

# Research Programme for Organic Food and Farming in Finland 2014-2018

food chain food system producer **farm** processing food industry wholesale trade **restaurant** ecological ethical safety healthiness savour **taste** scent livestock **soil** biodiversity additive-free **diversity** nutrient recycling multi-disciplinary cross-disciplinary **green fertiliser** welfare agriculture rural areas society kitchen food culture legislation rural policy food policy consumer local **global** refinement **production method** agricultural technology **consumer** ecosystem service greenhouse gas emissions eutrophication antioxidants chemicalisation natural organic-**forerunner** plant cultivars **value chain** politics legislation taxation business packaging materials consumer behaviour climate change **attitude** demographics dynamic local global energy system side-streams food chain producer farm **processing** food industry wholesale trade restaurant **ecological** ethical safety **healthiness** savour taste smell livestock soil biodiversity additive-free diversity **nutrient** recycling multidisciplinary cross-disciplinary **green fertiliser** welfare agriculture rural areas society kitchen food culture legislation rural policy local global refinement **production method** agricultural technology ecosystem service greenhouse gas emissions eutrophication antioxidants chemicalisation natural **organic** forerunner plant cultivars value chain politics legislation **food policy** taxation business **packaging materials** consumer behaviour climate change **demographics** dynamic local global energy system side-streams **food chain** food system producer farm processing food industry **wholesale trade** restaurant ecological ethical safety healthiness taste smell livestock soil biodiversity **additive-free** diversity nutrient recycling multi-disciplinary cross-disciplinary food chain food system producer **farm** processing **food industry** wholesale trade **restaurant** ecological ethical safety healthiness savour



441 670  
Painotuote



# Research Programme for Organic Food and Farming in Finland 2014-2018

Mikkeli 2014

**Authors:**

Jaakko Nuutila, Pirjo Siiskonen, Helena Kahiluoto, Minna Mikkola, Winfried Schäfer and Carina Tikkanen-Kaukanen

**Information on the Research Programme:**

The Research Programme for Organic Food and Farming will be updated annually. Amendments and changes to the programme will be applied to the electronic version. Please send any feedback on the research programme to Research Coordinator Jaakko Nuutila, [jaakko.nuutila@mtt.fi](mailto:jaakko.nuutila@mtt.fi) and Director of the Finnish Organic Research Institute Pirjo Siiskonen, [pirjo.siiskonen@helsinki.fi](mailto:pirjo.siiskonen@helsinki.fi).

**Electronic version of the Research Programme:** [www.luomuinstituutti.fi](http://www.luomuinstituutti.fi)

**Publisher:**

Finnish Organic Research Institute  
Lönrotinkatu 7  
FI-50100 Mikkeli  
[www.luomuinstituutti.fi](http://www.luomuinstituutti.fi)

The Finnish Organic Research Institute is an expert network operating under the University of Helsinki and MTT Agrifood Research Finland. The Institute promotes organic food production and consumption throughout the Finnish food chain.

**Layout:**

Jaana Huhtala, University of Helsinki Ruralia Institute

**Printed at:**

Etelä-Savon Kirjapaino Oy  
Mikkeli 2014

# Introduction

The national objectives for organic food and farming set by the Finnish Government in 2012 are ambitious but attainable. Organic farming currently covers some 9% of arable land in Finland. However, the objective – to increase the organically farmed area to 20% by 2020 – will require significant input from the entire Finnish food chain. To better reconcile supply and demand, and to replace increasing imports with Finnish production, activities must become more versatile with respect to primary production and the processing of organic foodstuffs and product development.

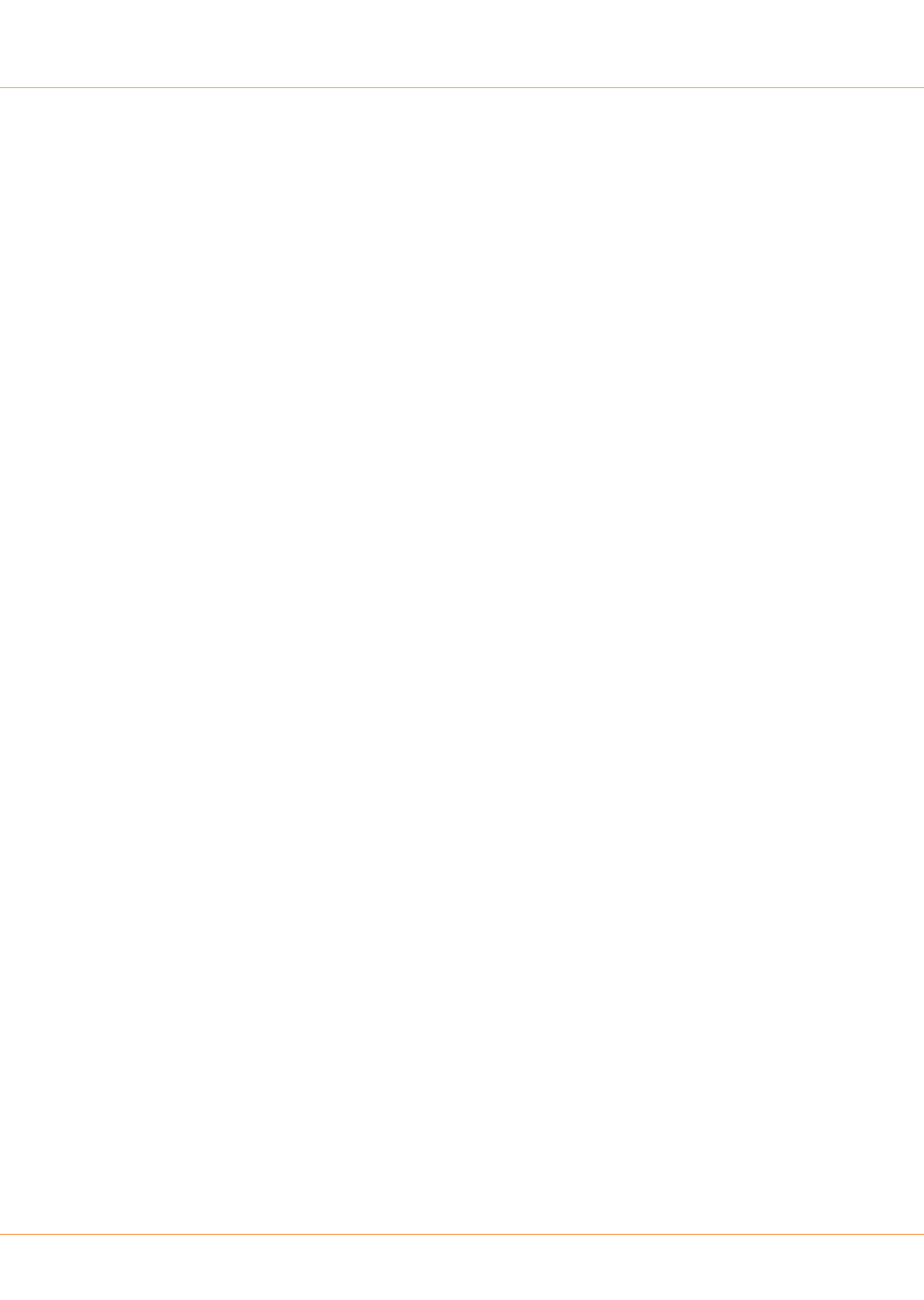
As in all “from farm to table” food production, the success of organic production chains will depend on strong professional know-how. Expertise is needed in multifaceted quality assurance activities concerning organic foodstuffs. This will involve more than ensuring that the taste and texture of such foods meet consumer expectations, although these are very important issues. It will also be important to understand and comply with statutory requirements, which are more stringent in the case of organic foods. Finnish consumers trust that a food branded with the EU organic farming logo is indeed organic. Such trust should be carefully nurtured.

During the last year, increasing attention has been paid to ensuring that various decisions are based on scientific research. The Government is also conducting a survey, in order to promote decision-making based on well-researched information. From the point of view of the food production chain, this is a familiar idea. The European Union’s food safety legislation and legislation at national level are strongly rooted in science. Such legislation is based on scientific risk assessments conducted by the European Food Safety Authority (EFSA) and, in Finland’s case, the Finnish Food Safety Authority Evira. In addition, Finland has a long tradition of other research on food quality, conducted in both higher education and sectoral research institutions.

Several organic production research programmes have already been completed. The Research Programme for Organic Food and Farming in Finland 2014–2018, now being launched and coordinated by the Finnish Organic Research Institution, will continue a research tradition that was begun by MTT Agrifood Research Finland in the 1990s. This research programme reflects the ambitious nature of the strategic national objectives for organic production. Its four fields of research cover the entire organic production chain, from the production of raw materials to the standing and impact of the chain within society. The research focuses on all of the elements that decision-makers, legislators and consumers of organic products will need as a basis for future decision-making.

This new research programme will provide excellent support for the development of our national priority project, organic production. Such an approach will ensure that development is not based on best guesses, but on scientifically sound research and its assessment. On my own behalf and that of the Ministry of Agriculture and Forestry, I would like to wish the programme every success. It will form part of the valuable work being done for the benefit of Finnish consumers and the environment.

Jaana Husu-Kallio, Permanent Secretary, Ministry of Agriculture and Forestry



# CONTENTS

INTRODUCTION .....	3
<b>1 FINNISH FOOD SYSTEM AND THE ROLE OF ORGANIC PRODUCTION WITHIN IT.....</b>	<b>7</b>
1.1 The structure and special characteristics of the Finnish food system .....	7
1.2 Development goals set for the organic production chain .....	8
<b>2 SCIENTIFIC ORGANIC PRODUCTION AND FOOD RESEARCH IN FINLAND.....</b>	<b>10</b>
2.1 International organic research programmes .....	10
2.2 Earlier organic research programmes .....	11
2.3 Finnish Organic Research Institute begins to coordinate organic research .....	13
<b>3 RESEARCH PROGRAMME FOR ORGANIC FOOD AND FARMING IN FINLAND.....</b>	<b>15</b>
3.1 The Research Programme for Organic Food and Farming in Finland 2014-2018 .....	15
3.2 The preparation process of the Research Programme for Organic Food and Farming in Finland.....	15
3.3 The nature of the research programme.....	16
3.4 The coordination and funding of the research .....	17
<b>4 THE FOCAL AREAS OF BUSINESS-ORIENTED SCIENTIFIC ORGANIC RESEARCH IN 2014-2018 .....</b>	<b>18</b>
4.1 Multi- and cross-disciplinary combinations of research themes.....	19
4.2 Organic primary production.....	20
4.3 Organic production and the environment.....	23
4.4 Organic foods.....	26
4.5 Organic food and farming and the society.....	29
<b>5 POPULARISATION OF SCIENCE .....</b>	<b>34</b>
<b>REFERENCES.....</b>	<b>35</b>
<b>Appendix 1. Targets set for organic food and farming by the European Community and Finland.....</b>	<b>38</b>
<b>Appendix 2. Individuals and actors who participated in the research programme.....</b>	<b>40</b>





# 1 FINNISH FOOD SYSTEM AND THE ROLE OF ORGANIC PRODUCTION WITHIN IT

## 1.1 The structure and special characteristics of the Finnish food system

The food chain forms part of the food system. It begins with the production input industry, which produces fertilisers, chemical pesticides, concentrate supplements, machines, equipment and energy for primary production. Primary producers cultivate and grow raw materials that are forwarded to the food industry for processing and refinement. Most foodstuffs are sold to consumers through the retail trade. Consumers can also purchase food directly from the farmers, through organic food cooperatives and online. Food services purchase their raw materials from the food industry, wholesale trade or directly from farmers. A food system refers to a more comprehensive whole than the food chain alone. The food system regulates and steers the food chain through legislation, political decision-making and foreign trade and is in turn affected by culture, trends and economic conditions.

The organic food chain differs from ordinary food chains mainly in terms of production input. Organic production does not, for example, involve chemical fertilisers or synthetic chemical pesticides. Use of medication in organic livestock farming is regulated under organic production regulations (e.g. IFOAM and Evira). The greatest differences between the food chains that constitute the food system lie in legislation: organic production is certified and separately monitored. (European Community 2007.)

In 2013, the food chain employed 78,000 people in primary production (agriculture and fisheries); 41,000 people in the refinement sector (foodstuffs and beverages); 255,000 people in the trade sector (including wholesale and retail trade chains and specialist stores, marketplaces and direct sales) and 71,000 persons in catering services (Kambur 2013). It is difficult to estimate the share of foodstuffs and beverages as job creators in the trade sector, because most shops also sell other products.

In 2013, organic production (transition period included) covered some 9% of arable land in Finland, a total of 4,293 organic farms or 7.5% of all Finnish farms (Evira 2013). The number of organic farms and the organic production sector are increasing.

Finnish consumption of organic products lags somewhat behind many other EU Member States. The greatest annual consumption per capita in 2012 was recorded in Switzerland (€189), Denmark (€159) and Luxembourg (€143). The corresponding figure in Finland was €37, amounting to 1.9% of the total value of the daily consumer goods trade (Meredith & Willer 2014).

Pro Luomu ry, a registered association for key players in the Finnish organic industry, has identified the following 'bottlenecks' in the organic food chain: 1) organic foods make up only a small part of food markets and production, and small raw material flows cannot be refined in large units, 2) distributed production poses a challenge in terms of logistics, and primary production cannot meet potential demand peaks, 3) lack of and difficult access to information throughout the chain, 4) operational risks are not evenly distributed among all players, 5) cumbersome bureaucracy, 6) society's willingness to pay; it currently invests very little in organic production through subsidies and public services, for example, 7) opposition to organic production and 8) a major lack of information and skill throughout the entire organic production chain and stakeholder groups. (Pro Luomu ry 2012.)

## 1.2 Development goals set for the organic production chain

Different actors have defined their own goals for the development and operation of the Finnish organic production chain. Some are qualitative, and some quantitative. These objectives have not been achieved so far. Appendix 1 describes goals for organic production, set by the European Community and Finland. Development of organic production has been mentioned in Finnish government programmes since 1999 (Government 1999, Government 2009). In 2007, organic production gained more attention when the Government Programme of Prime Minister Matti Vanhanen's Government included the Promotion Programme for Finnish Food Culture (Government 2007, Ministry of Agriculture and Forestry 2012). None of these government programmes set concrete, qualitative objectives for organic production, or highlighted organic research. The most ambitious development goal for organic production has been set by Finland's Country Brand Delegation: Half of Finland's agricultural production should be organic by 2030 (Country Brand Delegation 2010).

The Development Programme for the Organic Product Sector – included in the Government Programme of Prime Minister Jyrki Katainen – outlines clear targets for 2020. This programme is one of the Government's top priorities. Together with the local food programme, it has been allocated a budget of 1.58 million euros for 2012–2015, for the planning and execution of projects. The Ministry of Agriculture and Forestry has stated the following on the subject of organic research: The Ministry of Agriculture and Forestry is supporting organic research as part of other research. Organic research has mainly been funded through the international ERA-NET scheme, through which the ministry offers researchers the opportunity to engage in international networking. This will enable Finnish organic production researchers to participate in international research projects. It will also support the rapid dissemination of international research-based information in Finland. Several funding sources will be required for the creation of a separate organic research programme. (Ministry of Agriculture and Forestry 2012.) The related targets have been dubbed "Organic 20/2020" referring to the idea that, by 2020, 20% of the arable land in Finland will be farmed organically and the amount of organic farming and livestock production will correspond to or exceed Finnish consumption rates. "Sales of Finnish organic foods have tripled in the retail and professional catering sectors. One fifth of the food served in day care centres and schools is organic" (Ministry of Agriculture and Forestry 2012).

Other EU Member States have adopted similar targets for organic production's share of total arable land used for primary production: France is aiming at 20% by 2020 (European Topic Centre 2010). Sweden's report on organic markets (Ekoweb 2012) defines the related goals and Denmark has adopted a set of targets. Both countries aim at a 20% market share for organic products by 2020. Organically produced food forms an important part of the Swedish Government's "Sverige – det nya matlandet" ("Sweden – the new food country") programme.

## 2 SCIENTIFIC ORGANIC PRODUCTION AND FOOD RESEARCH IN FINLAND

### 2.1 International organic research programmes

This section summarises the key contents of the research programmes of several European organic production research institutes.

EPOK – Centre for Organic Food and Farming at the Swedish University of Agricultural Sciences (SLU) distinguishes between the following research themes: robust systems, added value for the environment and society and competitiveness and thriving rural communities. The most important research themes based on these are: 1) High productivity with maintained sustainability, 2) innovative production systems with many functions, 3) closed-loop nutrient cycles and renewable resources, 4) sustainable enterprises and market development and 5) healthy food with added value. (SLU 2013.)

The Danish ICROFS<sup>1</sup> published a research and development strategy in 2012, focusing on the following areas: 1) Existing organic production systems, 2) new organic production systems, 3) different types of farms, organisation and cooperation, 4) microbial interactions in soil, plants, animals, fodder and food, 5) markets and business development, 6) animal and human health, 7) climate, energy and resource management and 8) nature and environment, and the importance of organic production to society. The ICROFS divides research themes into short-term and long-term categories. Short-term research sets out to improve existing practices, while long-term research seeks visionary system-oriented solutions. Research viewpoints are divided into sectoral and society perspectives. The former benefit actors in the food chain, while the latter mainly benefit society. (ICROFS 2012.)

The Swiss FiBL<sup>2</sup> has not published a specific organic research programme, but distinguishes between the following areas of academic organic production research: 1) Soil sciences, 2) crop sciences, 3) plant protection and biodiversity, 4) livestock sciences, 5) socioeconomics and 6) food quality and processing. (FiBL 2013.)

<sup>1</sup> Sustainable Public Procurement, Kestävät julkiset hankinnat

<sup>2</sup> Green Public Procurement, Vihreät julkiset hankinnat

## 2.2 Earlier organic research programmes

Three organic research programmes have already been conducted in Finland. They were coordinated by the Agro-economic Research Centre – the predecessor of MTT Agrifood Research Finland – and the third programme was granted programme funding. The first programme was drawn up for the period 1992–1995 and updated in 1995–1997. Although the second programme, whose programme period began in 1997, was a continuation of its predecessors, it had been rewritten and restructured. The third programme, funded by the Ministry of Agriculture and Forestry, was implemented in 2002–2006.

The research needs identified by these programmes are described below.

### Programme period 1992–1995

The working group mapped out the needs of the various parties that make use of organic research results, by sending a questionnaire to 90 representatives of primary production, information service, refinement, trade, administration, consumers and development projects. A total of 40 replies were received.

The research programme focused on the following topics:

1. Production systems: 1) more-versatile, in-depth research particularly aimed at identifying success factors, 2) monitoring problems and solutions on farms converting to organic production, in research partly based on the assistance of advisers, 3) crop rotation and the use of legumes, 4) organic cultivating on peatland and 5) rotations on vegetable farms.
2. Plant production: 1) soil biology (e.g. soil microbiology and microfauna research; the effect of soil microbes on the usability of plant nutrients), 2) soil composition (development of composition analysis for farmers), 3) soil nutrients (development of a usable test for determining the total phosphorus concentration), 4) biological nitrogen binding and mycorrhiza (e.g. leguminous plants that sustain grazing; clover on peatland), 5) fertilisation (e.g. optimising manure use; liquid composting of liquid manure; use of garden composts), 6) weeds (e.g. mechanical and thermal weed control in the case of row crops; control of weeds on cereal farms), 7) diseases and pests (e.g. the development of biopesticides for vegetables; biological seed dressing), 8) cultivars and propagation (e.g. the suitability of grain varieties for organic production; vegetable cultivation using saplings) and 9) machines and work methods (e.g. soil tillage and soil management in field and garden cultivation).
3. Livestock farming: 1) a literature review should be carried out in the beginning of the research, 2) organic preservation of feed, 3) development of production models (cattle, pigs, sheep, egg production) and 4) questions related to processing and animal ingredients.

4. Beekeeping: 1) using fallows in beekeeping and 2) organic prevention of the Varroa mite.
5. Quality and packaging: 1) monitoring the internal, technical and external quality and fitness for storage of products in the context of production method development, 2) the impact of milk processing on its quality and 3) materials suitable for the packaging of organic products.
6. Economy: 1) private households (e.g. economic aspect of all research involving the development of production methods; the effects of transition period subsidies granted on farms), 2) national economy (means of ecological agricultural policy) and 3) ecology (e.g. reducing direct environmental impacts such as soil erosion). (Agro-economic Research Centre 1992.)

### **Programme period 1997**

This programme was a continuation of its predecessor. The programme aimed to define organic production research at all stages of the production chain, from the preparation of production inputs to food processing and marketing. It also aimed to meet the development needs set by an organic production development working group appointed by the Ministry of Agriculture and Forestry.

1. Renewable resources, the economy and society: 1) creating a theoretical basis for environmental economics; reconciling this with business economics and the national economy, 2) food chain analysis; regional organisation of nutrients, crop rotation, livestock production, machinery, labour force, energy, food processing and marketing on a sustainable base, 3) life cycle and energy analyses, 4) regional development of machines, labour force and energy consumption, 5) physical and financial substitution ratios of production inputs and 6) soil fertility factors.
2. Production technology: 1) nutrient supply (fertilisation and fertilising technology), 2) physical soil care, 3) plant protection (diseases, pests, weeds), 4) production of healthy propagation material, 5) integrating a farm's area of production, machine capacity and labour force, 6) energy sources on farms, 7) horticulture, 8) feed and care keeping environment of monogastric livestock and 9) the ecological sustainability of livestock production.
3. Food quality systems and criteria, and the effect of cultivation methods on quality: 1) product quality indicators and criteria, 2) development of production quality assessment methods for farm level and for the entire food chain, 3) crop quality, 4) vegetable quality and 5) breeding processes and quality breeding of cultivation plants and livestock.
4. Transport, refinement, packaging, marketing and product development: 1) food processing and 2) food product development. (Agro-economic Research Centre 1997.)

## Programme period 2002-2006

The Ministry of Agriculture and Forestry appointed a working group to assess the need for organic research. The working group reviewed ongoing research and prepared an evaluation of research needs and their order of priority for the following 3–5 years. It proposed that the organic research programme be allocated a budget of some 4.5 million euros per year for the following 3–5 years. This was some 2 million euros greater than the 2001 budget. The Ministry of Agriculture and Forestry was to contribute around a million euros of this each year. The research programme emphasised a multi-disciplinary approach to organic research.

1. Foods and markets: 1) factors affecting demand for organic products, 2) the quality, health effects and safety risks involved in organic products and 3) consumer-oriented research and product development.
2. Production and information systems: 1) cultivation technology, 2) propagating material and breeding, 3) production of vegetables, berries and herbs, 4) greenhouse cultivation technology, 5) feeding and feed production strategies and their environmental and financial impacts and 6) animal health care and welfare.
3. Rural policy and environment: 1) sustainability and locality of food systems and 2) how alternative agriculture and rural and environmental policy measures are connected to the development of organic production. (Ministry of Agriculture and Forestry 2002.)

## 2.3 Finnish Organic Research Institute begins to coordinate organic research

In a 2010 report, a Country Brand Delegation appointed by Alexander Stubb and led by Jorma Ollila gave the University of Helsinki and MTT Agrifood Research Finland the task of establishing the Finnish Organic Research Institute, in order to develop the Finnish organic food and production chain based on scientific research and education (Country Brand Delegation 2010). The University of Helsinki and MTT Agrifood Research Finland duly established the Finnish Organic Research Institute in late 2012 and the Institute began its work at the beginning of 2013. The administrative structure of the Finnish Organic Research Institute is a managed expert network.

One of the Institute's key tasks during its first year in operation was to prepare a Research Programme for Organic Food and Farming in Finland. By means of this programme, the Finnish Organic Research Institute aims to bring organic researchers and funding providers together with the sector's research needs.

The Research Programme for Organic Food and Farming in Finland 2014–2018 lays down guidelines for research cooperation between these parties. This programme is being coordinated by the Finnish Organic Research Institute.

The Finnish Organic Research Institute distinguishes four main fields of research: agricultural production, the environment, food sciences and social and political sciences. A Research Director has been appointed at the Institute to preside over each field of research. Research conducted under the Research Programme for Organic Food and Farming in Finland is correspondingly divided into four fields. The research programme is industry-oriented and takes a multi- and cross-disciplinary approach.



## **3 RESEARCH PROGRAMME FOR ORGANIC FOOD AND FARMING IN FINLAND**

### **3.1 The Research Programme for Organic Food and Farming in Finland 2014-2018**

This organic research programme has been prepared in order to steer Finnish organic research and its funding over the five-year period 2014–2018. If necessary, the research themes and topics will be assessed and adjusted on an annual basis. Any changes will be made to the electronic, printable version of the programme, available on the website of the Finnish Organic Research Institute ([www.luomuinstituutti.fi](http://www.luomuinstituutti.fi)). The preparation of the programme formed part of the “Uuden luomutiedon tuottaminen” project (Finnish for “production of new knowledge in the organic sector”) funded by the Ministry of Agriculture and Forestry, MTT and the University of Helsinki. The ministry allocated a budget of 43,640 euros for the preparation of the programme.

### **3.2 The preparation process of the Research Programme for Organic Food and Farming in Finland**

The Finnish Organic Research Institute was responsible for drawing up the programme. This work began as initial planning in 2012, when the Institute engaged in preparing a project application. The preparation process began in earnest in 2013, when the Ministry of Agriculture and Forestry granted Quality Chain funding for this purpose. Programme preparations involved researchers and organic experts from the University of Helsinki and MTT, as well as actors and stakeholders of the food system. The businesses and organisations involved in the preparation process are listed in Appendix 2. Programme planning included consultation with various groups and the programme was approved by the Steering Committee of the Finnish Organic Research Institute, and the steering committees of the Quality Chain’s “Uuden luomutiedon tuottaminen ja levittäminen” project (Finnish for “Production and dissemination of new knowledge in the organic sector”). Figure 1 presents the preparation process of the programme.

Research themes were prioritised in workshops in which representatives of the sector suggested research themes and researchers pointed out which areas had already been researched. The research themes selected in this manner are presented in the research programme, which has been broken down into individual research topics by the Research Directors. The various scientific fields were not given any particular order of priority.

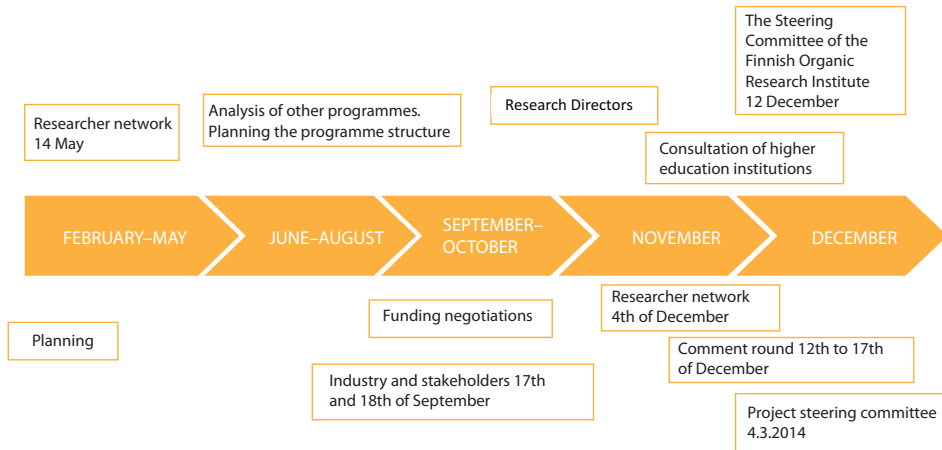


Figure 1. The preparation process of the organic research programme in 2013

### 3.3 The nature of the research programme

The research programme is a national programme. It is hoped that researchers working at the University of Helsinki and MTT – the founders of the Finnish Organic Research Institute – as well as those in other universities and research institutions around Finland, will wish to participate in the programme. As research is always international in nature, the intention is to include international cooperation in the Research Programme for Organic Food and Farming in Finland. The research programme is multidisciplinary and, it is hoped, will raise cross-disciplinary interest and result in cooperative projects between different academic fields. It is built on research needs that have been identified and prioritised by the business sector.

However, the research programme is not a funding instrument in itself. Rather, it serves as a document on whose basis research activities can be steered and seeks to answer topical, research-related questions. It also expresses the shared intent of researchers in the field and actors in the organic food production chain concerning the priorities of the related research.

The research programme is divided into four main fields of research: agricultural production, environment, food sciences and social and political sciences. The research topics in each main field have been prioritised and grouped into four research themes. Figure 2 presents the four research themes included in each of the four main fields of research. It also presents multidisciplinary research theme combinations that cut across the research fields.

### 3.4 The coordination and funding of the research

The Finnish Organic Research Institute is monitoring the progress of the research programme and reports on such progress annually. Funding applications for the research defined in the research programme are made to various sources. Funding is based on separate research project plans whose preparation in the Finnish Organic Research Institute is the responsibility of Research Directors, researchers and research groups. The Finnish Organic Research Institute is eager to see universities and research institutions cooperate over the preparation of research projects. To this end, the Institute provides forums for presenting project plans, projects and their results.

Potential funders of the programme and of its themes and theme combinations include Tekes – the Finnish Funding Agency for Technology and Innovation (e.g. through the FiDiPro – Finland Distinguished Professor Programme), the Academy of Finland, various ministries, the founding organisations of the Finnish Organic Research Institute, the Horizon programme of the EU, structural funds, funds and foundations. The Research Programme for Organic Food and Farming in Finland seeks to influence the Academy of Finland, with the aim of increasing the sums it grants for organic research and obtaining strategic funding. In addition, it is hoped within the Finnish Organic Research Institute that the research programme creates dissertation opportunities for postgraduate students.

## 4 THE FOCAL AREAS OF BUSINESS-ORIENTED SCIENTIFIC ORGANIC RESEARCH IN 2014-2018

The research topics included in the research programme are divided into four main fields: agricultural production, environment, food sciences and social and political sciences. Each main field includes four large research themes, which in turn cover 3–5 research topics. The research topics are presented in Table 1, at the end of Section 4. As the intent is to steer organic research in a multi- and cross-disciplinary direction, the research themes have been merged to form larger theme combinations that enable such an approach. (Figure 2.) It is hoped that the research programme will take the form of cooperation between businesses, researchers and funders.

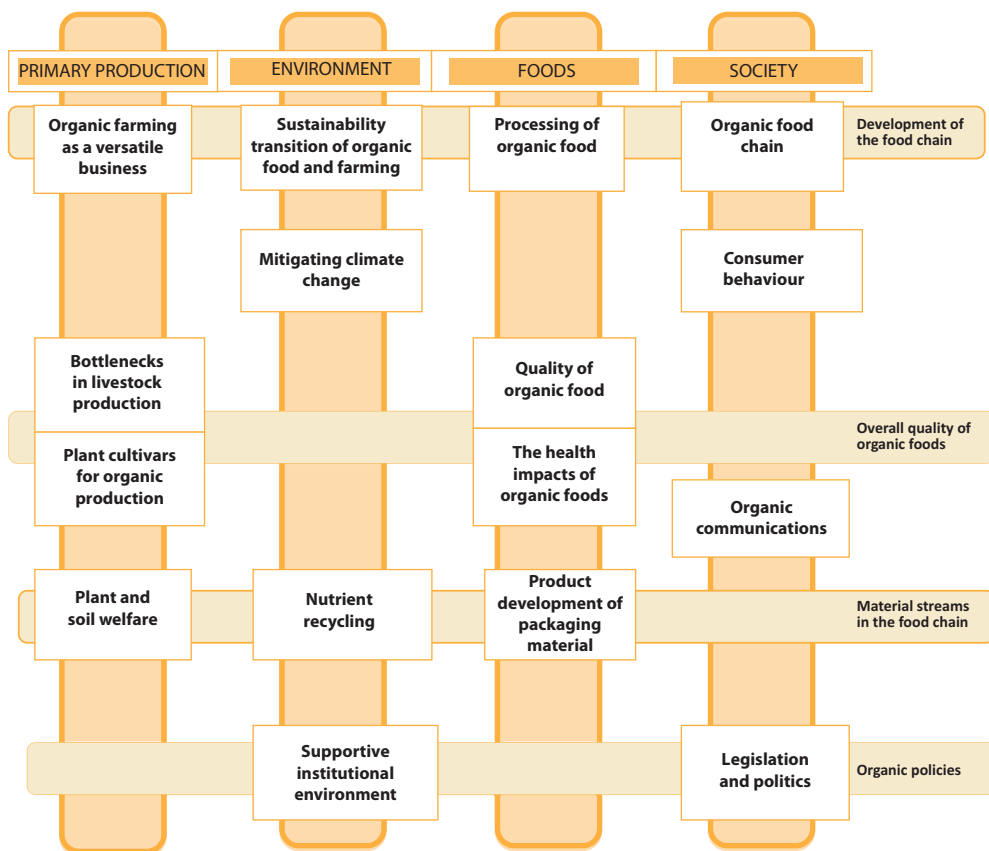


Figure 2. The research themes within each field of research, and cross-sectoral theme combinations

## 4.1 Multi- and cross-disciplinary combinations of research themes

The organic food system is a multi- and cross-disciplinary whole in which several factors and phenomena interact. For this reason, this research programme includes research theme combinations that cut across all four main fields of research. These combined research themes and topics are strongly interlinked. There are also other similarities and connections, and the programme encourages researchers to form even broader-based combinations of research themes. Several funders also share this aim.

### **Research theme combination 1. Development of the food chain**

The food chain begins at the primary production stage: at this stage, high-quality performance is a prerequisite for a functioning food chain, high-quality raw materials and their availability. Organic production is a forerunner in food chain sustainability and the protection of biodiversity. In the future, this forerunner status could also become a factor in the fight for global food justice. Organic raw materials behave differently to non-organic ones, and the processing of organic raw materials is regulated in a different manner to ordinary processing. While this creates challenges, it also provides opportunities to develop food safety and investigate the connections between production methods and nutrition. The organic food chain should also be examined from the viewpoint and as a manifestation of various phenomena in society. Interesting questions include the status of organic foods in Finnish society, means of developing the organic food chain in a customer-oriented manner and means of matching supply with demand. The food chain should be examined and developed as a whole, in order to ensure that it becomes a vital, functioning environment for all of its operators and that any negative effects are minimised.

### **Research theme combination 2. Overall quality of organic foods**

The basic prerequisites of organic production include plant cultivars and animal breeds that are suitable for such production. Ensuring the correct production methods, the choice of cultivars and breeds in question, plant protection, organic feed and animal care all affect organoleptic and nutritional quality. These factors should be continuously developed in order to ensure that the product meets consumer requirements. Quality criteria should be created for organic hand-picked products, in order to guarantee their quality and value as organic products. Nutritiousness and safety are key qualities of food. Insufficient research has been conducted on the effects of production methods on the health of humans and livestock. Factors that either promote or compromise health are being researched throughout the food chain. Organic foods lack sufficient versatility, availability and uniform quality. Product quality is affected by distribution channels. The authenticity of organic products must be verifiable. High-quality organic foods are products of the entire food chain, all of whose sections can increase, secure or even impair the quality of organic food. Quality work throughout the chain should be treated as a coherent whole and supported by research.

### **Research theme combination 3. Material streams in the food chain**

Organic production requires healthy soil. The principles of organic production are based on sustainable solutions. Improving the efficiency of nutrient recycling in agriculture and the food chain is a challenge shared by both environmental and primary production re-

search. Recyclable side streams in the retail sector include biodegradable packaging. In an urban society, nutrient recycling is a particular challenge – research should assist in the search for solutions to this.

#### **Research theme combination 4. Organic policies**

All EU Member States adhere to the same organic production legislation. They can also encourage or limit organic production at national level through taxation, legislation and subsidy policies. These means can be employed to regulate the development of the organic chain, by either increasing or decreasing the related opportunities in relation to ordinary production. Policy-makers can extend the reach of various phenomena to affect the entire organic chain. However, national legislation and interpretations of EU legislation differ from one production sector and country to another. Comparative research should provide information on these differences and on best practices in various countries. Organic production plays a major role in the national economy, but many organic raw materials and products are imported into Finland. Several imported products could be replaced with Finnish production. This would also reduce the budget deficit and stimulate rural business activities. The effects of policies on the entire organic chain should be examined, in an attempt to understand their role in the development of organic production.

## **4.2 Organic primary production**

Scientific research into organic primary production focuses on the bottlenecks affecting organic food and production. The related research themes are based on the TP Organics<sup>3</sup> technology platform, which aims to 1. reduce the price of organic food, 2. improve crop yields, 3. improve internal and external quality and organoleptic quality, 4. prevent food safety risks and 5. achieve significant savings in environmental and social costs. Here, 'organic' refers to organic farming and the organic food industry. The aims of organic production include sustainable business activities, versatile development of farm production and the production of healthy raw materials and processed agricultural products.

### **RESEARCH THEME 1. ORGANIC FARMING AS A VERSATILE BUSINESS**

According to the IFOAM's<sup>4</sup> principles, research into organic primary production should be holistic. As well as satisfying business aims, the aim of conducting versatile, ecologically sustainable business activities on an organic farm is to secure biodiversity and cooperate with other farms and the organic production chain, while developing new business models. Organic business also involves a social and cultural sustainability dimension. Studying the turning points affecting organic businesses could support the development of the organic sector by generating new, important information.

**More versatile operations on farms:** The aim is to increase the competitiveness of rural businesses by seeking sustainable, practical solutions in support of farms that are developing their operations.

<sup>3</sup> Ministry of Agriculture and Forestry

<sup>4</sup> Ministry of the Environment

**The structures of and cooperation between actors – taking account of security of supply:** The retail sector takes a critical stance towards the security of organic food supply, in terms of both schedules and quality. Research in this area should be primarily aimed at improving the flow of information between farmers and the retail sector. This could be achieved by gathering information on solutions developed in other countries, in order to enable cooperation between primary producers and the trade sector. Organic businesses could also test and apply distribution methods other than those associated with retail.

**Organic production and employment:** Existing data should be analysed and distributed. Several examples from across the world illustrate the way in which organic production, processing and sales can improve employment rates in rural areas.

**Health effects in agriculture (salutogenesis):** This research topic refers to the introduction of nature-, animal- and farm-oriented operating methods, which are in receipt of government support, to organic production. The research sets out to identify means of using organic primary production and natural resources in a socially sustainable manner in order to foster well-being.

## RESEARCH THEME 2. BOTTLENECKS IN LIVESTOCK PRODUCTION

Research into bottlenecks in livestock production is conducted in cooperation with livestock farmers. Such research, and the researchers involved, should value the insights of professional livestock farmers on production bottlenecks and key research questions. The research should be conducted in the form of cooperation between researchers and farmers.

**Livestock breeds suitable for organic production:** The production of breeds suitable for organic primary production (e.g. multipurpose breeds) has been neglected. Finland has no companies that specialise in the breeding of livestock suitable for organic primary production. Researchers should begin by selection suitable breeds at international level.

**Livestock feeds:** Finnish livestock production is largely based on the use of imported protein (soy). This research topic originates in the need to replace imported protein with organic feed produced in Finland. Alternative protein feeds, and their status and use in crop rotation, all require experimental research.

**Recognising best practices on organic farms:** It would be necessary, and would prove beneficial to researchers, to investigate the production methods used by organic farms in Finland and abroad. Young researchers in particular would benefit from familiarising themselves with the practices of primary production – both organic and conventional – and building good relationships with farmers.

**Building ecological production facilities that enable species-typical behaviour:** Organic production livestock must live in facilities that allow species-typical behaviour. In turn, such facilities must accord with organic production legislation. Research is needed on the

construction of ecologically sustainable livestock farm buildings and the connection between different construction materials and animal welfare.

**Livestock welfare and medication:** Ordinary livestock farming is heavily reliant on medication. Use of medication in organic livestock farming is regulated under organic production regulations (e.g. IFOAM and Evira). An interesting research question lies in the connection between livestock feed, natural herbs and natural materials, and animal health and welfare.

### RESEARCH THEME 3. PLANT CULTIVARS FOR ORGANIC PRODUCTION

The production and development of plant cultivars suitable for organic primary production has been neglected. There is a need for research-based information on plant cultivars and indigenous plant varieties that can thrive in Finnish conditions. Only a handful of businesses are producing seeds suitable for organic primary production, and these seeds do not cover all cultivars needed in production.

**Testing organic plant cultivars in Finnish conditions:** Other countries produce plant cultivars suitable for organic production. Testing these in Finnish conditions would be an important task for researchers. Research should also be conducted on indigenous plant cultivars and their suitability for organic production.

**Mapping the need for genetically improved seeds, plant breeding criteria:** Insufficient information exists on the need to genetically improve organic plant cultivars. This research topic is grounded in farmers' needs and researchers' willingness to serve such needs. There is also a lack of information on organic plant breeding criteria. This could be partially solved by analysing existing data and engaging in international cooperation.

**Prerequisites and parameters of the production of organic seeds and seedlings:** Finnish organic seed production does not meet the related requirements and is not profitable. In other words, this topic concerns business development and the supporting research. Until now, organic seed production has mainly been funded by donations and/or subsidies.

**Organic garden berries and hand-picked products:** In Finland, there is demand for and a shortage of organically gardened berries. With the exception of Lapland, we also lack a certification system for organic natural products (wild berries and herbs, mushrooms). Business based on organic garden berries and natural products should be developed with the support of research.

### RESEARCH THEME 4. PLANT AND SOIL WELFARE

This research theme combination covers most questions concerning organic plant production, including crop rotation, plant nutrition, plant protection, soil organisms, soil preparation and farming activities, as well as interaction between the soil and crop. Healthy soil yields a healthy crop – *mens sana in corpore sano*.



**Mapping the practical challenges of farming:** Organic farmers have plenty of hands-on experience of organic plant production, the related challenges and best practices. This experience is important to both research and researchers, who should learn from it and disseminate the results to other farmers.

**Farm-level technology solutions:** Organic farming is based on different machines and equipment to those employed in ordinary farming. Since developing such equipment is expensive, in this farmers need the support of research-based information. The development of machines for organic primary production also requires cooperation with machine manufacturers and other international actors.

**Plant protection:** Organic production does not involve the use of synthetic chemical pesticides. Weeds must be tackled by other means, including mixed cultivars, intercropping of two or several cultivars, no-dig gardening and mechanical weed control. Research into plant diseases and pest control is also required. Allelopathic effects number among the key research areas, particularly in plant production.

**Combining plant and livestock production:** A special challenge facing developers of Finnish organic production lies in the fact that livestock and plant production have diverged. This research theme addresses the basic prerequisites of organic farming: closed-loop nutrient recycling at farm level and energy efficiency. Another research question focuses on cooperation between farms.

### 4.3 Organic production and the environment

The environment plays a key role in the development of food systems and agriculture. Organic production may offer sound solutions for building a healthy environment. Even if the main focus of organic research lies elsewhere – such as in productivity, availability or ensuring the health-related qualities of products – it is natural to include environmental sustainability as a starting point. For this reason, food and agricultural system research aimed at improving environmental friendliness is sometimes difficult to distinguish from organic research. However, improved sustainability of organic production has rarely been the main objective, even though it involves both significant environmental opportunities that have so far been neglected, and weak areas that need to be strengthened.

#### RESEARCH THEME 1. SUSTAINABILITY TRANSITION OF ORGANIC FOOD AND FARMING

In recent decades, organic production has inspired the development of sustainable food systems. Now is the time to take further steps towards achieving this goal. Organic production is still in a good position to do this, if a comprehensive approach is taken to the differentiation of production – in pursuit of sustainability – when developing the food system. In addition, the inefficiency of the organic food chain also poses some problems that still need to be solved.

***A learning, negotiating, fair food system:*** Communications within and the rules of the organic chain should be improved in order to create incentives for producers. Research should support the development of a learning, negotiating and fair food system.

***Diversity from farm to table:*** Plant, livestock and product diversity has market and environmental potential and resilience advantages. Research supports the development of the diversity of organic food and farming.

***Sustainable increase in crop yields:*** When selected as a goal, higher crop yields could at best result in environmental and financial efficiency.

***Organic production as a pioneer in global justice:*** Increasingly scarce resources and climate change are aggravating global inequality. Organic production could set an example of how the food system can be made fair. This line of thought would also prompt research questions.

## RESEARCH THEME 2. MITIGATING CLIMATE CHANGE

Food production practices are directly linked to climate change. Climate effects provide a clear example of an intersection between organic production practices – based on the use of ruminants, generous tillage and grass with species of the Fabaceae family – and the systemic approach, resulting in new challenges that need technology-based solutions. Research should contribute to meeting these challenges.

***Energy systems based on residues:*** Nutrient recycling as part of organic production supports the use of waste and by-products, but there is a lack of operating models for this. Research and development is required in this area.

***Climate-efficient food chain (trade, logistics, packaging):*** Cold storage in shops, ample packaging and slow rotation are presenting the food system with a challenge to develop new solutions. Research-based organic production could seek new, more climate-efficient forms of retail, logistics and packaging solutions.

***Climate efficiency in livestock farming:*** Climate efficiency in livestock farming must also be improved. Means of achieving this include the efficient use of residue-based energy and nutrients, feeding, greenhouse gas recovery and long life-cycles.

***Fields to become carbon sinks (life-cycle greenhouse gas emissions):*** Use of manure and ley in crop rotation, and an increase in soil organic matter content and fertility would balance emissions from animals. Research should contribute to the development work under way in this area.

### RESEARCH THEME 3. NUTRIENT RECYCLING

Nutrient recycling is already being discussed in Finland. In organic production, the nutrient supply is built on recycling. Biological nitrogen fixation provides a way of making up for the inevitable losses involved. Although some problems are rooted in change resistance and entrenched operating methods, some are due to knowledge gaps in basic research and technology.

***Improved recycling and its impact on the food system:*** The coordination of various activities requires the development of network creation procedures and technological solutions. Research is required into potential solutions and the related best practices.

***More efficient use of manure on and between farms:*** Manure use could be made more efficient, but more research-based information is needed on soil ecology, technical issues and obstacles to cooperation.

***Recycled fertilisers and suitable fertilisation strategies:*** The use of residues involves risks. Fertilising practices must be developed. In order to minimise residue risks and optimise the release of nutrients, solutions should be developed that enable the use of versatile wastes and by-products and the cultivation of good crops. Research should support the development of working practices.

***Recycling phosphorus in fields and waterways:*** Arable land contains both organic and inorganic phosphorus which, although bound to both the topsoil and subsoil, is not directly available to plants. Phosphorus bound in the bottom sediments of waterways could be released back into the cycle. These development challenges involve unanswered questions in the fields of soil ecology and technology.

### RESEARCH THEME 4. SUPPORTIVE INSTITUTIONAL ENVIRONMENT

Until now, operations have often been sustainable only because individual actors have committed themselves to environmental friendliness, even at the risk of financial loss. However, large-scale development and use of environmentally friendly technologies and practices will require an operating environment that rewards such behaviour.

***Environmental justice in the global food system:*** The environment would benefit from the more equal distribution of nutrients, energy and feeds. Ways are needed of creating a fairer global food system.

***Coherent environmental policy – carrots, sticks and agreements:*** Environmental policy-making suffers from a silo mentality. Information on the factors that divide different actors into silos and incentives to reverse this process would serve the environment.

***Incentives through ecosystem service trade:*** Ecosystem service trade could offer new incentives to increase organic production. A portion of the price of organic products could

be derived from the ecosystem service market. Decisions made concerning the development of such a system should be supported by research.

**Market communications tools:** Communications and marketing should be developed that publicise the environmental benefits of products. Some consumers would happily pay for environmental benefits if such benefits were communicated transparently. Research should assist in the development of marketing communications on organic products and production.

#### 4.4 Organic foods

Our food culture has undergone a major change in just a few decades. Use of processed and packed foods, imported foods and demand for long shelf lives have become commonplace. Processed food and long shelf lives necessitate the use of food additives and/or innovative processing technologies. The long-term or combined health effects of food additives are unknown.

Conventional production uses different pesticides that can leave residues in crops and vegetables. There is reason to suspect that pesticide residues are harmful to human health. Besides, there is already research-based evidence available on the negative impacts of the pesticides to the environment.

Scientists think that, on a global scale, antibiotic resistance is as serious a problem as climate change. A key factor behind antibiotic resistance is the use of antibiotics in animal feed to prevent infections. In organic food production, the use of antibiotics is limited, and controlled through withdrawal times. Furthermore, there has been major growth in consumer awareness and demands for cleaner, healthier food. People have become concerned about the negative health impacts of pesticides, traces of antibiotics and food additives. However, turning organic foods into consumer products will require a great deal of new research-based information. Scientifically sound research on organic foods is scarce, while Finnish research has been small-scale or almost non-existent.

#### RESEARCH THEME 1. PROCESSING OF ORGANIC FOOD

Important basic questions include: How do organic raw materials behave when processed? Do they retain their characteristics when handled in various ways and in large-scale industrial production? Additionally, new information will be needed as regards synthetic chemicals replacing natural preservatives and other additives, on their use and behaviour in different processes.

**Production-related technical characteristics of organic foods:** Scientific investigation, which includes a range of methodologies and covers several technologies will be necessary to reveal the behaviour of organic raw materials during organic food processing and preservation.

**Retaining nutritional and functional food components:** Food processing methods, such as heating, may affect the nutritional components in the raw material. A substantial number of different processing methods combined with scientific research will be needed for keeping the nutritional and functional food ingredients during the processing and preservation of organic foods. Careful processing technologies should be used and developed for organic foods.

**Additives and their health effects:** The number and quantity of food additives in organic foods is carefully regulated. Although research has shown that synthetic additives can be used in foods, no information is available on their long-term and combined health effects (e.g. allergies).

**Production-related bottlenecks affecting organic foods:** Organic foods can be produced in small-scale manufacturing plants, for example on individual farms. When small-scale organic food is processed, research and development will be required in order to identify potential opportunities for product development. This should take account of modern requirements such as ease of use, trends, attractiveness, taste, marketing, packaging and distribution.

**Environmental impact of food processes:** A comprehensive examination of organic food processes includes the analysis of the environmental impact of the processes with respect to several different production technologies.

## RESEARCH THEME 2. QUALITY OF ORGANIC FOOD

The organoleptic, microbiological and nutritional quality of organic food is important to consumers.

**Risk factors in organic food safety:** The microbiological quality of organic foods is regulated by the same legislation as any other foodstuffs; the quality of organic foods has to be ensured in the future. However, novel organic preservatives for organic foods should be developed based on scientific research.

**Consumer-oriented quality factors:** The development and use of organic products should be consumer-oriented. Distribution channels for organic food and their impact on the availability of organic food should be examined. Organoleptic research methods (consumer surveys, product developments, etc.) should be used comprehensively in the development of organic food.

**Uniform quality, versatility and availability:** The availability, uniform quality and versatile selection of organic foods should be guaranteed, for example by conducting systematic cultivation tests using cultivars suitable for Finnish agricultural and processing conditions. Distribution channels for organic food and their impact on the availability of organic food should be examined.

**Authenticity:** Verifying authentic organic products requires not only certified control but also new, research-based analytics. The transparency of the organic production chain and the origin of raw materials and production could be highlighted using novel, research-based methods that are highly consumer-oriented.

### RESEARCH THEME 3. PRODUCT DEVELOPMENT OF PACKAGING MATERIAL

The development of packaging technologies for organic food products requires expertise in organic foods, food legislation and packaging technology.

**Biodegradable and recyclable packaging materials:** The current packaging materials do not meet the environmental quality standards set for organic products, and are thereby at odds with the environmental friendliness of the organic food product itself. The development of biodegradable and recyclable packaging materials should be supported by active research.

**The development of packaging technology:** Packaging technology should be developed. Research in this area should be conducted in close cooperation with the food industry. Small-scale organic food production should be included in the research projects in question.

**Shelf life and safety of ecological packaging:** The shelf life characteristics and product safety of ecological packaging must be guaranteed. Novel packaging, created through research and development, must be safe for the consumers. Packaging developers must also take steps to prevent possible microbe contamination. The shelf life of foods must be ensured when they are packed ecologically.

### RESEARCH THEME 4. THE HEALTH IMPACTS OF ORGANIC FOODS

At present, there is not much scientific information available on the health benefits of organic food. Health impacts can be investigated from several points of view. Research could be focused on general health and disease prevention.

**Multi-generation animal studies:** Multi-generation animal studies offer an alternative to long-running multi-generation studies of people. Human genetic proximity to the pig enables the results of pig studies to be applied to human beings. Studies conducted on animals must be ethically sound and meet scientific criteria. The impacts of organic and non-organic feed on animal health in general, on the development of microbial immunity, susceptibility e.g. to infections and cardiovascular diseases and impacts on reproductive capability could be studied over several pig generations in a reasonable time frame.

**Clinical studies on people:** Clinical, scientifically sound and placebo-controlled double-blind studies can be conducted on humans in a longer run according to ethical standards. Such studies may for example include the prevention of infections and effects on

allergies and obesity. These studies can later be expanded to include consumer surveys on nutrition and lifestyle. It is also possible to target the research at risk groups.

**Functional organic foods and dietary supplements:** Little research has been conducted on functional organic foods and dietary supplements. For example, the health impacts of organic berries, honey and milk should be carried out.

**Organic milk as a research subject:** The effects of feed on the composition of (organic and non-organic) milk (proteins, fatty acids, vitamins/toxins, antibiotics, microbes) should be studied and the resulting health impacts of the raised milks could be investigated through human interventions. Issues such as the effects on gut microbial flora and immunity should be studied.

## 4.5 Organic food and farming and the society

Organic food and farming are generally understood as geographically distributed phenomena, which places an emphasis on communal values and lifestyles, while valuing human and environmental welfare. Such a phenomenon is located outside the centralised economic-industrial complex ('big science'). Such a fact places the focus on increasing equality between different actors in the value chain. Organic production methods as such enable large-scale exports. Consumers regard organic production and consumption as ethically sound. It is often also valued by those who do not necessarily buy organic products. Organic production forms an alternative production and consumption network within the food system. The related questions involve individual actors in the first instance, before their scope is widened to include prerequisites and practices on a chain- and network-wide scale. This also creates change potential involving the entire food system. From a research perspective, opinions and expectations related to organic production need to be backed by evidence that could be applied to the development of organic production from its starting points, in which it takes a critical stance, into an expanding part of the food system.

Organic food and farming are generally and ideally understood to emphasise communal values and lifestyles entailing human and environmental well-being, distanced from centralised modes of economic power deploying respective research ('big science'). Organic food and farming also focus on more equal socio-economic positions of actors within its value chains. While organic agriculture may grow to considerable export industries, its inherent interests lie in more localised food systems. Consumers often regard organic production and consumption as ethically sound, and those not buying organic products tend to agree with this view. As organic food and farming forms an alternative network of production and consumption within the mainstream food system, and its operations take place by individual actors building up chain and network level constellations, it also represents potential for systemic change. From a research perspective, the views and expectations regarding organic food and farming need evidence which may critically support their expansion.

## RESEARCH THEME 1. ORGANIC FOOD CHAIN

***The standing of organic food and farming within the Finnish food chain:*** Research under this topic examines operations and economics of the organic value chain, within which actors position themselves and build up the chain. Research can show possibilities for change and growth of the organic value chain.

***Logistic challenges of the organic chain:*** The extent (geography and the number of actors) of the organic chain has an effect on the supply and price of organic products. Clustering opportunities would form an interesting research and development objective.

***Price formation at different stages of the organic chain:*** Such research would explain price formation within the organic chain and describe the distribution of responsibilities, risks and profit. In other words, research of this kind could involve an investigation of socio-economic inequality between different players and the changes needed in order to support organic production and consumption.

***Matching of supply and demand for organic products, and alternative sales channels:*** While the retail industry provides an important sales channel for organic products in Finland, the importance of other channels may increase. Recognition should be given to the potential of current retail chains and other channels as promoters of organic consumption. Research could also identify best practices in other countries and the applicability of such practices in Finland.

***Development of a consumer-oriented organic food chain:*** Research is being conducted on consumers' commitment to and interest in organic foods. Research themes include consumers' current experiences and their opportunities to participate in the organic chain. Consumer requirements, experiences and expectations may change as consumers interact with the organic chain.

## RESEARCH THEME 2. CONSUMER BEHAVIOUR

***Consumer awareness of organic production and the behaviour of different consumer groups:*** Organic food and farming are often understood as an 'eco brand' of food. It would be essential to understand different marketing channels and the related consumer behaviour pertaining to organic products, and how these might be developed.

***Organic foods and public catering:*** Public procurement of organic food often represents conflicting interests, since products of this kind do not easily comply with public procurement criteria. Research in this area means investigating the interaction between parties to transactions, and may provide new insights and criteria which may change procurement practices. Public food services play an important role in supporting the use of organic food, since public catering, particularly in schools, may wield influence over the future consumption of organic food.



**Demographics and dynamics of appreciation of organic foods:** Different age and professional groups have a different relation to organic foods. Organic consumption also varies according to location, income level and family situation. Research-based information on the demographics and dynamics behind people's relation to organic foods would provide the basis of better marketing pitches.

### RESEARCH THEME 3. ORGANIC COMMUNICATIONS

**Experimental communications:** Appreciation of organic food and farming does not mean that people are always able to construct an informed view about them. Research should focus on developing interactive communications which can, in turn, enable consumers to develop their understanding of the organic food chain.

**Organic food and farming in the media:** The way organic food and farming are presented by the media influences the discourse pertaining to them. Research should analyse the portrayal of organic food and farming in the media to date, and how such a portrayal relates to consumer perception and consumption. This would support the development of communications on organic production and products.

**The relationship between organic and other sustainable foods in the media:** Organic, local, fair trade, ethical, vegetarian, vegan, wild, Finnish foods... Much effort is being made to increase sustainability in the food systems. Research could provide information on consumer perceptions of organic and other sustainable foods, which would assist the development of communications.

**Effective communication channels:** Communications on organic food and farming could be carried out in connection to different spaces, levels and practices of organic food chains. Research could identify effective forms of communications suitable for the development of discourse on organic food and farming.

**Interaction between researchers and actors in the food chain:** One of the key means of expanding organic food and farming would be to provide actors in the organic food chain with concrete, practical and research-based information on the chain itself. Research should support such a process by creating information of this kind for professional use and by examining how practical applications of such information would assist in the expansion of organic food and farming.

## RESEARCH THEME 4. LEGISLATION AND POLITICS

***The role of organic production in the national economy:*** Growth of the organic markets is leading to corresponding changes in the import and export of organic products, in the import of agricultural input products and in the development of Finnish input production and employment levels. Finnish cultivated plants and livestock play a role in the value chain, including from the perspective of the national economy and security of supply. Growth of the organic markets impacts on relative changes of imports and exports of organic food, changes of imports of agricultural inputs, and developments of domestic input industries and employment. Domesticity of animal and plant breeds used in organic agriculture is important from the perspective of the organic value chains, the national economy as well as of the food security. Research should monitor such changes in the conventional and organic value chains and generate information on them.

***Status of organic food and farming in legislation:*** Legislation involves strong societal objectives that place an emphasis on better monitoring of organic food and farming. Problematic sections of the value chain and potential solutions to such problems should be charted. Since organic food and farming in all EU Member States are regulated under the same legislation, interesting research areas include disparities in legislative interpretation and the respective monitoring and control measures adopted in various countries. Differences in taxation practices and their effects form another research area of great interest.

***Obstacles to the small-scale processing of organic foods, caused by legislation or its interpretation:*** Small-scale producers must often resolve issues that are different to those which face large-scale producers. Researchers should chart such issues and produce suitable solutions in cooperation with businesses and the authorities. Such research would serve all actors within the sector.

***Decision-makers' knowledge of and relation to organic food and farming:*** Decision-makers' views on organic food and farming often depend on their understanding of and personal stance on the issue. The contents of the policy on organic food and farming could be improved by using research-based information to support decision-makers' understanding of the matter.

Table 1. Research topics of the Research Programme

PRIMARY PRODUCTION	ENVIRONMENT	FOODS	SOCIETY
<p><b>1. ORGANIC FARMING AS A VERSATILE BUSINESS</b></p> <ul style="list-style-type: none"> <li>More versatile operations on farms</li> <li>The structures of and cooperation between actors</li> <li>Organic production and employment</li> <li>Health effects in agriculture (salutogenesis)</li> </ul>	<p><b>1. SUSTAINABLE CHANGE THROUGH ORGANIC PRODUCTION</b></p> <ul style="list-style-type: none"> <li>A learning, negotiating, fair food system</li> <li>Diversity from farm to table</li> <li>Sustainable increase in crop yields</li> <li>Organic production as a pioneer in global justice</li> </ul>	<p><b>1. PROCESSING OF ORGANIC FOOD</b></p> <ul style="list-style-type: none"> <li>Production-related technical characteristics of organic foods</li> <li>Retaining nutritional and functional food components</li> <li>Additives and their health effects</li> <li>Production-related bottlenecks affecting organic foods</li> <li>Environmental impact of food processes</li> </ul>	<p><b>1. ORGANIC FOOD CHAIN</b></p> <ul style="list-style-type: none"> <li>The standing of organic food and farming within the Finnish food chain</li> <li>Logistic challenges of the organic chain</li> <li>Price formation at different stages of the organic chain</li> <li>Matching of supply and demand for organic products, and alternative sales channels</li> <li>Development of a consumer-oriented organic food chain</li> </ul>
<p><b>2. BOTTLENECKS IN LIVESTOCK PRODUCTION</b></p> <ul style="list-style-type: none"> <li>Livestock breeds suitable for organic production</li> <li>Livestock feeds</li> <li>Recognising best practices on organic farms</li> <li>Building ecological production facilities that enable species-typical behaviour</li> <li>Livestock welfare and medication</li> </ul>	<p><b>2. MITIGATING CLIMATE CHANGE</b></p> <ul style="list-style-type: none"> <li>Energy systems based on residues</li> <li>Climate-efficient food chain (trade, logistics, packaging)</li> <li>Climate efficiency in livestock farming</li> <li>Fields to become carbon sinks (life-cycle greenhouse gas emissions)</li> </ul>	<p><b>2. QUALITY OF ORGANIC FOOD</b></p> <ul style="list-style-type: none"> <li>Risk factors in organic food safety</li> <li>Consumer-oriented quality factors</li> <li>Uniform quality, versatility and availability</li> <li>Authenticity</li> </ul>	<p><b>2. CONSUMER BEHAVIOUR</b></p> <ul style="list-style-type: none"> <li>Consumer awareness of organic production and the behaviour of different consumer groups</li> <li>Organic foods and public catering</li> <li>Demographics and dynamics of appreciation of organic foods</li> </ul>
<p><b>3. PLANT CULTIVARS FOR ORGANIC PRODUCTION</b></p> <ul style="list-style-type: none"> <li>Testing organic plant cultivars in Finnish conditions</li> <li>Mapping the need for genetically improved seeds, plant breeding criteria</li> <li>Prerequisites and parameters of the production of organic seeds and seedlings</li> <li>Organic garden berries and hand-picked products</li> </ul>	<p><b>3. NUTRIENT RECYCLING</b></p> <ul style="list-style-type: none"> <li>Improved recycling and its impact on the food system</li> <li>More efficient use of manure on and between farms</li> <li>Recycled fertilisers and suitable fertilisation strategies</li> <li>Recycling phosphorus in fields and waterways</li> </ul>	<p><b>3. PRODUCT DEVELOPMENT OF PACKAGING MATERIAL</b></p> <ul style="list-style-type: none"> <li>Biodegradable and recyclable packaging materials</li> <li>The development of packaging technology</li> <li>Shelf life and safety of ecological packaging</li> </ul>	<p><b>3. ORGANIC COMMUNICATIONS</b></p> <ul style="list-style-type: none"> <li>Experimental communications</li> <li>Organic food and farming in the media</li> <li>The relationship between organic and other sustainable foods in the media</li> <li>Effective communication channels</li> <li>Interaction between researchers and actors in the food chain</li> </ul>
<p><b>4. PLANT AND SOIL WELFARE</b></p> <ul style="list-style-type: none"> <li>Mapping the practical challenges of farming</li> <li>Farm-level technology solutions</li> <li>Plant protection</li> <li>Combining plant and livestock production</li> </ul>	<p><b>4. SUPPORTIVE INSTITUTIONAL ENVIRONMENT</b></p> <ul style="list-style-type: none"> <li>Environmental justice in the global food system</li> <li>Coherent environmental policy - carrots, sticks and agreements</li> <li>Incentives through ecosystem service trade</li> <li>Market communications tools</li> </ul>	<p><b>4. THE HEALTH EFFECTS OF ORGANIC FOODS</b></p> <ul style="list-style-type: none"> <li>Multi-generation animal studies</li> <li>Clinical studies on people</li> <li>Functional organic foods and dietary supplements</li> <li>Organic milk as a research subject</li> </ul>	<p><b>4. LEGISLATION AND POLITICS</b></p> <ul style="list-style-type: none"> <li>The role of organic production in the national economy</li> <li>Status of organic food and farming in legislation</li> <li>Obstacles to the small-scale processing of organic foods, caused by legislation or its interpretation</li> <li>Decision-makers' knowledge of and relation to organic food and farming</li> </ul>

## 5 POPULARISATION OF SCIENCE

The popularisation of science, or applying research-based knowledge in practice, forms an important part of every research process. Popularisation places research-based information within reach of all those who need it, across all sectors: producers, processors, retail, consultants, decision-makers and consumers. For an industry-oriented research programme to be successful, the resulting information will have to be converted into a form in which laymen can apply it within the business sector.

Scientific information has an impact when it meets three requirements: its contents are relevant, it is transferable and the recipient is able to use it. From the viewpoint of its societal impact, information must also be usable by its recipients and all others who seek to make use of it. (Nieminen 2004.) The practical application of new, research-based information and its use in business contexts are key factors behind achieving greater innovation capacity and maintaining competitiveness (Iivonen 2011).

Planning of science communications should begin during the research planning stage. Every research project should have a science communications plan which details not only communications directed at the academic community, but also the means and channels through which the project's results will be popularised. In addition to traditional press releases, articles in professional publications and newspapers, and public lectures will play a key role. The web also offers new opportunities for popularising science, through channels such as blogs.

The Finnish Organic Research Institute provides its researchers with assistance in science communications, through the communications units of its founding organisations and the Coordination Unit of the Finnish Organic Research Institute. The Finnish Organic Research Institute website, the luomu.fi website and the Organic ePrints database present easy ways of gaining national and international visibility.

## REFERENCES

- Agro-economic Research Centre 1997, Luonnonmukaisen tuotannon tutkimusohjelma, Agro-economic Research Centre, Jokioinen.
- Agro-economic Research Centre 1992, Maatalouden tutkimuskeskuksen luonnonmukaisen tuotannon tutkimusohjelma vuosille 1992–95, Agro-economic Research Centre.
- Commission of European Communities 2008, Public procurement for a better environment; Commission staff working document, communication to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions., Brussels.
- Country Brand Delegation 2010, Mission for Finland – How Finland will demonstrate its strengths by solving the world’s most wicked problem, country brand report 25 November 2010, Country Brand Delegation, Helsinki.
- Ekoweb 2012, Ekologisk livsmedelsmarkand [Ekoweb website], [Online]. Available: [http://www.lrf.se/PageFiles/64119/Marknadsrapport\\_eko\\_20120126.pdf](http://www.lrf.se/PageFiles/64119/Marknadsrapport_eko_20120126.pdf); [2012, 08/06].
- European Commission 2009, Catering & Food – Green Public procurement (GPP) Product Sheet, European Commission, Brussels.
- European Community 2007, Organic production – summary of the Council Regulation (EEC) No 2092/91, Brussels.
- European Commission 2007, GPP Training Toolkit, purchasing recommendations, Catering & Food. Available: [http://ec.europa.eu/environment/gpp/pdf/toolkit/food\\_GPP\\_product\\_sheet.pdf](http://ec.europa.eu/environment/gpp/pdf/toolkit/food_GPP_product_sheet.pdf) [2011, 12/14].
- European Topic Centre 2010, Sustainable Consumption and Production – France. Available: European Topic Centre [http://scp.eionet.europa.eu/facts/factsheets\\_scp/france#overall\\_economy](http://scp.eionet.europa.eu/facts/factsheets_scp/france#overall_economy) [2012, 11/21].
- Evira 2013, Organic production statistics 2013 [Evira website], [Online]. Available: [http://www.evira.fi/files/attachments/fi/evira/asiakokonaisuudet/luomu/tilastot/luomu\\_2013ep.pdf](http://www.evira.fi/files/attachments/fi/evira/asiakokonaisuudet/luomu/tilastot/luomu_2013ep.pdf) [2013, 12/02].
- FiBL 2013, Horticultural sciences [FiBL website], [Online]. Available: <http://www.fibl.org/en/switzerland/research/horticultural-sciences.html> [2013, 12/02].
- Government 2009, Valtioneuvoston periaatepäätös kestävien valintojen edistämisestä julkisissa hankinnoissa [Government website], [Online]. Available: <http://valtioneuvosto.fi/toiminta/periaatepaatokset/periaatepaatos/fi.jsp?oid=258914> [2011, 10/09].
- Government 2007, “The Government Programme of Prime Minister Matti Vanhanen’s second Cabinet 19 April 2007 to 22 June 2010”.
- Government 1999, “The Government Programme of Prime Minister Paavo Lipponen’s second Cabinet 13 April 1999 to 17 April 2003”.
- ICLEI 2008, GPP Training Toolkit, Food and Catering Services, Background Product Report, European Commission, Brussels.
- ICROFS 2012, Research and development strategy 2012 [ICROFS website], [Online]. Available: [http://www.icrofs.org/pdf/2012\\_web\\_UKforskingsstrategi\\_indmad.pdf](http://www.icrofs.org/pdf/2012_web_UKforskingsstrategi_indmad.pdf) [2012, 09/12].

- livonen, S. 2011, "Tutkimusorganisaatiot elintarvikeketjun yritysten kumppaneina" in TUKI – Tutkimuksesta kilpailukykyä -hankkeen loppuraportti, 75th edn, University of Helsinki, Ruralia Institute, Mikkeli.
- Kambur, O. 2013, Interview with Senior Statistician Olga Kambur on 26 November 2013: The number of people employed in the food chain 2013.
- Kottila, M. 2011, Luomualan kasvu- ja kehitysohjelma 2011–2015. Available: <http://www.luomu.fi/wp-content/uploads/2011/08/Luomualan-kasvu-ja-kehitysohjelma.pdf> [2012, 01/13].
- Meredith, S. & Willer, H. (eds) 2014, Organic in Europe – prospects and developments, IF-OAM EU Group, Brussels.
- Ministry of Agriculture and Forestry 2012, MMM:n suuntaviivoja luomualan kehittämisohjelmalle "LUOMU 20/2020" [Ministry of Agriculture and Forestry website], [Online]. Available: [http://www.mmm.fi/attachments/luomu/678W6W0V9/luomuohjelma\\_FINAL\\_nettiin.pdf](http://www.mmm.fi/attachments/luomu/678W6W0V9/luomuohjelma_FINAL_nettiin.pdf) [2012, 08/23].
- Ministry of Agriculture and Forestry 2010a, Food for Tomorrow – National Food Strategy, version 16, proposal for the Finnish Government and Parliament.
- Ministry of Agriculture and Forestry 2010b, Valtioneuvoston selonteko ruokapolitiikasta [Ministry of Agriculture and Forestry website], [Online]. Available: [http://www.mmm.fi/attachments/maatalous/maatalouspolitiikka/newfolder\\_14/5tTDQgJLk/selontekosuomi.pdf](http://www.mmm.fi/attachments/maatalous/maatalouspolitiikka/newfolder_14/5tTDQgJLk/selontekosuomi.pdf); [2012, 07/06].
- Ministry of Agriculture and Forestry 2002, Ehdotus luonnonmukaisen elintarviketalouden tutkimuksen painoaloiksi – Luonnonmukaisen tuotannon tutkimustarpeita arvioivan työryhmän muistio, Ministry of Agriculture and Forestry, Helsinki.
- Ministry of Agriculture and Forestry 2001, Ehdotus luonnonmukaisen elintarviketuotannon kehittämisestä [Ministry of Agriculture and Forestry website], [Online]. Available: [http://wwwb.mmm.fi/julkaisut/tyoryhmuistiot/2001/TR2001\\_10.PDF](http://wwwb.mmm.fi/julkaisut/tyoryhmuistiot/2001/TR2001_10.PDF); [2011, 09/09].
- Ministry of the Environment 2005, Vähemmästä enemmän ja paremmin – kestävän kulutuksen ja tuotannon toimikunnan (KULTU) ehdotus kansalliseksi ohjelmaksi [Ministry of the Environment website], [Online]. Available: [http://www.ym.fi/fi-FI/Ajankohtaista/Julkaisut/Erillisjulkaisut/Vahemmasta\\_enemman\\_ja\\_paremmiin\\_Kestavan\\_\(4706\)](http://www.ym.fi/fi-FI/Ajankohtaista/Julkaisut/Erillisjulkaisut/Vahemmasta_enemman_ja_paremmiin_Kestavan_(4706)).
- Nieminen, M. 2004, "Lähtökohtia yliopistojen kolmannen tehtävän tarkastelulle" in Yliopistojen kolmas tehtävä, eds. K. Kankaala, E. Kaukonen, P. Kutinlahti, T. Lemola, M. Nieminen & J. Välimaa, Edita, Helsinki.
- Organic strategy work group 2006, Luomumarkkinoiden kehittämisen strategiset tavoitteet 2007–2015 [Organic strategy work group website], [Online]. Available: [http://www.mmm.fi/attachments/maatalous/maataloustuotanto/luomutuotanto/5q9gIsOWM/Luomumarkkinoiden\\_strategiset\\_tavoitteet\\_07\\_15.pdf](http://www.mmm.fi/attachments/maatalous/maataloustuotanto/luomutuotanto/5q9gIsOWM/Luomumarkkinoiden_strategiset_tavoitteet_07_15.pdf) [2011, 08/27].
- Pro Luomu ry, 2012, Luomua lisää. Luomualan kehittämissuunnitelman toimeenpanosuunnitelma, <http://proluomu.fi/wp-content/uploads/2012/09/Toimeenpanosuunnitelma-lopullinen-26062012.pdf>
- Renda, A., Pelkmans, J., Egenhofer, C., Schrefler, L., Luchetta, G. & Selcuki, C. 2012, The uptake of Green Public Procurement in the EU27 - Submitted to the European Commission, DG Environment [European Commission website], [Online]. Available: <http://ec.europa.eu/environment/gpp/pdf/CEPS-CoE-GPP%20MAIN%20REPORT.pdf> [2012, 10/13].

- Steering group for the preparation of the food strategy 2010, Food for Tomorrow – Proposal for Finland’s National Food Strategy [Ministry of Agriculture and Forestry website], [Online]. Available: [http://www.mmm.fi/attachments/mmm/tiedotteet/5qZTC31Sw/Huomisen\\_ruoka\\_-\\_Ehdotus\\_kansalliseksi\\_ruokastrategiaksi.pdf](http://www.mmm.fi/attachments/mmm/tiedotteet/5qZTC31Sw/Huomisen_ruoka_-_Ehdotus_kansalliseksi_ruokastrategiaksi.pdf) [2011, 10/10].
- SLU 2013, Research agenda for organic agriculture in 2013 [SLU website], [Online]. Available: <http://www.slu.se/Documents/externwebben/centrumbildningar-projekt/epok/Publikationer/Research%20Agenda%202013-web.pdf> [2013, 10/12].

## Appendix 1. Targets set for organic food and farming by the European Community and Finland

Who set the target?	Target	Source
European Community: SPP <sup>5</sup> and GPP <sup>6</sup> , 2007 and 2008	Increasing the sustainability of public food procurement, by using e.g. organic products.	(Ministry of Agriculture and Forestry 2012, Commission of European Communities 2008, European Commission 2009, ICLEI 2008, European Commission 2007)
European Commission, 2008	By 2010, the average GPP level must be similar to that of the best-performing countries in 2006.	(Renda et al. 2012)
Ministry of Agriculture and Forestry <sup>7</sup> , organic strategy, 2001	10% of arable land must be dedicated to organic production, and 1,100 livestock farms must be certified as organic by 2006.	(Ministry of Agriculture and Forestry 2001)
Ministry of the Environment <sup>8</sup> and Ministry of Trade and Industry <sup>9</sup> , Getting more and better from less, 2005	10% of arable land must be dedicated to organic production by 2010, and 25% by 2015. There must be an annual 10 to 15% increase in the use of organic and local foods.	(Ministry of the Environment 2005)
Organic strategy work group, 2006	Finland will be a European forerunner in terms of organic food and farming in 2015. 6% of retail trade will be organic. All public food services will make use of organic products, with 15% annual growth in the private sector. 10% of exported Finnish foods will be organic.	(Organic strategy work group 2006)
Government <sup>10</sup> , resolution, 2009	Organic, vegetarian or seasonal foods will served in public administration cafeterias and food services at least once a week by 2010 and at least twice a week by 2015.”	(Government 2009)
Steering group for the preparation of the food strategy 2010, Food for Tomorrow - Proposal for Finland's National Food Strategy, 2010	The value of Finnish organic production, exports included, will have doubled by 2030. This would mean an annual growth target of 4% in terms of exports and the switch to more processed products.	(Ministry of Agriculture and Forestry 2010a, Steering group for the preparation of the food strategy 2010)
Government, food policy report, 2010	A versatile offering of organic products must be ensured for both the retail trade and professional food services. The use of organic and local foods in public procurements must be promoted.	(Ministry of Agriculture and Forestry 2010b)
Country Brand Delegation, 2010	By 2030, at least half of primary production will be organic.	(Country Brand Delegation 2010)

<sup>5</sup> Sustainable Public Procurement

<sup>6</sup> Green Public Procurement

<sup>7</sup> Ministry of Agriculture and Forestry

<sup>8</sup> Ministry of the Environment

<sup>9</sup> Ministry of Trade and Industry

<sup>10</sup> Finnish Government



Pro Luomu ry, Luomualan kasvu- ja kehitysohjelma, 2011	In 2015, organic foods will form a daily part of consumers' lives and the food chain. The product range will meet consumer needs and cover key product groups. In 2015, the organic market will be worth 300 million euros, with 60 euros per capita being spent each year on organic products.	(Kottila 2011)
Pro Luomu ry, Luomua lisää. Luomualan kehittämissuunnitelman toimeenpanosuunnitelma	The overall organic market will be worth 330 million euros and The organic professional catering services market will be worth 21 million euros in 2015.	(Pro Luomu ry 2012)

## Appendix 2. Individuals and actors who participated in the research programme

### Throughout the research programme:

Research Coordinator Jaakko Nuutila and Director Pirjo Siiskonen of the Finnish Organic Research Institute

Communication planners Anne Hytönen (until 31.12.2013) and Heli Peltola (1.1.2014 onwards) of the Finnish Organic Research Institute

Research Directors Helena Kahiluoto, Minna Mikkola, Winfried Schäfer and Carina Tikkanen-Kaukanen of the Finnish Organic Research Institute

The expert and researcher network of the Finnish Organic Research Institute (University of Helsinki ja MTT Agrifood Research Finland)

### The following people participated in the workshops in person or by responding to the workshop survey:

Heli Ahonen, Saimaan luomu ry

Tapani Alatossava, University of Helsinki

Anu Arolaakso, EkoCentria

Markus Eerola, Central Union of Agricultural Producers and Forest Owners MTK

Tarja Haaranen, Ministry of the Environment

Sampsa Heinonen, Finnish Food and Safety Authority Evira

Johanna Ikävalko, Finnish Meteorological Institute

Arto Jokinen, Pajuniemi Oy

Hannu Korhonen, MTT Agrifood Research Finland

Rikard Korkman, Central Union of Swedish-speaking Agricultural Producers in Finland SLC

Marja-Riitta Kottila, Pro Luomu ry

Jukka Lassila, Finnish Association for Organic Farming Luomuliitto ry

Teija Lindén, Finnish Food and Safety Authority Evira

Mika Lyytikäinen, SOK

Juha Mantila, National Emergency Supply Agency

Annikka Marniemi, Consumers' Union of Finland

Patricia Munsch-Alatossava, University of Helsinki

Maarit Mäki, MTT Agrifood Research Finland

Tuulia Pelli, Kuntaruokailun asiantuntijat ry

Kimmo Peltonen, Finnish Food and Safety Authority, Evira

Ilkka Pohjamo, Central Union of Agricultural Producers and Forest Owners MTK

Mikko Rahtola, Finnish Association for Organic Farming Luomuliitto ry

Marika Rikkonen, HK-ruokatalo Oy

Eeropekka Rislakki, Eat and Joy Maatilatori/Unione Oy

Tiina Ritvanen, Finnish Food and Safety Authority Evira

Pekka Siiskonen, entrepreneur and chain expert

Marja Suutarla, ProAgria

Raija Tahvonen, MTT Agrifood Research Finland

Marleena Tanhuanpää, Research Institute of the Finnish Economy

Tero Tolonen, Ministry of Agriculture and Forestry

Tuomo Tupasela, MTT Agrifood Research Finland

Laura Uotila, Animalia ry

Heidi Valtari, University of Turku and the Food-Finland network

Tapani Veistola, Finnish Association for Nature Conservation



food chain food system producer **farm** processing food industry wholesale trade **resta**  
**rant** ecological ethical safety healthiness savour **taste** scent livestock **soil** biodiversity add  
tive-free **diversity** nutrient recycling multi-disciplinary cross-disciplinary **green fertilis**  
welfare agriculture rural areas society kitchen food culture legislation rural policy food policy consumer  
**global** refinement **production method** agricultural technology **consum**  
ecosystem service greenhouse gas emissions eutrophication antioxidants chemicalisation natural organ  
**forerunner** plant cultivars **value chain** politics legislation taxation business packaging  
materials consumer behaviour climate change **attitude** demographics dynamic local global energy sy  
side-streams food chain producer farm **processing** food industry wholesale trade restaurant **ec**  
**ological** ethical safety **healthiness** savour taste smell livestock soil biodiversity additive-  
diversity **nutrient** recycling multidisciplinary cross-disciplinary **green fertiliser** w  
agriculture rural areas society kitchen food culture legislation rural policy local global refinement **pro**  
**duction method** agricultural technology ecosystem service greenhouse gas emission  
trophication antioxidants chemicalisation natural **organic** forerunner plant cultivars value chain p  
legislation **food policy** taxation business **packaging materials** consumer  
behaviour climate change **demographics** dynamic local global energy system side-streams **fo**  
**chain** food system producer farm processing food industry **wholesale trade** resta  
ecological ethical safety healthiness taste smell livestock soil biodiversity **additive-free** diver  
nutrient recycling multi-disciplinary cross-disciplinary food chain food system producer **farm** pro  
ing **food industry** wholesale trade **restaurant** ecological ethical safety healthiness sav  
**taste** scent livestock **soil** biodiversity additive-free **diversity** nutrient recycling multi-discipl  
cross-disciplinary **green fertiliser** welfare agriculture rural areas society kitchen food cult  
legislation rural policy food policy consumer local **global** refinement **production met**  
**od** agricultural technology **consumer** ecosystem service greenhouse gas emissions eutrophic  
antioxidants chemicalisation natural organic **forerunner** plant cultivars **value chain**  
itics legislation taxation business packaging materials consumer behaviour climate change **attitud**  
demographics dynamic local global energy system side-streams food chain producer farm **processi**  
food industry wholesale trade restaurant **ecological** ethical safety **healthiness** savour