Institute
ISOFAR	International Society of Organic Agriculture Research
ISSA	Iranian Scientific Society of Agroecology
KACA	Korean Agricultural Cooperative Agency
KIOF	Kenyan Institute of Organic Farming
KALRO	Kenyan Agricultural and Livestock Research Organization
KOAN	Kenya Organic Agriculture Network
KOFA	Korean Organic Farmers Association
KSA	Kingdom of Saudi Arabia
LBI	Louis Bolk Institute

MEA	Millennium Ecosystem Assessment
MENA	Middle East and North Africa
MEP	Ministry of Environment Protection
MOST	Ministry of Science and Technology
NARI	National Agricultural Institute of Papua New Guinea
NACF	National Agricultural Cooperative Federation
NPOF	National Project on Organic Farming
NOAM	National Organic Agriculture Movements
NOARA	Network for Organic Agriculture Research in Africa
NODP	National Organic Development and Action Plan
NORA	National Organic Research Agenda
NORAD	Norwegian Agency for Development Cooperation
OACC	Organic Agriculture Center of Canada
OACK	Organic Agriculture Centre of Kenya
OECD	Organization for Economic Cooperation and Development
OFDC	Organic Food Development Center, China
OFIA	Organic Farming Innovation Award
OFP	Organic Farming Project, Saudi Arabia
OFPA	Organic Foods Production Act
OFRF	Organic Farming Research Foundation
OMRI	Organic Materials Review Institute
ORC	Organic Agriculture Research & Development Center
OREI	Organic Agriculture Research and Extension Initiative, USDA
ORG	Organic Transitions Program, USDA
OTARE	Organic Trust Australia - Research and Education
OWC	Organic World Congress
PAR	Participatory Action Research
PGS	Participatory Guarantee Systems
PFI	Practical Farmers of Iowa
PhilRice	Philippine Rice Research Institute
POETCom	Pacific Organic and Ethical Trade Community
ProGroV	Productivity and Growth in Organic Value-chains
R & D	Research and Development
RDA	Rural Development Administration, Republic of Korea
RIOA	Research Institute of Organic Agriculture of Dan Kook University
SARE	Sustainable Agriculture Research and Education
SATNET	Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia
SCAR	Standing Committee on Agricultural Research
SDC	Swiss Agency for Development and Cooperation
SEPA	China State Environmental Protection Agency
SIDA	Swedish International Development Cooperation
SINAB	Sistema d’Informazione Nazionale sull’Agricoltura Biologica
SOAAN	Sustainable Organic Agriculture Action Network
SOCLA	Sociedad Cientifica de Agricultura Latino Americana de Agroecologia
SOFA	Saudi Organic Farming Association
SPC	Secretariat of the Pacific Community
SyProBio	Systèmes de Production Biologique diversifiés
TIPI	Technology Innovation Platform of IFOAM
TFP	Total Factor Productivity
TP Organics	European Technology Platform for Organic Food and Farming Research
TEEB	The Economics of Ecosystems and Biodiversity
TOA	Towards Organic Asia
TOFA	Organic Alternative for Africa
WHO	World Health Organization
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environmental Programme
UNIDO	United Nations Industrial Development Organization
USDA	United States Department of Agriculture

1. Executive summary

Globally, organic agriculture offers the promise of a future in which food and other farm products are produced and distributed in a healthy, ecologically sound, truly sustainable and fair way. The full and multiple benefits of organic agriculture are just now being realized—from ecosystem services to the provision of healthier food. Yet, to reach its full potential, organic farming needs to address many challenges. While organic agriculture has grown in strength and is in the most favorable position it has ever been in with respect to market conditions, government policies and international institutional support, it still does not have sufficient resources to continue its expansion.

The Technology Innovation Platform of IFOAM – Organics International (TIPI) has developed a vision and an agenda to advance organic agriculture through research, development, innovation and technology transfer. TIPI's vision recognizes that current technologies based on heavy use of external inputs that are toxic, pollute the environment and are very energy-intensive come at a price. Investments in ecosystem services and the development of technologies that are productive, stable, adaptable, resilient and fairly shared are much more likely to sustain the world's population in a rapidly changing environment. Sustainable pathways to innovation will require the engagement of a wide range of stakeholders in a science-driven multi-disciplinary approach. Such an approach seeks to empower rural areas, provide eco-functional intensification that produces food, while harnessing and regenerating eco-system services as well as strengthening resilience to climate change; and provide food that promotes health and well-being and is available to all.

If organic agriculture is to fulfil its mission it must build its capacity in order that it can quantitatively, qualitatively and structurally meet the food needs of the world's entire population.

The new paradigm proposed by TIPI is founded on a holistic and systemic approach. It involves engaging farmers, researchers and other practitioners in co-innovative processes; and developing open access technologies that can be readily adapted to local conditions. Many barriers and bottlenecks will need to be overcome for this vision to be realized. Nonetheless, TIPI calls upon the organic community to support its 17-point action plan to advance organic agriculture in a forward-thinking and innovative way.

TIPI's vision and strategy for organic farming research: The process

The outline of TIPI's vision and strategy for organic farming research was prepared at the second Science Day at Biofach, the world organic trade fair in February 2014, and the first draft was elaborated during 2014 by experts from all parts of the world. This draft was discussed at the Workshop 'Practitioners' Research Agenda' in October 2014 at the IFOAM Organic World Congress in Istanbul. A consultation among TIPI members took place between October 2014 and January 2015. Final discussions took place at Science Day 2015. In February 2016, the vision and strategy was finalized integrating the discussions from the various events.
More information: http://www.organic-research.net/tipi/about/vision.html

2. About TIPI, the Technology Innovation Platform of IFOAM – Organics International

The Technology Innovation Platform of IFOAM – Organics International (TIPI) was launched in February 2013 in Nuremberg, Germany, at BioFach, the world's leading trade fair for organic food, with researchers and stakeholders from all over the world present. TIPI's mission is:

- to engage and involve all stakeholders that benefit from organic agriculture research;
- to develop a global research agenda for organic food and farming;
- to advocate for organic agriculture research in order to achieve the Sustainable Development Goals (SDG);
- to foster international collaboration in organic agriculture research and facilitate exchange; and
- to disseminate, apply and implement innovations and scientific knowledge consistent with the principles of organic agriculture.

TIPI is unique as the global Technology Innovation Platform for organic research that includes all stakeholders. It seeks to co-operate with regional, national and transnational technology platforms and research networks such as the European Technology Platform for Organic Food and Farming Research (TP Organics) as well as national platforms.

TIPI seeks to work constructively and positively with all organizations involved in organic agriculture research, technology development and innovation. In particular, TIPI will help IFOAM – Organics International to bring together and mobilize different organizations that are working on organic research issues. TIPI promotes continuous discussions, which will be led by stakeholder driven research platforms. These discussions cover issues such as animal welfare, agro-ecology, agroforestry, landscape, climate change adaptations and mitigation, soil and nature conservation. TIPI aims to enable open and intensive exchange of knowledge, information dissemination and strong communication via its webpage[1] and by using international organic research archives. In general, membership is open to all stakeholders with an interest in advancing organic agricultural research. TIPI welcomes organizations and individuals that represent farmers, processors, traders, suppliers, consumers, scientists, states, foundations and civil society, as well as individual members. Full and supporting TIPI member organizations are listed on the TIPI website.

As a platform within IFOAM – Organics International, TIPI is an informal network and sector group that is self-organizing and self-governing. The members are able to develop its purpose, terms of references, goals, strategies and activities independently.

More information

TIPI - Technology Innovation Platform of IFOAM – Organics International, c/o Research Institute of Organic Agriculture (FiBL), Ackerstrasse 113, 5070 Frick, Switzerland, tipi@ifoam.org, http://www.organic-research.net/tipi.html.

[1] www.organic-research.net

3. General introduction to organic agriculture

Organic farming[2] is based on practices that are environmentally friendly, animal welfare oriented and geared towards improving the living conditions of farmers. To strive for close-to-nature farming is often a central plank within farmers' own thinking and praxis. Going beyond agricultural practices and their technical and economic implementation, organic farming has always been a way of life and as such has always included important aspects of social reform, philosophical lifestyle and 'new social movements'. The principles of ecology, health, fairness and care that guide IFOAM – Organics International encompass this comprehensive thinking (IFOAM 2005).

Organic farming began without any public financial, institutional or technical support. The pioneers promulgated organic farming as an alternative model to intensive, specialized and partially industrialized – 'anonymous and soulless' – food production (Rusch 1968; Meadows et al. 1973). The economic exchange of the pioneer farmers with consumers, among themselves and with up- and downstream businesses were predominantly personal and direct. Products were sold from farm to farm or hand to hand, or in some cases traded on a restricted level. In the cities, food coops were started, organic stores opened and farmers' markets and box schemes appeared (Heldberg 2008).

Today, organic agriculture and food processing are governed by regulations based on the principles established by pioneers in Europe, the United States and Asia. Farmer associations have defined private standards and labelled organic food since the middle of the 20th Century. In 1980, IFOAM introduced the first global organic standards.

Early governmental regulations were introduced in a few European countries and in several US States in the 1970s and 1980s. In 1991, the European Commission put in force the regulation on organic agriculture and in 2002, the United States Department for Agriculture (USDA) enacted the National Organic Program. Currently, 88 countries have organic regulations and 12 countries are in the process of drafting regulations (Huber & Schmid 2014).

Private bodies, such as IFOAM, governmental authorities (using bilateral negotiations and agreements) and international organizations, such as the CODEX Alimentarius of the World Health Organization (WHO), the Food and Agriculture Organization of the United Nations (FAO) and the FAO/IFOAM/UNCTAD International Task Force on Harmonization and Equivalence in Organic Agriculture, have worked to harmonize standards for organic foods. Growth in production and consumption of organic produce is occurring in all regions; although demand for organic products is mainly in North America, Japan and Europe. The most important equivalence agreement is the 2012 arrangement between the European Union and the United States. Globally, these two standards account for over 90 % of all organic sales.

While organic food markets are well organized in developed regions, the organic sector is still in its infancy in most developing countries. These countries often lack a robust domestic organic sector, and, as with their agricultural economies as a whole, the organic sector is

[2] Any system that uses organic methods and is based on the Principles of Organic Agriculture as 'Organic Agriculture' and any farmer that employs such practices and such systems as an 'organic farmer' regardless of whether the products are marketed as organic or not. Biological, biodynamic, permaculture, agroecological or natural farming etc., are also considered consistent with organic agriculture methods and approaches. Organic farming is not exclusive to any form of land and/or resources ownership nor is it restricted to the size of a farm (IFOAM 2005)

largely dependent on producing export-oriented commodities. These value chains are often subject to third-party inspection and control by external organic certification bodies accredited by agencies in the importing countries. Participatory Guarantee Systems (PGSs) that rely on mutual control within a farm community or group of farmers are being used in some places as a viable way of building local markets.

The first private organic research institutes emerged in Europe in the 1970s. From 1990 onwards, market growth and the economic success of some organic farmers attracted a new generation of farmers and governments started to fund research. Applied research for organic agriculture started in Western Europe and the USA. Later, Canada, Brazil (and other Latin American countries), China, South Korea and India started to catch up. Meanwhile, organic agriculture research has aroused global interest, although it is still marginal compared to conventional agricultural research. As a rough estimate, less than one percent of the 49 billion US Dollars spent annually on food and agricultural research by public and private donors is used for the specific solutions and contexts of organic farming (Tittonell 2013; Beintema et al. 2012; Niggli et al. 2008). The gradient between the countries leading organic research and those where it is not a priority is steep. As such, the potential for mutual learning and information exchange is enormous.

In 2007, the European organic stakeholders started to develop a vision for organic food and farming research which was followed by a research strategy and an action plan on how the strategy should be implemented (Niggli et al. 2008; Padel et al. 2010; Schmid et al. 2009). The process was driven by the Technology Platform TP Organics. Technology Platforms are widely used by the European Commission to encourage stakeholders to participate in research agenda setting. TP Organics' main target was the European Commission, as funding of trans-national research projects in the field of agriculture is important in the European Union (EU). The number of open calls with a focus on the technical restraints and opportunities of organic agriculture has considerably increased in the EU's research work programmes due to the work of TP Organics. The Platform has significantly raised the profile of organic farming and its research community and has led to a stronger acknowledgement of organic agriculture as an ecological and farmer-driven intensification strategy.

By contrast, the profile of organic agriculture still needs to be raised in the arena of international agriculture and food research. Moreover, the work done so far by TP Organics cannot be automatically extrapolated for other parts of the world. Despite these gaps, there is enormous potential for exploring the contribution that organic agriculture can make in raising the productivity of farms in developing countries, in improving the livelihoods of small family farms persevering with (semi) subsistence agriculture and in enhancing the attractiveness of rural areas and strengthening the environmental services that they provide. The adaptation of organic principles within tropical, subtropical and arid zones is an especially important question concern. Furthermore, the focus on bottom-up innovation, farmer-to-farmer learning and farmer-to-consumer value added generation – all typical features of organic food and farming systems – might offer partial solutions to current global challenges.

TIPI, the Technology Innovation Platform of IFOAM – Organics International will not repeat the activities conducted so far in the EU but integrate them with other initiatives and contexts. Its main focus is on the integration of all activities in Europe, the North and South American continent, Africa, Asia and Oceania. It emphasizes not only the role of organic food as a successful niche market but more the potential of organic agriculture to address trade-offs between productivity and the sustainable use of the environment and limited resources.

Trade-offs also exist between productivity and social/ethical aspects of farming. Furthermore profit sharing in the food chain is so distorted that it acts as a barrier to sustainable farming.

TIPI's work on a global vision, a strategic research agenda and an action plan will be a participative process, involving all organic stakeholders as well as related communities, including the fair trade movement, smallholder farmers, environmentalists and different traditional farming communities, such as pastoralists and other indigenous movements. Scientists will be just one stakeholder group among many others. It is not the goal of TIPI to become a platform for scientists; their interests are represented by the International Society of Organic Agriculture Research (ISOFAR[3]).

This report is the first draft written by TIPI's international board for a wider consultation among organic stakeholders. Its contents were developed at a workshop at the IFOAM Organic World Congress in Istanbul, October 2014. The Istanbul congress generated the momentum for the global implementation of the action plan, with the goal of boosting organic agricultural research in all regions of the world and to provide input to international organizations and their high level conferences.

Box 1: Key facts and figures on organic agriculture

The latest data on organic agriculture show a continued growth in land farmed organically and in the market; however there are substantial differences in the level of development between continents (Willer & Lernoud 2016)

- There were 43.7 million hectares of certified organic agricultural land in 2014.
- The regions with the largest areas of certified organic agricultural land are Oceania (17.3 million hectares) and Europe (11.6 million hectares). Latin America has 6.8 million hectares followed by Asia (3.6 million hectares), North America (3.1 million hectares) and Africa (1.3 million hectares).
- Currently almost 1 % of the agricultural land of the countries covered by the FiBL survey is organic.
- Some countries have higher shares: Falkland Islands 36.3%, Austria 19.4 %, Sweden 16.4 %, Estonia 16.2 %, Switzerland 12.7 %.
- There were more than 2.3 million organic producers in 2014.
- 40 % of the world's organic producers are in Asia, followed by Africa (26 %) and Latin America (17 %).
- The countries with the most organic producers are India (650'000), Uganda (190'552), and Mexico (169'703).
- The latest research from marketing and information services company Organic Monitor finds international sales of organic food and drink approached 80 billion US Dollars in 2014.
- Growth is occurring in all regions; however, demand for organic products is mainly in North America, Europe and Japan. The sales of organic produce are projected to continue to rise in the coming years.
- In 2014, the countries with the largest organic markets were the United States, Germany, and France.
- The highest per capita consumption was in Switzerland, Luxembourg, and Denmark.
- The highest market shares were reached in Denmark, Switzerland and Austria.

[3] Website of the International Society of Organic Agriculture Research : www.isofar.org

4. The strengths, challenges and potentials of organic farming

4.1 Introduction

At present, agriculture faces the unprecedented challenge of securing food supplies for a rapidly growing human population while seeking to minimize the adverse impacts of agriculture on the environment, reduce the use of non-renewable resources and energy and enhance resilience to global warming. A shift towards sustainable agricultural production entails the adoption of more system-oriented strategies, which include farm-derived inputs and productivity based on ecological processes and functions (Garnett & Godfray 2012). Sustainable agricultural systems also involve the traditional knowledge and entrepreneurial skills of farmers (IAASTD 2008). System-oriented sustainable practices include organic farming, low external input sustainable agriculture and agro-forestry. In addition, a few elements of agroecology – such as integrated pest management, integrated production, and conservation tillage – have also been successfully adopted by conventional farms.

4.2 The strengths of organic agriculture

4.2.1 Multi-functionality – the most characteristic feature of organic agriculture

Organic agriculture produces both commodity and non-commodity outputs and addresses ethical concerns such as animal welfare and the livelihoods of farmers and farm workers (fair trade). Hence, it is a multi-functional form of agriculture. The public goods – or non-commodity outputs – provided by organic farms have been comprehensively reviewed by several authors (Niggli, 2014; Tittonell 2013; Schader et al. 2012; Rahmann et al. 2009; Niggli et al. 2008; Scialabba et al. 2002; Stolze et al. 2000). The different meta-analyses consistently confirm that organic agriculture can be characterized as multifunctional and system-oriented.

In Switzerland, calculations made using a comparative static mathematical model showed that state support schemes for organic farming (direct payments) are equally cost-effective at achieving environmental policy targets as the combination of different targeted and tailored agri-environmental measures (Schader et al. 2013). The study also reveals that specific agri-environmental measures such as ecological compensation areas (e.g. hedgerows, field margins with wild flowers, and extensive grassland) are more cost-effective when implemented on organic farms than on non-organic farms.

4.2.2 (Bio)diversity on organic farms

Diversity is an important driver for the stability of agro-ecosystems (Altieri & Nicholls 2006) and hence for a continuous and stable supply of food. At the farm level, organic farmers often practise diversification by producing several different commodities, both livestock and crops, and/or processing and marketing them directly into different chains.

Comparative biodiversity assessments on organic and conventional farms reveal that organic fields have 30 % higher species diversity and a 50 % greater abundance of flora and fauna (Rahmann 2011; Bengtsson et al. 2005; Hole et al. 2005; Fuller et al. 2005). The higher biodiversity applies to a wide range of different taxonomic groups, including microorganisms, earthworms, weeds and wild flowers, insects, mammals, and birds (Hole et al. 2005; Kragten & de Snoo 2008; Kragten et al. 2008; Wilson et al. 1997; Wickramasinghe et al. 2003; Gabriel & Tscharntke 2007; Holzschuh et al. 2007; Gabriel et al. 2006; Frieben & Köpke 1995). In regions where the number of organic farms increased, the diversity and abundance of bees grew considerably, contributing to the pollination of crops and wild plants over larger areas (Rundlöf et al. 2008). Most studies attribute the greater diversity of species on organic farms predominantly to the ban on pesticides, herbicides, and fast-release fertilizers. Furthermore, diversified crop rotation and non-chemical weeding have a positive effect on the species diversity of organic farms (Rahmann 2011; Hole et al. 2005). Organic farmers also make use of semi-natural landscape elements, such as hedgerows, fallow-ruderal habitats and wildflower strips to stabilize pest populations (Zehnder et al. 2007).These are part of the toolset of organic farmers, used in order to make crop production more resilient, but which also promote biodiversity.

The most recent hierarchical meta-analysis of 184 observations from 94 individual studies confirmed that species richness on organic fields was on average 34 % greater than on conventional fields (Tuck et al. 2014). This effect has been robust over the last 30 years. There is a lot of heterogeneity within these results. Organic agriculture has a greater effect in intensively farmed regions and in regions dominated by arable crops. Not all taxonomic and functional groups and crops benefit from organic farming, but a significant majority does.

4.2.3 Lower negative environmental impacts

The high dependence of conventional farming on chemical fertilizers, herbicides, and pesticides has caused considerable environmental damage. Meta-analyses comparing the environmental impacts of organic and conventional farming show that organic farms are likely to have lower nutrient losses and lower ammonia emissions per unit of land (Tuomisto et al. 2012; Gomiero et al. 2011; Stolze et al. 2000; Drinkwater et al. 1998), but not necessarily per ton of food produced, because of the lower yields. As both nutrient losses and ammonia emissions are good indicators for local and regional eutrophication (Dahlgaard et al. 2012), these negative environmental externalities cannot be compensated for by higher yields.

Other nutrient elements such as potassium and phosphorous, are not found in excessive quantities in organically managed soils, which means they are used more efficiently (Mäder et al. 2002). Since synthetic herbicides and pesticides are not applied on organic farms, leaching and run-off effects are unlikely to occur. The only pesticides used in organic agriculture that cause persistent residues in soils are copper fungicides. These are used in horticultural crops such as potatoes, grapes, hops, and a few vegetables at annual rates of 3 to 4 kg of copper per hectare. The future replacement of copper fungicides by breeding disease-resistant varieties and by using more easily degradable botanicals has a high priority in national and European Union organic research.

4.2.4 Stable soils – Less prone to erosion

Fertile soils with stable physical properties have become the top priority of sustainable agriculture. The essential conditions for fertile soils are vast populations of bacteria, fungi, insects, and earthworms, which build up stable soil aggregates. There is abundant evidence from long-running field studies that organic farms and organic soil management improve soil fertility. Compared to conventionally managed soils, organically managed ones show a higher organic matter content, higher biomass, higher enzyme activities of microorganisms, better aggregate stability, improved water infiltration and retention capacities, and less susceptibility to water and wind erosion (Edwards 2007; Fliessbach et al. 2007; Marriot et al.

2006; Pimentel et al. 2005; Reganold et al. 1987; Reganold et al. 1993; Siegrist et al. 1998; Mäder et al. 2002).

4.2.5 Carbon sequestration

Organic farmers use different techniques for building soil fertility. The most effective ones are fertilization by animal manure, by composted harvest residues, and by leguminous plants – either main or intermediate crops. Introducing grass and clover leys as feedstuff for ruminants into the rotation, diversifying the crop sequences and reducing ploughing depth and frequency also augment soil fertility. All these techniques increase carbon sequestration rates on organic fields. The only references for quantifying this effect are long-running field experiments in different parts of the world (Lee et al. 2008). A scientific meta-analysis of the raw data of 74 long-term field trials—most of them in temperate zones—reveal significant carbon gains in organically-managed plots, whereas, in the conventional or integrated[4] plots, soil organic matter is either stable or exposed to losses by mineralization (Gattinger et al. 2012). In this meta-analysis, which gathered the data from all existing long-term field trials (the average duration of which was 16 years), the average difference in the annual sequestration rate between organic and conventional management was 450 kg atmospheric carbon per hectare per year. The mean difference between the carbon stocks of soils was 3.5 metric tons per hectare per year. A further increase of carbon capture in organically managed fields can be measured by reducing the frequency of soil tillage. In an experiment in Switzerland, the sequestration rate increased to 870 kg of carbon per hectare per year by not turning the soil over with a plough but, instead, by preparing the seedbed by loosening the soil with a chisel plough (Gadermaier et al. 2012). In conclusion, the combination of organic agriculture and reduced soil tillage is likely to be among the best strategies for increasing carbon sequestration in arable crops. Unfortunately, this technique is not yet widely adopted by organic farmers as it leads to weeds becoming harder to manage.

4.2.6 More efficient nitrogen use

Crop productivity has increased substantially through the use of large inputs of soluble fertilizers – mainly nitrogen – and synthetic pesticides. However, according to a meta-analysis in the United States (Erisman et al. 2008), only 17 % of the 100 metric tons of industrial nitrogen annually applied on conventional farms is taken up by crops; the remainder is lost to the environment.

In a long-term field trial in Switzerland (run since 1978), the total nitrogen input into an organic arable crop rotation was 64 % of the integrated/conventional rotation; the total organic yields over the same period were 83 % of the conventional ones. This shows that these organic farms were using nitrogen in a more efficient and less polluting way (Mäder et al. 2002).

As a result of the limited availability of nitrogen in organic systems, careful and efficient management of fertilizers is required (Kramer et al. 2006). On the other hand, high levels of reactive nitrogen (ammonium NH_4, nitrate NO_3) in soils may contribute to the emission of nitrous oxides, which are a major source of agricultural greenhouse gas emissions. In a scientific meta-analysis based on 12 studies of annual measurements, it emerged that organically-managed soils gave off significantly less nitrous oxide emissions than

[4] Integrated production as an improved conventional farming approach that uses pesticide sprays according to economic thresholds, fertilizes according to nutrient budgeting and some minimum crop rotation requirement.

conventional ones: 492 ± 160 kg carbon dioxide CO_2 equivalence per hectare less (Skinner et al. 2014). However, yield-scaled nitrous oxide emissions were higher - by 41 ± 34 kg CO_2 equivalence t^{-1} DM under organic management (arable land use). To equalize this mean difference in yield-scaled nitrous oxide emissions between the two farming systems, the yield gap has to be less than 17 %. This underlines the importance of addressing yield stability and productivity in organic agriculture especially in the context of greenhouse gas emissions where the negative externalities are global and closely linked to total food production (Rahmann et al. 2008).

The overall performance of organic farming contributing to the reduction of greenhouse gas emissions has been evaluated in Germany through a case study of 40 conventional and 40 organic farms (Hülsbergen & Rahmann et al. 2013) which ran for five years (2009 to 2013). The comparison showed the organic farms had a higher nutrient and energy efficiency and lower greenhouse gas emissions in terms of CO_2 equivalence per product unit (for milk and wheat). Nevertheless, there was more variability in the organic farms than on the conventional ones (Hülsbergen & Rahmann 2013).

4.2.7 Adaptation to climate change

As a result of climate change, agricultural production is expected to face less predictable weather conditions than those experienced during the last century. South Asia and Southern Africa are expected to be the worst affected by negative impacts on important crops, with possible severe humanitarian, environmental, and security implications (Lobell et al. 2008).

Thus, the adaptive capacity of farmers, farms, and production methods will be a key to coping with climate change. As unpredictability in weather events increases, robust and resilient farm production will become more competitive, and farmers' local experiences will be invaluable for permanent adaptation. Organic agriculture stresses the need to use farmers' and farmer communities' knowledge, particularly about aspects such as farm organization, crop design, manipulation of natural and semi-natural habitats on the farm, use – or even selection – of locally appropriate seeds and breeds, on-farm preparation of fertilizers, natural plant strengtheners and traditional drugs, and health care techniques for livestock, as well as innovative and low-budget techniques. Tengo and Belfrages (2004) describe such knowledge as a 'reservoir of adaptations'.

There are many techniques for enhancing soil fertility and thus maintain crop productivity in case of drought, irregular rainfall events with floods, and rising temperature. Soils under organic management retain significantly more rainwater due to the 'sponge properties' of organic matter. Water infiltration capacity was 20 to 40 % higher in organically-managed loess soils in the temperate climate of Switzerland when compared to conventional farming (Mäder et al. 2002). Pimentel et al. (2005) estimated the amount of water held in the upper 15 cm of soil in the organic plots of the Rodale experiment in Pennsylvania, US, at 816,000 liters per hectare. This water reservoir was most likely the reason for higher yields of corn and soybean during dry years. The water capture in the organic plots was approximately 100 % higher than in the conventional ones during torrential rains (Lotter et al. 2003). In addition, the higher proportion of permanent and temporary grassland such as grass-clover leys on organic farms and higher earthworm populations (Pfiffner et al. 2003) reduce run-off and improve infiltration. These factors significantly reduce the risk of floods, an effect that could be enhanced if organic agriculture were practised over much larger areas. Improved physical soil properties and therefore a better drought tolerance of crops have also been observed in on-farm experiments in Ethiopia, India, and the Netherlands (Pulleman et al. 2003; Eyhorn et al. 2007; Edwards 2007).

The diversification of farm activities, which is typical of organic farms, also greatly reduces weather-induced risks. Landscapes rich in natural elements and habitats more effectively buffer climate instability. New pests, weeds, and diseases – the results of global warming – are likely to be less invasive in natural, semi-natural, and agricultural habitats that contain a higher number of species and a greater abundance of individuals (Zehnder et al. 2007; Altieri et al. 2005; Pfiffner et al. 2003).

4.2.8 The health of farmers and rural communities

Organic agriculture is a low risk farming technique where more than 90 % of all pesticides are banned. This is not only an advantage for consumers but, first and foremost, for rural dwellers. In the US, where knowledge about the 'safe' application of pesticides is generally high, at least 20,000 farm workers are poisoned by pesticides each year, according to data from the US Environmental Protection Agency. In an interview survey of the Pesticides Action Network done among 2200 farmers in Africa, Latin America and Asia, the results show that half of those exposed to pesticides suffered from strong acute or chronic symptoms including headaches, nausea, diarrhoea, skin rashes and irregular heartbeat. Hence, organic farming and the experience of farmers with other techniques than chemical ones for securing yields is utmost important.

4.3 Weaknesses of organic agriculture

4.3.1 Yield gap

The fast-growing human population gives rise to the crucial question of whether organic agriculture could feed the world.[5] The indisputable advantages of organic farming in delivering public goods and services would shrink if much more land were needed to produce food (Rahmann et al. 2009). The lower yields of organic agriculture are often the main reason that lead critics to question the sustainability of organic farming. The productivity question is addressed by organic stakeholders by applying strategies of ecological or eco-functional intensification. The impacts of intensification are global and strongly influence the amount of food produced. Most environmental goods and services are absolute and qualitative and cannot be easily quantified. This is especially true of the leaching and run-off of nutrients, such as nitrogen and phosphorous, into ground and surface water, the eutrophication of natural and semi-natural habits, losses of biodiversity on arable land, permanent crops and grassland, soil erosion and soil compaction and microorganism and animal diversity and activity in agricultural soils. While proxies can be used to estimate these impacts, they often defy direct measurement. One quantifiable negative externality of agriculture is nitrous oxide emissions, which are strongly correlated with synthetic nitrogen fertilizer application (Eichner, 1990; Bouwman, 1996).

Two scientific meta-analyses shed light on this important question: the overall yields of organic crops have been estimated to be 25 % (Seufert et al. 2012) lower than conventional ones, based on 316 comparisons, and 20 % lower, based on 362 comparisons (De Ponti et al. 2012).The yield difference is an average for all crops in a range of locations. The categorical meta-analysis showed that productivity in organic crop rotations are likely to be limited by

[5] Posing the question in this way implies that food production and consumption patterns remain largely unchanged.

nitrogen availability, that phosphorous limits yields in strongly alkaline and acidic soils and that only best organic management practices can result in yields comparable to those of conventional farms. Out of 362 studies, 316 define best practice as adequate control of weeds, diseases, and pests. However, when the biodiversity of organic farming is factored in to the same data, the yield gap is reduced or even eliminated (Ponisio, 2015).

Another meta-analysis, that mainly gathered data from a case study in Africa (Hine et al. 2008), indicated that organic farms are more resilient on water-restricted and drought-affected sites and therefore, likely to be more productive than conventional farms (the number of farms in the study was in excess of 1 million, and the yield of the organic farms was 116 % higher than on conventional ones). Major factors that positively influenced the productivity of organic farms were soil fertility building and improved on-farm and in-field biodiversity (better use of natural capital). In addition, there were also many socio-economic factors responsible for the result (improved human and social capital).

The majority of scientists agree that organic farming does not maximize the yield potentials of favourable soils and site climates but has a good total factor productivity (TFP)[6] even under intensive farming in temperate zones (Mäder et al. 2002). In less favourable zones and in regions with predominantly subsistence farming, organic agriculture is an important first step towards an intensification of food production which is mainly driven by farm internal intensification, sustainable practices and improved farmer knowledge.

4.3.2 Social, animal welfare and quality gaps

Organic production in developing and emerging countries is driven by the demand of the fast growing markets in Europe, United States and Asia. Exports are the main focus and domestic markets and self-supply are neglected. The global trade with organic commodities and foods is dominated by companies and traders from Europe and America. This means that the organic standards of Europe and the United States take precedence over local regulations (if there are any) and that inspection and certification bodies are based in Europe and the United States. It is important that the domestic markets are developed together with locally adapted standards and certification procedures.

Fair payments and good living conditions (as specified in the FAO's and WHO's human well-being criteria) are an important principle of organic farming (established in IFOAM's Principle of Fairness). Many consumers of organic foods expect that farmers will get fair prices for their produce farm workers and staff working in processing and trade will enjoy safe labour conditions. Nonetheless, the fair trade ideal is far from fully operationalized in the standards and regulations and is not an inherent part of the certification process.

Another issue is animal health and welfare standards. Consumers often purchase organic meat, eggs and dairy products because they reject the practices of industrial livestock production. However, the quality of animal welfare practiced on organic farms around the world varies considerably (Rahmann 2010). In Europe high levels of animal welfare are only achieved in countries, where specific animal welfare programmes are subsidized by the government, such as in Switzerland. But even there, the reality often differs from the ideals. The removal of horns from beef cattle is still widely practiced. Hybrid poultry—bred for cage and intensive keeping but kept free-range on organic farms often show severe difficulties in behaviour and health. Feather picking and cannibalism are still unresolved problems. Male chicks from laying hen populations are still killed instead of fattened. There are no races of

[6]TFP is the ratio between the aggregation of all inputs used and the aggregation of all outputs produced (Latruffe 2010)

poultry or double purpose breeds used because they do not fulfil the performance and production requirements of farmers. Poultry is still kept in large flocks often with several thousand animals in one barn.

Feeding of livestock is one of the most difficult problems facing organic producers. As a consequence of the BSE[7] crisis, omnivore animals such as pigs and poultry have been turned into pure 'vegans'. While conventional animal husbandry permits the use of synthetically produced feeds, their use is prohibited in organic agriculture. Plant based organic feeds have not yet been able to close the protein gap for fast growing young animals (piglets, chicks) and high yielding animals (sows, laying hens). This makes organic meat economically uncompetitive, causes financial problems for organic farmers in these sectors and raises animal welfare issues. One 100 % organic feed should have come into force in 2012, but this deadline has been postponed several times, now until 2021.

There are some significant differences in the quality of organic and conventional foods. A recent comparative meta-study, based on 342 scientific papers (Baranski et al. 2014), highlighted that organic plant products have a higher density of nutritionally valuable ingredients especially secondary plant metabolites, antioxidants and some vitamins. In addition the meta-study found significantly lower levels of contaminants including cadmium, nitrate and nitrite and other residues, due to organic farming's avoidance of the use of pesticides. These differences have also been documented by regular market surveys, such as those carried out every year since 2001 by the Food Monitoring Agency of Baden-Württemberg[8]. Yet, contamination can also occur on organic farms: higher than normal dioxin loads have been found in eggs and meat as the areas where these animals roam can be exposed to industrial and other forms of air pollution. Other issues include organic fruits and vegetables sometimes not meeting the organoleptic (sensory) expectations of the consumers and problems in processing other organic commodities. Best practices in many countries show that these problems can be resolved, but that they require training and research.

4.3.3 Research gaps

Globally, about 49 billion US Dollars is spent every year on research into food and farming (Beintema et al. 2012). The amount of this spent on developing the knowledge, techniques, and tools that are highly specific to, and in compliance with, organic standards is thought to be far less than one percent of private and public research and development (R&D) budgets (Rahmann et al. 2013; Titonell 2013; Niggli 2008). Innovation on organic farms is, therefore, still largely driven by farmers' own initiatives and far less by scientists and farm advisors. This lack of basic and applied research on organic farming systems is a crucial deficit of organic farming and considerably limits its development.

Despite this the principles of organic agriculture offer ample scope to increase the productivity of farms, through both eco-functional intensification and the smart and selective use of modern techniques and technologies. TIPI's vision and research agenda aims to highlight such potential advances and how more research could contribute to their development. Given the limited amount of research that has gone into organic farming in the past the potential for rapid advances and good returns to research funding is high.

[7] BSE: Bovine spongiform encephalopathy.

[8] www.bvl.bund.de

4.4 Opportunities for organic agriculture

The current and future challenges facing agriculture, especially the fast changing ecological, social and economic context of food security, create many opportunities for the future development of organic agriculture:

i) Reducing the trade-offs between productivity and sustainability: There is a consensus in the most recent scientific and political debates that the long-term productivity of agriculture can only be based on dramatically reducing the trade-offs between food, feed, fuel and fibre production on the one hand and all the other ecosystems services on the other hand (Millennium Ecosystem Assessment reports, 2005; the TEEB report, 2010). Rockström et al. (2009) call for a substantial reduction in the inputs, emissions and impacts of agriculture as their current levels are significantly destabilizing planet's natural balances. The International Assessment of Agricultural Science and Technology for Development (IAASTD) report (2009) and the most recent UNCTAD Trade and Environment report, (2013) both call on policy makers to make radical changes to national and international agricultural policies, the framework for international trade and the support provided to farmers with research and training.

ii) Sufficiency in times of limited resources: The report of the 3rd SCAR Foresight Exercise of the European Commission (EU- SCAR 2011) highlighted that future food security is likely to be defined by expected resource scarcities. The report identified two competing narratives. In the past, the productivity of farms was often, wrongly, considered solely in terms of yields or the productivity of labour. By contrast, the sufficiency narrative recognizes planetary boundaries and the need for behavioural change. According to the definition of the Wuppertal Institute, sufficiency is an inherent aspect of sustainability (Schneidewind et al. 2014).

iii) More multi-actor cooperation is crucial in accelerating innovation in agriculture and food systems. The roots of organic farming were characterized by three types of cooperation: (1) 'farmer-to-farmer' cooperation, which helped to maintain and exchange individual and site specific knowledge; (2) 'farmer-to-scientist' cooperation, which helped to conceptualize organic farming and to improve its agronomic and economic performance; (3) 'farmer-consumer cooperation' which helped to develop a variety of food chains and to link sustainable production with sustainable consumption.

iv) The need for farmers to actively participate in co-innovation. The first concepts of this kind of interaction between science and farm practice were called prototyping (Vereijken 1997). The prototyping strategy sought to address the ecological deficits of conventional farms and the redesigns they came up with pointed towards the need for integrated and organic farming systems. However, prototyping was criticized as being dominated by scientists, not sufficiently integrating farmers and not paying sufficient attention to the diversity of farms and the contexts in which they operate (Leeuwis 1999). More recent approaches place more emphasis on co-innovation and in involving farmers, farm advisors and scientists in all stages of the innovation process in order to ensure relevance, applicability and thereby increase adoption (Dogliotti et al 2014). Off the shelve 'validated packages of solutions' or technology fixes offered to farmers on a 'take it or leave it' basis are unlikely to be attractive to farmers who may need to make significant and complex changes to their farms. Farmers need to be involved from the outset, the more so since they are often a source of innovation.

4.5 The challenges facing organic agriculture

Organic agriculture is still currently a niche: globally only 0.9 % of farm land is certified. However, there are many more farmers who are organic by default and the agroecological farming movement, especially in Latin America and also in Europe (with High Nature Value (HNV)) farms, is much bigger. Breaking out of this niche is proving to be a challenge. Since 2009, the global area under organic certification has grown only slightly (Willer & Lernoud 2014). Markets for organic food are mainly only growing in Europe and the United States and, to a lesser extent, among the fast-growing privileged classes of emerging and developing countries.

The readiness to invest public money into research on organic farming systems depends on the ability to combine a growth in the area of organically farmed land and to demonstrate the positive environmental and social impacts of organic agriculture. Without public support, through schemes such as those which are mostly run in Europe, organic agriculture is unlikely to grow and may even decline.

Innovation on organic farms is both a social and a technical process. The productivity and profitability of farms can be raised by cooperation among farmers and by new models of value sharing along the food chain. Farmer-to-farmer cooperation increases the knowledge base and this can considerably improve production techniques. This kind of innovation can be seen as an improved management of already-existing knowledge. Organic regulations also facilitate science-driven innovation such as bio-control and botanical agents, managing the predators of pests and diseases, marker-assisted breeding techniques and many kinds of precision farming techniques, robots and making full use of information and communication technology (ICT). Other farming systems are able to draw on a far wider array of scientific progress and technologies, which often attracts high levels of funding, which are not permissible under organic standards. These include innovations in molecular sciences, nanotechnology and breeding techniques. These prohibitions are based on the IFOAM Principle of Care which requires precaution in cases where potential risks to human health, the environment and society cannot be excluded (IFOAM 2005). As the scientific progress in these areas is very rapid, we cannot predict whether other farming systems will come to minimize the trade-offs between productivity and sustainability more effectively than organic farming. There has also been an increase in voluntary sustainability standards in recent years which increasingly compete with organically labelled produce (Niggli, 2015; Potts et al. 2014).

5. The current state of organic farming research, globally and by continent

5.1 Global overview

Globally, 43.7 million hectares of agricultural land are managed organically by at least 2.3 million producers. The global market for organic products reached 80 billion US Dollars in 2014 (Willer & Lernoud 2016). The area of organic land, numbers of producers, range of products and market size and share have all grown considerably in the past decade. There has been an accompanying increase in research into organic farming. Up to now, Europe has been at the forefront of research activity, but organic research has recently also increased in other parts of the world, and more players are appearing on the scene. Research is mostly carried out in a national context, but international coordination and cooperative efforts are increasing.

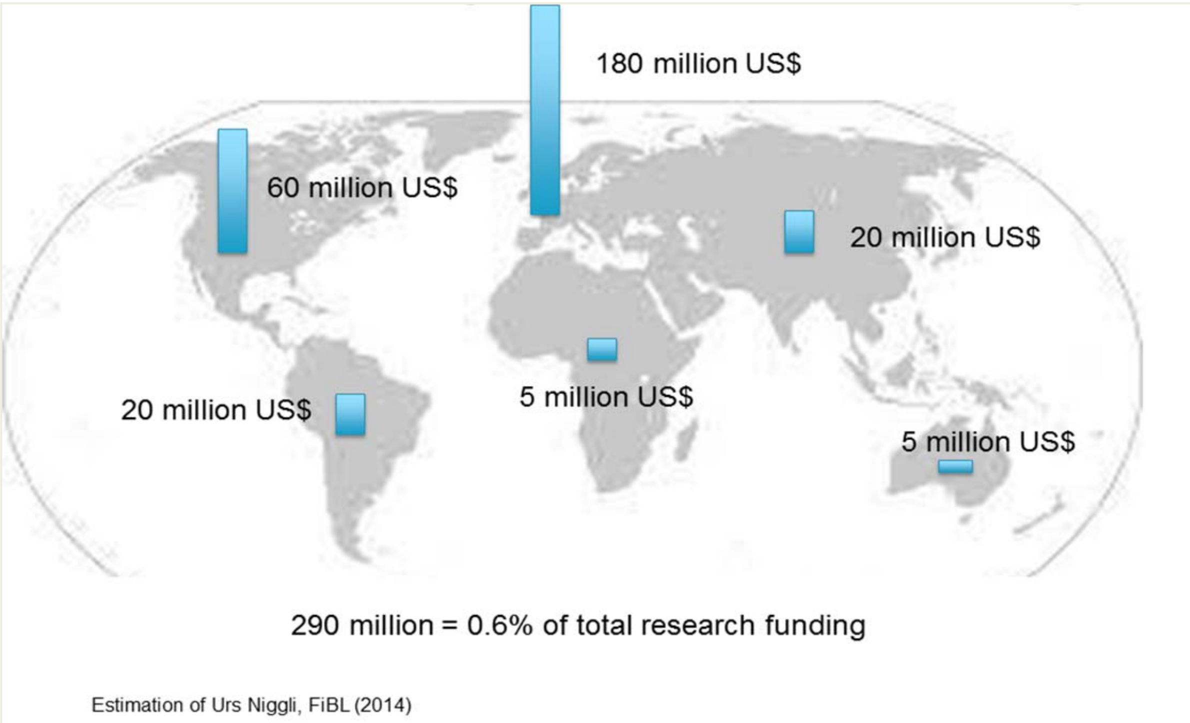

Figure 1: Annual spending on organic food and farming system research. The figures are estimates as it is difficult to differentiate between organic, agroecological, biodiversity, environmental and animal welfare research.

5.1.1 Support for organic farming from international organizations

A number of international organizations are involved in supporting and promoting the organic sector, including research, on a global and/or regional basis. One milestone event was the International Conference on Organic Agriculture and Food Security in 2007,[9] when FAO said that states should integrate organic agriculture objectives within national priorities.[10] FAO runs a website on organic agriculture (www.fao.org/organicag) and over the

[9] Website of the 'International Conference on Organic Agriculture and Food Security', Rome, 03 - 05 May 2007. The FAO website, available at http://www.fao.org/organicag/ofs/index_en.htm

[10] Food and Agriculture Organisation of the FAO (2007): Meeting the food security challenge through organic agriculture. States should integrate organic agriculture objectives within national priorities, FAO says. FAO press release of May 3, 2007. FAO website, available at http://www.fao.org/newsroom/en/news/2007/1000550/index.html

last 20 years has funded several research reports which are highly relevant for organic farming. These include:

- Low Input Farming: Merits and Limits (FAO 1993)
- Biological Farming Research in Europe (Krell 1997)
- Research Methodologies in Organic Farming (Zanoli and Krell 1999)
- Research Methodologies in Organic Farming: On-Farm Participatory Research (FAO 2000)
- Organic Agriculture, Environment and Food Security (El-Hage Scialabba and Hattam 2002)
- Proceedings of the first World Conference on Organic Seed - Challenges and Opportunities for the Organic Agriculture and the Seed Industry (FAO 2004)
- Reports of the International Conference on Organic Agriculture and Food Security (FAO 2007)
- Report on the Africa Conference on Ecological Agriculture (FAO 2008)
- Organic Agriculture and Climate Change Mitigation A Report of the Round Table on Organic Agriculture and Climate Change (FAO 2011)

FAO has also jointly published some reports with other UN organizations, including the United Nations Conference on Trade and Development (UNCTAD), the United Nations Environmental Program and the United Nations Industrial Development Organization (UNIDO). In 2008 UNCTAD and UNEP published the report 'Organic Agriculture and Food Security in Africa' (UNEP and UNCTAD 2008).

The International Trade Center (ITC), a joint agency of the World Trade Organization and UNCTAD, is involved in the publication of global statistical data on organic agriculture (Willer & Lernoud 2016). In order to facilitate the access of producers to organic markets, UNCTAD and FAO also cooperated with IFOAM on the Global Organic Market Access (GOMA) project, which officially ended in 2012. The activities now continue in the new framework of the United Nations Forum on Sustainability Standards (UNFSS), which was officially launched in March 2013.[11]

Apart from these selected activities, organic agriculture is not a high priority for United Nations Organizations. The same is true of research into organic farming. It is notable that e.g. the 'Science for a food secure future report of the Consultative Group on International Agricultural Research (CGIAR 2010),[12] a consortium of 15 international research centres, does not have an organic component. Equally, organic research is not among the research priorities of the Global Forum on Agricultural Research (GFAR).[13]

In developing countries, the concept of organic farming has been tested, further advanced and institutionalized by development cooperation projects funded by the European Union and national aid organizations, including the Dutch Humanist Institute for cooperation (HIVOS), the Swedish International Development Cooperation (SIDA), the Swiss Agency for Development and Cooperation (SDC), the Norwegian Agency for Development Cooperation

[11] IFOAM – Organics International (2016): Information about IFOAM projects for harmonization and equivalence of standards (ITF, GOMA, UNFSS). The IFOAM website at http://www.ifoam.bio/en/ifoam-projects-harmonization-and-equivalence-standards-itf-goma-unfss

[12] Information on the Consultative Group on International Agricultural Research (CGIAR)can be found on their website at www. cgiar.org

[13] Information on the Global Forum on Agricultural Research (GFAR) can be found at their website at www.gfar.net

(NORAD), the German Corporation for International Cooperation (GIZ) and many others. Some of these projects encompass applied research, learning methodologies and training. Some of these north-south cooperation projects are described in the continent-specific chapters that follow.

5.1.2 Conferences

The first international conference on organic farming of the International Federation of Organic Agriculture Movements (IFOAM; today: IFOAM – Organics International) took place in in Sissach, Switzerland in 1977. Today known as the Organic World Congress (OWC), this conference takes place every three years. It is now jointly organized by IFOAM – Organics International and the International Society of Organic Agriculture Research (ISOFAR, www.isofar.org), the leading international society of organic scientists which has been partner in a growing number of national and regional scientific conferences. The proceedings of these conferences provide a global overview of ongoing organic farming research. A list of IFOAM conferences in reverse chronology is given in Table 1.

Table 1: IFOAM/ISOFAR conferences since 1977

Year	Venue	Theme	Proceedings
2014	Istanbul (Turkey)	Building organic bridges	18th IFOAM Organic World Congress (21st IFOAM General Assembly) 4th ISOFAR Scientific Conference at the 18th Organic World Congress
2011	Gyeonggi Paldang (South Korea)	Organic is life	17th IFOAM Organic World Congress (20th IFOAM General Assembly) 3rd ISOFAR Scientific Conference at the 17th Organic World Congress (proceedings available on www.isofar.org)
2008	Modena (Italy)	Cultivating the future	16th IFOAM Organic World Congress (19th General Assembly) 2nd ISOFAR Scientific Conference at the 16th Organic World Congress[14]
2005	Adelaide (Australia)	Shaping sustainable systems	15th IFOAM Organic World Congress (18th General Assembly) 1st ISOFAR Scientific Conference at the 15th Organic World Congress C[15]
2002	Victoria (Canada)	Cultivating communities	14th IFOAM International Scientific Conference (17th General Assembly)
2000	Basel (Switzerland)	The world grows organic	13th IFOAM International Scientific Conference (16th General Assembly)[16]
1998	Mar del Plata (Argentina)	Organic agriculture: the credible solution for the 21st century	12th IFOAM International Scientific Conference (15th General Assembly) (available from IFOAM – Organics International)
1996	Copenhagen (Denmark)	Down to earth- and further afield	11th IFOAM International Scientific Conference (14th General Assembly)[17]
1994	Christchurch (New Zealand)	People-ecology-agriculture	10th IFOAM International Scientific Conference (13th General Assembly)
1992	Sao Paulo (Brazil)	A key to a sound development and a sustainable environment	9th IFOAM International Scientific Conference (12th General Assembly)
1990	Budapest	Socio-economics of organic	8th IFOAM International Scientific Conference (11th General

[14] The proceedings by Neuhoff et al. (2008) are available at http://orgprints.org/13672and http://orgprints.org/13674.

[15] The proceedings by Köpke et al. (2005) are available at http://orgprints.org/4013/

[16] Information on the proceedings by Alföldi et al. (2000) is available at https://www.swissbib.ch/Record/003440397

[17] The proceedings were published by Kristensen, Niels Heine and Henning Høgh-Jensen (1996)

Year	Venue	Theme	Proceedings
	(Hungary)	agriculture	Assembly)
1988	Ouagadougou (Burkina Faso)	Agriculture alternatives and nutritional self sufficiency	7th IFOAM International Scientific Conference (10th General Assembly)
1986	Santa Cruz (USA)	Global perspectives on agroecology and sustainable agriculture systems	6th IFOAM International Scientific Conference (9th General Assembly)
1984	Kassel-Witzenhausen (Germany)	The importance of biological agriculture in a world of diminishing resources	5th IFOAM International Scientific Conference (8th General Assembly)
1982	Boston (USA)	Global perspectives on agroecology and sustainable agriculture systems	4th IFOAM International Scientific Conference (7th General Assembly)
1980	Brussels (Belgium)	The maintenance of soil fertility	3rd IFOAM International Scientific Conference (6th General Assembly)
1978	Montreal (Canada)	Basic techniques in ecological farming	2nd IFOAM International Scientific Conference (5th General Assembly)
1977	Sissach (Switzerland)	Towards a sustainable agriculture	1st IFOAM International Scientific Conference (4th General Assembly)[18]

5.1.3 Networks

In 2003, the International Society of Organic Agriculture Research (ISOFAR) was founded in Berlin, Germany, by the Institute of Organic Agriculture (IOL) of the University of Bonn, Germany, and the Research Institute of Organic Agriculture (FiBL), Switzerland. The goals of ISOFAR are to promote research in organic agriculture, by facilitating global cooperation in research and education and knowledge exchange. The individual scientists who are members of ISOFAR are from all parts of the globe, although the majority reside in Europe, where ISOFAR is based. Major activities include the organization of scientific conferences, the maintenance of a website and the publication of a scientific journal ('Organic Agriculture').

In 2013, TIPI - the Technology Innovation Platform of IFOAM - was founded to engage and involve all stakeholders that benefit from organic agriculture research. The main objectives of TIPI are to develop, and make visible, an organic research agenda that addresses current global challenges, to foster international collaboration in organic agricultural research and to facilitate the exchange of scientific knowledge about organic food and farming systems.

5.1.4 Journals, websites and newsletters

Journals, websites and newsletters are important communication tools for researchers. Increasingly, organic researchers are also publishing in more general peer-reviewed journals and this has helped increase the scientific credibility of organic farming research. ISOFAR has launched the scientific journal 'Organic Agriculture' in association with Springer Science.[19] The ISOFAR newsletter reports regularly about global trends in organic farming research.

The open access Organic E-prints Archive www.orgprints.org now has almost 20,000 entries; mostly from Europe. The archive gives a very good overview of ongoing research, and research institutions are encouraged to use this archive. One constraint on this is that many peer-reviewed scientific papers are subject to the copyright of the publishers and cannot,

[18] The proceedings were published by Besson, J. M. & Vogtmann, H. (1978)

[19] Information on the journal is available at www.springer.com/life+sciences/agriculture/journal/13165.

therefore, be publicly archived. News, events and background on organic farming research worldwide is provided at www.organic-research.net.

5.2 Africa[20]

Box 2: Key figures on organic agriculture in Africa 2014

- 1’263’105 hectares of certified organic agricultural land
- 593’050 producers
- Uganda has the most certified organic land and the largest number of producers (240’197 hectares; 190’552 producers)
- The island state of Sao Tome and Principe has the highest proportion of organic agricultural land (12%)
- The majority of certified organic produce is for export markets.
- Key crops: coffee, olives, cocoa, oilseeds, cotton

Source: Willer & Lernoud 2016

5.2.1 Policy environment

Despite daunting challenges and constraints, the organic sector in Africa has developed greatly over recent decades and many in Africa, including the African Union, recognize that organic food and farming can play a positive role in the continent’s development. Some policymakers and donors recognize the potential of export-oriented organic agriculture as a means of generating foreign exchange and increasing the incomes of smallholder farming households. However, the broader benefits of organic farming often go unrecognized or are simply ignored.

In 2011, the African Union (AU) coined the term ‘Ecological Organic Agriculture’ (EOA); and the African Union’s decision on ecological organic farming (African Union 2011) aims to generate synergies between these two concepts and their practices in order to benefit the continent. The EOA community describes EOA as a production system that sustains the health of soils, ecosystems, and people and which relies on ecological processes, biodiversity and cycles that are adapted to local conditions, rather than the use of costly inputs that can have adverse effects.

The conference ‘Ecological Organic Agriculture – The agricultural alternative for Africa’ took place in November 2011 at the Headquarters of the United Nation’s Environment Programme (UNEP) in Nairobi, Kenya,[21] and helped build the alliances required to capitalize on the African Union’s Decision and to implement the ‘African Ecological Organic Agriculture Action Plan’ (Amudavi 2012).[22] Since then, the EOA Initiative for Africa[23] has been developed with the overall goal of mainstreaming EOA in Africa by 2025 and building capacities in six interrelated thematic areas (‘pillars’) with ‘research, training and extension’ and ‘networking and partnerships’ being two of them.

[20] Contributors: Irene Kadzere, Research Institute of Organic Agriculture (FiBL), Switzerland; Gian Nicolay, FiBL, Switzerland; Brian Baker, US; Urs Niggli, FiBL, Switzerland; Brian Ssebunya, FiBL, Switzerland.

[21] Information about this conference is available at http://bit.ly/1E7VaI4.

[22] The other four pillars of the action plan are: information and communication; value chain and market development; policy and programme development and; institutional capacity development.

[23] Information on this initiative is available at www.eoa-africa.org.

As part of the Ecological Organic Agriculture Initiative (EOAI), IFOAM- Organics International launched the 'IFOAM Organic Alternative for Africa'[24] (TOFA) campaign in 2011. This campaign aims to build a united continental approach to advocating organic agriculture and its multiple benefits and ensuring that EOA is included in national development policies.

5.2.2 Key actors in organic research in Africa

There are some research institutions and universities that have been active, to varying extents, in organic farming research in Africa.[25] These include the Universities of Ibadan and of Abeokuta in Nigeria, the Universities of KwaZulu-Natal and of Fort Hare and the Nelson Mandela University in George, (all in South Africa), the Chinhoyi University of Science and Technology in Zimbabwe, the University of Ghana, Makerere University in Uganda, the University of Nairobi in Kenya, Sokoine University in Tanzania and several others. Another important actor is the Institute of Rural Economy with its Regional Research Centre in Sikasso, Mali (IER-CRRA).

There are further research institutions that carry out organic agriculture projects on an occasional basis. These include the Institute of Insect Physiology and Ecology (icipe) in Kenya, the Kenya state research stations (KARI) and the Agricultural Research Council in South Africa.

The Forum for Agricultural Research in Africa (FARA),[26] and its sub-regional research organizations are committed towards promoting ecological organic agriculture. Such research fits very well with its thematic areas, particularly the cross-cutting theme of 'sustainable intensification through the mobilization of different kinds of knowledge and stakeholders' of the Science Agenda for Agriculture in Africa, which was launched in November 2014 and spearheaded by FARA (FARA 2014). However, the number of research projects in the area of EOA in Africa is still very small in comparison with research on conventional and GMO-related approaches.

5.2.3 Funding and programmes

Funding for organic farming research in Africa is still very limited, particularly from national sources. The EOAI is being implemented in 8 countries in East (Ethiopia, Kenya, Tanzania and Uganda) and West Africa (Nigeria, Mali, Senegal, and Benin) and includes a research component; it is currently funded mainly by the Swedish and Swiss Governments. There are also a number of ongoing transnational research projects in Africa. These projects are variously funded by the European Union, the US, European governments and development agencies. They are carried out by African researchers and stakeholders working with US and European partners. Some examples are listed below.

[24] The Organic Alternative for Africa (TOFA) aims to sensitize governmental decision makers in Africa to the benefits of organic alternatives in achieving sustainable development. Taking a continental approach to advocating organic agriculture, this campaign strengthens the African Ecological Organic Movement and empowers Africans, especially smallholder family farmers, pastoralists, women and youth in both rural and urban communities, by creating new opportunities for organic development. More information is available at www.ifoam.org/en/core-advocacy-campaigns/organic-alternative-africa.

[25] A list of institutions active in organic farming research in Africa is available at www.organic-africa.net/address-directory.html.

[26] The Forum for Agricultural Research in Africa (FARA) is the apex continental organization responsible for coordinating and advocating for agricultural research-for-development. (AR4D). FARA serves as the technical arm of the African Union Commission on matters concerning agriculture science, technology and innovation. More information can be found at http://faraafrica.org.

Table 2: Selected transcontinental research projects on organic agriculture in Africa

Project	Funded by	Running from – to	Countries involved	Coordinator
Productivity and profitability of organic and conventional farming systems (ProEcoOrganicAfrica): A comparative analysis in sub-saharan Africa[27]	Dutch Humanist Institute for Cooperation (Hivos), Swiss Development Cooperation (SDC)	2013-2016	Ghana Kenya Switzerland	Research Institute of Organic Agriculture (FiBL)
Amélioration des revenus et de la sécurité alimentaire des producteurs à travers des Systèmes de Production Biologique diversifiés (SYPROBIO) [28]	EuropeAid	2010-2015	Benin Burkina Faso Mali Switzerland	Research Institute of Organic Agriculture (FiBL)
Sustainability of organic farming in a global food chain perspective	Danish Government	2007-2010	Global	International Center for Research in Organic Food Systems (ICROFS)
Development of organic agriculture, certification and trade in Africa	United States Department of Agriculture	2010	Ghana USA	Washington State University
Farming systems comparison in the tropics[29]	Swiss Agency for Development and Cooperation, Liechtenstein Development Service, Coop Sustainability Fund, Biovision Foundation	Since 2007	Kenya India Bolivia	Research Institute of Organic Agriculture (FiBL)
Productivity and growth in organic value-chains (ProGrOV))[30]	Danish Ministry of Foreign Affairs	2011-2016	Uganda, Kenya, Tanzania, Denmark	International Center for Research in Organic Food Systems (ICROFS)

[27] The project 'Productivity and Profitability of Organic and Conventional Farming Systems (ProEcoOrganicAfrica): A Comparative Analysis in Sub-Saharan Africa' was initiated in 2013 and is being implemented in Ghana and Kenya by FiBL together with the Kenyan Agricultural and Livestock Research Organization (KALRO), icipe (in Kenya), the Dutch Louis Bolk Institute (LBI), the Directorate of Crop Services of the Ghanaian Ministry of Food and Agriculture (MOFA) and the University of Ghana. The policy link of this research project, which is financially supported by the Swiss Government and by the Dutch Government (via Hivos), is provided by IFOAM - Organics International, MOFA and KALRO. This project is implemented in close consultation with local and regional stakeholders in Africa. In Ghana these include: the Ghanaian Organic Network (GOAN), FARA, Ghana COCOBOD and the International Institute of Tropical Agriculture (IITA). In Kenya they include the Ministry of Agriculture, Livestock and Fisheries (MALF), the Kenyan Organic Agriculture Network (KOAN), the Kenyan Institute of Organic Farming (KIOF), the Organic Agriculture Centre of Kenya (OACK), Participatory Ecological Land Use Management (PELUM Kenya) and Macadamiafans Company Ltd. At the regional level, ProEcoAfrica is implemented in close consultation with Biovision Africa Trust (BVAT), the African Organic Network (AfrONet), IITA, and the Forum for Agriculture Research in Africa (FARA). More information is available at www.proecoafrica.net

[28] The EuropeAid-funded project Syprobio (2011-2015) is based on the existing organic cotton value chain, which has been developed by Helvetas since1999, and which is reinforced by the national Centre Régional de Recherche Agronomique (CRRA) from Mali, the Institut de l'Environnement et de Recherches Agricoles (INERA) in Burkina Faso, the Institut National des Recherches Agricoles du Bénin (INRAB) and FiBL.

[29] Since 2007, the project 'Farming Systems Comparison in the Tropics has been implemented in Kenya by FiBL, icipe and the Kenya Agricultural and Livestock Research Organization (KALRO). Other stakeholders include Kenyatta University, the Tropical Soil Biology and Fertility (TSBF) Institute of CIAT (TSBF-CIAT), the Kenya Institute of Organic Farming (KIOF), and the Kenya Organic Agriculture Network (KOAN). This transcontinental project is currently supported financially by the Swiss and Liechtenstein Governments, as well as the Swiss Coop Sustainability Fund and the Biovision Foundation. Information about this project is available at www.systems-comparison.fibl.org.

[30] A collaborative project led by ICROFS and titled 'Productivity and Growth in Organic Value-chains (ProGrOV)' has, since 2010, been investigating the potential of, and developing methods for, improving productivity, growth and sustainable development in existing organic value chains in Uganda, Kenya and Tanzania. It is implemented by Universities in Denmark (the University of Copenhagen), Uganda (Makerere University), Kenya (University of Nairobi) and Tanzania (Sokoine University) together with the national organic organizations from the three countries:. the National Organic Agricultural

With the implementation of the Organic Ecological Action Plan for Africa (Amudavi 2012), it is expected that funding for organic farming research will increase. Under the first pillar of the action plan ('Research, training and extension') the following activities are envisaged:

- conduct a research needs assessment;
- develop research strategies and initiate programmes;
- support research programmes; and
- conduct innovative research.

The expected outcomes of Pillar 1 of the action plan are a comprehensive inventory of research needs and the implementation of operational research programmes, regional research projects and technology packages which facilitate and enhance the uptake of organic farming and its application by farmers and other value chain actors.

5.2.4 Key research themes

To date, there is very limited research that tracks the extent to which organic agriculture approaches are being employed on the ground, or their effectiveness, compared to other conventional approaches, in meeting economic, social and environmental objectives,. Yet, there is growing evidence that the appeal of EOA approaches is increasing and is often proving highly successful in meeting these aims.

During the conference 'Mainstreaming Organic Agriculture in the African Development Agenda', held in Lusaka, Zambia, from 2 to 4 May 2012, participants shared research results from the continent. These largely confirmed that organic agricultural practices increase yields, improve livelihoods and food security, conserve indigenous knowledge, plant varieties and animal breeds, as well as contribute to socio-cultural development. It was also shown that they provide much greater resilience in times of climate extremes, such as drought and heavy rains. [31] During the conference it was decided to formulate a framework and develop a focus strategy and research agenda for promoting ecological organic research in Africa, and this is currently being developed by the Network for Organic Agriculture Research in Africa (NOARA). The participants also recommended that NOARA should be strengthened. During the 2nd East African Organic Conference held in Dar es Salaam, in July 2013, a process to identify the key thematic areas for research on EOA in Africa was initiated during a side event[32] held by NOARA. This was further discussed at the third African Conference in Lagos, Nigeria, in October 2015.[33]

A number of studies, notably those by Niemeyer and Lombard (2003), Svotwa et al (2009), Kisaka-Lwayo (2012), and Kisaka-Lwayo and Obi (2014), and Thamaga Chitja and Hendriks (2008) on organic agriculture in Africa have called for the need to undertake more research

Movement of Uganda (NOGAMU), the Kenyan Organic Agriculture Network (KOAN), and the Tanzanian Organic Agriculture Movement (TOAM), respectively, with funding support from the Danish Government. Information about this project is available at http://drp.dfcentre.com/project/productivity-and-growth-organic-value-chains-progrov

[31] Some information about this conference can be found at http://www.organic-research.net/news-organic-research.html?&tx_ttnews[tt_news]=832&cHash=0f91ae77be96b866f0f272015e789817

[32] http://www.ifoam.bio/sites/default/files/mwatima_juma_deepening_organic_agriculture_research_in_africa_3_july.pdf

[33] The report 'The 3rd African Organic Conference held in Lagos consolidates the progress made on transforming the continental food and agriculture systems' by Gian Nicolay is availabe at the website of the Research Institute of Organic Agriculture (FiBL), Frick, at http://www.fibl.org/en/service-en/news-archive/news/article/veraenderungen-in-den-afrikanischen-lebensmittel-und-agrarsystemen-dritte-afrikanische-biolandbau.html

on the topic of organic agriculture. An overview of current research is still missing but EOAI and NOARA aim to produce one.

5.2.5 Networks and conferences

The African Organic Network (AfroNet),[34] which was formed in 2011 as an umbrella organization uniting and representing African ecological/organic stakeholders, is complemented by the above-mentioned Network for Organic Agriculture Research in Africa (NOARA), which was established during the Organic World Congress in June 2008 in Modena, Italy. The network was then launched in Kampala, Uganda in May 2009, and at the 2nd African Organic Conference in May 2012, Lusaka, Zambia, NOARA was strengthened, and regional committees for Eastern Africa, Southern Africa, Western Africa, and West Africa have been formed (NOARA 2012). NOARA's goals are to create a scientifically sound evidence base supported by research in ecologically sound practices in agriculture and environmental protection in order to increase productivity of crop and livestock production, enhance the value of system outputs, and sustain resilient farming systems. One important current activity of the network is the development of a research agenda for Ecological Organic Agriculture (EOA) as noted in the 2013 NOARA updates (Juma et al. 2013). The EOA was the first high-profile political endorsement of organic farming in Africa.

Box 3: Network for Organic Agriculture Research in Africa (NOARA)

The overall responsibilities of NOARA are outlined in a document titled 'The Development of an Ecological Organic Agriculture Research Strategy and Agenda in Africa' prepared and circulated in 2012 by the NOARA chairperson following the May 2012 Organic Conference held in Lusaka.

- Develop research portfolios by bringing together research domains, functions and institutions that efficiently allocate responsibilities among actors in order to better position organic agriculture and encourage its mainstreaming into national policies.
- Develop research policies and system strategies.
- Support research programme design and management to enhance development of necessary and appropriate technologies, practices and institutions to promote efficiency along the agricultural value chain.
- Manage scientific information by tapping into information and research results from other countries and global sources in order to provide advisory and regulatory functions for EOA.
- Promote public awareness of the importance of science, technology and indigenous knowledge in advancing best practices in EOA through documentation and sharing.
- Foster a scientific community within Africa which recognizes interdependencies with national, regional and international research partners.
- Seek support from credible potential and established and research agencies who can be called upon to support research initiatives.

The Mediterranean Organic Agriculture Network (MOAN), coordinated by the Mediterranean Agronomic Institute in Bari, Italy, is important for North Africa. It has a distinctive focus on research cooperation (Bteich et al. 2010).

A number of important organic conferences have taken place in Africa over the years, at which African organic research results were presented. Probably the first major conference in Africa was the International IFOAM conference that took place 1988 in Ouagadougou, Burkina Faso. The first pan-African conference was held in 2009 in Kampala, Uganda, followed by the 2012 conference in Lusaka, Zambia and another in October 2014 in Cotonou,

34 Information about the network is available at http://africanorganicnetwork.org

Benin. The 4th African Organic Conference took place in October 2015 in Nigeria. Also, some regional conferences have taken place.[35]

5.2.6 Challenges for future organic farming research in Africa

Identification of the research needs and priorities for organic agriculture in Africa has been initiated. The specific needs and priorities to be identified from the various sub-regions of the continent will be consolidated to inform the continental priorities. The section below highlights some of the challenges often reported to be facing organic agriculture in Africa and the research needs that might address them.

Institutional challenges

Most organic agriculture projects are promoted by international NGOs or development agencies and lack governmental support and/or involvement, often due to prejudices against the viability and/or appropriateness of organic farming. Other reasons for resistance to organic approaches include the complexity of its knowledge-intensive nature and resistances by importers of mineral fertilizer and pesticides who fear dwindling markets. National civil societies and domestic consumers are largely not actively engaged in organic related issues.

Challenges related to the development of the sector

African organic agricultural research currently has limited funding support, which is urgently needed to tackle the challenges of developing the organic sector.

There is limited evidence comparing productivity and profitability of organic agriculture with conventional systems. Globally, there are reports and an evidence of a gap of up to 20% (Seufert et al., 2012), but specific figures for Africa are not known. More comparative research is needed that covers the various contexts of African farming.

Subsidies for fertilizers and even in some cases pesticides make organic agriculture less competitive with conventional. African organic producers, face additional costs, especially for certification, limited market access and a lack of development opportunities for the sector. Efforts to address these conditions in a creative and regionalized manner, through for example collective (smallholder group) certification, are being tried. Regionalized organic standards are being put in place, and these, it is hoped, will help increase the domestic organic market and access to it.

There is limited access to certain inputs - such as organic seeds, appropriate equipment for smallholder farms, locally produced bio-control organisms and botanicals for pest and disease control. In addition there is a lack of access to information which reduces the competitiveness of African organic agriculture compared with other global regions. This needs to be addressed and informed by research.

The transition to organic is often hampered by contamination, which lengthens the transition period. This is another area for research.

Because of the diversity of Africa's climates and soils, and its economic, social-cultural and institutional conditions, there are marked differences in its organic farming systems. In its present form, organic farming originated as a production technique practiced on mixed

[35] A list of organic farming conferences is available on the Organic Africa website at http://www.organic-africa.net/1318.html

farms in temperate zones, with an abundant supply of animal manure and organic matter. Adapting organic practices to complex agroforestry systems or the conditions in arid and semi-arid regions poses great challenges, particularly the insufficient supply of organic matter or biomass.

Other major problems also include the low phosphorous availability for plants in both highly acidic and alkaline soils, how to recycle nitrogen without livestock, the prevention and biological management of pests and diseases of a vast range of horticultural and arable crops, the breeding of varieties and landraces suitable for organic conditions, and the management of tropical livestock diseases.

With its huge number of smallholder farmers and rich knowledge of diversified agriculture, organic agriculture can be particularly attractive in Africa. It enables the co-evolution of new technologies for system-oriented practices with traditional and indigenous knowledge. Organic agriculture demands innovative and knowledge-intensive information exchange to generate a dynamic and fruitful cooperation among all those involved.

In order to create employment opportunities, improve ecological and social sustainability in African nations and keep farm families on the land, technological and social innovations are needed. Organic farming responds to the global trends in markets, policies, and social structures to overcome societal and some environmental challenges.

Successful field experimentation and implementation needs to be supported by demand-oriented extension services, technology transfer and knowledge dissemination that is appropriately embedded within institutional set-ups. Particular attention needs to be paid to organic marketing and consumer expectations as these form part of the contextual socio-economics and policies in a highly competitive global market. The question of standards and the definition of ecological organic agriculture (EOA) will be important, as these influence how policy makers and the markets perceive organic farming and will impact on production processes at farm level. It is important to note that, according to how EOA is defined, over 60 % of current African farming produce could potentially meet its requirements (the figure for organic research is currently less than 1 %). Researchers and farmers need to propose strategies and programmes for both the public and the private sectors as to how best to exploit the huge potential of applying organic principles, approaches and technologies in Africa.

Transferring research results from other parts of the world to the Africa situation

On a global level, the organic farming research community is currently seeking to assess and quantify the benefits and impacts of organic farming. The African organic sector wants to see this put within a regionalized (at the level of Africa’s five sub-regions) or even national context in order enhance the credibility of organic farming and of the research itself.

5.3 Asia[36]

Box 4: Key figures on organic agriculture in Asia 2014

- Total organic agricultural area: 3.6 million hectares
- 910’841 producers (mostly in India)
- Leading countries by area: China (1.9 million hectares) and India (0.7 million hectares)
- Highest proportion of organic agricultural land: Timor-Leste (6.8 %)
- Market data are not available for all countries, but we can assume that the market is continually growing. In 2014, China reported 3.7 billion euros of organic retail sales, making the country the world’s fourth biggest market for organic products.

Source: Willer & Lernoud 2016

Due to the high natural and cultural diversity of this continent, we have added a number of individual country reports to the general text about Asia.

5.3.1 Policy environment

Asia is the world’s largest continent in terms of population and area. Most Asian countries are classified as low- to middle-income countries by the World Bank. Yet, the region also includes some of the wealthiest countries in the world on a per capita income basis. There are pressing food security issues in some countries with large populations. Most governments in these countries are promoting policies to increase food production with little consideration of the quality and safety of foods or the environmental impacts of such policies.

Foods consumed locally are grown in ways that have been sustainable for centuries and are often organic in practice. Based on this knowledge and production practices, more sophisticated organic farming techniques could significantly enhance soil fertility and make these traditional farming practices more productive. Local institutions need to be made aware of this potential, particularly in rural areas where population growth remains high. Beyond the supply of traditional ‘organic’ food in rural areas, the establishment of distinct high-value-added markets for organic food could also increase organic production. Some countries in southern and western Asia have a long history of sustainable food production caused by limited access to agrochemicals or farmers’ traditional and religious beliefs. Therefore, there is an already a big organic movement in the region, but it needs to be organized according to international standards and regulations on organic agriculture and market needs. At the same time, organic agriculture needs to demonstrate that it is sufficiently productive, produces high quality and safe food and quantify the environmental services and public goods that it provides.

In some countries of western Asia, organic markets are growing fast and many governments are promoting the development of the sector including providing funds for research and development. More affluent countries in this region, such as Saudi Arabia, are seeing a growing consumer interest for healthy and environmentally-friendly products, and organic operators are called upon to increase organic production to meet growing domestic demand.

[36] With input from (in alphabetical order) Reza Ardakani, Vugar Babayev, Brian Baker, Mahesh Chander, Jennifer Chang, Kim Seok Chul, Marco Hartmann, Shaik Tanveer Hossain, Carolin Möller, Toshio Oyama, Vitoon Panyakul, Mohammadreza Rezapanah, Felix Ruhland, Arun K. Sharma, Sang Mok Sohn, Nazim Uddin, Helga Willer, Qiao Yuhui.

At present, organic regulations have been implemented in 23 countries in Asia (Huber & Schmid 2014), which represents a major step towards prosperous organic markets.

The market size in Asia is estimated to be at least 5 billion Euros of the global organic market in 2014 (Willer & Lernoud 2016), but data is not available for all countries. The Standard for Organic Agriculture[37] of the Association of Southeast Asian Nations (ASEAN) has been formally adopted in late 2014, and a Strategic Action Plan has been developed for its implementation among the ASEAN member states (Ong 2015).

Regarding organic research in the region, the overall situation was summarized in the summary document of the Asia-Pacific Regional Symposium that took place in December 2103. This stated that more organic research is needed, specifically: 'Research in organic farming should be a priority area and organic agriculture should be recognized as a science. Very little is yet known about the complex interactions between the various beneficial and harmful microorganisms, fungi and their effect on plant development and productivity, as well as other areas such as bio fertilizers, pesticides and fungicides. It was reported that less than 0.1 percent of public agricultural research funds is spent on organic research, a percentage that does not correspond to organic agriculture's relative shares of either the market or cultivated area (estimated at about one percent). Private sector research funding is driven to a large extent by large chemical input suppliers. The same incentives do not exist for organic research because organic agriculture promotes the use of local raw materials and resources rather than the use of purchased cash inputs. The Symposium, in its Declaration, called for parity in research funding which would imply that one percent of all agricultural research would be devoted to organic research.' (FAO 2013)

5.3.2 Key actors

In many Asian countries there are already a number of institutions that carry out organic farming research. In many cases some organic farming research takes place at state research institutions such as the Philippine Rice Research Institute (PhilRice), the Organic Food Development Center at the Nanjing Environmental Research Institute and the Tea Research Institute (both in China), and the National Academy of Agricultural Sciences (NAAS) under the Rural Development Administration (RDA) in Korea. In some countries, universities have played a major role in the promotion of organic agriculture. This is particularly true of Azerbaijan and Iran, and in China, where the China Agricultural University (Beijing) plays an important role.

5.3.3 Funding & research programmes

Since 2000, several international organizations, such as the Food and Agriculture Organization (FAO), the International Fund for Agricultural Development (IFAD), the United Nations Conference on Trade and Development (UNCTAD), and the Asian Development Bank (ADB), have promoted applied research in organic agriculture in Asian countries. IFOAM – Organics International has implemented several projects in Asia with international organizations. Though there are no big multi-country projects on organic research in Asia, several projects and activities with international funding have taken place in individual countries, including China. While national funding for organic farming research is limited in most countries in China, the government has paid it considerable government attention in

[37] The standard can be downloaded from the ASEAN website: at www.asean.org/communities/asean-economic-community/category/other-documents-6

the past couple of years, and a number of programmes have been carried out or are ongoing. The same is true for India and the Republic of Korea. In Saudi Arabia, organic farming research is funded as part of the state support policy for organic agriculture. For more information, see the country reports at the end of this chapter. Other Asian countries, such as Sri Lanka, Nepal, Malaysia, Indonesia, Vietnam, and Bangladesh also have organic research programmes conducted by public and private organizations.

5.3.4 Key research themes in Asia

Current research priorities are organic production practices, appropriate technologies, marketing, and policy analysis. Soil fertility, plant nutrition, biological pest control based on permitted organic inputs, issues related to in organic regulations and standards are among the most common research activities.

5.3.5 Conferences

The Asian Network for Sustainable Organic Farming Technology (ANSOFT) has annually held workshops to share organic farming technology and information since 2010. Two workshops (2010 and 2011) took place at the Rural Development Administration (RDA), Korea. Further workshops were held in 2012 in the Philippines, 2013 in Dhaka, Bangladesh, and 2014 in Kathmandu, Nepal. Researchers from the 12 member countries attended the workshop each year. Every year, proceedings are published.

Table 3: Asia: Important regular conferences related to organic agriculture research

Conference name	Organization	Location	Rhythm
ANSOFT Workshops	Asian Food and Agricultural Cooperative Initiative (AFACI)	Korea (2010, 2011, 2013) Philippines (2012) 2014 (Nepal)	Regular
Asian Organic Rice Conferences		Korea and China	Regular
The Korean Organic Conference	Korean Federation of Sustainable Agricultural Organizations	Korea	Irregular
The Organic Scientific Conference	Center of Excellence for Organic Agriculture (CEOA)	Iran	Annual

An important event was the IFOAM Organic World Congress, which was held for the first time in Asia in Korea in October 2011, and it created immense interest in the organic movement in the region. The proceedings of the scientific conference provided insights into the current organic farming research in Asia and globally (Neuhoff et al., 2011). Another major event was the Expo in Korea in the autumn of 2015, which was organized jointly with the International Society of Organic Agriculture Research (ISOFAR).

The Government of Bhutan, in collaboration with IFOAM, Navdanya (an organization for the protection of biological and cultural diversity) and the Millennium Institute organized the ‘International Conference on Organic and Ecological Agriculture in Mountain Ecosystems’ in Thimphu, Bhutan from March 5 to 8, 2014. The country has declared its intention of going 100% organic. The Thimphu Declaration calls for more funds for organic farming research (IFOAM 2014).

In Iran, an annual national scientific conference on organic production systems is organized. The theme of the 2015 conference was organic animal, poultry, and aquatic products. In Korea, a scientific conference on organic agriculture is held, though not annually.

5.3.6 Networks

The Korean Rural Development Administration (RDA) initiated the Asian Network for Sustainable Organic Farming Technology (ANSOFT) to promote information exchange among its member countries and to develop working groups of researchers, international organizations, and national authorities that can generate solid scientific information and thereby contribute to improvements in organic production and agribusiness activities. ANSOFT has twelve member countries.

The Asian Research Network of Organic Agriculture (ARNOA) is a network of individual researchers scattered in 17 Asian countries. It was established on 4th November 2001, at Hangzhou, China during the 5th IFOAM-Asia Scientific Conference. One goal was to develop the ARNOA Standards for Organic Rice Cultivation with funding provided by the Korean RDA. The 3rd ARNOA Conference was held in Yangpyung, Korea, in November 2004.

Table 4: Asian Organic Research Networks

Networks	Members	Activities
Asian Network for Sustainable Organic Farming Technology (ANSOFT)	Network of 12 nations (Bangladesh, Cambodia, Indonesia, Korea, the Kyrgyz Republic, Laos, Mongolia, Nepal, Philippines, Sri Lanka, Thailand and Vietnam) in Asia.	Management of ANSOFT website Workshops and working group meetings Publication of technical reports, newsletters, workshop proceedings, etc. Construction of database for organic farming technology, alternative techniques for pest and soil management, traditional knowledge, and natural resources, especially organic seeds Introduction of organic model farms in each member country to share successful experiences.
The Asian Research Network of Organic Agriculture (ARNOA)	Network of individual researchers	Development of standards for organic rice cultivation Organization of conferences.
The Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia (SATNET)	Institutions	SATNET facilitates knowledge transfer through the development of a portfolio of best practices on sustainable agriculture, trade facilitation and innovative knowledge sharing.
IFOAM Asia	More than 100 members (individual and institutions)	Officially approved by the IFOAM World Board on November 24th, 2012.
Bangladesh Organic Agriculture Network (BOAN)	25 organizations and 70 individuals based in Bangladesh	In 2011 BOAN was formed to coordinate organic stakeholders in Bangladesh. The network is being developed by Bangladesh Agriculture Research Institute (BARI). The main focus of the network is research, advocacy, capacity building and promotion.
Iran: Centre of Excellence for Organic Agriculture	Researchers	Promotion of common research projects, Annual conference
Korean Society of Organic Agriculture	Researchers	Conferences

The Network for Knowledge Transfer on Sustainable Agricultural Technologies and Improved Market Linkages in South and Southeast Asia (SATNET, www.satnetasia.org) is working with institutions that share knowledge on sustainable agricultural technologies and improved market linkages in the region. SATNET facilitates knowledge transfer through the development of a portfolio of best practices on sustainable agriculture, trade facilitation, and innovative knowledge sharing.

After the successful conclusion of the 17th IFOAM Organic World Congress in 2011 many Asian organic stakeholders wanted to build an organic alliance in the region. 'IFOAM Asia' was officially approved by the IFOAM World Board on November 24, 2012 and now has more than 100 members.

There are also a number of networks that operate on a national level. One example is the Bangladesh Organic Agriculture Network (BOAN), which engages in research networking activities, e.g., organizing conferences. Another important network is the organic research network in Korea that regularly organizes conferences and publishes a journal. In Iran, the Iranian Scientific Society of Agroecology (ISSA) serves as an exchange platform for agroecology and organic scientific research, and the Centre of Excellence for Organic Agriculture coordinates research actors and supports the national research initiatives.

5.3.7 Challenges for organic farming research

The challenges for organic farming research are very diverse, and it is difficult to make generalizations. Many of the problems faced by farmers are very specific to location as well as the social, political, and economic context. Thus it is difficult to formulate regional policies or research strategies that are relevant everywhere. The Asian organic industry is still in its infancy, but it is growing rapidly due to market influences. To sustain sufficient levels of production to meet growing demand, organic agriculture needs to be science-based and market-oriented.

Institutional challenges

Public research institutes in most of Asia have limited research programmes on long-term organic research, particularly in mid and low-income countries. Advocacy and demonstration pilot projects are needed to help persuade policymakers to give organic agriculture research a higher priority. Policy dialogues, awareness building programmes, social media, and stakeholder involvement all can play roles in this. In most of Asia, there are few research programmes on organic agriculture, and funding is badly needed. Authorities underestimate the importance of research on organic production technologies and institutions that conduct such research have insufficient resources. Organic agriculture, as an industry, requires pre-, mid- and post-production services. Cultivation, husbandry, preserving, packing, transportation, and marketing all face challenges that demand solutions. Although researchers have accomplished some good results, their research has not been enough to fully address the needs of the rapidly developing organic sector. In many places, extension services are not provided by the government, and farmers cannot afford to hire private consultants. Aside from research, investments in an organic agriculture extension system, technology transfer and knowledge dissemination will be crucial to meet future organic productivity goals.

Research needs

Among the most important research needs in Asia are:

- Increase the production of smallholder farmers as smallholder farmers are a fundamental pillar of Asian society and innovative technology to increase production and support market development is needed.
- An important challenge of the transition to organic agriculture is the management of plant nutrition and protection against pests, diseases, and weeds during the first years of conversion to prevent any yield reduction. More research is needed on these issues.
- Combining traditional agriculture and new techniques is not well developed, understood or implemented. Research in technologies to reduce production risk, integrating modern techniques with the traditional organic farming systems is needed.
- Policy research is also needed to identify conflicts between different policies; propose appropriate policies to support the development of organic agriculture such as subsidies, technology extension, and marketing.
- The organic market is the driving force for the development of the organic industry, and research is needed to study market linkages with organic farmers with competitive, trustworthy, and fair supply chains locally and internationally from production and processing to market.
- Rice is the most important crop in Asia; most rice research in the world is conducted in Asian countries, and more research is needed on rice production under organic conditions.
- Animal husbandry faces different needs throughout the continent.
- Much of the continent is extremely arid, particularly the Arabian Peninsula and Central Asia. Organic farming research is needed to develop appropriate technologies on-farm to further improve farming systems under such dry conditions.
- And finally, research published in Europe and North America needs to be validated under Asian agronomic and socioeconomic conditions in order to support how organic systems are a suitable farming approach for these countries. Documented evidence would help convince Asian policymakers and scientists to fund, support, and become involved in organic agricultural research.

Asia: Country information

5.3.8 Bangladesh[38]

In Bangladesh, organic agriculture has recently gained momentum, and public research organizations are gradually becoming interested in this sector. A number of scientists and academics have received training in organic farming, and are sharing their knowledge with public and private organizations. NGOs play a pioneering role in campaigning for organic agriculture in Bangladesh and are conducting research, mostly on socio-economic aspects.

[38] Nazim Uddin, Bangla Desh Organic Agriculture Network, c/o Bangladesh Agricultural Research Institute BARI, Bangladesh and ShaikTanveer Hossein, Board Member IFOAM-Asia, Friends in Village Development Bangladesh, Bangladesh

Actors in the field of research on organic farming:

- The Bangladesh Agriculture Research Institute (BARI), the largest multidisciplinary research institute, initiated organized organic research on vegetable crops in 2006.
- Some sporadic socio-economic research, ethno-botanical studies, and training have been conducted by a couple of organizations. The Bangladesh Rice Research Institute (BRRI) has some organic-related programmes in the area of agronomical management and soil health management.
- The Bangladesh Agricultural University, Bangabandhu Sheikh Mujib Agricultural University, Sher-e-Bangla Agricultural University, Sylhet Agricultural University and others have been conducting research on themes related to organic agriculture.
- The Bangladesh Organic Agriculture Network (BOAN) and the Bangladesh Society for Organic Farming and Safe Food (BSOFSF) aim toward coordinating and sharing research and development activities. BOAN organized national workshops on organic farming research and development in 2011, 2013, and 2015.

Research programmes

There are a number of research programmes related to organic farming; these include ethno-botanical studies of local food systems, low-input breeding, agroecosystems research, evaluation of genotypes resistant or tolerant to target pests and diseases, the preparation of organic fertilizers and botanicals and their efficacy, the development of effective bio-control methods, the study of species diversity in soil and insects in organic fields, intercropping focusing on balanced nutrient consumption and pest management, farming systems research, postharvest techniques, and consumer research.

The most important challenges for organic agriculture in Bangladesh are the lack of political commitment; the lack of data on organic yields, leading to scepticism about organic agriculture's ability to meet the food security needs of the country; the lack of science-based research evidence and documentation; the lack of national organic standards and certification; the lack of consumers' trust in organic products; and the lack of transparency and poor development of the organic value chain. More organic-relevant research programmes should be implemented by the government research institutes in order to generate and promote new organic methods and technologies.

5.3.9 China[39]

During the early 1990s, the Nanjing Environmental Research Institute under the China State Environmental Protection Agency (SEPA) started two organic research projects, 'Comparative Study on Energy, Material & Economic Flows of Organic and Conventional Production Systems in the Pan-Pacific Area' and 'Comparative Study on the Production of Organic and Conventional Wheat, Rice & Vegetables'. The projects were carried out in cooperation with the University of California, Santa Cruz and with support from the Rockefeller Foundation.

In 1994, the Organic Food Development Center (OFDC) of SEPA at the Nanjing Environmental Research Institute became the first organization to engage in organic agriculture research, certification, training, and promotion. Besides the OFDC, other institutes and universities are also very active in organic research. These include the Agroecology Research Institute and

[39] Qiao Yuhui, China Agricultural University, Beijing, China

the Organic Agriculture Technology Center at China Agricultural University, the Institute of Organic Agriculture at Nanjing Agricultural University, South China Agricultural University, the Tea Research Institute of the Chinese Academy of Agricultural Sciences and the China Certification and Accreditation Institute under the Certification and Accreditation Administration of the People's Republic of China (CNCA).

From the late 1990s to the early 2000s, most of the research projects on organic agriculture in China were funded by international organizations such as the International Fund for Agricultural Development (IFAD), the German Technical Cooperation (GTZ, nowadays GIZ), the AMBER Foundation, Greenpeace, the Asian Development Bank Institute, the International Centre of Research in Organic Food Systems (ICROFS, Denmark), Asialink, and the Asia-Pacific Economic Cooperation.

From the late 2000s, following the development of organic production and the domestic organic market in China, some state authorities also funded projects on organic research. These organizations included the Ministry of Science and Technology (MOST), the Ministry of Environmental Protection (MEP) and the Ministry of Agriculture (MOA). The projects include organic food development and biodiversity conservation in natural conservation areas, the ecological benefits of organic farming, and organic product certification technology research and demonstration. The total grants available for these projects are up to 7 million US Dollars for 3 to 4 years. The research covers the entire organic food chain instead of focusing on one single technique. Local authorities, research institutes and enterprises are also paying more attention to organic research and development. More than half of the projects focus on high-value and complex crops such as organic tea, vegetable, and fruit.

With the expansion of organic agriculture in China, research has been carried out on a wide range of research issues, including:

› organic development, poverty alleviation and capacity building;
› organic production techniques;
› assessment of organic agriculture;
› standards, certification and accreditation, and
› promoting organic education.

Although the national and local governments have given some support to organic research since late 2000s, this still comprises only a small fraction of the entire agricultural research fund. The organic agricultural research and consulting system in China is in its early development stages. Much work is still needed in order for it to develop into a mature research and consulting system.

5.3.10 India[40]

As in most parts of the world most agricultural teaching, training, research, and extension in India concentrates on conventional practices. Only a small fraction of the research budget is spent on organic agricultural research, training, and extension. However, a number of programmes have been funded or are ongoing. Key actors active in organic farming research include the Institutes of the Indian Council of Agricultural Research (ICAR) and the State Agricultural Universities in India, which are developing research projects in different areas of

[40] Arun K. Sharma, Sr Scientist-Agronomy, Division of Integrated Land Use and Farming Systems, Central Arid Zone Research Institute, Jodhpur, India, and Mahesh Chander, Principal Scientist, Division of Extension Education, ICAR - Indian Veterinary Research Institute (IVRI), Izatnagar, India

organic agriculture, including organic research topics chosen by the students for their Master's and doctoral dissertations. For example, the Indian Agricultural Research Institute (IARI) and the Central Arid Zone Research Institute (CAZRI) have taken up projects on the development of organic farming modules for sustainable production and quality in high-value crops. The projects aim to meet nutrient requirements from efficient sources and to develop protocols for use of inputs in organic farming.

The key actors in organic agriculture research are:

- Department of Organic Agriculture, Choudhary Sharvan Kumar Himachal Pradesh Krishi Viswavidyalaya (CSK HPKV University), Palampur, Himachal Pradesh
- ICAR - Central Arid Zone Research Institute, Jodhpur, Rajasthan
- ICAR - Indian Agricultural Research Institute, New Delhi
- ICAR - Indian Institute of Farming System Research, Modipuram, Utter Pradesh
- ICAR - Indian Veterinary Research Institute, Izatnagar
- Kerala Agricultural University, Thiruvananthapuram, Kerala
- Research Institute of Organic Agriculture , University of Agricultural Sciences, Bangalore
- Research programmes and funding for organic farming research

From 2004-2005 (during the 10th Five-Year Plan (2002-2007), the Natural Resources Management Division of ICAR ran a network project on organic farming (NPOF) with the following objectives:

- To study the productivity, profitability, sustainability, produce quality and input-use efficiencies of different crops and cropping systems under organic farming in different agroecological regions.
- To develop efficient crop and soil management options for organic farming.
- To develop needs-based, cost-effective new techniques for farm-waste recycling.

This project involved nine state agricultural universities (SAUs) and four ICAR institutes with a budget of approximately 10 million US Dollars. The Indian Institute of Farming System Research, Modipuram has a division of organic agriculture systems (OAS) with the main objective of improving resource-use efficiencies and soil health for sustainable production systems in different agroecological zones. ICAR is currently developing a base paper on organic farming, for which it has invited suggestions/inputs from different stakeholders. The base paper has a provision to document the research and development interventions including the findings from various research projects undertaken on organic farming in India.[41]

To achieve the objectives of the project, a number of sub-projects were taken up at each of the cooperating centers from 2004-2007, with site-specific changes in respect of crops, crop varieties, cropping systems, inputs (e.g., nutrient sources, bio-pesticides), and cultural practices.

The Network Project on Organic Farming (NPOF) is continuing under India's 12th five-year plan (2012-2017). Recently, in 2015, the Government of India launched a flagship mega-project called Paramparagat Krishi Vikas Yojna (PKVY; Traditional Farming Improvement

[41] More information can be found on the ICAR website at http://www.icar.org.in/en/node/8830.

Programme) [42] with a budget of 47.07 million US Dollars. The PKVY envisages supporting and promoting organic farming and improving soil health. It is expected that this will encourage farmers to adopt eco-friendly methods of cultivation and reduce their dependence on fertilizers and agricultural chemicals and improve yields.

Overall, however, most of the interventions in the area of organic farming so far are developmental in nature with little investment in organic agriculture research.

5.3.11 Iran[43]

Unlike many other countries, interest in organic agriculture in Iran started within universities, when Professor Alireza Koocheki of Ferdowsi University began teaching specific lectures and then courses in the 1990s. While he can be seen as the founder of science-based organic agriculture in the country, the potential for organic agriculture and production had existed for a long time, in particular for crops such as pomegranate, pistachio, saffron, figs, and medicinal plants. Since then a number of post-graduate courses on agroecology are being offered at Iran's universities. Certified organic farming started in 2001 with organic rose-water production in Kerman province, in the south of Iran.

Organic farming was promoted via a national project of the 'Research Committee on Chemical Use Reduction Policy' between 1994 and 2004.

In 2005, the Iranian Scientific Society of Agroecology (ISSA) was established bringing together the active agroecologists and other scientists involved in sustainable and organic agriculture. In 2006, the Iranian Organic Association (IOA) was established, with a focus on market development and trade of organic products. Both organizations have been drivers behind the legislation that instituted the national standards for organic products, established by the Institute of Standards & Industrial Research of Iran (ISIRI). Thus the scientific and market based arms of the organic sector have been growing in parallel.

With commitment from the Iranian Organic Association and support from the Iranian Chamber of Commerce a new branch of IFOAM in the Middle East was established in May 2014, IFOAM-IRAN. This should play an important role in providing Iranian organic farmers, traders, and scientists links with foreign partners, thus opening doors for their activities and produce and accelerating the development of the organic movement in the country and in the region.

In 2012, the Centre of Excellence for Organic Agriculture (CEOA), a scientific consortium consisting of the top universities and research institutes, was approved by the Ministry of Science, Research, and Technology. The goal of the CEOA is to promote research focusing on organic agriculture, through national, regional and international projects on local and nomadic production. The Biological Control Department of the Iranian Research Institute of Plant Protection (IRIPP), a research institute in the Ministry of Agriculture, hosts the Secretariat of the research committee and has provided a strategic programme of research into organic agriculture that was approved in March 2012. This strategic programme is intended to ensure the quantity and quality of organic research in Iran over the coming decade. It has also provided support to research on native organic inputs which has

[42] More information about the Paramparagat Krishi Vikas Yojana project is available at the General Knowledge Today website: http://www.gktoday.in/blog/paramparagat-krishi-vikas-yojana/ ttp://www.gktoday.in/reference/paramparagat-krishi-vikas-yojana

[43] Reza Ardakani, Azad University, Karaj, Iran, and Mohammadreza Rezapanah, Iranian Research Institute of Plant Protection (IRIPP), Tehran, Iran

stimulated the development and use of locally produced biological control agents (BCAs) and biological fertilizers.

Recently, the Ministry of Agriculture established the Cropping Systems Research Department, a new department with a focus on sustainable agriculture which includes organic agriculture among its areas of interest. A number of research projects related to organic agriculture production, processing, and marketing strategy have been started by the universities and governmental research institutes (including Ferdowsi University; Azad University; the Agricultural Research, Education and Extension Organization with participation from the Soil and Water Research Institute, the Animal Science Research Institute, the Iranian Research Institute of Plant Protection and the Seed and Plant Improvement Research Institute).

An annual scientific organic conference is held. In 2015, it focused on organic animal, poultry, and aquatics products and was organized by Guilan University, supported by the CEOA.

5.3.12 Korea[44]

The Korean Organic Farmers Association (KOFA) has established education, training, and a research programme and is a key actor in the sector. The Korean government provides research, education, training, and other support services to the organic sector through the National Agricultural Cooperative Federation (NACF), the Rural Development Administration (RDA), universities, and state agricultural research institutes, including the Environment-Friendly Agricultural Research Center (Jeonnam province) and the Organic Agriculture Institute (Gyeongbuk province) under the Agricultural Research and Extension Services. The Journal of Organic Agriculture, which is published by the Korea Association of Organic Agriculture, is regarded as an organic academic journal of high quality.

In the Cheonan Province, the Research Institute of Organic Agriculture (RIOA) of Dan Kook University was established to advance joint industry-academic research for the promotion of organic agriculture with an emphasis on scientific technology, the promotion of organic agriculture, and the improved harmonization and global competitiveness of Korean organic agriculture. Since 2002, RIOA has also offered a one-year Advanced CEO Course for Organic Agriculture and trained more than 480 farmers.

In 2006, the Organic Agricultural Research Team, funded by the RDA, was established to meet the challenges of organic farming research in Korea. Research funds of about 3.6 million US Dollars have been provided annually to develop organic farming technologies. The Korean government has driven environmentally friendly agricultural policies to expand organic cultivation areas, promote agricultural products of high quality and safety, and provide proper organic farming technologies to farmers since 1996.

With the expansion of organic agriculture in Korea, national cooperative research has been carried out focused on a wide range of issues,

- Seed production and the selection of appropriate cultivars.
- The establishment of nutrient cycling systems between crop production and livestock farming.

[44] Kim Seok Chul, director of the organic agriculture division of Rural Development Administration (RDA); Sang Mok Sohn, Dankook University, Anseo-Dong, Korea; Jennifer Chang, IFOAM Asia, Seoul, Republic of Korea.

- The sustainable development of organic crop production, and on soils and nutrient management.
- The elucidation of multi-functionality and changes in biodiversity under organic agriculture.
- The establishment of low-input resource-recycling systems.
- The formulation and scientific verification of farm-made liquid fertilizers.
- The evaluation of nutrient utilization rates and the quality of organic materials.
- The development of nursery soil and seedling cultivation methods.

The RDA hopes to contribute to the development of global organic agriculture. At the occasion of the 17th Organic World Congress (OWC), held in Korea, the RDA established an international award – the Organic Farming Innovation Award (OFIA) - for organic agriculture research. The objective of this award is to disseminate good techniques globally for ecosystems and organic agriculture, promote scientists studying locally available organic farming technology in developing countries, and support global R&D and international collaboration among organic researchers. The award is meant to promote global cooperation and innovation of organic agricultural R&D especially for environmental conservation, increasing biodiversity, and the development of traditional knowledge and culture. The OFIA committee selects an award recipient every three years. The first award was presented at the 17th OWC in Korea and the second, in Turkey in 2014. RDA and IFOAM will collaborate through a strategic partnership to maintain the continuity of this award.

Twice a year, in Korea, the Organic Farming Technology Committee (OFTC), composed of organic farming experts, researchers, professors, farmers, farmers' associations, politicians, currency experts, and consumers, discuss current and pending issues in organic farming. In addition, the OFTC explores technical demands for new organic research projects and hands them over to organic researchers.

5.3.13 Saudi Arabia

The Department of Organic Agriculture (DOA) and the Saudi Organic Farming Association (SOFA) are the most important actors in the organic sector in the Kingdom of Saudi Arabia (KSA). National standards are based on the organic regulation of the European Union, with some specific local conditions that address the arid environment. The fast-growing sector is supervised by the Department of Organic Agriculture in the Ministry of Agriculture, which ensures that the policy framework conditions favour the development of the organic sector. In 2011, the Ministry of Agriculture delegated the development of the Organic Agricultural Policy to GIZ, a German provider of international cooperation services for sustainable development, as a key activity of its Organic Farming Project (OFP). The OFP finalized a comprehensive organic support policy concept in mid-2012, incorporating input from numerous Saudi stakeholders and drawing on international expertise. The organic agricultural policy links market orientation with a resource oriented strategy and is focusing on the following four major objectives: 1) an increase in productivity and in the number of organic farms, 2) the production of healthy foods, 3) the conservation of natural resources, and 4) the preservation of water and sustainable water use. Policy priority measures have been suggested by the OFP that are designed to achieve these objectives.

The Organic Farming Research Center (ORC) was designated by the Saudi Ministry of Agriculture in June 2009 to conduct organic agriculture research in Saudi Arabia. Located in Qassim region, the ORC is a research institution that trains farmers in organic production methods and delivers farm-based consultancy on special topics. It is Saudi Arabia's first organic research centre, and its main areas of expertise are soil science, horticultural science, plant protection, and biodiversity. The ORC is improving its capacity for playing the lead role in the coordination and implementation of research and extension services related to organic agriculture. Despite a clear public focus on developing organic farming research, at present, the center may still be considered to be in its infancy. The ORC is a learning centre for public and private stakeholders and has conducted a variety of activities and events to promote organic farming. It is seeking to shift its research activities closer to farmers' fields to provide better hands-on solutions to the technical challenges faced by farmers and to build a stronger link between research and extension activities. The centre is dedicated to deliver practical solutions to meet organic producers' needs throughout the Kingdom (Hartmann et al. 2012).

5.4 Europe

Box 5: Key facts and figures on organic farming in Europe 2014

- 11.6 million hectares of agricultural land managed organically
- Almost 340'000 farms
- 2.3 % of the agricultural area is organic (European Union: 5.7 %)
- Twenty-seven percent of the world's organic land is in Europe
- Countries with the largest organic agricultural area are Spain (1.7 million hectares), Italy (1.4 million hectares), and France (1.1 million hectares)
- Eight countries have more than 10 % organic agricultural land including Liechtenstein (30.9 %), Austria (19.4 %), Sweden (16.4 %), Estonia (16.2 %), and Switzerland (12.7 %)
- Sales of organic products: 26.1 billion Euros (European Union: 23.9 billion Euros), strong annual growth
- Largest markets for organic products: Germany (retails sales of 7.9 billion Euros), France (4.8 billion Euros) and the UK (2.3 billion Euros)
- Consumption of organic food: more than five percent in several market

Source: Willer & Lernoud 2016

5.4.1 Policy environment

In recent years, policymakers in Europe have come to recognize the dual role of organic farming. On the one hand it strives to meet consumers' demand for high quality products. On the other, it fulfils an important role in securing certain public goods including the protection and improvement of water and soil quality and the enhancement of biodiversity, that result from organic land management practices (European Commission 2004). This understanding began to emerge in the early 1990s, when organic farming was legally defined under EU Regulation (EEC) No2092/91, and when organic farming support payments for conversion and maintenance were introduced under the Common Agricultural Policy (CAP). The development of the EU regulation included a full revision of the regulation, culminating in the adoption of European Organic Regulations (EC) No 834/2007. Another revision is currently in progress. On 24 March 2014 the European Commission published a new legislative proposal for organic regulation complemented by annexes, an impact assessment report and a new European Organic Action Plan (European Commission 2014). Similar developments have taken place in non EU countries, where organic farming is both legally protected and financially supported. As in the EU, over time, in these countries, recognition of organic farming has also extended into other policy areas such as research and innovation.

5.4.2 Key actors

The most important research actors in Europe fall into three main categories: universities, state and privately run research centres. The most prominent institutes are listed in Table 5-

Table 5: Selection of key research centres in Europe

Categories	Key actors (sorted by country)
Universities	• University of Natural Resources and Life Sciences, Vienna (Austria) • University of Tartu (Estonia) • ISARA Lyon (France) • Technical University of Munich (Germany) • University of Applied Sciences Eberswalde (Germany) • University of Bonn (Germany) • University of Hohenheim (Germany) • University of Kassel in Germany - with an entire faculty of organic agriculture (by far the biggest in the EU) • Corvinus University Budapest (Hungary) • Polytechnic University of the Marche in Ancona (Italy) • University and Research Centre Wageningen (the Netherlands) • The University of Aarhus, the Swedish University of Agricultural Sciences (Sweden) • University of Barcelona (Spain) • University of Applied Sciences Zurich/Wädenswil (Switzerland) • Coventry University, Agroecology, Water & Resilience (UK) • University of Aberystwyth (UK) • University of Newcastle (UK)
State research centres	• LFZ Raumberg-Gumpenstein (Austria) • International Centre for Research in Organic Food System (ICROFS) as the coordination unit of organic farming research at Arhus University (Denmark) • Finnish Organic Research Institute (Finland) • INRA, INRA Comité Interne en Agriculture Biologique (CIAB) (France) • Bayrische Landesanstalt für Landwirtschaft (Germany) • Thünen Institute (Germany) • Consiglio per la Ricerca e la sperimentazione in Agricoltura (Italy) • EPOK as the coordination unit of organic farming research at the Swedish University of Agricultural Sciences (Sweden) • Agroscope Research Station (Switzerland)
Private research institutes	• Bioforschung Austria in Vienna (Austria) • Research Institute of Organic Agriculture (ÖMKI) (Hungary) • Research Institute for Organic Agriculture (IBLA) (Luxemburg) • The Louis Bolk Institute (Netherlands) • NORSOEK (Norway) • Institute for Sustainable Development (ISD) (Slovenia) • Research Institute of Organic Agriculture (FiBL) (Switzerland, Germany and Austria) • Organic Research Center Elm Farm (UK)

5.4.3 Funding & research programmes

Today, there is substantial funding for research into organic farming research available through national research programmes and/or national organic action plans, as well as through European projects.[45] Even though figures for all European countries are not

[45] Organic research projects funded by the European Union are available at www.organic-research.org/european-projects.html.

available, it is known that the funds of the eleven countries that were part of the ERA-Net[46] project CORE Organic I amounted to more than 60 million Euros in 2006 (Lange et al. 2006). Newer data are not available. Taking into account that organic research is often difficult to differentiate from agroecological, environmental, and animal welfare research, other specialists estimate organic research spending in Europe as being worth up to 140 million Euros. This figure might be more a better estimate as it also should include some research that is done by in-kind projects of state research centers, which is sourced from their general budgets .

Applied research output that is of high relevance for organic farm practices has been produced by various national research schemes. The size of research programmes varies substantially between different European countries, with the most support found in Germany, Denmark, Switzerland, Austria, Sweden, Italy, France, Norway, the Netherlands, Finland, UK and Poland. On the other hand, new EU member states often have little funding for organic research even though their farmers export organic food and feed products to the 'old' member states. Since the Concerted Action 'Channel'[47] was terminated in 2004, there is a lack of sharing of research results and between 'East' and 'West'.

Since the mid-1990s more and more organic farming research projects have been funded under the framework programmes of the European Union (EU) (Figure 2). In addition there are several EU projects that do not have organic farming as their focus which carry out research related to organic farming. In the Seventh Framework Programme for Research and Technological Development, launched in 2008, 13 projects focused on organic farming.

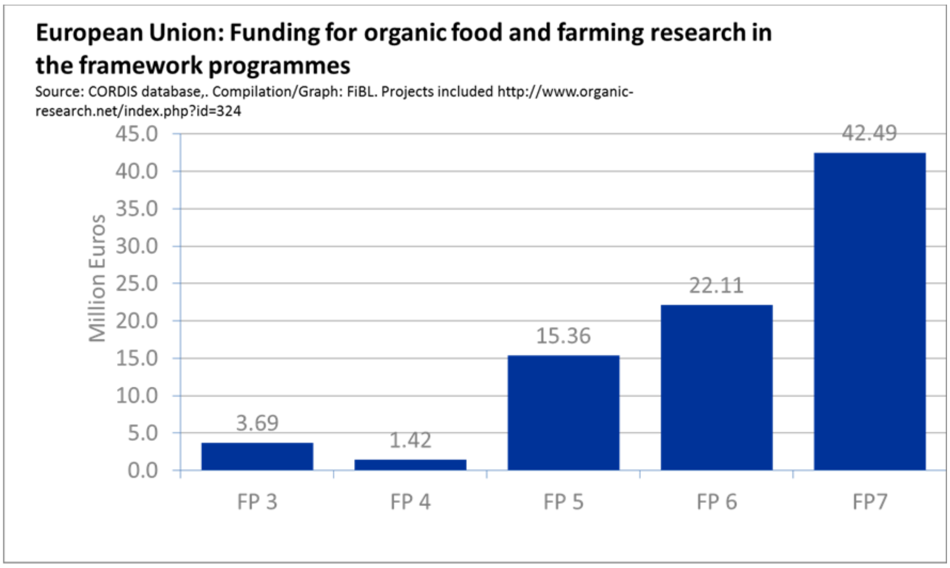

Figure 2: Increase of funding for organic food and farming research under the research framework programmes of the European Union. Source: CORDIS database, projects listed at www.organic-research.net

One of the reasons why organic agriculture has increasingly attracted research interest is to better understand the complex agroecological interactions, interventions and responses. Interest has also grown because of the growing economic importance of the sector. In the 6th an 7th EU Framework Programmes alone, five consortia worked on crop rotations

[46] The objective of the ERA-NET scheme is to step up cooperation and the coordination of research activities carried out at the national or regional levels in the Member States and Associated States.

[47] More information about the project 'Opening channels of communication between the associated candidate countries and the EU in ecological farming '(Channel) is available on the CORDIS.lu website at http://cordis.europa.eu/project/rcn/84740_en.html

(including weed control), six on soil fertility building (legumes, cover crops, mulching, organic fertilizers, soil tillage) and twelve on crop protection issues. Another six consortia worked on crop breeding with aspects that were relevant for organic farms (Lutzeyer & Kova 2012; complemented by Niggli 2014)[48]. Many aspects limiting productivity of organic farms have also been addressed in the Integrated Project QualityLowInputFood[49] and in the transnational research cooperation CORE Organic, and CORE Organic II and CORE Organic Plus (ERA-Net scheme).

In its second action plan for organic food and farming, the European Commission is addressing organic farming research (European Commission 2014). Two actions related to organic farming research are suggested. (See box).

Box 6: European Action Plan on organic food and farming: Actions related to organic food and farming research

- Action 6: The Commission will organize a conference in 2015[50] to identify research and innovation priorities for producers in relation to the challenges that may result from the future organic production rules.
- Action 7: The Commission will take into account in the relevant Horizon 2020 formats: a) the need to strengthen research, exchange and uptake of research results through specific measures such as research and innovation actions, thematic networks and other types of 'Cooperation and Support Actions' that address synergies between, on one hand, research outputs of other production sectors and, on the other hand, conventional and organic research; and b) to support ERA-Net or other types of instruments to improve coordination of research among research funding bodies in the EU, in view of presenting joint research calls. (See Table 5 of key actors in organic research in Europe).

Currently the European organic farming sector benefits from the Common Agricultural Policy (CAP), both for direct payments (Pillar 1) and rural development (Pillar 2). Of particular interest in terms of mainstreaming organic farming in rural development is the acknowledgment by EU leaders of the need for agroecological innovation to redirect European agriculture onto a more sustainable path. Innovation is a priority of the next programming period, and will be promoted through the newly established European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI). This is an EU policy instrument supported jointly under the European Union's research framework programme Horizon 2020 and rural development policy until 2020. The main objective of the EIP-AGRI is to bridge the gap between research and farming practice by encouraging stakeholders from different areas of the agri-food system – farmers, businesses, researchers and advisers – to share ideas and experiences, develop innovative solutions to current problems and challenges, and to put the results of research projects into practice.

5.4.4 Networks

There are a number of organic research networks in Europe – on a European level, on a national level as well as permanent thematic levels. CORE Organic - 'Coordination of

[48] www.organic-research.net/european-projects.html?&L=eeknldejqsnizq
[49] www.qlif.org
[50] The conference 'Organic production, Research and Innovation: setting priorities for the future' took place at Expo Milano, may 28-29, 2015. Information about the event is available at http://ec.europa.eu/agriculture/expo-milano-2015/cap-events/organic-farming_en.htm.

European Transnational Research in Organic Food and Farming Systems' intends to increase cooperation between national research activities. CORE Organic Plus, the third CORE Organic project that started in 2014, has 24 partners from 21 countries/regions. The overall objective of CORE Organic is to enhance the quality, relevance and utilization of resources in European research in organic food and farming and to establish a joint pool for financing transnational research in organic food and farming.

The European Technology Platform for Organic Food and Farming (TP Organics), which was founded in 2008, joins the efforts of industry and civil society in defining organic research priorities and promoting them to policy-makers. The TP Organic vision paper, published in December 2008, reveals the huge potential of organic food production to mitigate major global problems, from climate change and food security, to a whole range of socio-economic challenges in rural areas (Niggli et al. 2008). In February 2010, the Strategic Research Agenda, the second major document of TP Organics (www.tporganics.eu) was finalized, underlining research priorities and containing a number of suggestions for research projects (Schmid et al. 2009). The Implementation Action Plan explains how the research priorities and research topics, identified in the Strategic Research Agenda, can be implemented. A focus is placed on funding instruments, research methods, and the communication of results (Padel et al. 2010). Many of the topics covered in these documents were taken into consideration in recent European calls. In July 2013, TP Organics was granted official 'technology platform' status by the European Commission; this status is reserved for outstanding European technology platforms (TPs).[51] TPs are explicitly mentioned as stakeholders to be consulted on EU research priorities in the context of the European Innovation Partnerships and play an influential role in setting priorities for Horizon 2020, the current EU framework programme for research running from 2014 to 2020.

In addition the International Society of Organic Agriculture Research (ISOFAR) and the Technology Platform of IFOAM (TIPI) are both based in Europe.

5.4.5 Conferences

The first international scientific conference on organic agriculture took place in 1977 in Sissach, Switzerland. This was the first IFOAM conference and was organized by FiBL the Research Institute of Organic Agriculture.

There is also a bi-annual conference on organic agriculture organized in German speaking countries; these have taken place regularly for more than 30 years (the first one was organized in 1991), and since 2005 all the papers presented there have been available on Organic EPrints.

In the new member states of the European Union the Bioacademy, which holds an annual conference, has been important. Currently, annual scientific conferences are held under the auspices of ICOAS, the International Conference on Organic Agricultural Sciences.

Furthermore there are a number of national scientific conferences that take place regularly, such as the annual organic producers' conference in the UK or the annual conference of the Spanish Society of Ecological Agriculture (SEAE).

[51] IFOAM EU Group (2013): Organic research and innovation platform, TP Organics, officially recognized by the European Commission. Press release by the IFOAM EU Group of July 17, 2013. Available at www.ifoam-eu.org/en/news/2013/07/17/organic-research-and-innovation-platform-tp-organics-officially-recognized-europe

5.4.6 Challenges for organic farming research

The current focus of European stakeholders in organic food and farming is on achieving further increases of productivity within the means of ecosystem functions ('eco-functional intensification') specifically on soil fertility, nitrogen fixating leguminous (inter)crops, functional biodiversity, botanicals and bio-control agents and the genetic robustness of crops and livestock. In addition to make better use of the natural capital available to promote farm productivity, this research priority also looks at the integration of precision farming, robot technology, Information and Communication Technology (ICT) and sensor technologies in farm management. Research projects are targeting the bottlenecks facing organic farming in temperate zones, in both, annual and perennial crops.

A second set of priorities look at the role organic agriculture can play in order to keep rural areas economically, ecologically and socially attractive ('empowerment of rural areas'). Many of the research projects needed for these second priorities target the power of social innovation for improved farming systems and food chains. Some key words are farmer-to-farmer learning, farmer-to-consumer partnerships or joint innovation of farmers, farm advisors and scientists. Ethical and political questions of agriculture such as profit sharing along the food chain, fair trade models, the true cost accounting approach in agriculture to better internalize external costs and animal welfare are also part of this second research priority.

A third set of the future European research priorities revolves around the quality of food ('healthy food for well-being'). These classical themes for organic research deal with how organic management practices improve the farm gate quality of foods, food processing technologies and packaging materials used with organic produce ('gentle food processing technologies'), the interactions between food quality, food eating patterns and human well-being and changing social perceptions of food qualities.

All these priorities have been identified nationally by intensive stakeholder dialogues in many countries, especially in Austria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Norway, UK, Sweden, Switzerland, the Netherlands and others. The 25 partners of the transnational research cooperation CORE Organic Plus[52] have also regularly mapped research priorities in Europe's different regions. The Mediterranean Agronomic Institute of Bari, which coordinates the Mediterranean Organic Agriculture Network, regularly synthesizes the research needs of organic producers and food companies in southern Europe, Turkey, the Near East and North Africa (Bteich et al. 2010).

[52] Information about the CORE Organic Plus project is available at www.coreorganic.org

5.5 Latin America and the Caribbean[53]

Box 7: Key figures on organic agriculture in Asia 2014

- Slightly more than 387,000 producers manage 6.8 million hectares of agricultural land (2014)
- 16 % of the world's certified organic land and 1.1 % of the region's agricultural land
- Leading countries are Argentina (3.1 million hectares), Uruguay (1.3 million hectares) and Brazil (0.7 million hectares, 2012 data).
- Highest shares of organic agricultural land are in the Falkland Islands/Malvinas (36.3 %), French Guiana (8.9 %), and Uruguay (8.8 %)

Source: Willer & Lernoud (2016)

5.5.1 Policy environment

Although export markets are still the main driving force for organic growth, domestic organic markets are showing strong growth in many countries such as Brazil and Peru. Most countries have a Third Party Certification System, but also Participatory Guarantee Systems are legally accepted in several countries, such as Peru, and Costa Rica, and commonly used in local markets. There are three countries with the status of 'Third Country' for exporting to the EU, Argentina (since 1992), Costa Rica and Peru. The Inter-American Commission for Organic Agriculture (ICOA) was founded in 2008 by the Executive Committee of the Inter-American Institute for Cooperation on Agriculture (IICA), - composed of the region's ministers of agriculture to contribute to the development of the organic agriculture sector in the region and to facilitate trade in organic products; at the end of 2014, USDA joined. Every year 18 government representatives meet to harmonize organic standards, strengthen control systems and support market development in Latin America.[54]

5.5.2 Key actors in the field of organic research

Key actors in organic research in the region can be found in academia, national governmental research centres and NGOs. The better known research centres include the Centro Latinoamericano de Desarrollo Sostenible (CLADES) in Chile, la Corporación Educativa para el Desarrollo Costarricense (CEDECO) in Costa Rica and the Brazilian Association of Agroecology (ABA). In addition, more recently, private companies have been doing important research in the development of biological or natural inputs for organic farming.

However, it is the farmers themselves were the pioneers and who have done most of the research in organic agriculture for the last 30 years. Since there were few alternatives for them in the market and there was little institutional research happening, they became researchers on their own farms. Many of the technical resources used in the region for organic farming, such as Mountain Microorganism (MM) or Bocashi, were developed through local farmers' research. This situation has led that many university-based organic researchers to seek to collaborate with organic farmers, since most of the knowledge is in their fields.

In academia, there are several universities working on organic farming or agroecology, though more at the graduate level than undergraduate. However, there is an undergraduate

[53] Gabi Soto, Tropical Agricultural Research and Higher Education Center, Costa Rica

[54] More information about the Inter-American Institute for Cooperation on Agriculture (IICA) and its organic programme is available at http://www.iica.int/eng/programs/innovation/Pages/Agriculturaorganica.

programme a B.Sc. in Agroecology at the National University in León Nicaragua and the University of Chapingo.

Research in organic farming that is funded by governments is a relatively recent activity in the region, and represents just a small proportion of the total investment in agricultural research. Research in organic production is usually not an institutional political decision, but rather the effort of individual researchers committed to this field. However, it is common to find a 'sustainable agriculture' research theme with topics such as biological control, composting, agroforestry, etc. What is frequently absent is the integration of those topics to define an organic production system.

Table 6: Examples of research and training programmes in agroecology and organic farming in Latin American universities

Country	University	Department or Section dedicated to organic farming
Argentina	La Plata University	Agroecology Programme
Brazil	EMBRAPA	EMBRAPA Agrobiología
Colombia	Antioquia University National University (Medellin) and SOCLA[55]	PhD Programme in Agroecology Support of the University of California, Berkeley
Costa Rica	Costa Rica University (UCR)	Programme in Organic Agriculture: researchers working together to promote organic research
Costa Rica	National University (UNA)	Master's in ecological agriculture
Mexico	El Colegio de la Frontera Sur[56] (ECOSUR)	
México	Chapingo University- CIAO	Centro de Investigación en Agricultura Orgánica-
Nicaragua	National University, León	BS in Agroecology
	National University of Nicaragua, SOCLA	PhD Programme in Agroecology[57] Support of the University of California, Berkeley
Peru	Agrarian University La Molina	El Huerto: line of research in organic agriculture[58]

5.5.3 Funding and research programmes

Investment in agricultural research (conventional and organic) in the region varies widely. On the one hand the three largest countries (Argentina, Brazil and Mexico) invest around two billion US Dollars per year (70 % of the total Latin American investment on agricultural research). At the same time, countries in Central America, such as El Salvador or Guatemala, invest just five million US Dollars a figure that is decreasing year after year (with a 4 to 5 % decrease over the last decade according to Agricultural Science and Technology Indicators (ASTI) and the International Food Policy Research Institute (IFPRI). In most countries, funding for research comes from the government, with the exception of some countries (e.g. Nicaragua and Honduras) where international donors' funds are still the main source of

[55] More information about the National University (Medellin) is available at http://agrarias.udea.edu.co; **Fehler! Hyperlink-Referenz ungültig.**

[56] Information about ECOSUR is available at www.ecosur.mx

[57] More information about the PhD programme in agroecology at the National University of Nicaragua is available at www.una.edu.ni/

[58] More information about the Agrarian University La Molina is available at www.lamolina.edu.pe/hortalizas/agriculturaorg.html

founding. Nevertheless, a mix of these two financial sources is the general situation in the region.

In most countries, state agriculture research funds finance the National Institutes for Agricultural Research (INTA or INIA in Spanish). A few INTA's, such as those in Argentina and Chile (Chillan) have developed agroecological research programmes. In Argentina, INTA, which has multiple research stations, has done research into organic food systems and value chains.

5.5.4 Research themes

Most of the research is oriented towards crop production, particularly fruits, coffee, bananas, and vegetables. There only in few countries, such as Uruguay and Argentina, where there are funds for research in livestock.

5.5.5 Networks

Diverse networks promote collaboration among Latin American organic production and agroecology researchers. The main regional network is SOCLA (Latin America Society for Agroecology[59]) lead by Clara Nichols (University of California, Berkeley and Universidad de Antioquia, Colombia), Miguel Altieri (University of California, Berkeley), and Fernando Funes (Cuba). SOCLA is a member organization created to promote research and communication in agroecology throughout Latin America. SOCLA network works at different levels. There are SOCLA country chapters (e.g. in Peru and Chile), and alliances with national universities such as Universidad de Antioquia in Colombia, or the National University in Nicaragua, with the creation of PhD Programmes in agroecology.

The Iberoamerican Agroecology Network for the Development of Climate Change Resilient Agricultural Systems (REDAGRES[60]) was developed by SOCLA and the Spanish Society for Ecological Agriculture (SEAE) with whom SOCLA maintains close links. The development of this network is financed by the Ibero-American Programme for Science, Technology and Development (CYTED).

Another network is the ELAO (Encuentro Latinoamericano de Agricultura Orgánica), the Latin American Meeting on Organic Agriculture. ELOA organizes conferences to promote farmers' research in organic production. In general, ELAO's speakers are 70% farmers who share their research results, and 30% are academic researchers and technicians. The first ELAO conference took place in Costa Rica in 2003, where the concept was developed and presented as a strategy for Mesoamerica (Central America, Mexico and Colombia) and the Caribbean. After five conferences in the region (in Costa Rica, Cuba, Mexico, Nicaragua, and El Salvador) it was decided to make it a Latin-American platform. Since then, there have been further conferences in Peru, Bolivia and Colombia. ELAO conferences have had always the support of FiBL, Switzerland.

There are also very active national networks such as SOMAS[61] (the Mexican Society of Sustainable Agriculture), which has 175 researchers. They have organized 12 national

[59] More information about SOCLA, the Latin America Society for Agroecology, is available from http://agroeco.org/socla

[60] More information about the Ibero-american Agroecology Network for the Development of Climate Change Resilient Agricultural Systems REDAGRES is available at http://www.redagres.org-

[61] More information about SOMAS, the Mexican Society in Sustainable Agriculture, is available at **Fehler! Hyperlink-Referenz ungültig.**

conferences, and keep a record of publications. There are also networks of NGOs doing research in organic farming, such as ABA,[62] the Brazilian Association of Agro-ecology,

5.5.6 Publications

There are several journals and magazines on agroecology published in the region. The University of Murcia, Spain, in collaboration with SOCLA, the Spanish Society for Ecological Agriculture (SEAE) and Brazilian Association of Agroecology (ABA) publish the Agroecology Journal on line.[63]

The Agriculture Network publishes a Spanish language and regionally focused edition of the LEISA magazine in Peru.

The Tropical Agriculture Research and Higher Education Centre (CATIE[64]) established a journal on integrated pest management, but then transformed the journal by adding an agroecological component; Manejo Integrado de Plagas y agroecologia (MIPA).

Communication of research results to producers has been a major role for NGOs and universities. The NGO Information Service for Mesoamerica for Sustainable Agriculture (SIMAS) has played a major role since 1992 in Nicaragua[65], as have the Centro de Educación y Tecnología (CET[66]) and Centro Latino Americano de Desarrollo Sustentable (CLADES) in Chile.

5.5.7 Challenges for organic farming research

Some of the challenges for organic research are:

- To strengthen collaboration between academic researchers and producers, through a two-way communication strategy.
- To develop a more interdisciplinary research strategy, to design organic integrated farming systems within a fair value chain.
- To promote more nutrient efficient agroforestry systems with the use of soil amendments (i.e. biochar), crop rotations, intercropping, etc.
- Weed management with a better understanding of the ecology and potential use of weeds.
- To promote the development of appropriate equipment for small farmers and farms, in hilly areas.
- To promote research on topics such as livestock production, seed production, fruit production, waste management, postharvest and processing, nutrition and marketing.
- To define appropriate social, ecological and economic indicators for integrated agroecological food systems.
- To promote alternative fair marketing strategies, including more inclusive alternative guarantee systems and short channels of production and consumption.

[62] More information about ABA, the Brazilian Association of Agro-ecology is available here http://aba-agroecologia.org.br.
[63]http://revistas.um.es/agroecologioca
[64]www.catie.ac.cr
[65]www.simas.org.ni
[66]www.corporacioncet.cl

- To articulate more research process with small-scale farmers, to improve not only the production but also the consumption of organic products in family farming systems.
- To consolidate networks among research institutes to cover different bioclimatic regions for the construction of better adapted resilient agroecological systems.

5.6 North America

Box 8: Key figures on organic agriculture in North America 2014

- Total organic agricultural land area: 3.1 million hectares
- Of these, 2.2 million are in the United States (2011 data) and 0.9 million in Canada
- Represents 0.8 % of the total agricultural area in the region and 7 % of the world's organic agricultural land
- US market: Organic food sales rose by 11 % , between 2013 and 2014, to reach 35.9 billion US Dollars (nearly 5 % of total food sales)
- Canadian market: 3.7 billion Canadian Dollars

Source: Willer & Lernoud (2016)

5.6.1 Policy environment

Organic agriculture research in North America has had a long and uneven history. Scientific examination of organic farming methods began over 100 years ago, with the scholarly work of Frank King, who examined the permanent agricultural systems of China, Korea and Japan (King, 1911). North American awareness of Asian, Latin American and European developments in organic agricultural research were soon picked up and integrated into existing research programmes in the US and Canada. North American farmer innovations in organic farming and post-harvest technologies predate the existence of a separate market for organic food, despite the negative image historically held of organic practices by agricultural experts (Lockeretz & Anderson1993).

United States

In 1980, USDA published its Report and Recommendations on Organic Farming, which for the first time officially viewed organic agriculture as a legitimate alternative to conventional farming in the US. The report made numerous recommendations about how research and education in organic agriculture could address a wide range of issues in the American food system, mainly related to water pollution, biodiversity and exposure to pesticides. However, this official approval was short-lived with the appointment of Secretary of Agriculture John Block in 1981. Block called organic farming a 'dead-end' and methodically marginalized organic agriculture within the USDA and creating an explicit agenda to negate any support for organic farmers (Youngberg & DeMuth 2013).

Organic agriculture withstood the USDA's assault, and by the end of the 1980s had recovered and was growing again. With a lack of support from public institutions, a research infrastructure developed in the private sector, led by the Rodale Institute, with programmes from New England to California. While not all the programmes were strictly organic by later standards, these institutions conducted research and working demonstrations of ecological farming systems. The New Alchemy Institute in Massachusetts, the Meadowcreek Project in Arkansas, the Michael Fields Institute in Wisconsin, the Land Institute in Kansas, Farallones Institute in California, and the Aprovecho Institute in Oregon. The Organic Farming Research

Foundation (OFRF) was started in 1990 to conduct original organic farming, starting with a series of on-farm projects. By the end of the 1980s, various state governments also supported ecological, renewable, sustainable and organic farming systems research, including the University of California and its campuses at Santa Cruz, Berkeley and Davis; the University of Maine; and Iowa State University.

With the passage of the Organic Foods Production Act (OFPA) as part of the 1990 Farm Bill, the Federal embargo on organic agriculture research effectively ended, but official support was still years away. The 1990 Farm Bill also authorized the Sustainable Agriculture Research and Education (SARE) program. While SARE funded a number of projects relevant to organic farmers, the mandate was not limited to organic farming systems and it was not practical to conduct large-scale or long-term projects within the constraints of SARE. With support from the USDA's Initiative for Future Agriculture and Food Systems, a coalition of Iowa State University, North Carolina State University, The Ohio State University, Tufts University and the Organic Farming Research Foundation (ORF) formed the Scientific Congress for Organic Agriculture Research or SCOAR. SCOAR held two assemblies and three workshops in 2001 and 2002 to listen to organic farmers' research priorities and OFRF conducted a series of surveys of organic farmers to determine their research needs. Results of the most recent survey were published in 2004 (Walz 2004). The conclusions and recommendations of SCOAR and the organic farmers' survey were published in the National Organic Research Agenda (NORA) in 2007 (Sooby et al. 2007). This led to organized efforts to promote a research agenda to serve the organic farming sector and led to the creation and authorization of the Organic Agriculture Research and Extension Initiative (OREI) in the 2008 Farm Bill [PL 110-234]. Congress also authorized the Organic Transitions (ORG) program.

Canada

Organic agriculture in Canada developed in parallel to the US and Europe, drawing from both the US and UK experiences (Hill & MacRae 1992). The Canada Organic Regime (COR) is implemented by the Canada Organic Office in the Canadian Food Inspection Agency. The framework for the COR is the Organic Products Regulations of 2009 which sets out labelling and certification guidelines, administrative rules/procedures and the key agencies responsible for organic agriculture in Canada. The Canadian Food Inspection Agency (CFIA) is responsible for the monitoring and enforcement of the regulations. Under the regime, certification bodies are accredited based on the recommendation of CFIA-designated Conformity Verification Bodies. The certification bodies are responsible for verifying the application of the Canadian Organic Standards. The Canadian Organic Production Systems General Principles and Management Standards are the property of the Canadian General Standards Board (CGSB) which hosts the Technical Review Committee of the standards. These regulations apply to food and drink intended for human consumption and food intended to feed livestock, including agricultural crops used for those purposes. They also apply to the cultivation of plants. The Canadian Organic Aquaculture Standards are not presently regulated in Canada, but the standards are also the property of the CGSB. The Government of Canada, with the support of leading stakeholders in Canada such as the Canadian Organic Trade Association, has established equivalency agreements or is in negotiation with multiple markets including the European Union, United States, Switzerland, Japan, and Costa Rica. Canadian policy on organic agriculture is influenced by the Canadian Organic Trade Association, the Organic Federation of Canada, and various other provincial and national bodies.

5.6.2 Key actors

Private research organizations in the USA

Prior to the Organic Foods Production Act and official recognition of organic agriculture by the USDA, the private sector led most organic farming research. Rodale Institute was founded in 1947 as the first organization to conduct organic agriculture research in the US. Other research institutions conducting organic agriculture research were founded subsequently and had some successful projects, but most did not have the longevity or impact of Rodale. These included the New Alchemy Institute in Massachusetts, The Meadowcreek Project in Arkansas and the Farallones Institute in California.

The five principle private sector organizations responsible for organic agriculture research in the US are the Rodale Institute, the Organic Farming Research Foundation (OFRF), the Organic Materials Review Institute (OMRI), The Organic Center (TOC), and the Michael Fields Agricultural Institute (MFAI). All have seen significant drops in funding since 2008 (revenues of all 5 private research centers: 7.8 million US Dollars) to 2010 (less than 7 million). While 2011 saw a slight improvement, most organizations were level or declined in 2012. Funding has not recovered to pre-2008 levels. Funding in organic agriculture research has not kept pace with the growth in the organic market or demand. There has been some support for organic farming research at private institutions, including Tufts University and Middlebury College.

Public research institutions in the USA

Most publicly funded agricultural research in the US is carried out in the Land Grant University / State Agricultural Experiment Station (LGU / SAES) system. The system has institutions in every state in the US.[67] In 2011, there were 37 LGUs with certified organic land used for research (OFRF, 2012), up from 18 in 2003.

The USDA also supports the Agricultural Research Service and the Economic Research Service, both of which now have personnel and some field and laboratory capacity that are dedicated to organic agriculture research.

There are many long-established programmes at non-LGU public institutions. These include the Center for Agroecology and Sustainable Food Systems (CASFS) at the University of California, Santa Cruz (UCSC). CASFS grew from a programme founded in 1967, and the farm has been organic since 1971. Steve Gliessman became the first Chair of Agroecology at UCSC in 1983. The Evergreen State College in Olympia, Washington also had a programme that predated the Organic Foods Production Act.

Canada

The Organic Agriculture Center of Canada (OACC) was created in 2001 to serve Canada's organic sector through science and education. OACC has led a number of national initiatives relating to knowledge transfer and communication, research prioritization and leadership in development of the Organic Science Clusters described below.

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[67] The full list of Land Grant Institutions is available at: nifa.usda.gov/sites/default/files/resource/lgu_map_6_25_2014_0.pdf

5.6.3 Funding and programmes

State research programmes on organic agriculture (USA)

OREI was originally authorized to receive up to 16 million US dollars and ORG up to 5 million US dollars. OREI received 16 million US Dollars in 2009 and 2010. In 2011, the funding was increased to 20 million US Dollars and fell slightly to 19 million US Dollars in 2012. Its goals and priorities were set legislatively. Priority was given to projects with an integrated systems approach: several such projects were funded with between 1 and 3 million US Dollars. Several planning grants were given to regions and research areas considered underserved in order to build capacity. Grants were also given for regional or topical conferences. A list of OREI projects is available from the OREI website. [68]. ORG has been appropriated between 3 and 4 million US dollars in every year since its creation except 2013.

Because of the budget impasse, sequester government shutdown and the failure to reach agreement on a Farm Bill in 2013, no OREI or ORG funds were granted that year. The new Farm Bill was signed on February 7, 2014, authorizing funds of 20 million US Dollars per year over five years. However, OREI's funding for 2013 was not carried forward, and several long-term projects were interrupted or stopped as a result. Congress also inserted more restrictive language that may limit the effectiveness of the programme.

Research programmes in Canada

Until 2009, organic research in Canada occurred primarily on a provincial basis at various Universities, and provincial and federal government research stations. The community of organic scientists was relatively small, and there were few scientists who were fully dedicated to studying organic systems. Following a national survey of research needs and a research prioritization process in 2008, the Organic Agriculture Centre of Canada led the Organic Science Cluster (OSC) initiative in collaboration with the Organic Federation of Canada. The OSC's goals are 'to facilitate a national strategic approach to organic science in Canada, link scientists across the country and disseminate the knowledge generated to organic stakeholders'. The Organic Science Cluster identified 10 sub-projects including 30 research activities to be conducted by over 50 researchers plus 30 collaborators in approximately 45 research institutions (Organic Agriculture Center of Canada). The OSC received 8.8 million Canadian Dollars from federal (75%) and industry (25%) sources over four years from 2009-2013. The success of this initiative led to Organic Science Cluster II (OSCII), again a collaboration between the OACC and Organic Federation of Canada which has received 10.6 million CAN Dollars again from federal (75%) and industry (25%) sources over five years from 2013-2018. OSCII is supported by over 65 contributing partners on 37 Research Activities. OSCII includes over 170 collaborating researchers at over 36 institutions across Canada. A variety of research projects also continue outside of the OSCII umbrella at research stations across Canada.

[68] At the website of the Organic Agriculture Research and Extension Initiative (OREI), this list is continually updated and can be downloaded at http://nifa.usda.gov/funding-opportunity/organic-agriculture-research-and-extension-initiative. Go to 'OREI abstracts of funded projects'

5.6.4 Networks

USA

There have been noticeable improvements in many states and a handful of states with strong institutionalized programmes have maintained their continuity. However, institutional continuity is needed on a national basis to maintain programmes and build support in the US. These farmer-researcher networks need to be established on an ongoing basis. Some regional efforts are underway (CERES Trust 2013).

Sporadic attempts have been made to establish conferences that bring together researchers, farmers and other practitioners to share the latest information on organic farming research, going back to the early 1980s. However, there has been no continuity in these efforts. Over the past 15 years, various academic societies, such as the Tri-societies (the Agronomy, Crop Science and Soil Science Societies of America), the Horticulture Society, the Agricultural and Applied Economics Association, and the Institute of Food Technologies have all held workshops on organic agriculture. The first International Organic Research Conference at the American Society of Agronomy, co-sponsored by OECD, ASA and ICROFS, was held on November 1-2, 2014 in Long Beach, CA, with 12 countries represented (Ngouajio 2015) .

To promote continuity, an annual Organic Agriculture Research Symposium (OARS) was started. The first OARS was held at the Midwest Organic and Sustainable Education Service (MOSES) Organic Farming Conference in LaCrosse, WI in February 2015. It was intentionally held at what is now the largest organic farming conference in North America. The event was co-sponsored by the University of Wisconsin and The Organic Center. The next OARS will be held in conjunction with the Ecological Farming Conference at Asilomar in Pacific Grove, CA in January 2016. The sponsors are the University of California and the Organic Farming Research Foundation. The purpose of OARS is to provide current information to farmers, ranchers, extensionists, educators, agricultural professionals and others interested in organic agriculture.

Canada

Organic Agriculture Centre of Canada at Dalhousie University coordinates science and knowledge transfer in organic agriculture. It also coordinates the Organic Science Cluster, industry-supported research and development endeavours in collaboration with the Organic Federation of Canada. The website of the Organic Agriculture Research Centre lists all of these projects and the researchers involved.

5.6.5 Challenges for organic farming research

North American organic agriculture is among the most advanced in the world and has the technological capacity for high production on a large scale. Despite the recent global economic crisis, the organic sector continues to grow as does its research needs. Despite some progress over the past twenty years, researchers in both the US and Canada face limited capacity and an uncertain funding climate. However, there is no question that capacity to conduct organic agriculture research has increased in the US in the past ten years. Whether it will continue to grow, has hit a plateau, or fall as a result of the combined fiscal and economic crises remains to be seen. Continued growth in organic farming research capacity, as well as technology transfer is needed to ensure that the growing needs of the organic sector are met in the future.

5.7 Oceania[69]

Box 9: Key figures on organic agriculture in Oceania 2014 Total organic agricultural land area: 17.3 million hectares.

- Represents 40 % of the world's organic land.
- 22'115 producers.
- Australia: 17.2 million hectares (figures from 2013), 97 % of which is extensive grazing land
- New Zealand: 106,753 hectares (2012 data)
- Samoa: 40'477 hectares.
- Highest share of all agricultural land are in Samoa (14.3 %), followed by Tonga (6.4 %), Solomon Islands (6.3 %) and Kiribati (4.7 %)
- Growth in the organic industry in Australia, New Zealand, and the Pacific Islands: strongly influenced by rapidly growing overseas demand
- In Australia, the domestic market was valued at 1.3 billion Australian Dollars and in New Zealand at 130 million New Zealand Dollars, in 2013.

Source: Willer & Lernoud (2016)

5.7.1 Policy environment

Oceania, which consists of Australia, New Zealand and the Pacific Islands has 40 % of the world's organic agricultural land. Despite this, support for organic farming, including support for organic farming research is limited.

Even though Australia is the country with most certified organic land in the world, overall, there is, as in New Zealand, very little policy support for organic agriculture. Support is, however, given in the area of organic exports, for which the Department of Agriculture is responsible, overseeing and implementing the National Standard for Organic and Biodynamic Produce which is mandatory for exports. Australia, along with New Zealand, was one of the first countries to achieve third country status for organic exports into the European Union. The cost maintaining and implementing the standard is (at least partly) paid for by the organic industry. In 2009, the voluntary Australian Standard for Organic and Biodynamic Products was established for the domestic market (Wynen 2013). This standard is based on the National Standard, but it was more up-to-date and comprehensive.

In 2012, the Government of Australia published the National Food Plan (Department of Agriculture, Fisheries and Forestry, 2012). This paper enabled discussions on directions the government could adopt by joining all governmental food related policies, including organic production, for the first time. The Organic Federation of Australia (OFA) submitted recommendations on this paper to support organic agricultural production in Australia (Leu 2014). The Australian Government is engaging in consultation with stakeholders as part of its continuing dialogue in order to further develop the National Food Plan.

New Zealand has one of the most deregulated and un-subsidized agricultural systems in the developed world, and likewise the rest of the political system is generally much more 'hands-off' than the approach of, say, the European Union. Governments, of both left and right, are unwilling to intervene in promoting particular agricultural sectors over others which means there is little direct support for organic agriculture. The one key activity the government does undertake is the Official Organic Assurance Programme (OOAP) which

[69] Australia: Els Wynen, Eco Land Use Systems, and Tim Marshall, TM Organics Pty Ltd; New Zealand: Charles Merfield, Biological Husbandry Unit Organics Trust, and Brendan Hoare, Organic Systems Ltd; Pacific Islands; Karen Mapusua, Secretariat of the Pacific Community (SPC), Fiji

facilitates organic exports, mostly to the European Union, Japan, Switzerland, Taiwan and the USA. This is paid for by the Organic Export Levy.

There has recently been a concerted effort by Organics Aotearoa New Zealand (OANZ) to bring domestic organic production under similar legal protection to jurisdictions such as the EU and USA. Initial discussions with the Ministry of Primary Industries (MPI) failed, as the idea was seen as a low priority. However, more recent work by OANZ, the MPI and the Ministry of Business, Innovation and Employment (MBIE) are currently proving more fruitful as they focus on developing a single national standard.

In the Pacific Islands the Secretariat of the Pacific Community (SPC) developed a policy brief on organic agriculture in 2009. The policy brief aims to assist governments and others in the region to develop relevant policy stances that will enable organic agriculture to play a part in meeting regional challenges. It contained seven initial policy recommendations. There has since been gradual but steady progress, with organic agriculture increasingly gaining a mention and recognition in national policy and planning documents, such as the recent 'Over-arching sector plan for productive industries' in the Organic Policy of Vanuatu and the Solomon Islands. However, in most cases this has not evolved into legislation although both French Polynesia and New Caledonia have enacted organic regulations that recognize the Pacific Organic Standard as their national reference standard and also recognize Participatory Guarantee Systems for organic certification. The Secretariat of the Pacific Community (SPC), as a regional intergovernmental organization, continues to provide support for coordination and now houses the Secretariat of the Pacific Organic and Ethical Trade Community (POETCom), but the need for developing a longer term financing strategy to support the movement is critical (Mapusua 2014).

5.7.2 Key stakeholders

Australia: Organic Trust Australia – Research and Education (OTA-RE) was set up by OFA as an independent not-for-profit organization in 2009 to enable Australia to facilitate investment in scientific research and education in areas relevant to organic and bio-dynamic agriculture. The Trust is to achieve these goals by attracting funding from private and government sources: it is a charitable trust which accepts tax-deductible donations, provides grants for relevant research, education and industry development, helps investors to find appropriate researchers, negotiates with Research and Development organizations, and provides links to national and international network of research organizations.
The Australian Rural Industries Research and Development Corporation (RIRDC) is a government body and is charged with working with industry to invest in research and development for a more profitable, sustainable and dynamic rural sector.
Some universities and colleges of higher education include organic agriculture courses and do some organic farming research. Courses in organic and sustainable agriculture are taught at Charles Sturt University. Curricula to diploma level are available at some technical and further education colleges (TAFE colleges). Additionally, private providers of short courses such as the Biodynamic Education Centre exist.

New Zealand: The key actors of the organic sector are the association Soil & Health (established in 1941), the two certifiers Bio-Gro and AsureQuality, the Organic Exporters Association, and the Bio Dynamic Farming and Gardening Association in New Zealand. Since 2006 New Zealand has had an umbrella body, known as Organics Aotearoa New Zealand (OANZ). OANZ is the national voice of the New Zealand organic sector and member organizations include organic producers, processors, consumers, exporters, domestic traders

and Maori. As the organic sector's representative body, OANZ delivers leadership, coordination and advocacy at a national level, actively promoting organic production and consumption as being better for our health, our communities, our environment and our economy.
The Biological Husbandry Unit Organics Trust was established in 2001 to manage the organic unit established at Lincoln University in 1976 by lecturer Bob Crowder. It has two main arms: the Organic Training College which teaches certificate level organic horticulture and the Future Farming Centre which is dedicated to the science and extension of permanent and whole-system agricultures and horticultures, such as organic agriculture, ecological agriculture, agroecology, and biological farming, for the benefit of all farmers and growers.

Pacific Islands: The Pacific Organic and Ethical Trade Community (POETCom)[70] is the main body of the organic and fair trade movement in the Pacific region, it has been housed in the Secretariat of the Pacific Community since 2012. POETCom is a membership organization with over 30 members in 13 Pacific Island Countries. Activities include coordination, information sharing, networking, and capacity building programmes as well as establishing a regional certification scheme to support market access and trade. A key role of POETCom is management of the Pacific Organic Guarantee System which includes Third Party and PGS certification and the Pacific Organic Standard. The Pacific High Level Organics Group (PHLOG), an informal grouping of Pacific Island leaders chaired by the Prime Minister of Samoa, provides valuable advocacy support for the organic sector in the region and endorsement of POETCom's aims and objectives (Mapusua 2014). To date, no specific research activities are taking place.

5.7.3 Research funding and programmes

Australia: At present, very little research relevant to organic agriculture is undertaken in Australia (Wynen and Mitchell 2013). In the context of limited government support for organic farming, OTA-RE, continues to develop opportunities for co-funding projects through sponsorships, donations and support for grant applications. A travel grant scheme was established in 2013 to provide support for postgraduate students to attend conferences to present their research.[71] RIRDC initiated the Organic Produce Research Programme in 1996, worth approximately 275,000 Australian Dollars – and based its research priorities on the R&D Advisory Committee's recommendations. However, RIRDC abandoned its organic programme in 2009 on the grounds that organic agriculture in Australia was now a 'mature industry', and hence should look after itself. RIRDC still publishes – or sells – publications of past research on its website.[72] Other Research and Development Corporations (of which there is one for each major agricultural industry) allocate some funding to an organic project on a casual basis. For example, Horticulture Australian Limited (HAL) allocated 1.2 million Australian Dollars to Australian Organic to appoint a horticulture industry development officer whose task is to educate and support growers, and produce a marketing report for 2014.
New Zealand: There is no systematic government or tertiary level research into organic agriculture in New Zealand (i.e. dedicated research teams, professorial chairs), and there are no courses in organic agriculture or academic positions at the two universities (Lincoln and

[70] More information about the Pacific Organic and Ethical Trade Community (POETCom) is available at http://www.spc.int/lrd/the-pacific-organic-a-ethical-trade-community-poetcom
[71] Information is available at http://organictrustaustralia.org.au/travelgrant.html
[72] Information is available at http://www.rirdc.gov.au/search-results?searchCriteria=organic

Massey) that teach agriculture. The main dedicated research organization is the BHU Future Farming Centre, which is a charitable trust. There is also no dedicated research fund for organic research and all funding has to come from either private sources, which are limited, or a range of competitive government funds, some of which are dedicated to agriculture, others being general scientific funds. Organic sectors that are performing well financially are able to fund or part fund research, while others that are less economically well off are effectively left without support. Most research is therefore *ad-hoc* and often small scale. Despite the lack of systematic organic research, the research that is undertaken is done by a wide range of bodies, including universities and government research stations. However, in a number of cases, the scientists have had little understanding of organic agriculture and as such some results have been of limited value. In a number of cases, organic research can be included as part of larger projects, such as www.nzdashboard.org.nz.

OANZ is the body responsible for commissioning the nation's biennial organic market report which pulls together both domestic organic sales and export data and gauges consumer perceptions. The 2016 report will also identify the size of the uncertified organic market and the scale of fraudulent claims.

Pacific Islands: There is no formal research agenda for the organic sector in the Pacific region and research currently occurs in an ad-hoc manner without consultation with the organic industry about priorities. Research is required for crops and products with market potential but also to ensure food security under the pressure of climate change. Pest and disease management and soil fertility are key areas of concern, and low-lying atolls have particular needs with regard to soil fertility and building soil. The Pacific Organic Standard has a section pertaining to climate change and research is also required on cost-effective green technologies for assign value to organic products.

5.7.4 Research topics

Examples of past and present research in Australia include studies on phosphorus management in organic agriculture (Cornish 2007 and Nachimuthu et al 2007) and a comparison of soil properties under organic and conventional farming in Australia (2005) done by a research group from the Agronomy and Soil Science Department at the University of New England (Nachimuthu et al 2007). Furthermore, some studies on economic viability and market development have been published by researchers from the University of New England. Andrew Lawson, a PhD student at UNE's Australian Centre for Agriculture and Law (AgLaw) focuses on the experience of farmers participating in certification systems, and how such certification can assist farmers and non-farmers become more involved in managing agriculture's impacts on the environment. The Food Matters Research Program[73] at the University of Canberra does socio-economic and consumer behaviour research in Australia. OTA-RE has indicated that research in phosphorus is a priority area for the Trust, and hopes to fund projects in that area in the future. Two other topics of priority for the Trust are consumer confidence in organic products – as Australia still has no unified mark for all organic products – and information to the public in general about what organic agriculture is.[74]

As noted above, much organic research in New Zealand is ad-hoc being undertaken by a wide range of research organizations as the opportunities and/or funding arise. Research over the last two decades has been very broad, from highly practical agronomy, e.g. weed,

[73] More information about this programme can be found at http://www.canberra.edu.au/research/food

[74] For more information see http://organictrustaustralia.org.au/index.html

pest and disease management, through to sociological and farm system research, such as www.argos.org.nz. This said, significant amounts of this research has focused on comparing organic with conventional systems, rather than concentrating on improving organic systems and helping organic farmers *per se.*

In the Pacific region, some work has been done by the Australian Center for International Agricultural Research (ACIAR), a statutory authority that operates as part of the Australian Aid Programme. Although the organic sector is not a stated priority for ACIAR it has undertaken some research work in this area and has the potential to become an important stakeholder. ACIAR also work closely with the National Agricultural Institute of Papua New Guinea (NARI), the University of the South Pacific and SPC which also undertake some research activities in the area of organic agriculture.

5.7.5 Networks, journals and conferences

The Journal of Organic Systems (www.organic-systems.org) was started in 2006 as a peer-reviewed scholarly journal, in which researchers could publish their findings on organic systems across a wide range of discipline areas. While the original aim was to focus on the Australasian and Pacific Regions, in recent years, the journal has broadened its scope, publishing papers from Africa, the Middle East, South Asia and Europe. It operates within an increasingly competitive niche in academic publishing as new journals emerge with a focus on organic systems, such as Organic Agriculture (Springer) and Organic Farming (Librello).

The Organics Knowledge Hub (www.organicshub.com.au) is a website, which has a tailored search engine that provides access to Australian research reports content and other targeted sources on the web.

In 2005, the National Association for Sustainable Agriculture Australia (NASAA) organized the International Scientific Conference on Organic Agriculture 'Researching Sustainable Systems' in Adelaide. It was coordinated by the International Society of Organic Agriculture Research (ISOFAR) in cooperation with IFOAM (Köpke et al. 2005).[75]

In New Zealand aside from the JOS (see above) the only other scientific publication applicable to organics is the Future Farming Centre's Bulletin[76] however, this is aimed more broadly at all farmers interested in sustainable techniques and it solely focuses on practical farming information and does not cover other issues such as politics and news, nor does it promote organics, so it cannot be considered a dedicated organic publication. An important magazine is Soil & Health's 'Organic NZ', and there are newsletters or other short 'in-house' type communications of organic organisations.

Over the years there have been a range of conferences, workshops and similar meetings, but, there is no regular / ongoing conference schedule. However, some sector groups, e.g. wine, and dairy, organize their own meetings, which can vary from a few dozen participants for a day and include farm walks, to full-blown multi-day conferences with several hundred participants, overseas speakers, etc.

In the Pacific Islands, POETCom hosts an annual technical exchange, bringing together organic practitioners from the region to share learning and experience, on-farm trials and research. This is a farmer-to-farmer exchange and it is expected that as more formal research takes place in the region that more scientific papers will also be presented.

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[75] The proceedings of the conference are available in the online-shop of the Swiss Research Institute of Organic Agriculture (FiBL), one of the co-organizers of the event https://www.fibl.org/fileadmin/documents/shop/1394-research-sustainable-systems.pdf. The individual papers can be downloaded at http://orgprints.org/view/projects/int-conf-isofar-2005.html.

[76] The bulletin is available at www.bhu.org.nz/future-farming-centre/information/bulletin

5.7.6 Challenges for organic farming research

In 2006, the OFA, the main body of the organic sector in Australia, published its position paper 'Priorities for Research and Extension in Organic Agriculture in Australia' (Wynen 2006), in which it laid out its priorities for research and extension/education.

The conclusion was that, as Australia has such a dearth of funding in this area, it would be best to put most of available funding into information gathering and dispersal as opposed to original research. Educating consumers about organic quality and how to recognize it in the shop/market was considered to be of great importance (and prioritized by OTA-RE, along with identifying bottlenecks in the supply chain). The topic of any research that was going to be undertaken would need to be determined by wide consultation with all stakeholders.

6. What will organic farming look like by 2030? A visionary forecast

6.1 Future challenges for agriculture in general

Since the World Food Summit organized by the FAO in 2009, the dominant challenge facing agriculture, food chains and human nutrition is that of considerably reducing the negative trade-offs that currently exist between productivity and sustainability. This new paradigm is referred to as 'sustainable intensification' by UN organizations, as 'ecological intensification' by the European Commission and as 'eco-functional intensification' by the European Union Group of IFOAM (IFOAM-EU Group) (for related literature, see Buckwell et al. 2014, Garnett & Godfray 2012, and Elliot et al. 2013). This chapter is a brief summary of likely global developments and conflicts that society and the economy will face in the coming decades. More detailed information is available in the Millennium Ecosystems Report (2005), the Report of the International Assessment of Agriculture Science and Technology for Development (IAASTAD 2008) and the UNCTAD Trade and Environment Review (2014).

Foresight studies from different continents unanimously emphasize that several **resources** which are indispensable for agricultural productivity are likely to become scarcer and markedly more expensive. **Fossil fuel energy** is likely to become too expensive to be used to produce **nitrogen**. Forecasts about peak oil vary between 2010 and 2030 (Chapman 2014). The loss of considerable amounts of nitrogen fertilizer is likely to have a significant negative impact on conventional productivity. **Water** has always influenced agriculture – people have either adapted their agricultural practices to make use of the available supply –or failing that have had to migrate, either temporarily or permanently. With the anthropogenic acceleration of climate change, water scarcity has become a global problem. Individual farms, farming communities and systems, whether rain-fed and irrigated are not yet equipped to deal with increased water scarcity or the likelihood of increased and more dramatic flooding and urgently need to put adaptation measures in place (Lobell et al. 2008). **Phosphorous** which is essential for plant growth as it is for all forms of life is mostly mined and is a finite resource. Estimates for when supplies will be exhausted range between 100 and 300 years. The optimistic scenarios are based on the assumption that new sites for mining are continuously being discovered and that current prognoses are likely to be wrong (Heckenmüller et al. 2014; Scholz & Wellmer 2013). The most recent models see no indication of a 'peak phosphorous' situation any soon. Nonetheless all experts urge better recycling of phosphorous and using more phosphorous from organic and mineral pools in soils, a huge but rather inert resource (Cornish 2010; Schachtman et al. 1998).

Ecosystem services will continue to be increasingly threatened by agricultural production. Locally, biodiversity, soil fertility and water quality will suffer and this in turn will reduce agricultural productivity. Globally, the destruction of huge natural ecosystems such as rainforests, coastlines or permafrost systems will increase the planet's climatic instability (Rockström et al. 2009). Some of these negative externalities can be quantified. Food production has globally degraded 60 % of ecosystem services, including over 70% of regulating services, such as maintaining air, soil and water quality (MEA 2005). The growing costs of biodiversity loss and ecosystem degradation for both society (macro-economic costs) and business (micro-economic costs) are already partly known and are horrendous (TEEB 2010). The recent example on bee death, largely a result of the use of certain insecticides such as nicotinoids and habitat-poor landscapes illustrates this problem. Bee death is not only a massive loss of bio-diversity but also has profound economic implications as bees provide a 'free service' pollinating a high proportion of commercial crops, specifically fruit trees. The degradation of ecosystem services will limit future productivity gains and is not likely to be compensated for by technological progress. In addition, intensive soil tillage and the spatial separation of crop and livestock production will increase carbon losses from soils and nitrous oxide emissions. Soil erosion will continue to be a problem, as it is strongly linked to industrialized forms of agriculture in combination with the impacts of climate change. The pace of soil degradation and soil erosion has not been halted although it is a problem that was recognized a long time ago and has been high on the national and international political agendas. The current loss rates of fertile soils suited for agricultural production (both arable land and grazing areas) is 10 million hectares per year (Pimentel et al. 2005) and likely to be higher than per area yield gains by progress in breeding.

Migration of people from the land to the urban and per-urban centres will continue. More than 50 % of the human population already lives in cities. All over the world, farmland is being abandoned and is no longer used for food production. This development is partly mitigated by professional companies buying or renting land from farmers and producing on 'mega-farms' for the global markets ('land grabbing').[77] Productive, knowledge-intensive and site-specific agriculture based on a careful and sustainable exploitation of local, natural resources is not possible under this kind of industrialized agriculture which threatens ecological, economic and social sustainability and further accelerates migration from the land. The estimated climate-change-induced losses in agricultural productivity are estimated to be highest (some 70% by 2080) in those regions with the fastest expected future population growth (i.e. Sub-Saharan Africa and South Asia) thus provoking massive future migration.

All these developments clash with the **growing demand for food**. Current levels of agricultural production are enough to feed more than 10 billion people. But we do not live in an ideal world where everybody has access to good quality and nutritious food. The current economic and political frameworks are unable to solve the tragedy of one in seven people (one billion out of seven billion) being undernourished while the same proportion of people are obese. One third of the food produced in the world is lost after harvest or is wasted in processing, trade and consumption. In addition, a growing portion of arable land is being converted to energy production, often heavily subsidized by public money from both developed and emerging countries.

The Millennium Ecosystem Assessment examines future scenarios and argues that it is possible to respond to these challenges, if we make the appropriate political, institutional and policy changes (MEA 2005). IAASTD (2008) focused on the new approaches needed in research, knowledge creation and learning. Its recommendations emphasize that ecosystem research is the only approach that can successfully cope with food security, that such research needs to be interdisciplinary and to include the indigenous/tacit knowledge of farmers. It also argued that it is imperative that women play a central role, not only in farming, but also in research, teaching, and advising. The IAASTD report also made the case for a precautionary approach to the adoption of new technologies, whose likely impact should be assessed on a case-by-case basis.

[77] According to various estimates, in recent years, foreign land acquisitions in developing countries in monetary terms have been 5-10 times higher than overseas development aid and public investment for agriculture (Institute for Agriculture and Trade Policy, 2012).

Box 10: Extract from the conclusions of the Millennium Ecosystem Assessment (2005)

The challenge of reversing the degradation of ecosystems while meeting increasing demands for their services can be partially met under some scenarios that the Millennium Assessment has considered, but these involve significant changes in policies, institutions, and practices that are not currently under way. Many options exist to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs or that provide positive synergies with other ecosystem services.

To summarize, the future challenges facing agriculture centre on minimizing agriculture's negative impacts and achieving further productivity gains. This is the only way to achieve long-term sustainability and to foster rural development and livelihoods. Recognizing this, the European Commission has already established the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) and in 2013 published a Strategic Implementation Plan (SIP) setting aside a part of the common research budget for this over the coming years.

6.2 Organic agriculture: can it be part of the solution and does it respond to global challenges?

Certified organic agriculture is practices on less than one per cent of agricultural land and is seen by many as tiny niche. As a result many underestimate the extent to which organic agriculture can contribute to solving these global challenges. It is useful perhaps to look at the few countries where organic agriculture is already practiced on 10 % or more of agricultural land. In some marginal or ecologically sensitive areas such as Austrian and Swiss alpine grassland area, organic farms cover more than 50 % of the agricultural land. Where watershed and water catchment management is a priority organic farming is recognized as the most appropriate solution. The same is true of buffer zones between agriculture and nature conservation areas. There is much evidence to show that organic farm management practices halt the loss of species diversity on agricultural land and in the semi-natural buffer zones between wilderness and natural habitats and vegetation. Similarly, there is much evidence that soil erosion is significantly lower than in organic systems than in other forms of agriculture. In many cases, soil fertility and soil structures are rebuilt by organic farming.

All these aspects of organic land management are leading farmers, scientists and others involved in organic agriculture to claim that organic management offers a viable dual strategy for providing 'high quality foods' and 'mainstreaming the best sustainability farm practices', two seemingly contradictory trajectories.

6.2.1 Factors that shape economic competiveness and environmental impact

Organic agriculture is a niche production method, with just 43.7 million hectares of certified land (Willer and Lernoud, 2016): 1 % of global agricultural land. After rapid growth between 1990 and 2009, it has slowed down in recent years. Organic farmers are only really present in significant numbers in a few European countries, especially in Austria with 20 % of the farmland, Sweden with 16 %, in Estonia with 15 %, in Switzerland and the Czech Republic with 12 %. In the global South, only the Malvinas/Falkland Islands, French Guiana and Samoa have 10 % or more organically certified land.

The main focus of organic production is high-quality and high-priced markets in the North. The European and the USA markets represent more than 90 % of all organic sales. Globally, sales of organic food are likely to be less than 1 % of all retail food sales. The profile of organic foods is the superior quality of the raw material, the special requirements for processing that seek to enhance qualities such as authentic, natural, gentle, by using nonevasive techniques, its higher safety levels and better traceability. It also embodies ethical values including animal welfare, fair payments for farmers and farm workers and places a strong emphasis on the precautionary principle. Organic consumers are often (though not always) wealthier members of society. In some countries they can raise the proportion of organic food sales considerably. In Denmark and Switzerland organic food accounts for 8 % of all food sales. In Germany and the United States the figure is around 4 %. Some individual products reach far higher shares. In Switzerland, more than 20 % of eggs sold are organic.

While organic agriculture is a productive system that safeguards public goods and has less negative impacts on the environment, it is not likely to become mainstreamed under the present current codes of conduct and regulations, applied by governments, farmers' associations, and business actors, that shape the organic market today. But we can look at, agroecological farming approaches which function without certification systems, impose fewer restrictions on the use of technologies and have a stronger focus on increasing production through eco-intensification. These approaches, many pioneered in Latin America, also have a beneficial environmental impact and are gaining momentum (Altieri & Nicholls 2006).

More research into organic systems is likely to improve the economic competitiveness of organic farming and organic foods. Most factors which influence productivity and profitability are linked to unresolved agronomic problems and the need for more labour input. Another factor that reduces the economic competiveness of organic agriculture is that the negative environmental and social externalities of agricultural production are not, or only marginally, internalized. Organic agriculture absorbs far more of these costs than conventional production and so is disadvantaged. True cost accounting would address this issue and make organic systems more economically competitive. Earlier attempts to introduce true cost accounting failed, not just because of disinterest among influential economic and policy actors, but also because the scientific community was not able to develop practical solutions. Applying true cost accounting to agriculture would have two main benefits. It would make organic agriculture more economically competitive, and would reduce the negative externalities of conventional farming.

6.2.2 Organic agriculture: an interesting model for agricultural and food research

Organic agriculture provides an interesting model or case-study for how the global challenges might be addressed in a more comprehensive or holistic way. Organic agriculture is a model for a number of issues.

- Reducing the negative trade-offs between productivity and sustainability.
- Making better use of farmer knowledge and farmer-based innovation, which is crucial for any sustainable farming system.
- Improving famer-to-farmer as well as farmer-to-consumer communication and cooperation.
- Developing co-innovation between farmers, farm advisors, and scientists.
- Technological development that focuses on the long-term sustainability of farms, landscapes and food systems.
- Exploiting high value food chains and voluntarily adopting sustainability standards that progress societal objectives and produce or maintain public goods and services.
- Focusing agricultural production more on ethical values, such as animal welfare, social concerns, such as farmers' livelihoods and working conditions and cultural ecosystem services, such as amenity landscape management.

These model functions of organic agriculture are described in more detail below.

6.2.3 A model for research on how to reduce negative trade-offs

The public goods provided by organic agriculture have been documented in several hundred scientific papers that have been published over the past 30 years or so (Niggli 2014). The literature encompasses all of the climatic and socio-economic zones of the world, but is biased towards Europe. In general while organic farming has a better ecological and social performance than conventional farming it is also less productive, often by up to 20 to 25 %. Nonetheless, there is much potential for yield increases, especially under subsistence farming conditions and in marginal and drought-affected regions (Hine et al. 2008). These are exactly those parts of the world with the highest concentration of hungry and malnourished people.

Organic agriculture provides an excellent model of how food production can be intensified while respecting overall and long-term sustainability. Organic farmers adopt a different starting point than conventional farming systems. They seek to organize themselves so as to maximize their economic, social, agronomic and ecological resilience and to develop synergistic interactions with the landscape and semi-natural habitats. This means focusing on increasing whole farm productivity without diminishing the surrounding environmental, social, and ecological qualities. This aspect is an interesting theme for future research activities into organic farming systems.

The meta-analyses on yields (see chapter 4.3.1) show that organic crop rotations are often limited by limited nitrogen availability, that in strongly alkaline and acidic soils phosphorous limits yields and that yields comparable to those of conventional farms can only be achieved by using best management practices (meaning the best control of weeds, diseases, and pests). These limitations already frame future research priorities in organic crop production.

Organic farmers tend to allocate their limited resources, labour, land, internal inputs or farm infrastructure, differently than conventional farmers, seeking to optimize the performance of the whole farm(as opposed to maximizing the output of one crop). They aim for a high Total Factor Productivity (TFP), a ratio that relates the aggregation of all outputs to the aggregation of all inputs (Latruffe 2010). This means that, maximizing single crop and/or livestock yields can be subordinated to optimizing farm income often through diversifying and becoming more multi-functional. This strategy often helps to keep rural areas attractive. These kinds of whole farm productivity and profitability strategies are further interesting fields for research.

6.2.4 A model for research on how to deal successfully with scarcities

In part at least, organic agriculture adds the element of sufficiency to that of productivity. The report of the 3rd SCAR Foresight Exercise highlighted that resource scarcities were expected to define future food security and identified two competing narratives to address these scarcities, productivity and sufficiency (Schneidewind et al. 2014). Organic farming systems have an excellent input/output ratio and therefore a high efficiency (Mäder et al. 2002). On the European policy level, for example, the Regulation on Organic Production (Council Regulation (EC) 834/2007) reduces or bans the use of high-energy nitrogen fertilizers and restricts the use of phosphorous, both of which depend on finite mining activities. As such organic farming can respond well to both the productivity and sufficiency narratives.

6.2.5 A model for research on co-innovation

Organic agriculture has always had a strong tradition of co-innovation between farmers and scientists - working as partners. That continues to this day. By contrast, the adaptation of sustainable farming practice in conventional agriculture is often impeded by not involving farmers in the research process at an early enough stage (i.e. in identifying priorities) and paying insufficient attention to the diversity of their farms and the contexts in which they are managed (Leeuwis 1999). Research is often led by and dominated by scientists. Dogliotti et al. (2014) argue that there is more interest on co-innovation these days, with farmers, farm advisers, and scientists being involved on an equal basis. They also point out that significant and complex changes of farming practice cannot occur simply by offering farmers an off- the- shelf package on a 'take it or leave it' basis . Farmers need to be involved in all stages of the innovation process in order to ensure the relevance, applicability and up-take of new technologies or management regimes. For many practical problems, farmers are often the main source of innovation and this active knowledge creation often supersede passive 'technology transfer' (Koutsouris 2012). A farmer-driven approach is important, but a process that looks only at farmers' immediate and short-run needs without a deeper understanding of the causes of what they identify as research needs will be limited in its effectiveness. Experienced organic farmers are aware that their innovations evolve over time and that, as the ecological state of their farm changes, some problems go away and new ones emerge. Transitional farms have a different set of needs than those of experienced organic farmers.

More open knowledge systems are required in order to develop better responses to global environmental change, Some leading European universities have shifted towards knowledge systems which include societal agenda setting, collective problem framing, a plurality of perspectives, better handling of dissent and controversy and stakeholder participation (Cornell et al. 2013). The multi-actor approach of organic agriculture embodies these principles and provides a good example of how to practically use them.

To conclude, organic farmers need to take the lead in conducting co-innovative research. However, a comprehensive innovation culture that brings together social, ecological, scientific and technological innovations requires the participation not just of farmers and researchers, but also the entire value chain and civil society.

6.2.6 A model for research on innovation pathways

The innovation pathway of organic agriculture is slower and much more challenging for farmers, farm advisors and scientists. Innovation emphasizes social processes, traditional knowledge and best farm practices. Technical innovation is mainly based on combining breeding and different crossing methods, managing the antagonists of pests and diseases, developing bio-control and botanical agents for plant and animal health, precision farming and robot technologies. This kind of more holistic, but slower and less risky, innovation pathway makes organic farming an interesting model. Other farming systems use all or part of permanent scientific advances, many of which are not accepted by organic standards, especially some innovations in the fields of molecular science, nanotechnology and modern breeding and multiplication techniques. These categorical bans are based on the IFOAM Principle of Care which requires a precautionary approach in cases where the potential risks for human health, the environment, and society are probable and unknown, and there is no social consensus accepting the technology. The burden of proof is on the promoter of the technology to demonstrate that the risks are acceptable, not on society to show that risks are unacceptable. As a consequence, the innovation strategy of organic agriculture needs a much stronger support through basic and applied research in order to maintain economic competitiveness against conventional agriculture.

A crucial question in the innovation debate will be whether organic will remain focused on elite and expensive niche markets (currently 0.9 % of global area and 5.7 % of the area in the EU) or whether organic farming and food systems will become mainstreamed and help pave the way towards long-term sustainability.

Organic farmers want to produce abundant, high-quality, nutritious and healthy food for a growing population. Farmers who are not organic, but who are interested in growing more sustainably, cite a number of obstacles to making the transition. Many of these obstacles are technical in nature and can potentially be addressed through improved technology. A number of studies have explored organic farmers' research priorities using a number of methods. Over the years, researchers and research institutions have conducted a number of surveys to find out the research, innovation, and technology needs of organic farmers (Baker & Smith 1987; Walz 2004; Formas 2006; EPOK 2014; Wivstad 2013). Researchers have also surveyed and interviewed non-organic farmers to identify obstacles that discourage or form barriers that prevent the adoption of organic practices (Blobaum 1983; Fisher 1989).

By contrast, improving farming or processing methods, making better use of existing traditional and modern knowledge, further exploring the functioning of organic farming with agroecological, agronomic or technical research are drivers that will help mainstream the organic approach. Interdisciplinary collaboration requires building interdisciplinary scientific bridges. To be effective and implemented in farming systems, research needs to address the agroecological, socioeconomic, productivity, and health contexts for both crops and livestock.

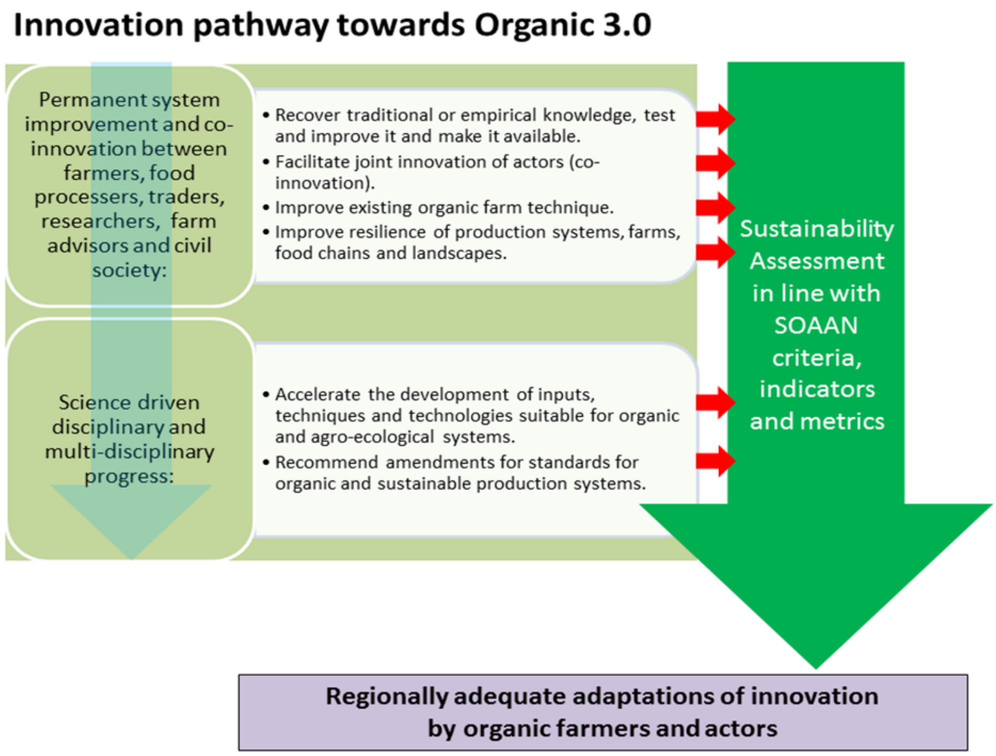

Figure 3: Innovation pathway towards Organic 3.0[78]

[78] For detailed information see Arbenz (2014).

7. Vision 2030 for the future development of organic farming

The future development of organic agriculture is likely to follow three main pathways. The first is related to organic agriculture's potential for empowering rural areas. Organic farms and organic farm families can help to increase the attractiveness and the viability of rural regions especially those that are being ecologically, economically and socially marginalized (pathway 1). In many rural areas of the world, organic agriculture has the potential to become the predominant land use system. The second pathway of the future development of organic agriculture is related to the need to further intensify food production in areas that are both highly productive and those that are marginal. Organic agriculture has the potential to be sufficiently productive to meet food demand while also delivering ecosystem services (pathway 2). And finally, a steadily growing number of consumers are interested in healthy foods, organoleptic properties, food safety, transparency in the food chain and ensuring that agriculture and food processing operate within an ethical framework (pathway 3).

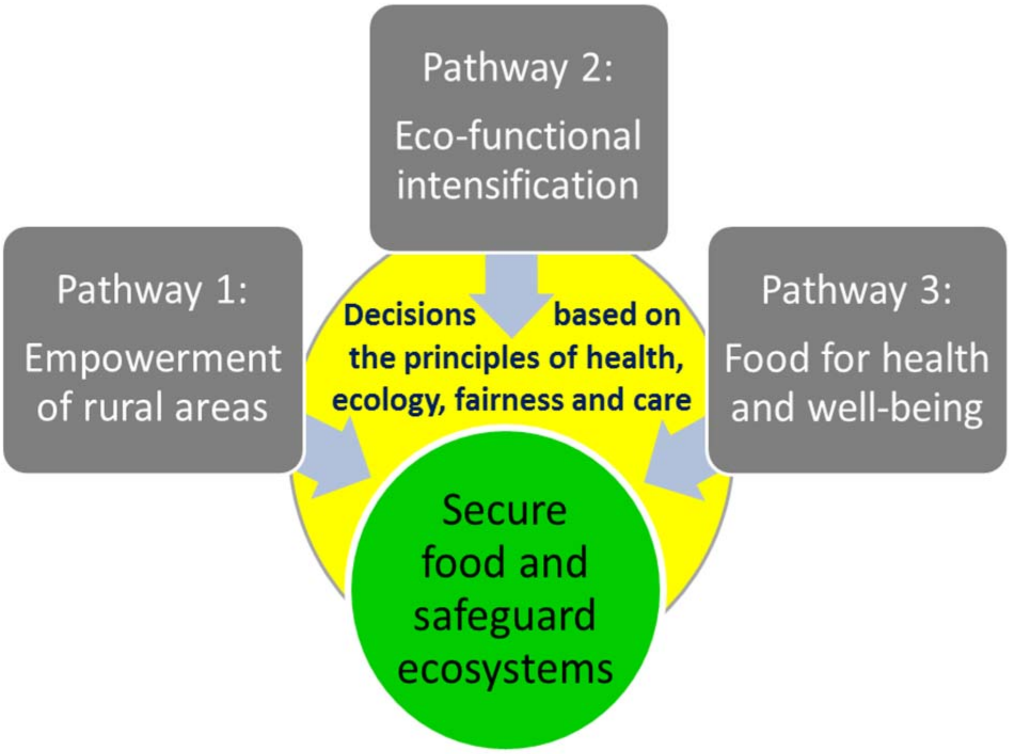

Figure 4: Pathways of future development of organic agriculture

The future development of organic agriculture are driven by these three visions, each of which represents a pathway.

7.1 Pathway 1: Organic farming and food systems crucially empower rural areas across the whole world and help stop migration from the land

Vision

Organic agriculture, food processing and eco-tourism will become important drivers of the empowerment of rural economies. In many disadvantaged regions, organic agriculture will be the preferred land use model and become mainstreamed. A diversified local economy will attract people and improve livelihoods and will halt or even reverse migration from rural areas to urban centers. Organic farm practices, animal welfare and organic food will foster a dialogue between urban and rural populations leading to intensified forms of partnership between consumers and producers. Organic farming will motivate and unite actors of sustainable food chains and contribute to the attractiveness and unique quality of the world's landscapes. It will be a powerful intensification strategy on marginal sites and for subsistence farm making best use of nature, as well as human and social capital in agriculture.

Examples of research fields and activities that follow on from this vision are set out below.

- **Create value added food chains** in rural economies by sourcing regional, high-quality foods from organic farms, and using local processing, packaging and labelling units. Use and modernize traditional food techniques in order to create regional products that bond consumers to local agriculture and increase their commitment to it. Add value by combining organic agriculture with Fair Trade, agroecology and conserving genetic resources.
- **Include all stakeholders**— traders, processors, retailers and consumers, as well as farmers—in the organic value chain in improving the quality of rural life and sharing the benefits of organic farming.
- **Improve the economic viability of short food chains** – e.g. community supported agriculture, box schemes, and farmer's markets in cities, towns and villages though the use of new media and information and communication technologies.
- Establish farmer-researcher innovation groups to boost co-innovation in rural areas.
- **Compare the transformation costs and macroeconomic efficacy** of organic agriculture with other agri-environmental and social schemes and see how these can bought together to promote the sustainable development of rural economies. Collect data on the environmental and social costs of organic agriculture in comparison with conventional and other farming approaches and validate them with models.
- **Further improve the ecological, social and economic sustainability of organic farms.** Develop and validate concepts, indicators, metrics and tools for advice, benchmarking, and certification activities towards truly sustainable farms, regions, and food chains.
- **Regionalize organic farm practices** with a focus on resilience and local adaptation under all foreseeable global, pedagogical, climatic, cultural, social, and economic conditions.
- **Improve** the methods and concepts of **Participatory Guarantee Systems** and group certification.
- Study consumer preferences in different regions and the barriers to organic consumption
- Apply indicator-based benchmarking and certification schemes.

7.2 Pathway 2: Secure food and ecosystems through eco-functional intensification

Vision

The availability of food and the stability of the food supply will be noticeably increased through eco-functional intensification, and access to food will be considerably improved thanks to revitalized rural areas. Food productivity based on non-renewable resources and off-farm inputs will become partly obsolete. Knowledge among farmers about how to manage ecosystem services in a sustainable way will be much greater, and animal welfare and environmentally sound farming will be state-of-the-art in food production. Organic farms will demonstrate how negative trade-offs between productivity and sustainability can be minimized. It will be the benchmark for the responsible and precautionary use of the scientific progress in food and farming systems. Organic farmers will become models for ecosystem managers, co-researchers, and in- and output optimizers.

Examples of research fields and activities which can be drawn from this vision are set out below.

- **Improve the resilience and homeostasis of farms** drawing on available traditional and modern knowledge.
- **Combine system design/habitat management with direct interventions** ('nature & high-technology')**.** Examples here include: enhancing functional biodiversity through the (inundative and inoculative) release of biological control agents; mixed cropping systems ('contour' arable or vegetable farms but also fruit, vine and berry orchards with variety mixtures modelled and designed using epidemiological data); harvesting with precision farming technology (camera- and sensor-geared harvesters); the intelligent encapsulation of plant extracts against animal and crop diseases.
- **Intercrop with legumes** in order to reduce nitrogen and protein shortages. Increased investment in breeding leguminous crops (for yields, robustness). Co-breeding of the most adapted crop partners e.g. maize and beans; lupines and cereals.
- Improve **plant health** in organic crops. Replace fungicide and insecticide applications with new bio-control organisms, botanicals, low energy physical equipment and other products.
- Improve **animal health** in organic livestock. Find preventive and alternative treatments to conventional chemical veterinary medications.
- Address the **main reasons for yield gaps** in arable crop rotations - such as nitrogen and phosphorous shortages, as well as inadequate weed control. The main focus should be put on crop breeding programmes for low-input conditions and on ways of improving the recycling of nutrients (e.g. new sewage sludge technologies).
- **Enhance the diversity** of local food, medicinal, and non-food products based on the conservation and selection of underutilized agricultural products, thereby increasing the opportunities for eco-intensification with corresponding economic rewards.
- **Soil fertility building techniques** for soils in tropical and arid zones.
- **Breed** crops and livestock that are better adapted to low external input farming systems and enable the best use of local resources.

- **Improve climate-smart farming systems** (livestock and mixed) that promote carbon sequestration and the effective use of resources, are adaptive to unpredictable climate changes and fulfil high animal welfare standards.

7.3 Pathway 3: High quality foods – a basis for healthy diets and a key to improving the quality of life and health.

Vision

In the future, people will have more healthy and balanced diets. Food and quality preferences will have changed: fresh and whole foods will be the ultimate trend and processing technology will produce foods with only minimal alterations to their intrinsic qualities. Specific tastes and their regional variations will be more appreciated than those that are artificially designed. This trend towards a higher quality of foods, a more conscious and less wasteful consumption of food and the renaissance of authentic traditional foods will be spearheaded by organic farmers and food processors and distributors. Cooperative and participative models of transport, and safe and traceable food systems will prevail, and organic actors will be the most innovative ones.

Examples of research fields and activities which can be drawn from this vision are set out below.

- Explore experimentally the **interaction between food quality parameters of organic foods with people's health status** (intervention or cohort studies). The major differences among crops are considerably higher contents of secondary plant nutrients and significantly lower nitrate, cadmium and pesticide levels (see Baranski et al. 2014). Collect data, analyze and document the health relevance of these differences.
- **Reduce and avoid food wastes in organic food chains** on the field, in processing, and with longer shelf life. New techniques for recycling food wastes so they can be re-used in organic farming.
- **Resource management** throughout the food chain and effects of different **distribution systems.**
- **Explore the value of genetic diversity** (inter- and in-species) of foods for the health and well-being of animals and humans.
- Experimentally develop, improve, and adapt **traditional and modern food processing techniques for natural, authentic and heritage foods.**
- Develop strongly improved concepts - based on HACCP, analytical tools and process documentation - **for inspection and certification** in order to improve the integrity of organic foods and prevent fraud in food chains. These concepts can be extended to other quality foods such as animal welfare, regional and heritage foods.
- **Improve methods and concepts for Participatory Guarantee Systems** (PGS) and group certification.
- Prevent pesticides, genetically modified organisms, and other **contaminants prohibited in organic production and handling** from entering the organic food supply.
- Develop **Eco-friendly packaging** of organic foods
- Implement **indicator and metric-based certification system** on the basis of the Guidelines of the Sustainable Organic Agriculture Action Network (SOAAN 2013).

8. Approaches and methods for globally advancing organic agricultural research and farmer innovation

This section sets out to address a number of questions concerning the priorities and strategies for future organic research.

- Should organic research be focused on certified systems or agreed production standards, or should it be based on the wider ideas, principles and goals of organic farming. Should the existing standards/certification paradigm be overhauled to enable a real move towards 'Organic 3.0'[79]?
- Is 'Organic 3.0' a means for developing new perspectives and principles or an opportunity to rediscover the original principles and goals that perhaps have become obscured by a focus on specialist markets and certification?
- Should organic and agroecological research be separated, or is there significant common ground, accepting that the term agroecology itself is often used by organic researchers?
- Can organic be THE solution to every problem or do we need to recognize and find ways of working with its limitations and the trade-offs between multiple goals?
- Is the organic concept more critical of science itself or the technologies that result from scientific endeavours as they are currently structured? The scientific method is fundamental to the work of organic researchers, but can organic research provide a basis for rediscovering a critical but evidence-based approach to technology assessment, which is arguably often lacking in current debates?
- Does organic research need to find global or more locally-adapted solutions?
- Should the emphasis be on systems rather than components or system (re)design rather than technological inputs?
- What is the role of stakeholders in the process? What does participatory really mean? Are researchers still leading innovation or are farmers leading the research process with researchers playing only a supportive role (possibly in the context of farmer innovation clubs or field schools)? What about other research questions, aimed at different audiences where participatory approaches may not be relevant? (Lockeretz & Anderson 1991).

8.1 Different approaches to addressing the challenges of organic agriculture

The continued growth in demand for organic foods and the sustainability of organic food and farming systems strengthen the case for more local, national, and international organic agriculture research. In order to fulfil the promise and deliver the benefits described in the previous sections, many of the production and distribution challenges associated with organic food and farming systems need to be addressed. The focus of appropriate research programmes and the way solutions have to be approached can be characterized is set out below.

i. Disciplinary or multidisciplinary innovations can develop novel solutions to the agronomic problems that farmers face. These solutions might target economic (yields, marketable quality, shelf life), ecological (reduction of leaching and run-off of nutrient elements, emissions of greenhouse gases, losses of biodiversity) or social

[79] For detailed information see Arbenz (2014).

weaknesses (hand weeding in vegetables, hand thinning-out in apple orchards, both mainly done by cheap labourers; replacement of nicotine and rotenone insecticides by non-toxic bio-control organisms). These innovations are often regarded as ‘silver bullets’ the kind of input substitution solutions that typify conventional research. As such they are often criticized. One example is the replacement of the use of copper fungicides with biologically based solutions. As mentioned above, the European Union has made breeding of disease resistant varieties and development of bio-pesticides as substitutes for copper fungicides a high priority for organic research. It will take considerable time and money to achieve either aim. Organic farming requires research funding since the market for organic inputs and non-chemical techniques and appropriate farm equipment means that this is still not economically attractive for privately funded industrial research.

ii. Interdisciplinary research into improving and fine-tuning organic farming systems on different levels, such as fields or animals, crop rotations and livestock herds, farm units, farm-landscape interactions and along entire food chains (including consumers). This should be entirely done within an organic context and should involve a range of scientific disciplines. Interactions between partial components of systems can provide solutions which are sometimes unexpected and satisfying without needing ‘silver bullet’ interventions. The effects are influenced by varying site conditions, but can be generalized when experiments cover a sufficient range of environments. As the interactions between the partial components of the system studied are geared by the farmer(s), the effectiveness of the solutions depends greatly on the skills of the farmer(s). Human beings can cause a huge variability in research results and therefore need to be part of the research design. These innovations are often described as being typical of, or unique to, organic research yet can be part of any research activity that into food and farming systems that sets ‘best overall performance’ as the goal. While such research is urgently needed, it is critically underfunded.

iii. Describing, assessing and comparing food and farm systems as comprehensively and thoroughly as possible. This kind of research is sometimes seen as very static and contributing little to improved agricultural productivity or ecological and social sustainability. It requires multidisciplinary research as many different indicators need to be considered. It can encompass long-running field or livestock herd experiments under controlled conditions, a great number of farm comparisons or data modelling and verifying results with on-farm investigations. In many countries, organic research started from such comparative research. Some more famous experiments include the Rodale Farm System Trial in Pennsylvania, the DOK trial in Switzerland, the bio-dynamic field experiment in Darmstadt (Germany) and the System Comparison in India, Kenya and Bolivia. Other comparative investigations focus on entire farms and also cover socio-economic and animal welfare/health aspects. All these comparisons help us to understand the functioning and performance of organic farming in comparison with integrated, agroecological and conventional farming. In addition, they deliver important data for the public and for policy makers. Finally, they can be used a basis for developing indicators and metrics for sustainability assessments of food and farming systems.

The redesign of farming systems will require not only restructuring of the way in which research is done, but also creating a new way for disciplines to interface, refocusing the fundamental purpose of the work, and changing how results and technologies are disseminated. Much as organic agriculture tries to create close systems it still uses many inputs, some of which, such as copper and sulphur are contrary to organic agriculture's ethos. Rather than focusing on trying to substitute these substances, scientists should examine non-chemical solutions. One starting point could be the knowledge and traditional practices that farmers have built up over the centuries, which can then be built upon these through scientific exploration in order to improve organic agriculture's productivity, resilience and ecological services.

Capacity-building for organic agricultural research requires a different approach from any taken in the past. The special challenges and tremendous opportunities afforded by organic agriculture have not been adequately addressed by research institutions as they are currently constituted.

8.2 Methods for research that will successfully advance organic agriculture and practice

8.2.1 Controlled experiments and component research

Within the conventional scientific paradigm agricultural research breaks questions down into manageable hypotheses that can be verified or disproved. Research using controlled experiments – whether in mono or multidisciplinary approaches - is also a central element of organic farming research. , Organic researchers use classical or conventional research approaches when examining socioeconomic, agronomic, ethological, veterinarian, food quality, and food nutrition issues. One example is the current work trying to find replace the copper fungicides that are still currently widely used on organic vines, fruits, berries, vegetables, potatoes and hops in temperate zones against different diseases mainly of the *Oomycetes* family (discussed above). Current research work is focusing on breeding less sensitive or resistant varieties and on alternative copper-free fungicides (such as botanicals), or plant 'strengtheners' (including homeopathic and biodynamic preparations) that stimulate the plants' immune systems and different formulations of stone-meal powders. This is nothing less than state-of-the-art breeding and phyto-medical research and testing. Any of these potential solutions has to function within the context and environment of low input or organic farming. This context is often different from high input systems where farmers expect the measures they apply to have a high level of efficacy. They see more holistic approaches such as improving the production system through building soil fertility, good nutrient management, applying hygiene measures from pre-planting to harvest, planting density and orientation, crop rotations and crop mixtures, as unproven ways of achieving consistently good yields. There are several fungal diseases which have the potential to reach epidemic proportions. For other diseases, such as *Moniliophtoraperniciosa*, the 'Witches' Broom Disease' in cocoa, the design of the production system can have a powerful influence in reducing the damage done. Cocoa orchards with no shade (full sun) get 100 % infection rates, low diversity shaded agroforestry systems reduce infection to 50 %, and high diversity shaded systems, often practiced in organic farming can reduce infection to 20 % (Jakobi 2013).

8.2.2 Co-innovation between farmers, farm advisors and scientists

Organic standards place a number of restrictions on the 'quick fixes' used by modern agriculture. This is especially true for crop production, but also to a lesser extent for animal production and food processing. These restrictions include a ban on chemical and fast-release fertilizers, chemical pesticides and herbicides in general, on synthetic food processing aids and ingredients and finally, on Genetically Modified Organisms (GMOs) and derived products. Pharmaceuticals, such as antibiotics, are used to treat livestock diseases as the animals would otherwise suffer, but these are only used on sick animals and not, as in conventional agriculture, in a preventive way. There is a lack of research into health prevention and natural medications in both the organic and conventional livestock sectors.

'Co-innovation' is a powerful approach that is widely adopted by organic researchers, partly because of the scant resources available for organic research, but partly because of a recognition that organic farmers are true innovators. Unconventional as this approach was in the past it is now being taken up by more agricultural researchers as it often provides rapid results, and considerably improves farmers' productivity and financial results.

There are different methods of co-innovation that should be mentioned:

- Sharing, applying and further improving the **best organic practices** of farmer groups, mostly grouped along the production branches such as dairy, sheep, pig, poultry, arable crops, vegetables, fruits or vines. Here, the methods used are mostly farm visits, conferences where farmers and scientists talk about the latest results and achievements, simple experiments on individual farms with or without scientific backing (ring tests) and peer advisory services. Usually, such activities are voluntary although the output of ideas, new approaches and techniques can be huge and the learning effect is large and long-term. Farmers bring a variety of individual and site-specific observations, make long term improvements to their techniques and develop new tools and equipment. With many brains, eyes, ears and hands forming a critical mass, the innovation, its local adaptation and adoption by participating farmers and other practitioners, are accelerated.
- **Interviews with knowledgeable farmers, veterinarians and farm advisors** can also provide an abundance of ideas and solutions. Such an approach is not just interesting from an ethnographic perspective; but it is also a valuable source of practical techniques that can be applied in order to make farm management more sustainable. A good example is the first collection of techniques and agents used by the early organic gardeners in German speaking countries by Otto Schmid (FiBL), which was published as the first comprehensive book on biological plant protection in horticulture in 1978. In the next thirty years, the number of crop protection techniques and products multiplied tremendously, resulting in the farm input lists produced by the Organic Materials Review Institute (OMRI) and the Research Institute of Organic Agriculture (FiBL) which became a point of reference for organic standards. More recent examples include interviews with 200 farmers in Switzerland that were carried out by a team of pharmaceutical and veterinarian scientists. These document 1025 homemade remedies and the therapeutic use of 100 plants. The vast information, including modes of action from scientific literature, application rates, frequencies and farmers' experiences on the efficacy of these solutions is being made available for other farmers via internet databases (Walkenhorst 2014).
- **Classical on-farm research:** on-farm research offers many advantages for building capacity and asking questions about organic and agroecological farming systems. Farmers form theories about different aspects of their farm system and conduct experiments to find ways to solve the problems they are facing. However, they often lack the training, time, equipment and money to conduct rigorous experiments that can withstand external scrutiny. This is where the value of the involvement of scientists in on-farm investigations comes in. On-farm research can involve all kinds of

intensities, interactions and professionalisms. They can include i) the practical application of improved or novel techniques or products by the farmer who manages parts or windows in the field according to the old established procedure or no treatment and others with the new approach in order to have a visible comparison and control; ii) applications or treatments in strips along a field with no, one or several replications, or iii) professional field trials with randomized block designs. This last from is usually conducted by technicians and scientists as they involve regular sampling, measurements, scoring, and statistical interpretation. On-farm research is also an efficient way for livestock research since it is very costly to set up research facilities with different herd sizes. As a result such facilities are scarce. The potential of on farm livestock research can be illustrated by a recent project that was set up in Switzerland. This involved recruiting 200 dairy farmers to participate in an experiment that was used to design alternative and preventive health strategies in order to meet the challenge of replacing antibiotic treatments with a combination of homoeopathy and health prevention (Klocke et al. 2010). On-farm research has a number of advantages over research station based work (Lockeretz & Anderson 1993). It is often not practical for experimental stations and research centres to replicate the conditions found on farms, especially those which are less well-endowed. In addition the 'human element' of farm management is often neglected in off-farm research. Whole farming systems involve numerous interactions that are difficult, if not impossible, to capture in controlled experiments.

- **'Mother-daughter' experiments:** it is prohibitively expensive to develop a farming systems research programme entirely within an experimental station or research centre setting. Instead, the results of such research can be complement with on-farm verification and—hopefully—validation. One possible approach here is the 'mother-daughter' experiment. Under such a programme, the research centre or experimental station runs the 'mother' experiment, while components of the experiment (the daughters) are replicated on individual farms.
- **Participatory Action Research (PAR)** is a community-based research approach that emphasizes participation and action. It seeks to understand landscapes, production systems and farms by trying to change them, after collaborative reflection. The most important characteristics of PAR are that it is very dynamic, and the system, or part of the system being examined, is constantly evolving due to the interventions of farmers or other actors. This helps the participants better understand the reasons for failures or for low rates of adoption. Within PAR 'communities of inquiry and action evolve and address questions and issues that are significant for those who participate as co-researchers' (Reason & Bradbury 2008). This method contrasts with many other research methods, which emphasize disinterested (or, positively formulated, neutrally objective) researchers and the reproducibility of their findings. PAR practitioners make a concerted effort to integrate three basic aspects of their work: participation (life in society and democracy), action (engagement with experience and history), and research (soundness in thought and the growth of knowledge) (Chevalier & Buckles 2013). PAR has not been widely used in agricultural research, but is beginning to be utilized, partly in response to a growing number of successes with farmers in developing countries and in countries where agricultural production is not supported by government (such as Australia) (Aagaard-Hansen et al. 2007). It has a potential resonance for organic farming as it can help people to build up knowledge about the ecological systems they work with. PAR shifts the emphasis of research from

developing technologies for farmers to working with farmers (both on-station and on-farm) and facilitating participatory development of technologies (Rolling & Jiggens1998).

8.2.3 Component research and farming system research

Conventional research institutes and industry-based R&D work can solve many of the problems facing organic farmers. Experiments on different system components can help us to understand the mechanisms that cause responses to different stimuli or stresses. A deeper understanding of the causes of specific outcomes often requires more patience and more trial and error than a farmer is willing or able to risk. Experimental stations or research centres are better placed to bear such costs and dedicate land, labour and other resources to asking these questions. However, to date the conventional agricultural research community has shown little interest in organic agricultural farming research - partly because organic farming is seen as a niche. In addition, the strict framework imposed by organic principles and regulations is a disincentive to scientific approaches that seek quick fixes.

Farming systems research is inherently more difficult to design than controlled experiments. To begin with, the design is based upon the purpose of the farming system, which is built around different crops, animals and the people who manage them. As such, the human element cannot be excluded from the farming system, which inherently introduces human error and bias. Farming systems are complex and, with complexity comes chaos. Researchers are not able to fully control the treatments and variables, which increases the amount of random variability and error. Research into farming systems is interactive, particularly when conducted by collaborative partnerships of farmers and researchers. But, because farming systems research is interactive, it is also adaptable.

Because any empirical data collected is time and place, specific it is not possible to completely replicate any given farming system in another location and/or time frame. Results are time and site specific and depend on the state of the climate, soils, and the ecological pressures of a given season. This is not to deny the importance of replication—if anything, more replications are needed with farming systems, not fewer. However, in such research it is impossible to categorically state if a given practice will work on a given farm in a given year. This said the picture that emerges is more realistic than the yields and returns that occur under 'ideal' conditions, which often do not reflect the circumstances under which farmers manage their farms. More importantly, this approach challenges the notion that there are global 'optimal' practices for all farms.

Organic best practices are not based on maximizing single parameters. As such, performance needs to be measured by criteria other than a single season's yield and profitability. The ecologically-relevant metrics are whether a system is stable and resilient and produces a yield that can be sustained. Sustainable economic performance can be measured by the long-term returns to the farmer's work and equity, rather than short-run profits. As a general rule, a common lens of assessment – e.g. the Best Practice Guideline for Agriculture and Value Chains of developed by SOAAN (2013) should be employed.

A wide scale and long-term commitment of resources is needed in order to provide farm scale data over a time horizon sufficiently long to judge sustainability. This needs to be matched by enrolling a greater diversity of sites and specific farming systems. These studies need to be replicated in many locations and across similar and dissimilar production models, before any general conclusions can be made about a given practice. Several years of data are needed to test systems operating under different conditions. The longer a practice is shown to be successful, the more likely it is to be sustainable.

The design of experiments related to soil fertility, fertilizer response or the efficacy of various pesticides or herbicides in controlling pests, pathogens and weeds often ignores the influence that external components can have on the results. By contrast, farming systems research looks at all of the factors - natural as well as human – to explain the outcomes produced by a given farming system. As a result, farming systems research is inherently interdisciplinary.

Farming systems are primarily designed for the production of food, fibre, medicines and other products that are socially and economically useful. As such, they are human creations that cannot be viewed in isolation from social structures and economic forces. However, humans are not the only species to influence the stability, resilience and productivity of agricultural systems. As early as the late 1960s conventional research institutions, in particular the research centres of the CGIAR, recognized the need to understand farming systems (Simmonds 1986; Collinson 2000). However, the farming systems research done by these centres usually focused on technological packages geared towards the production of cash crops and the use of purchased inputs, rather than on self-reliance and local food systems (Pretty 1995). Farming systems research needs to be based on ecological principles and to look at natural regenerative cycles.

Component and system approaches to research can and do co-exist. Reductionism and holism are both needed to advance organic agriculture.

8.3 Farmers and researchers: A renewed partnership

The gap between the price of organic and non-organic food is due, at least in part, to the limited capacity to carry out the basic research, development and technology transfer for innovations that are appropriate for organic farming systems. The gap between funding for conventional and organic research has long been recognized and there is a general consensus that the expansion of organically-relevant research needs to be based on an agroecological and farming systems approach. However, building the capacity needed to address the research needs of organic farmers and other practitioners is more complex than capacity building under the conventional model. Within a systems approach the partnership between farmers and researchers is inherently different than in a components-based one. The way that research is conducted differs, which means changes are necessary in the education of both researchers and farmers. Carrying out long-term research on an ecological scale requires more physical capacity. In addition, an integrated farming systems approach has implications for the diffusion of innovations and technologies that flow from it.

The premise that farmers are not clients of, but also partners in, research creates a different working relationship that gives farmers greater responsibilities. Farmer-led research predated the existence of universities and governmental research centres in agriculture. Under the farmer-first model, the farmer's needs are the top priority. Farmers are involved in setting research priorities and in designing the research so it asks the right questions, which are rigorously examined in contexts that reflect farmers' actual practices.

After the design of the system, and the rigorous experimentation that follows, farmers can test and possibly validate the results by introducing the best practices resulting from the experiments. When successful such validation can increase farmers' confidence. Failure to validate the results of controlled experiments can also yield useful information, such as methodological flaws, or specific conditions that cannot be controlled.

In many cases, farmers can be trained and instructed as on-farm researchers, taking on the responsibility of dong timely work on the field and with the animals, collecting samples and data, and being responsible for some of the project management. Being a farmer-scientist is not only interesting; it can also improve farm income. Many of the farmers involved in on-farm activities later become farm advisors and help to spread knowledge among their colleagues. Farmers inherently deal with integrated whole systems and need to be conversant in different disciplines in order to make management decisions. The use of farmers as research associates, can add a much-needed integrative perspective. However, the farmers require training in order to understand the methodology and how to collect data. There is an opportunity cost in terms of the farmer's time given over to designing, managing, collecting data and analyzing. This is skilled work and farmers may well need to be compensated for it.

Exploring new potential management techniques involves dedicating time, farm land and equipment. The litmus test for a farmer is how well a practice or system performs under actual farming conditions. Enlisting organic farmers to participate in such experiments requires a trust building, a common understanding, a shared vision and incentives. Farmers need to be able to participate in the research as equal partners. But not all farmers are sufficiently trained and prepared to be equal partners. Sometimes they will need to be trained so that they are conversant in the scientific methods used to carry out the experimental work being conducted on the farm.

Farmers also have a role in information dissemination. Farmers often view other farmers as the primary and most reliable source of information on the performance of innovative technologies. Yet research follow-through, in the form of technology transfer and diffusion, is often neglected. Many promising research findings are not disseminated or taken up because of a lack of follow-through.

The role of researchers is not diminished by these new partnerships. To rigorously examine different systems is beyond the capacity of most farmers. Even within the context of farmer-first research, researchers provide the capacity needed to design, carry out, analyze and publish research results. Conducting on-farm research can involve several additional factors that do not exist in experiment station research. The sites can often be remote and scattered, requiring attention to logistics. Farmers focus on the management of their operations, usually with the aim of turning a profit. Peak demands for farm labour may well conflict with the research schedule.

A scientific revolution requires a new generation of scientists. Institutions of higher education in agriculture will need to develop curricula that can create a multi-disciplinary research environment. While specialization will still be needed, specialists need to be able to communicate their findings to specialists in other fields. Members of multi-disciplinary teams need to be able to share their knowledge through a common frame of reference. Developing the human capacity to conduct and disseminate the results of multi-disciplinary research requires a restructuring of the curriculum for training agricultural scientists, and the development of methodology that bridges different disciplines, draws from their collective strengths, and a system that rewards collaboration, creativity and performance.

Multi-disciplinary team building requires that research institutions, in many cases, change their missions and structures. As the pursuit of science has become more specialized, it has also become more fragmented, with no common frame of reference, methodology or even language between different disciplines. There is some ‘weak’ multi-disciplinary research that takes place on a number of projects, where different disciplines work independently, and the results are accumulated separately. A more intensive approach requires that the different disciplines work together from the beginning and throughout the project, interacting over the design, data collection, analysis, and final presentation.

There is a trend, in the various agricultural disciplines, towards increased specialization so broadening education will undoubtedly generate a departmental backlash in many universities. Breaking down the walls between—or even within—academic departments will require more than simple restructuring. New methodologies are needed to answer questions and test alternative hypotheses that do not produce simple ‘yes/no’ results. These methodologies allow researchers to make inferences regarding the quality of ecosystems and to go beyond the simple quantification of populations or biomass. Social scientists seem to be more open to embracing broader types of analyses than physical scientists. There is a need better integrate the two kinds of study and to build bridges between them. Holistic and qualitative methods need to co-exist with quantitative ones. Basic research in systems, genetics, and population dynamics can complement applied research to develop hypotheses and test the sustainability of agro-ecosystems and their ability to respond to different environmental stimuli and stresses, such as climate change. Similarly, questions of animal health and welfare are as often qualitative in nature as they are quantitative (Lund & Algers 2003).

Research institutions will not be restructured unless there is an incentive to do so. The restructuring needs to be understood, accepted, and broadly supported within the research community in order to be successful. The intrinsic rewards of working on the intellectual challenges of systems research and the recognition by peers, policymakers and practitioners for ground-breaking work can help move institutions to address the broader issues of sustainability in a more holistic way. Support for a research agenda that benefits the public through open-source technologies developed for long-term economic, social and environmental sustainability will need to come from a range of stakeholders. A reallocation of direct funding for relevant research is necessary, but not sufficient, for organic agriculture to grow and prosper. Renewed and reformed partnerships are needed—between farmers and researchers, between the public and private sectors, and among all those who care about the future of our food systems.

Farmers can influence research institutions to deal with whole systems and to address their needs. As the main clients of these institutions they can organize themselves and make their voices heard, thereby influencing the key policymakers who set and implement the research agenda.

Policymakers - legislators, administrators, foundation directors and others who set, fund, implement, and evaluate the agricultural research agenda – are influenced by a number of factors. The organic sector needs to directly advocate the practicality, feasibility and success of organic agriculture. While the models of success provided may not all be exclusively organic, they have a large organic component and are consistent with organic principles.

8.4 Models for success for farmer-researcher partnerships

Building successful partnerships between farmers and researchers requires organizational ability and a coordinated effort. Fortunately, there are some successful networks in place that can be used as models. These include participatory plant breeding clubs, farmer innovation networks, and farmer-to-farmer exchanges. These successful networks are not all exclusively organic, but organic farmers often participate in them.

One of the greatest knowledge gaps identified in consulting with various stakeholders is the lack of understanding among researchers of the circumstances and research needs of smallholders. These clients of the research systems are often marginalized by research programmes because scientists view them as technologically backward. For family and smallholder farms, traditional techniques are often affordable and easily implemented. Rather than seeking to replace traditional techniques, scientists should understand why these techniques continue to be used, and help farmers to preserve and even recover knowledge that has been fostered for centuries. While industrial farming capitalizes from modern research, organic farming builds on techniques used in varying circumstances. The health of farmers is a strong point of organic agriculture. Successful partnerships will produce innovations that can help smallholder farmers and processors increase profits, improve working conditions, and create a better quality of life.

8.4.1 Participatory plant breeding

With growing concentration in the seed sector, its control by biotechnology companies that are focused on genetic engineering and the control of the intellectual property of new varieties, increasing numbers of farmers throughout the world are turning to participatory plant breeding as a way to develop varieties that are suitable for their growing conditions. Organic farmers actively participate in organized plant breeding associations throughout the world. The European Consortium for Organic Plant Breeding ECO-PB[80] is an organization based in Europe that promotes participatory plant breeding for organic farms. The EU consortium, SOLIBAM, provides an overall view of such on-the-ground activities[81]. Their website also shows examples from different parts of the world. The number of participatory breeding activities involving farmers, coached by scientists or practical breeders, has grown incrementally in the past decade.

8.4.2 Farmer innovation networks

Throughout the recorded history of agriculture, farmers have been known to share information on their innovative technologies. Developments in information technology such as the Internet and cell phones have decreased the cost of transferring such knowledge and make it more readily available. This is true even in the poorest countries, where mobile phones have become a key tool used by peasants and small-holders. Formal and informal sharing of information on innovative farming techniques, have long been a feature of rural life. Mobile phones and the information and services that they can provide are becoming an essential tool for farmer networks. As an example, the iCow programme[82] offers, regular information to farmers on prices, demand and supply, technical advice, etc. via text messaging.

Practical Farmers of Iowa (PFI) was established in the 1980s to deal with the economic crisis in the Corn Belt of the US. PFI is a farmer-led, member-driven non-profit organization, with a mission to advance profitable, ecologically sound and community-enhancing approaches to agriculture through farmer-led investigation and information sharing (Practical Farmers of

[80] www.eco-pb.org
[81] www.solibam.eu/modules/addresses/viewcat.php?cid=1
[82] www.icow.co.ke/

Iowa 2014). There are two other, more recent, grassroots efforts, with very different histories and backgrounds that can serve as models for decentralized innovation and technology transfer. One is Farm Hack, a project of the (American) National Young Farmers Coalition. Technology is open-sourced and developed in a wiki-like environment, and ideas are swapped by farmers attending workshops.

The other is Syprobio, a EuropeAid funded research and development project to produce farmer-proposed innovations to be jointly tested by farmers and researchers. Syprobio works with farmers in Benin, Burkina Faso, and Mali to identify production challenges and promising solutions for cotton-grain rotation systems. The project's objective is to produce practical and scientifically tested technological innovations and approaches that are relevant to all West African cotton-cereal farmers through applied research. Farmer groups identified innovations based on their own ideas and experiences in five key areas: soil fertility, plant health, seeds, crop management, and socio-economics (Nicolay & Fließbach 2012). Farmers working cooperatively through associations can invent and implement technologies specifically designed to provide food security and to adapt to climate change. Innovations that are invented and tested jointly by farmers and researchers are presumably more likely to be adopted than those invented and tested only by farmers or only by researchers. Such jointly-developed technological innovations are expected to result in more robust agricultural and food systems that will improve food security. The services and information can also be delivered via text messaging and mobile phones.

8.4.3 Stakeholder engagement

These are not the only innovation networks involving organic farmers. It is also possible to have approaches that include more stakeholders. For example, the Technology Platform for Organic Food and Farming Research (TP Organics) also holds the promise of developing innovations that benefit society at large. As stated in the introduction to this report, all stakeholders need to be engaged in the process of transformation. Paradoxically, the agenda to promote a more sustainable agriculture has grown as the political power of farmers has been diminished. One reason is that non-farmer stakeholders are now taking an interest in the research agenda. Non-farmer support is essential for the continued growth of the organic sector. One of the strongest expressions of non-farmer support is through changing consumer preferences and the demand for organic food.

Organic agriculture continues to receive public support as a more environmentally sound practice. Many of the innovations that emerge from organic agricultural research strengthen public goods that cannot be privatized. These include a range of ecosystem services, reduced use of external inputs and social innovations. While farmers have developed and applied appropriate technologies on their own, a strategic multi-stakeholder approach is more likely to enable such innovations to reach their full potential (Schmid et al. 2012).

Organic research needs to become critically engaged in the science and practice of sustainability assessment. Organic farming techniques need to continuously improve in performance to move towards fulfilling the principles of organic agriculture. Sustainable food production depends on long-run farm-level impacts on the land and the surrounding environment. As such, short-run productivity oriented assessments will fail to capture criteria concerning sustainability and global food security. A methodology that incorporates socioeconomic, ecological, and geographical parameters into productivity models will provide a more complete long-run picture.

8.4.4 Advocacy for organic agricultural research

TIPI has a clear responsibility to advise the IFOAM World Board and inform the General Assembly so that their policies and standards are based on sound science. TIPI also expects to use IFOAM's regional and global influence to increase spending and set priorities for organic agricultural research. TP Organics, where the cooperation between the scientists and the European Union Group of IFOAM (IFOAM EU) has influenced the EU research budgets, can serve as a model that can be followed by other regions and scaled up to influence international institutions.

TIPI plans to facilitate the exchange of experience to set research priorities at the national, regional and international levels. TIPI will evaluate and disseminate the outcomes of various organic agriculture projects, allowing other researchers and practitioners to learn from both successes and failures. These results will help those interested in improving organic agriculture to understand what works and what doesn’t and to foster global cooperation between people who work under different conditions.

8.5 The dimensions of innovation in (organic) agriculture

One can broadly distinguish three categories of innovation:

- social innovation;
- ecological innovation, and;
- technical or technological innovation (innovation in the areas of products, services, procedures and processes).

Organic agriculture has never looked solely towards technological innovations as these may increase vulnerabilities and increase dependency. They also often arrive as ‘silver bullet packages’ which often prove to be counterproductive at the end of the day. In the other two areas of innovation, social and ecological, farmers themselves are often agents of innovation. They can control the innovations and do not become dependent on cost or capital intensive external services or inventions. Within a comprehensive culture of innovation, technical and technological innovations are used wisely and are carefully integrated with existing ecological and traditional knowledge. Organic agriculture is one of the most compelling 20th Century examples of social innovation. This element becomes especially visible during the conversion from conventional to organic practices. For farmers, consumers or traders, the conversion to organic does not simply involve technological or economic change. It usually requires separating from one social or professional peer group, joining another and undergoing social and value changes (Freyer & Bingen, 2014).

One of the characteristics of the IFOAM Principles is that techniques and technologies are used cautiously in order to avoid risks. The Principle of Care states that precaution and responsibility are the key concerns in agricultural management. Techniques and technology choices must give priority consideration to a technology’s potential impacts on animal welfare, the environment, food quality as well its socio-economic impact. Examples would be the aim to abandon ploughing in organic agriculture in favour of reduced tillage (as this increases humus formation, and the number of earthworms and reduces energy consumption), the fostering of the relationship between humans and livestock (reducing stress during transport and at slaughter), ensuring that technology upgrades do not lead to unbearable levels of farm debt, the rejection of patents on seed, new breeding methods that are open to small and medium-sized breeders, and innovations that respect the provisions of the UN Protocols on Biodiversity and Biosafety (Nagoya/Cartagena).

The societal context of food and farming is particularly of interest in organic agriculture. In a world where vast and rapid changes occur that can irreversibly transform individuals, society and the natural world, we must ask how the organic approach can offer answers to new societal challenges. Can the organic sector be a trendsetter that offers ground-breaking technologies and social innovations? The organic world is open to many kinds of social experiments. However, we still do not know much about the nature of the partnerships between the organic and other emerging social movements. The future development of the organic sector depends on its potential to integrate with these new social movements through new societal partnerships. Some of the most obvious ones are agroecology, food sovereignty, social justice, animal welfare, and the counter-globalization movements, but there are many others. Finally, we should look at the broader impact of organic on society and develop theoretical perspectives of organic agriculture as a broadly integrative approach that has links with other societal sectors, including energy, architecture, education, culture, media, industrialization, political economy, transportation and health. As noted elsewhere in this report, climate change, environmental pollution, limited natural resources, and increasing world population demand a huge change and major transformation of society including its agri-food system. Future technological and institutional innovations will be measured by the contribution they make in bringing about such a change.

8.5.1 Assessing impacts of innovations on sustainability

As organic production, handling, processing and distribution continue to improve, research in organic best practices will become increasingly important. Producers and the other agents in the supply chain will have more incentives to go beyond minimal compliance with organic standards towards adopting practices that improve the sustainability of their business model.

Various official bodies throughout the world are responsible for the evaluation of technologies and the determination of whether they meet organic standards or guidelines: in the EU (EGTOP), in Africa (AUC, CAADP, FARA), in Asia (Japan's MAFF), in the US (NOSB) and Canada (CGSB). However, ethical guidelines and social outcomes are not always part of the evaluation criteria. Going forward, we suggest using the IFOAM Principles as the point of departure to rethink and extend the decision-making process in developing organic standards. In the organic context we must broaden our perspective of successful technological innovation beyond the use of economic indicators. An organic technological innovation becomes relevant, if it fulfils ecological, social and ethical criteria. The IFOAM Principles offer these criteria for the entire organic value chain. Thus, the IFOAM Principles should be systematically used to assess technological innovations and to serve as a guide for accepting or rejecting new technologies for the organic system. Such evaluations of organic innovations should incorporate broader dimensions of sustainability and resilience. Additional concerns include at least: social justice, social transformation, respect for gender and future generations, food sovereignty, food and nutrition security, societal stability, job creations, rural development and open collaboration and participation among organic agro-food system stakeholders.

To achieve this, the Sustainable Organic Agriculture Action Network (SOAAN) of IFOAM created the Best Practice Guideline for Agriculture and Value Chains, a reference document that sets the benchmark for what is involved in a comprehensive discussion of agriculture-based sustainability (SOAAN, 2015). FAO's SAFA guidelines provide another useful template for comprehensive sustainability assessment. While SOAAN works with five sustainability dimensions (economy, ecology, society, accountability and culture), SAFA work with four (SAFA, 2015):

- **Social** dimension: people live in equality and equity.
- **Ecological** dimension: common resources are used sustainably.
- **Economic** dimension: trading leads to prosperity.
- **Cultural** dimension: inspiration, innovation, leadership and altruism are enabled.

The evaluation of best practices and the comprehensive assessment of sustainability will require the development of appropriate assessment tools. Qualitative and quantitative indicators will need to be further developed, validated, and refined. Continuous improvement of best practices and identifying research needs are crucial priority investment areas if organic agriculture is to remain a leader and model of sustainable business practices.

The currently most used sustainability tools are Life Cycle Assessment algorithms. Unfortunately, these fall far short of adequately considering all sustainability dimensions. There are other much-improved tools such as RISE and SMART[83] (HAFL and FiBL, Schader et al., 2014) and REPRO (Technical University of Munich, Germany).

[83] http://www.sustainable-food-systems.com und http://www.fibl.org/de/themen/smart.html

[83] FAO (2015): Sustainability Assessment of Food and Agriculture systems (SAFA) [online] Food and Agriculture Organization of the United Nations (FAO), Rome. Available at http://www.fao.org/nr/sustainability/sustainability-assessments-safa/en/ [Viewed 20.12.2015]

9. The knowledge chain

9.1 State of the art

Access to and exchanges of knowledge are key problems identified by many organic farmers and other actors in the organic food chain. There are knowledge gaps about both production techniques and market information. This means that businesses are unable to make informed decisions in order to develop markets rapidly.

Knowledge access varies from country to country and region to region. Countries with strong and very active organic farmers' associations include Switzerland, Denmark, Germany, Austria, Italy, Estonia, the Czech Republic and Sweden. These organic farmers' associations are important platforms for knowledge exchange and actively promote information exchange, learning and capacity building. Advisory and research services strongly support these farmer-driven activities. Similarly, active learning and information exchange capacities exist in Canada, United States, Australia, and in a few Latin American, African, and Asian countries.

Across the world, there are hundreds of national or regional organic associations, project co-operations between countries, IFOAM activities, regional IFOAM groups who have knowledge about organic agriculture to share as do many UN organizations.

In Europe, capacity-building in organic farming has been funded by the different Research Framework Programmes; the first project started in 1992. These applied research projects with a strong component in dissemination have had a positive impact on access to knowledge and have accelerated the sector's development.

9.2 Important online learning and information portals

Much information is already available on different websites and databases, although a great deal of it is written for scientists or farm advisors and rarely for practical farmers.

- The biggest online portal is the knowledge and literature archive Organic E-Prints[84] with 15,500 entries, more than 90 % of which are still by Europeans although the archive is promoted globally. The main languages of the entries are English, Danish, German, Spanish, French, Italian and Portuguese.
- The archive BIOBASE[85] , based in France is also important. It is entirely in French.
- SINAB is Italy's national information system for organic agriculture and its database provides information in Italian[86].
- For German-speaking farmers, the website of the Federal Organic Farming Scheme and Other Forms of Sustainable Agriculture[87] provides information on 850 (research) projects funded by the German government.
- The Organic Agriculture Center of Canada provides information on their website[88] in English and French.
- Extension is America's Research-based Learning Network and includes eOrganic.[89]

[84] www.orgprints.org
[85] www.abiodoc.com
[86] www.sinab.it/
[87] www.oekolandbau.de
[88] www.organicagcenter.ca
[89] www.extension.org/pages/25242/webinars-by-eorganic#.VB8G-P4cQdU

- One of the biggest online shops for technical guides, brochures, checklists, and other informative materials is the FiBL shop[90]. The material is available in German, French and some in Italian and English.
- Films, videos, and discussions about organic agriculture and organic themes can be watched via the FiBL YouTube[91] channel. Many of the films are practical demonstrations of farmers' techniques, new equipment and so on.
- For organic farming in Africa, the African Organic Agriculture Training Manual[92] provides comprehensive information in English, with some parts also available in Swahili.
- Swiss organic farmers will find most comprehensive practical information in three languages (German, French, Italian) at bioaktuell.ch[93].
- In India, the Organic Farming Association of India [94] makes information available to farmers.

9.3 Bottlenecks

The bottlenecks for the availability of, and access to, knowledge on organic farming systems are very much the same everywhere in the world.

- The size of the research community is correlated with the intensity of the knowledge creation and exchange; the same is true for the size of the markets and the position of organic farming in the national agricultural policy.
- The degree of organization and cooperation among organic farmers is essential for better knowledge exchange.
- While international communication between scientists has become easier because of the dominance of English, the exchange of knowledge on farmer level is exacerbated by language barriers. Knowledge can only be locally spread through national and regional languages.
- The scientific community, administrations and policy-makers are still dismissive of traditional, tacit and organic knowledge.

Section 8.2 described many of the ways in which knowledge creation, access to knowledge and mutual learning among farmers and other actors can be facilitated. These ways encompass the different qualities of knowledge and different ways of acquiring and further improving it. The first – and not so expensive – steps are interviewing knowledgeable farmers, farmer groups, and communities and planning simple joint on-farm experiments using freely available fields, labour and farmers' machinery.

9.4 TIPI's potential role in knowledge exchange

TIPI could realistically engage in a range of roles in promoting knowledge exchange.

- Making the best examples of farmer-driven innovations and of international cooperation among farmers more public and known.

[90] www.fibl.org/de/shop/startseite.html
[91] www.youtube.com/user/FiBLFilm/featured
[92] www.organic-africa.net/training-manual.html
[93] www.bioaktuell.ch
[94] www.ofai.org

- Providing and permanently updating access to all archives where research results and farm surveys are accessible (see section 4.3).
- Membership-based knowledge exchange: a comprehensive data and information gathered from all members of TIPI which is continuously up-dated[95] resulting in an inventory of all research programmes, institutes, and scientific literature;
- The consolidation of all existing data in one archive (e.g. Organic Eprints).
- Motivating farmers' associations, research institutes and advisory services to co-produce practical leaflets and brochures, as well as teaching materials. Examples of such co-productions are the FiBL technical leaflets which are jointly written by all the major organic farming associations in Switzerland, Germany, Austria and Luxemburg;
- As a mid-term vision, TIPI could produce thoroughly summarized and written practical state-of-the-art knowledge packs on the most important aspects and themes in international organic agriculture. Additionally, cutting-edge innovation from research could be reported on in a way that motivates farmers to learn more about it.
- Also, as a mid- or long-term option, TIPI could initiate and moderate an international farmer Wikipedia containing entries made by farmers all around the world. It would be a compendium of newly gained farmer experience, of tacit knowledge traded in farmer communities or families, or results from on-farm research, etc.

[95] www.organic-research.net

10. Next Steps: Towards an action plan

10.1 The role of TIPI

The Technology Innovation Platform of IFOAM seeks all stakeholders - farmers and other practitioners, industry, policymakers, and civil society - to engage in a dialogue where they can find common ground. The extent to which the agenda for organic agriculture research is farmer-driven will depend on the organizational ability and political will of farmers to articulate their research needs. Farmers will continue to innovate, as they always have, and farmer-to-farmer technology transfers are expected to remain the main way that innovation diffusion takes place.

The objectives of TIPI are to intensify cooperation within the organic community, to better communicate the powerful ideas and potential solutions of organic research and organic practice to decision makers and the public and to more effectively advocate the positive role that research on organic food and farming systems can play in meeting the challenges that global society faces today.

TIPI will need to engage farmers -on their terms –where ever they gather. Recruiting organic farmers' organizations to participate, as equal partners, with the research institutions is of crucial importance. Bridging the two distinct cultures of farmers and researchers will require effort from both parties. Researchers respond to a different set of incentives than farmers. Each side needs to understand and respect the other's situation and motivations. Farmers understand their own daily challenges, but do not always see how research can help them overcome those challenges. Not every challenge is a suitable subject for research, and researchers may not be interested in some of the mundane work that farmers do on a daily basis.

Similarly, the needs of other end users need to be addressed. The growing volume of production and trade in organic products needs to be looked at in order to identify any bottlenecks that exist between farmers and consumers. Input suppliers and manufacturers are key stakeholders in the innovation process and should also have a place at the TIPI table.

A key objective of TIPI is that research in organic food and farming systems will generate products that are relevant outside the organic world that can be used and appreciated by other farmers, businesses, consumers and stakeholders, and civil society. With its diverse stakeholder base, TIPI brings together multiple perspectives and has access to a large pool of expertise. These aspects emerged in the comprehensive analysis of research and development priorities. Policymakers and key decision makers in both the public and private sectors need to be convinced that TIPI is engaging a broad constituency and actively facilitating the basic research, applied development and technology transfer needed to improve the state of the art of organic farming. TIPI can then coordinate efforts and build teams to undertake this research.

10.2 TIPI's Action Plan

TIPI's Action Plan will define the next steps to be taken by TIPI towards empowering organic farmers through both social and technical innovations.

In order to expand global organic agriculture research, the following actions will be taken:

- Actively recruit local, national and regional organic associations to join TIPI.

- Persuade scientific institutes and groups—both organic and agroecological—to actively participate in TIPI as members.
- Invite appropriate civil society groups, NGOs, public administrations and governmental organizations to become members or supporters of TIPI.
- Further invest in the Organic Research website platform[96], to make it an attractive, lively and increasingly visited platform for international organic research and to permanently increase visitor numbers and downloads from the website;
- Reform the TIPI Council to ensure that all stakeholders are represented;
- Build a database of the benefits of, and greatest challenges to, the further global development of organic agriculture that is evidence-based, quantitative, and comprehensive.
- Prepare and disseminate policy briefings for IFOAM to make the case for organic agriculture based on scientific evidence, facts and findings from international debates, negotiations, and treaties.
- Establish a database on the leading experts for all themes of organic agriculture worldwide.
- Devise and promote a network to develop and transfer farmer driven innovations.
- Publish case-studies of successful farmer-driven innovation within the organic and agroecological movements.
- Bring a broad range of stakeholders to the scientific conferences of IFOAM and ISOFAR.
- Facilitate global discussions on the future pathways of organic agriculture through workshops and sessions at international or regional conferences –on themes related to innovation and the future development of organic agriculture and Organic 3.0.
- Identify and demonstrate organic best practices from all regions of the globe and highlight these via various information and communications technologies (ICT).
- Establish, build and maintain an international internship scheme for students working on organic farms and at research groups all over the world.
- Build capacity in areas where there is a serious lack of, or decline in, organic agricultural research particularly in parts of sub-Saharan Africa, South Asia, and Central America.
- Quantify and internalize the external costs of agriculture and food chains so that food reflects its true costs and market distortions do not discourage organic food production and consumption.
- Facilitate interaction between researchers and beneficiaries to make the global research agenda visible and create policies that promote organic agricultural research.

TIPI’s Action Plan is a dynamic and living process. As the Action Plan is implemented, the activities will evolve into a work programme for the TIPI Council and its members once the Vision Document is adopted by the membership. TIPI’s work programme will be regularly discussed with the World Board of IFOAM. The TIPI Council will report back to its membership about the progress of the work programme through regular news updates and articles that will appear on the Organic Research website.[97]

[96] www.organic-research.net

[97] www.organic-research.org

11. Appendix : Summary from the final stakeholder discussion February 2015

An interactive workshop was held during Science Day at BioFach in Nuremberg, Germany, on February 13, 2015. Participants, stakeholders in TIPI's programme, were presented with TIPI's goals and asked to develop a set of objectives and tasks that would need to be accomplished in order to reach those goals. The outcomes of the workshop are summarized below.

Facilitate interactions between researchers and the beneficiaries of research, development and technology transfer

Objectives

- Involve farmers at all stages of the development of a project.
- Broker and translate different 'languages' of stakeholders throughout the project implementation.
- Raise awareness of donors about the importance of participatory research in organic farming and their commitment to funding it.
- Create a platform, where scientists can listen to farmers.

Tasks

- Define participatory research and explain the basic approach
- Create a taxonomy of stakeholders who are – or should be - involved in participatory research.
- Establish a discussion forum for researchers and farmers.
- Identify and promulgate working models of fora (such as the farmers' plenary in India or O-Dairy in US).
- Organize a meeting with donors, in which the participatory approach in organic research is explained.
- Prepare a publication that explains participatory research in organic agriculture, which includes case studies.

Facilitate global access to information on organic farming and food systems

- Develop a concept and project proposal for a well-structured knowledge management platform/system
    - Incorporate suggestions from the other workgroups (e.g. address lists)
    - Give access to existing resources such as Organic Eprints.
    - Include information on new research results, relevant organic news and recent and forthcoming events.
    - Provide an inventory of information resources.
    - Cluster and give access to existing information and thus support the translation and adaptation of existing material.
    - When setting up the platform, use existing tools such as the AGROVOC of the Food and Agriculture Organization (FAO) of the United Nations for harmonized nomenclature
- Look at existing knowledge management systems in other domains, such as the medical/pharmaceutical industry to get inspiration (e.g. Medscape).
- Get professional support in knowledge management.

One group dealt with the following two themes, developing a global research agenda and supporting IFOAM as the two topics are closely interrelated. The following conclusions were reached:

Develop a global organic research agenda: set priorities and establish a programme to address those priorities in order to support IFOAM and the entire organic movement with scientific-evidence-based advocacy

The main aim of TIPI is to keep a global focus global and to connect scientific results and research needs with advocacy activities.

Therefore we need to pursue the following steps:

- Gather the existing organic research agendas from around the world (Canada, US, EU etc.)
- Continue gathering and structuring further research needs for specific areas, where no established research agendas exist. An open and easily understandable Internet-based consultation will be needed, to finalize research needs and priorities, (n.b. also covering socio-economic topics) that involves a broad audience.
- Identified research needs should be grouped according to their likely impact and their relevance, i.e. whether global, regional r more specific.
- Identified research needs should also be grouped according to possible funding channels

Through these activities TIPI will have built a comprehensive global research agenda for the organic sector that will enable more credible and more intensive advocacy for organic research funding, globally and regionally.

A second set of activities were identified that will facilitate the global connectivity of organic researcher, practitioners, farmers, and all who need information about organic research and its results:

- A directory of organic researchers around the world should be set up, where scientists and project managers can upload their names, contacts, research fields, and projects. This database should also be open for interested farmers and others participating in research projects.
- The directory will be a useful and highly visible networking tool for the organic sector that will inform participants about latest research results, the people involved people and available funds.
- The directory should facilitate trans-disciplinary research, by connecting scientists and other stakeholders in different disciplines

Assist IFOAM and the entire organic movement with scientific-evidence-based advocacy

The second question the group tackled was how the latest research results and research needs shall be communicated to IFOAM, in order to facilitate scientific evidence-based advocacy.

Initially the group discussed TIPI making scientific reviews such as journal articles available to IFOAM and providing IFOAM with position papers according to IFOAM's priorities. However, after some discussion the group concluded that review papers are too detailed for this purpose, and position papers would require too much effort from TIPI specialists. This led the group to identify an appropriate methodology for compiling background scientific materials, that is quick, concise, and brief and to come up with a good term for such materials.

The group concluded that the best approach would be to provide factsheets and/or PowerPoint slides to IFOAM, as these can be created quickly, using existing materials that experts already have and can be presented in a concise way to politicians and decision makers. The group devised a way in which these could be delivered.

- TIPI should have an internal database of specialists (which could be derived from the database mentioned above), who may be contacted upon request to provide specific factsheets or PowerPoint presentations.
- The process of work could be as follows: IFOAM informs TIPI's secretariat about the need for a scientific briefing on a certain topic, and this message is passed on to TIPI's Council. The Council then decides who will be responsible for the topic. A responsible Council member contacts the chosen expert and provides her/him, with a relevant (easy to handle) format (PowerPoint, factsheet template). The responsible Council members review the information provided by the expert, gets approval for the factsheet from TIPI's Council and forwards the factsheets on to the IFOAM contact.

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TIPI, the Technology Innovation Platform of IFOAM – Organics International, aims to foster international collaboration in organic agriculture research, engage and involve all stakeholders that benefit from organic agriculture research, facilitate exchange of scientific knowledge of organic food and farming systems, and help disseminate, apply and implement innovations and scientific knowledge consistent with the principles of organic agriculture.

This document lays down TIPI's Global Vision and Strategy to advance organic agriculture through research, development, innovation and technology transfer.

For more information about TIPI see www.organic-research.net/tipi.html