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CENTRE FOR
ORGANIC FOOD
& FARMING

Research Agenda for Organic Food and Farming

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Content

Research Agenda for Organic Food and Farming

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Introduction

Centre for Organic Food & Farming (Epok) at the Swedish University of Agricultural Sciences (SLU) is a knowledge centre for organic food and farming research. One of our missions is to coordinate and initiate research. One part of that task is to lead the preparations of a research agenda for different stakeholder groups in organic farming: farmers, advisors, businesses, NGOs, decision makers, funding bodies and researchers.

The purpose of the research agenda is to:

- contribute to organic food and farming research being relevant for different stakeholders
- contribute to research on organic farming promoting increased sustainability in both organic and other agricultural systems
- identify research that is needed to achieve political targets for organic food and farming development
- promote collaboration and interdisciplinarity

Although the agenda is primarily based on research needs identified in organic agriculture and organic food, many of the needs are also relevant to the development of conventional agriculture and conventional food.

The process: how the agenda has been drawn up

At the end of 2020, a survey was sent out to practitioners, researchers, and other actors with good insights about the situation for organic production and consumption in Sweden. The aim of the survey was to capture research needs in the area. A workshop was then held over two days, 13–14 April 2021, divided into different themes where research needs continued to be discussed and identified. Invited to the workshop were the same target groups that the survey was sent to. The results from the survey were used as a basis for the discussions at the workshop. Materials from previous workshops in 2019 for inventorying research needs were also incorporated. A meeting with relevant research funders was held in 2020 at the start of the agenda process, to see what special needs they might have for a research agenda for organic food and farming. At the turn of the year 2021–2022, a draft agenda was sent out for comments to the same persons who previously received the survey and the workshop invitation. The agenda text was then completed in the spring of 2022.

The framework: how to read the agenda

Those who contributed to both the survey and the workshop were invited to put forward thoughts and questions that could promote the development of more sustainable organic farming and a more sustainable food chain. This could include issues where, in the short term, quick and practically feasible solutions need to be found and/or ideas for more complicated long-term issues and development needs. This is also how the agenda is structured, with a mixture of research needs relating to challenges over the shorter and longer terms, where the most long-term needs are found under the part about Visionary Farming. The research needs are divided into thematic areas, but since many themes are connected, there are both simplifications and some overlap. For example, sustainability issues are included both under environmental sustainability (How do we Know what is Sustainable?), economic sustainability (Politics, Consumption and Market) and social sustainability (People in Focus). The agenda contains research needs both at an overall level as well as examples of

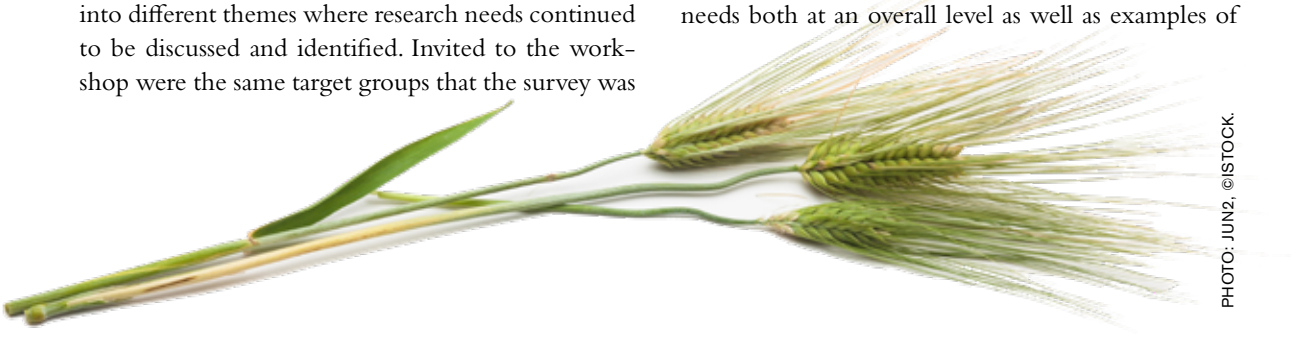


PHOTO: JUN2, ©ISTOCK.

research areas at a more detailed level that were captured during the process. The examples at a more detailed level thus do not cover all the research needs that exist within a certain research area, nor is the idea that all the examples mentioned in the agenda necessarily must be researched. The summary boxes after each thematic area address the highest priority research needs and divide these into research that is needed in the short term, comprising more urgent needs and bottlenecks identified in organic farming and organic food today, and research that is needed in the longer term, comprising identified needs that need to be researched today in order to solve challenges over the longer term.

Other agendas

The previous Swedish research agenda for organic production and organic food was published by Epok in 2013: "Research agenda for organic agriculture 2013 – research challenges and knowledge needs in organic production and organic food."[1] More recently published agendas within the EU and in the Nordic countries are TP Organics (EU) "Strategic research & innovation agenda for organics and agroecology'"(published in December 2019), ICROFS (Denmark) "Research and development strategy 2019–2021 for organic agriculture and food systems", FORI (Finland) "Research data and solutions for the development of organic production in Finland – Finnish Organic Research Institute's research strategy for 2021–2024."[2]

At the end of each identified research area in this agenda, related areas prioritized in TP Organic's agenda are also indicated.

The research and the funding

Over the past 20 years, Swedish research on organic food and farming has been largely financed with 'earmarked' funds, as Formas, SLU EkoForsk and the Swedish Board of Agriculture have had targeted funding programmes for organic production. The Swedish farmers' foundation for agricultural research and the Ekhaga Foundation also finance research in organic production. Further, Swedish research on organic food and farming has also been financed by international funds, for example by EU framework programmes. In addition, former ERA-NET programmes, mainly funded by national European partners, have been relevant to organic agriculture research. The most important ERA-NET in terms of financing research on organic production has been CORE Orga-

PHOTO: KNAPE, ©ISTOCK.

nic, where Formas has financed Swedish participation in most of CORE Organic's calls. CORE Organic is now being closed down (as are all ERA-NETs) but will continue as a looser network that can hopefully be included in the Horizon Europe Partnership, see below.

PHOTO: ©ISTOCK.

Organic production is mentioned as an important instrument to achieve the goals in the EU Green Deal and the strategy documents 'Farm to Fork' as well as the Biodiversity Strategy, which will most likely lead to more funds for organic production and consumption research. In the EU's action plan to reach Farm to Fork's goal of at least 25 percent organic agricultural land by 2030, research is emphasized as an important instrument. According to the action plan, the Commission must allocate a greater part of the funds for research and innovation to areas relevant to the organic sector. Within Horizon Europe, which is the EU's research program for 2021–2027, it is mainly within "Mission for Soil Health and Food" and within the Horizon Europe Partnership that funding for research and innovation in organic and agroecological production systems will be distributed. The partnerships are a new model that, among other things, replace the previous ERA-NET. The two partnerships that will be most relevant for organic production and consumption are "Safe and sustainable food system for people, planet & climate" and "Accelerating farming systems transition: agroecology living labs and research infrastructures."

According to a compilation[3] that includes research on organic farming and organic food in Sweden between 2008 and 2017, a total of approximately SEK 390 million was granted for research on organic farming. Formas was by far the largest funder, with a total of 145 million during that period. In 2018, Formas announced an additional SEK 48 million for research into organic food production and consumption. The most practice-oriented research can be said to be the research financed by the Swedish Board of Agriculture, where the amount decreased sharply during the studied period; from 10 to 12 million SEK per year down to around 1 million. During the period from 2018 to 2022, the Swedish Board of Agriculture has announced an additional SEK 26 million for research and development projects. This was included in a task that the Swedish Board of Agriculture was given in 2017 as part of the framework of the Swedish Food Strategy to promote the market for organic foods in order to achieve the national goals for organic production and consumption. Research projects from 2008 and onwards are listed on ekofakta.se[4].

A major part of the research was devoted to organic primary production, with approximately SEK 150 million in total in the area of crop production and approximately SEK 100 million in animal husbandry, while horticultural research was financed with SEK 70 million. As for other areas, research on biodiversity and ecosystem services had significant funding within the programmes, mainly from Formas. In other areas – such as food, business, and the market – the scope of research was very modest. Organic variety testing of straw grain, pulses and potatoes was carried out during the period with the Swedish Board of Agriculture as financier, with a grant of approximately SEK 2 million per year. Both the above-mentioned compilation and the Swedish Board of Agriculture's action plan to increase production, consumption, and export of organic food[5] published in 2018, highlight that an increased investment in research on organic agriculture is needed to reach the government's target for organic production and that such an investment also would provide environmental benefits for agriculture in general, as well as the rest of society. Both documents also highlight that only a small part of the resources have been spent on interdisciplinary research. ■

1. https://www.slu.se/globalassets/ew/org/centrb/epok/aldre-bilder-och-dokument/publikationer/forskningsagenda-2013-web.pdf
2. https://ekofakta.se/forskning-om-ekologisk-produktion/forskningsagendor
3. https://www.slu.se/globalassets/ew/org/centrb/epok/dokument/kartlaggning-ekoforskning_epok_-final.pdf
4. https://ekofakta.se/forskning-om-ekologisk-produktion/projektkatalog-ekoforskning-swedish-research-on-organic-food-and-farming
5. https://webbutiken.jordbruksverket.se/sv/artiklar/ra1816.html

Where are we now?

Organic production and consumption is growing strongly in most parts of the world, albeit from low levels in many places. During the coronavirus pandemic, more people prepared their food at home and interest in the origin of food commodities increased. In Europe, organic farming and agroecology have received increased political recognition with the Green Deal and the strategy documents "Farm to Fork" and the Biodiversity strategy. In Farm to Fork, the target is that at least 25 percent of the agricultural area within the EU should be managed organically by 2030, and in the new action plan for organic production from the European Commission, 23 measures are listed to increase consumption and maintain consumer confidence, increase production and improve the sustainability of the sector.

Extreme weather, the pandemic, and not least war and unrest in the world have recently directed a focus to issues of food supply, as well as agriculture's resilience and dependence on external resources.

Sweden has so far been a leading country for the development of organic production, with an organic area that in 2020 reached up to 20 percent of arable land. Current national political targets are to achieve 30 percent of the arable land area and 60 percent of public consumption by the year 2030. On behalf of the government, in 2018 the Swedish Board of Agriculture developed an action plan to increase the production, consumption and export of organic food. Consumption was at its highest in 2017, with close to ten percent of the market value, but has subsequently, unlike in most parts of the world, shown declining figures. The trend in both the consumer market and the public sector has been to increasingly focus on locally produced products, which may have caused the organic products to be overshadowed, even though there need not be any contradiction between local and organic. There is also a strongly increased focus on plant-based foods, where the development of organic alternatives in terms of processed foods has lagged behind.

Today, there is also a wide range of other sustainability initiatives in food production, for example regenerative agriculture in primary production and sustainability and climate labels later in the food chain. Some initiatives harmonize well with, and can be included in, organic production, while others may be primarily aimed at improved sustainability in various parts of conventional production. Organic farming has emerged out of a number of farming movements that turned against the so-called green revolution's negative aspects for the environment and people in farming. The organic regulations have been developed in cooperation with consumer interests, market and economy, research and more. The regulations are based on IFOAM Organic's four principles for organic farming (see the text box on the following page). Research has shown several environmental benefits of organic production, but in the interaction between the different interests that develop organic farming, and in a changing reality, goal conflicts that must be managed are arising. Here, research has an important task if organic food and farming are to be further developed towards improved sustainability and to respond to the major challenges, such as to mitigate climate change, preserve biodiversity, find solutions for resource conservational recycling and to feed a growing population with healthy food. Research needs to be both focused on an overall system level and on practical and local problem management. ■

Action Plan for Organic Production in the EU
https://ec.europa.eu/info/food-farming-fisheries/farming/organic-farming/organic-action-plan_en#organicsintheeu

Farm to Fork Strategy
https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

European Green Deal
https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

EU Biodiversity Strategy for 2030
https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_sv

Åtgärdsplan för att öka produktion, konsumtion och export av ekologiska livsmedel
https://webbutiken.jordbruksverket.se/sv/artiklar/ra1816.html

The four principles of organic agriculture

After discussions in the organic movement, in 2005 the international umbrella organization IFOAM Organics International formulated four principles for organic farming. The principles guide the development of organic agriculture and its regulations.

Health

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience, and regeneration are key characteristics of health. The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this, it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Ecology

This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling.

Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air and water.

Fairness

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties – farmers, workers, processors, distributors, traders and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products. This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being.

Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Care

Organic Agriculture is a living and dynamic system that responds to internal and external demands and conditions.

Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture.

Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time.

Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

Source: http://www.ifoam.bio/en/organic-landmarks/principles-organic-agriculture

The research needed

Healthy soil and plant nutrition

One of the basic ideas in organic production is that plant nutrients should circulate. Circulation of plant nutrients takes place primarily through fertilization with animal manure. In Sweden today, the geographical distribution of animal and crop production is skewed, and a large part of the plant nutrition that reaches society in the form of food is not returned to arable land. Organic production faces a major challenge in finding more sources of plant nutrients, primarily by returning them from society in different ways.

PHOTO: ©ISTOCK.

Especially for organic farming without animals, new fertilizers need to be developed. What could an increased sustainable return of non-contaminated nitrogen products from society look like? Circulation of plant nutrients from society is a major challenge because products from conventional crop production can contain pesticide residues and sewage-based products can contain pharmaceutical residues and other contaminants. In the long run, the availability of phosphorus and potassium fertilizers for use in organic farming must also be reviewed.

Other sources of plant nutrients that are interesting to study are **composted and fermented organic materials**, such as biogas digestate, bokashi, compost, compost tea and more. How could these products be produced on a smaller scale, for example in small-scale horticultural production, and how do they affect yields, greenhouse gas emissions, risks of plant nutrient leaching, carbon storage, soil health and weed emergence? Furthermore, we need to know more about the content of unwanted substances such as heavy metals, pathogens, residues from pesticides and more.

A further area of research concerns how to increase **plant nutrient utilization**. As nitrogen fixation is an important source of nitrogen in organic crop production, which will probably become even more important in the future, more research is needed on how nitrogen affects different legumes. Specific fertilizing recommendations for organic cultivation in fields as well as in greenhouses are currently lacking, and in order to come up with such, solid background facts are needed. Nitrogen availability after termination of ley for different species mixtures also needs to be analyzed to understand what the organic crop rotation delivers. Increased knowledge about nutrient availability in different systems also provides a basis for minimizing plant nutrient losses.

Since there are also no recommendations for liming in organic production, it is interesting to identify optimal pH levels, because this also affects soil-bound pathogens and nitrogen fixation rhizobia.

For **greenhouse production**, plant nutrition is a priority issue. This is further actualized through the new regulatory framework, which sets requirements for growing in soil with varied crop rotation. Research into crop rotations for greenhouse production, as well as how green manure and liquid fertilizers can be used for greenhouse cultivation systems is needed. In this context, it is important to highlight the research that exists from field cropping and apply it to horticultural crops. The focus should be on the availability of plant nutrition and that the products do not contain unwanted substances, such as pesticides from conventional production. Plant nutrient availability from added fertilizers when growing in pots also needs to be better understood.

Soil health is a concept that has received a lot of at-

tention in recent years. One definition of soil health is that a healthy soil is a living ecosystem that can deliver ecosystem services and functions that promote plants, animals, and people, without negatively impacting the environment. How do different additives, for example biostimulants and other organic soil improvers, as well as cultivation methods used in organic production affect soil health? Synergistic effects are also important to study. What are the connections between improved soil health and increased yield? What affects the soil's water-holding capacity? How do grazing animals affect soil health?

Mycorrhizae and microorganisms are considered important to a healthy soil and research should look at what influences these two factors. What inhibits and what favors occurrence and quantity? What effects does this have on harvest? What special impact does manure have that cannot be achieved with other organic fertilizers?

With increased use of catch crops and intercropping, it will also be interesting to study the effects on soil health of species such as chicory and other herbs.

To what extent is no-tillage or **minimized tillage** relevant to organic farming, for example, tillage-free termination of leys? What is the significance of importance for soil health, humus content and carbon sequestration?

More carbon needs to be stored in farmed soils. More research is needed here to identify which activities affect carbon storage. What is the optimal age of a ley in terms of carbon sequestration? Which crops, cultivars and cultivar mixtures optimize carbon storage? How do we best measure carbon sequestration? ■

Short-term research needs

- Development of more sources for plant nutrients (mainly nitrogen), especially for stockfree farming.
- Minimizing risks of contamination of pesticides and other unwanted substances in recycled fertilizers.
- Base facts for setting up specific fertilization recommendations for organic farming, including liming.
- Plant nutrition and crop rotations for greenhouses.
- The impact of different soil improvers and cultivation methods on soil health indicators.
- Optimization of carbon sequestration.

Long-term research needs

- Possibilities for returning plant nutrients from society, for example via sewage-based products.
- Opportunities to increase the availability of phosphorus and potassium fertilizers.
- Possibilities and impact of minimized tillage in organic farming.
- Relationships between soil health and yield levels.

Relevant topics from the TP Organics strategic R&I agenda

- Organic inputs and circular economy: increasing the circularity of agricultural production.
- Dealing with contamination in organic products.
- Carbon sequestration and soil management for mitigation and adaptation to climate change.

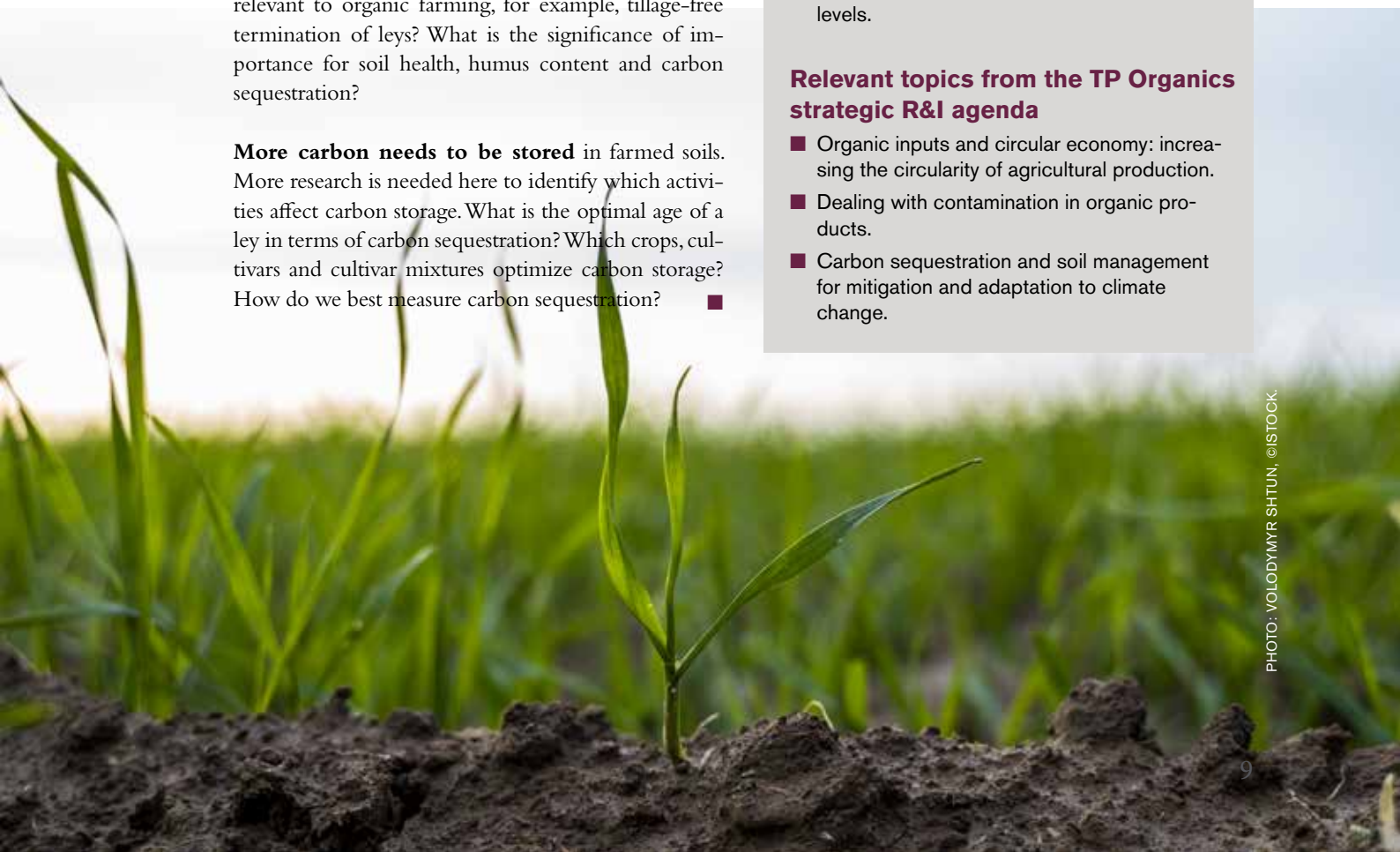


PHOTO: VOLODYMYR SHTUN, ©ISTOCK.

Sustainable production in fields, tunnels and greenhouses

Diversity and a varied crop rotation can be seen as the pillars of organic farming, but the climate is changing, pests can cause extensive crop losses, and there is a market with demands for larger volumes and more varied production for human consumption. To benefit biodiversity and create robust, resilient systems, the cultivated diversity in organic farming needs to increase further. Leguminous plants in particular are important to include in crop rotations, both as animal feed and for human consumption, as well as for the ecosystem services they provide. Even in greenhouses and in fruit and berry production, the new regulations for organic production that came into effect in 2022 require variation.

Dormancy of ley crops and other legumes is a priority research question, as the timing of dormancy changes in the changing climate. It affects the appropriate mowing or harvest time in the autumn in different parts of the country. More research is also needed on variety/species mixtures in leys that optimize both nitrogen fixation and carbon sequestration, as well as the economy in different cropping systems and different parts of the country.

To reduce energy consumption when establishing new crops, and to increase field-level resilience and biodiversity, more research and development of **systems for relay intercropping and other forms of intercropping** is needed. What combinations of species work for intercropping? What allelopathy effects can the crops have on each other? New seeds with mixed species and varieties have come onto the market but have been poorly tested under Swedish conditions. Technology for harvesting, weed management and optimization of seed rates in intercropping are important research areas here.

Catch crops can increase biodiversity and the humus content of the soil. Priority research questions are how to increase biomass production in intermediate crops, safer establishment through optimization of sowing time, correct seed quantities, possible species mixtures, best time for incorporation into the soil, crop rotation diseases and how the nutrient delivery from the intermediate crop to the following main crop works. The research needs to show what works in different parts of the country when it comes to catch crops.

The new regulation on diversity of plants in greenhouse production from 2022 will require a completely new approach to production in greenhouses. When using **green manure in greenhouses**, what are the risks of spreading diseases? What practical solutions are feasible from an economical perspective? How can you solve the jerkiness that can arise in the market when completely different things are grown in a greenhouse from year to year? What about intermediate crops for greenhouses, can they be esta-

PHOTO: ©ISTOCK.

blished late in the fall when the main crop has been harvested? Do catch crops provide a survival opportunity for pests?

The new regulation on diversity will also apply in fruit and berry production. How can **fruit and berry production systems with intercropping and diversity** best be designed to function under different Nordic conditions?

An important question is **whether new production systems, such as tunnel farming, are ecologically sustainable**. Are more or less resources required to produce a liter of berries? Development of production systems for organic ornamental plants is in demand.

For crops that are dependent on pollination, measures are needed to **increase pollination**, for example commercial propagation of solitary bees. ■

Short-term research needs

- Adaptation of greenhouse production to the new organic regulations, for example on how to implement crop rotation in greenhouses.
- Adaptation of berry and fruit production to the new organic regulations on more diverse systems.
- Production systems for organic potted plants, such as spices, vegetable and ornamental plants.

Long-term research needs

- Ley and legume production, including dormancy, mowing/harvest times and variety/species mixtures.
- Different forms of intercropping, including allelopathy effects, variety/species mixtures, harvesting techniques, weed management and seed rates.
- Varietal and species mixtures in silage that optimize nitrogen fixation and carbon sequestration.

Relevant topics from the TP Organics strategic R&I agenda

- Healthy crops and stable yields – crop management based on functional diversity.
- Digitalisation for more diversified farming systems.
- Agroecological management of protected cropping and greenhouse production.
- Diversified fruit orchards and vineyards for functional intensification.

FOTO: KARIN ULLVÉN.

Agroecological solutions for plant protection

Plant protection is generally a highly demand area of knowledge for organic farming. As it does not have conventional farming's opportunities for chemical control, organic farming must rely on more agroecological solutions in line with the organic principles (see page 7). With climate change, increased pressure from pests and plant diseases is expected. In addition, the new strategies for biodiversity and "Farm to Fork" in the EU, which implies a radical reduction of plant protection products, may also affect organic farming. Dose-based reductions may, for example, mean that fatty acids used in fairly high doses in organic farming must also be reduced – even halved.

As mentioned in the previous chapter, **increased diversification** is expected in organic farming with increased use of variety mixtures, intercropping, catch crops, protein crops, green manure crops and, for Sweden, completely new species. Many questions therefore need to be asked about how pests, plant diseases and weeds are affected – positively as well as negatively. For example, how will the increased production of leguminous plants affect the occurrence of various **crop rotation diseases**? What will be the effect on natural enemies? Can a very species-rich intercropping have a **sanitizing effect** on pests and weeds?

Favoring the surrounding biodiversity in different ways can also have effects on plant protection, but what specific measures will increase **biological control via increased biodiversity**?

Wildlife can also cause major damage to crops. How can **damage to crops by birds and other wildlife** be minimized using methods in line with the organic principles?

The connections between soil health, microbial life and plant protection is a complex area where basic knowledge needs to be built up.

Another area of research is to analyze both the status and the long-term trends regarding the **development of plant diseases in organic production**. How does this differ from conventional agriculture, directly after conversion and in the longer term?

PHOTO: PEART, ©ISTOCK.

Among plant diseases, **pea root rot** has been a difficult problem for many years in Sweden, as well as globally. After an infestation, peas cannot be grown for decades. **Clover rot** is also a growing problem where new methods to combat it are needed. Could the development of resistant varieties be a way to go? New seed treatment methods?

Increased basic knowledge is needed about **harmful**

insects such as aphids and flea beetles. The pesticide Raptol (based on natural pyrethrum and rapeseed oil) is no longer permitted in organic rapeseed production, and thus alternative **tools against insect attacks in organic rapeseed** are needed Some so-called basic substances that are interesting for plant production would need to be tested more. What doses, how and when to apply? Click beetle larvae in potatoes is another example where counteracting tillage practices and crop rotations with antagonistic plants can be tested.

Also **for horticultural crops, the lack of effective means against insect attacks is a very big problem**, especially for narrower areas of use and for crops that are grown on a small scale. In the short term, the application technique and the use of the preparations we have available today can be refined. How does the size of the deposit and the amount of substance deposited affect the pest? In the long term, more alternatives are needed. The pyrethrins that are used today involve some risks and should in the long run be phased out.

In general, more **robust systems for horticultural crops** need to be designed. In **cabbage production**, for example, the plant protection problem is extensive.

In berry production, the cultivation technology has developed a lot over the past decade, and **tunnel farming** is increasing. Tunnel farming extends the season and increases the quality of the berries, but it can also increase the risk of certain pests.

There is a need for an increased basic understanding of **weed biology,** for example in the case of *Galinsoga quadriradiata, Senecio vulgaris, Solanum nigrum* and millet. Weed strategies need to be developed. When and where can weed presence be accepted and when must soil cultivation be prioritized?

More methods for **weed control in row crops** need to be developed, for example weed control using electric pulses, photo technology, drones, and robots. Can seed mixtures be developed to be used in crop rotation to combat weeds? ■

Short-term research needs

- How increased legume cropping affects crop rotation diseases, pests and weeds.
- Measures against fungal diseases in legumes.
- Measures against wildlife damage.
- Measures against insect infestation in rape seed and horticultural crops.
- Methods for weed control in row crops.

Long-term research needs

- Measures for increased biological control.
- The connections between soil health, microbial life, and plant protection.
- Long-term trends in the development of plant diseases in organic farming.
- Fundamentals of insect pest biology.
- Basic weed biology.

Relevant topics from the TP Organics strategic R&I agenda

- Healthy crops and stable yields – crop management based on functional diversity.
- Digitalisation for more diversified farming systems.

PHOTO: ULF NILSSON.

PHOTO: JOHNMARQUESS, ©ISTOCK.

The farm animals

Organic animal husbandry is based on principles of a high degree of self-sufficiency in feedstuff and an interaction between forage plant production and the animals' feed needs. Grazing and outdoor opportunities are other important principles for organic animal husbandry, and the goal is to create systems for animal husbandry that will prevent diseases in production, with a focus on naturalness.

To promote natural behavior of the animals in organic animal husbandry, the **design of housing systems** is an important aspect that needs to be improved to further improve the well-being of the animals, both in their indoor and their outdoor environments. The interaction with the outdoor environment needs to be better studied to develop systems that make it easy to detect and possibly manage injuries or diseases, minimize the risk of nutrient leakage, and reduce threats from predators or infections from wild animals.

In organic animal production, grazing is a fundamental part. More research is needed on **grazing optimization** in terms of grazing systems as a strategy for efficient resource utilization. Keeping animals outdoors and grazing are important for consumers' trust in organic animal husbandry. There is a research need to develop the interaction between the plant species composition in the pasture, yield, biodiversity, risk of plant nutrient leakage, adaptation to local conditions, length of grazing period, product quality and more. Research is also needed on how to increase the proportion of pasture and forage in milk and beef production, as well as entirely grass-based production systems. Here, more knowledge is also needed about the impacts of a changing climate, for example when the possible grazing period becomes longer, and intense precipitation becomes more common.

There is a need for research on how animal husbandry can support crop production. For example, can rooting pigs be used for termination of ley, and is it possible to develop systems with chickens in horticultural systems to control weeds and pests? There is also a need for research on diversified animal husbandry with a focus on synergies, where you **mix**

PHOTO: KARIN ULLVÉN.

animal species and include these in crop production. In animal husbandry, the animals are often divided according to age, but in natural systems there is often a mixture of ages in the animal herd. Could there be advantages in mixing ages among animals, for example calves/young animals being allowed to go with older cows?

The research needs to take a comprehensive approach on **feed efficiency and feed optimization**. It is particularly important to find **suitable local protein crops for poultry and pigs** that meet the needs for essential amino acids in an efficient manner. Which indigenous protein crops can serve as alternatives to imported soy and fishmeal? Questions here include whether the import of protein feed can be reduced with a greater proportion of domestic protein from ley crops, how do we get domestic protein crops into the feed production system of today, and how do alternative protein crops work in practice as feed? Is a lower growth rate due to less well-adapted feed acceptable? How is profitability affected? Are more adapted breeds a solution? It would also be interesting to include more possible feedstuff based on residual products. Continued research on protein extraction from forage crops should be prioritized.

What do we mean by a **sustainable lactation and milk yield**? Factors affecting the lactation curve should be studied further, as well as which level of milk yield is long-term sustainable based on a forage-dominated feed ration to achieve a more sustainable milk production?

In general, more knowledge is needed on **how animal health can be improved** for animals in organic animal husbandry. Broad studies on animal welfare and the natural behavior of animals that take several aspects into account are lacking. For example, a better understanding of the interaction between the animals' behavior, the feeding and the animals' genotype is needed. There is a lot of research on parasites in outdoor animals, but this is an area that still needs to be focused on as it is more specific for organic

animal husbandry, where the requirements for being outdoors are high. Furthermore, it is highly relevant to study how a warmer climate affects the spread of infection among outdoor animals and which new diseases may increase in occurrence. In organic production, the focus is on preventive animal health work to reduce the risk of resistance problems. This results in a relatively low use of antibiotics in organic animal husbandry, but systems to further reduce the need for antibiotics should still be studied.

More specifically, there is a great need to research specific **animal health problems**, such as catarrhal fever and its spread between lambs and cattle, udder and hoof health during milk production, and leg health in all animal species. Research is needed to find accepted alternatives to surgical castration of pigs. Piglet mortality is higher in organic than in conventional pig production and systems to reduce this problem need to be further developed.

With a focus on animal welfare, research is also needed on **alternative methods and systems for slaughter**. A research need here is studies on stress in animals that are transported to the slaughterhouse compared to animals that are slaughtered on the farm where the animal was raised. To avoid animal transports, how can systems for small-scale slaughter be best designed? Alternative stunning methods for pigs and poultry is a high priority research area. Research should also look at alternatives to the slaughter of rooster chicks immediately after hatching. Increased knowledge is also needed about carcass characteristics and what affects meat quality for different animal species.

Improvement work that can extend the lifespan of cows, sows and laying hens is desirable.

It is also important to research optimal production systems with regard to the same aspects as mentioned above for more **unusual animal species** in organic animal production, such as goats, rabbits, horses, bird species other than chickens, deer, bees and more. Animals with multiple functions in the production system are particularly interesting, for example ducks that can provide both meat and eggs, function as part of plant protection, and possibly keep predators away from chickens. ■

Short-term research needs

- Design of housing systems including grazing.
- Optimized grazing based on minimal environmental impact and optimal forage share in milk and beef production.
- Suitable new protein feeds based on local raw materials, mainly for pigs and poultry.
- Measures against specific animal health problems including parasites.
- More alternatives to surgical castration of pigs and development of systems to reduce piglet mortality.
- Alternative methods and systems for slaughter that reduce stress and pain.

Long-term research needs

- Systems with mixed animal species and mixed ages of animals that provide synergies.
- Increased understanding of which new diseases may increase in occurrence, and how the spread of infections may be affected by a warmer climate.
- Integrating crop production and animals on the farm.
- Holistic view on animal welfare and natural behavior of animals.
- Optimum production systems for less common animal species and increased multi-functionality of such animals.
- Increased knowledge of factors that affect the lactation curve in milk production.

Relevant topics from the TP Organics strategic R&I agenda

- Achieving a circular economy in livestock production.
- Digitalisation for more diversified farming systems.
- Sustainable concepts for organic and low input monogastric systems.
- Climate-resilient grass-fed ruminants.

Production in water

Organic aquaculture faces the same challenges as other organic production areas. What does sustainability look like based on profitability, social aspects, good animal welfare, resistance issues, resource efficiency and minimal environmental impact? Aquaculture also has new rules to comply with in the new organic production regulations.

In terms of **animal welfare in fish production**, more knowledge is needed about stunning methods at slaughter that minimize suffering, as well as factors such as optimal stocking rate, environmental enrichments, and species adaptation.

More research is needed on how aquaculture can be designed and increased **within the framework of the EU regulations for organic production**. For example, the addition of micronutrients in the promotion of sporophytes for algae production is a potential stumbling block. It is interesting to develop systems for land-based fish farming that are compatible with the organic principles.

Sustainable ingredients for **feedstuff to use in aquaculture** is another important area of research. ■

Short-term research needs

- Stunning methods at slaughter in fish production.
- Optimum stocking rate and environmental enrichments in fish production.
- Design of organic aquaculture within the framework of EU regulations.

Long-term research needs

- Sustainable feed raw materials for organic aquaculture.
- System design for organic fish farming.

Relevant topics from the TP Organics strategic R&I agenda

- Increasing the sustainability of organic aquaculture.

Sustainable varieties and breeds

PHOTO: ANDERS LUNNERYD.

In organic farming as a whole – in crop production, in animal husbandry, and in horticultural production – there is today a discussion about whether the conventional varieties and breeds are also suitable in organic farming. They grow well and often they produce high yields, but what do you also lose by using materials adapted to conventional production? To a large extent, the use of conventional varieties and breeds is because there is a larger market for these. It is also difficult to find producers of organic seed and breeders of organic breeding animals, but what about the need for more robust crops in a changing climate, resistant crops that don't require chemical pesticides, and animal health when conventional breeds are allowed to live longer and go outdoors to a greater extent? The new EU regulation, with increased requirements on the use of organic seed and organic animals, gives rise to major challenges in organic production.

Research is needed to develop **varieties adapted to organic production in a Nordic climate**. The focus for the varieties, both in crop production and in horticultural production, should not only be on yield, but great importance must also be placed on the varieties being **resistant to more changing and varied weather, as well as to plant diseases and pests**. With possible increased production of pulses and an increased use of intercropping and catch crops, it will also be important to ensure the aftereffects and interactions in the entire crop rotation are known. **Variety testing in long-term field trials** is an important aspect here.

Many grain varieties used in organic production today are based on conventional production to give maximum volume under the conditions that nitrogen can be supplied in unlimited quantities. Varietal material bred in organic production should instead be good at making use of a lot of nutrients, especially nitrogen, and primarily provide **high protein content and quality.**

As **protein crops** will become more important, both for feed and human consumption, breeding work needs to focus on legumes, both domestic crops such as broad beans and peas but also newer crops that are used globally, for example lupines. As a future with more plant-based organic products is predicted, the development of new protein crops also needs to consider more qualities such as taste, nutrient availability, and amino acid composition.

Older **cultivars** that are already locally adapted can be interesting to study, as they have already been refined in the Swedish climate and are often more weather-resistant. Sweden is a small market for its own special varieties, so it will also be important to find good varieties from the **rest of the Nordic countries and northern Europe**.

As Sweden is a small country, domestic breeding of new varieties in professional horticulture on a larger scale is unrealistic. Here too, the research should invest in variety **testing of new foreign varieties in perennial crops**, such as fruit, berries, and perennial vegetables. All climate zones that exist in Sweden today, and a possible future climate need to be taken into account. There is also a great need for organic rootstocks.

Within animal husbandry as well, there is a great need for **better-adapted animal material** for organic production. The biggest challenges concern cattle,

pig, and poultry. An important question here is which characteristics should be bred for to produce animals adapted to organic production – especially for pigs and poultry where the differences between organic and conventional production are large. How do we carry out breeding at the farm level, for example, if the breeding companies are not interested? Can the conservation of native breeds be an added value for organic animal production?

Within **meat and milk production**, the sustainability of combination breeds would need to be investigated. Are there robust breeds that can fulfill several functions, such as landscape conservation, good animal welfare, high feed efficiency, etc., and which perhaps also produce both milk and meat? Within meat production, carcass characteristics should be studied for increased knowledge of suitable breeds and slaughter age, where yield over time is considered in the breeding goals. For dairy cows, increased longevity and feed efficiency are important aspects to take into account in the breeding work.

Genetic material adapted for organic pig production is a prioritized research area. Here, for example, leg problems in outdoor pigs, piglet mortality and feed efficiency are important aspects to consider.

PHOTO: SUVI TIAINEN, NORDGEN.

In a similar way as in pig production, the genetic material needs to be reviewed for organic **egg and broiler production**. Are there sustainable breeds that are more adapted as laying hens in organic egg production, for example, native breeds with a lower need for protein and breeds that are even slower growing or have lower egg production? ■

Short-term research needs

- More resistant varieties developed for organic production in a Nordic climate, especially for protein, cereal, and horticultural crops.
- Cereal varieties that are efficient in terms of nutrient absorption.
- New protein crops with regard to qualities such as taste, nutritional availability and amino acid composition.
- How to create an animal breeding material adapted to organic production.

Long-term research needs

- Robust multifunctional breeds for milk and meat production.
- Native breeds and varieties that may be better adapted to organic systems.

Relevant topics from the TP Organics strategic R&I agenda

- Boosting organic breeding and the production of organic cultivars.
- Microbiome and sustainable food production.
- Plant breeding for climate resilience, production stability and income robustness in organic farming systems
- Breeding of animals for longevity, hardiness, and multi-purpose production.

Focus on humans

An important part of sustainable food production is that the workers in organic farming have a sustainable working environment. The definitions of work environment differ somewhat, but generally includes physical, organizational, and social factors. In general, organic producers do not have to deal with highly toxic chemical pesticides, but on the other hand, an organic producer cannot resort to conventional inputs in cases of plant diseases and/or pest occurrences. Thus, there are to a greater degree sources of stress and psychological pressure. In general, many organic producers gain greater appreciation from consumers and the public. With more extensive requirements for keeping animals outdoors, there are also to a greater extent load-related ergonomic and risk-related problems in organic animal husbandry. An important factor for a good working environment is also financial sustainability, something that is largely controlled by the market and political support measures.

The research needs to review the **social and organizational sustainability** of organic producers. For example, an important area of research is to call in factors that make it difficult to get young people to become farmers, as well as factors that make a farmer become organic. Are there ways to support becoming an organic farmer into a more attractive profession? Is a vibrant countryside important? Would an increased collaboration around land and machinery make the profession more sustainable? What does social sustainability look like for small-scale organic producers who need to have other jobs on the side to make their economy work? Profitability is an important aspect that should be included in studies on new production methods.

Although the average Swedish organic farm is larger than the conventional one, a large part of organic production is carried out on a smaller scale and there is a new "green wave" of people who want to start farming, often on a small scale. How can knowledge about organic farming reach these farmers? How should they be able to find their own **identity as farmers**? There is today a strong identity around being either a conventional or an organic farmer. How is that identity created? What factors are behind someone being strongly for or against organic farming? Is this due to misconceptions and prejudices, or to deeper fundamental values?

Workload and risk factors in animal husbandry should be reviewed. Are there housing systems that give rise to less risk of injury to humans when handling animals but still maintain, or possibly improve, animal welfare? What are the pros and cons of breeding from calm animals? Can we train animals to be safer?

PHOTO: ASCENTXMEDIA, ©ISTOCK

Short-term research needs

- Social sustainability for organic producers and factors that make becoming an organic farmer an attractive profession.
- How knowledge of organic production can reach a new 'green wave' of small-scale growers.
- How workload and risk factors can be improved in animal husbandry.

Long-term research needs

- What factors give rise to an identity as an organic or conventional farmer?

Relevant topics from the TP Organics strategic R&I agenda

- Opportunities for young entrants in local sustainable food systems through green public procurement.
- Strengthening knowledge and innovation systems for organics through digital tools.

Technologies that make a difference

User-friendly technology and digitalization/digitization are important tools in organic production as these can facilitate in many areas where efforts are made to minimize and optimize inputs. For example, digital monitoring systems in crop production and horticulture can provide quick and site-specific information for preventative plant protection efforts, weed control, irrigation, plant nutrient needs, and more. In animal husbandry, corresponding technology can, for example, provide information on grazing, feeding and the animals' health status and growth.

New areas of technology where there is a need for research are the development of systems that can be used as **decision support** for the farmer in terms of measures to increase biodiversity, reduce resource use, increase efficiency, increase profitability, initiatives for carbon sequestration and more. Here, more knowledge is needed about **timing aspects for various activities**, for example in terms of efforts to increase carbon sequestration but also the best timing for different kinds of tillage. Technology also needs to be adapted to **complex production systems**, such as agroforestry and animal husbandry, where animals are both outdoors and indoors. An example of such technology is virtual fences that facilitate shifting of pasture areas and robots that can facilitate cultivation.

A lot is happening around '**food tech**' and smart urban food production systems. How does this affect organic farming and processing of organic products and what opportunities can this create for organic production and consumption? Research is needed that looks at which of these technologies are in line with the organic principles and can be focused on for increased local and sustainable organic food production.

Systems to simplify **administration** for the farmer are also an important area of research. How could digitization be helpful, for example in complying with regulations and regulation follow-ups or for subsidy applications? How should digitization be developed as a tool for increased traceability?

It is very important that this type of research is done in **collaboration with industry and those who use the technology** to ensure that the technology is really in demand and that it works with the intended production system (see also the chapter on How do we develop knowledge?). Here, research also needs to be interdisciplinary so that economics, environmental impact, user-friendliness, and ethics are taken into account. Research also needs to include reviewing of the **vulnerability** of the farmer, as technological systems and equipment can be difficult to replace when not functioning. ■

PHOTO: E. KARTEKINA, ©ISTOCK.

Research needs in both the short- and the long-term

- Utveckling av system som ger beslutsstöd vad gäller olika åtgärder i lantbruket.
- Teknik anpassad till komplexa produktionssystem.
- Utveckling av system som förenklar lantbrukarens administration.
- Vilka delar inom "food tech" som är förenliga med ekologiska principer och hur ekologisk produktion i så fall kan utvecklas inom dessa.

Relevant topics from the TP Organics strategic R&I agenda

- new genetic engineering technologies and their implications for organic farming.
- Digitalisation for more diversified farming systems.
- Carbon sequestration and soil management for mitigation and adaptation to climate change.
- Strengthening knowledge and innovation systems for organics through digital tools.
- Digital solutions for transparency across the value chains.

How do we know what's sustainable?

The four principles for how organic production should be conducted and developed, formulated by IFOAM Organics, are health, ecology, fairness, and care (page 7). All four principles concern the maintenance of a functioning ecosystem that shouldn't risk the health and well-being of the current generation of people, nor for future generations. It includes good soil health, good plant and animal health, ecological balance, fairly distributed resources, secure food supply, good animal welfare and the use of new technologies according to the precautionary principle. To ensure that all aspects are considered, the principles further mention that science is necessary, but also that practical, traditional, and local knowledge is important. In summary, it is sustainability that organic agriculture strives towards, but what is sustainability and how should research be able to evaluate and rate different aspects within sustainability?

Something that is of extra importance today is a more **holistic research approach**, where one looks at the system level and include as many sustainability aspects as possible, including economic and social sustainability. Today, research is often accused of looking one-sidedly at climate impact and that more sustainability aspects must be taken into account. Agricultural systems are complex, however, and many aspects of sustainability such as biodiversity, soil health and animal welfare are difficult to quantify. Here, new methods and systems are needed to better evaluate different organic production systems and their added value, as well as to shed light on goal conflicts within organic production. The influence of the level of details in the regulations, and what level would provide most sustainability could be studied.

On a more detailed level, research is needed on how organic farming is affected by, and can adapt to, a **changing climate**. How **resilient** is organic farming in terms of **aspects other than climate**, such as the degree of self-sufficiency and diversity of businesses as well as diversity among the products that the businesses produce?

The **use of fossil raw materials still needs to be reduced**. What opportunities are there to reduce energy use? Can animals graze in solar parks? What causes agriculture to continue to largely use fossil fuel? What are the obstacles to the use of new fossil-free technologies? How can organic production further reduce transport to better live up to the principle of local cycles?

PHOTO: ANDERS LUNNERYD.

More **scenario analyses** would be needed, for example analyses of alternative plant nutrient sources to see how these can facilitate organic farming. Scenarios for the prevention of the spread of disease in outdoor animals are another example. Scenarios for organic animal husbandry also need to be examined, where one looks more broadly at the role of this in a sustainable food system, especially given the trend that we are switching to a more plant-based diet. How does intensification in organic farming affect what is the most sustainable size and production intensity for an organic farm?

More knowledge of **which activities and methods provide increased carbon sequestration and biodiversity** is needed, including biodiversity in soil and water. This is needed partly as a basis for the design of regulations and agri-environmental payments, and partly as a basis for the development of decision support for the farmer in terms of measures to promote carbon sequestration and biodiversity. In general, more 'key figures' in addition to profitability would need to be developed for farmers to evaluate their own production.

To be able to evaluate the environmental impact of agricultural systems, **updated basic data** on emissions from various agricultural activities is also needed. ■

PHOTO: KARIN ULLVÉN.

Short-term research needs

- System-level sustainability analysis that include aspects such as biodiversity, soil health and animal welfare, as well as economic and social aspects.
- Analysis of resilience and opportunities for adaptation for organic farming in a changing world.
- Continued development work to reduce dependency on fossil fuels.
- Increased knowledge of activities and methods that contribute to carbon sequestration and increased biodiversity.
- Updated basic data for agricultural emissions.

Long-term research needs

- Scenario analysis on alternative plant nutrient sources to see how these can facilitate organic production.
- Scenario analysis to identify how the spread of infection in outdoor animals can be prevented.
- Scenario analysis to ensure optimal production systems in terms of sustainability.

Relevant topics from the TP Organics strategic R&I agenda

- Carbon sequestration and soil management for mitigation and adaptation to climate change
- Measuring agricultural sustainability and public goods in EU agriculture.
- Contribution of organics and agroecology to food security and sustainable management of natural resources on a global level.

The food we are eating

PHOTO: WEBPHOTOGRAPHEER, ©ISTOCK.

One of the basic principles (page 7) for organic production is health, where production, processing, distribution, and consumption must maintain and promote health. The intention for organic production is to produce high-quality and nutritious foods that have a preventive effect on health and well-being. This is one of the reasons why organic production regulates the use of certain fertilizers and pesticides, medicines for animals and additives that can have negative health effects.

Regarding the nutritional content of foods, the difference in the content of individual essential nutrients and pesticide residues between organic and conventional products is relatively well studied. However, more research may be needed on **differences in the content of antioxidants, bioactive components, and anti-nutritional substances** and how such differences may affect human health. It is also interesting to evaluate the composition of older varieties that may be relevant for organic production to use and process. In addition, the connection between the design of the production system and growing conditions, for example type of fertilizer, soil improver or biostimulants used, type of soil etc., and **influence on the content and taste** of the crops are unexplored areas.

Knowledge is also relatively limited regarding the **health effects** of organic products and where the effects of the food can be distinguished from other factors that affect human health, such as various lifestyle factors. More analyzes are needed here of long-term effects based on larger studies that follow study participants over a longer period.

Goal conflicts that arise when certain additives and inputs are avoided in organic production need to be addressed and resolved. Examples of such goal conflicts are the use of fishmeal in organic egg production, which leads to higher levels of dioxins in organic eggs than in conventionally produced eggs, and the ban on using nitrites in charcuterie products, which leads to difficulties in obtaining returns for pork.

How to **minimize the risk of pesticide residue contamination** in organic food products is a further question for the research.

There are a lot of possibilities for **product development in the processing** of organic raw materials. With the prevailing trend of an increased demand for plant-based foods, research and innovation is needed on how to produce **new vegetarian products** in accordance with the regulations for organic production. For example, how do you produce protein isolate according to organic principles? Are there other methods that can be used that do not require as much processing and that preserve the character and good qualities of the raw material? How can we develop new products based on dairy raw materials if milk consumption continues to decrease? How can we develop more foods based on proteins of marine origin? Processes for food production on both larger and smaller scales need to be developed.

Factors that can affect the **quality and the taste of the meat** should continuously be researched, as specific breeds and specific production methods can be an important niche for organic meat production if there is a demand and thus profitability for this type of niche.

Can we develop new products from raw materials that are being wasted by the food industry today? One example is wheat that does not have the protein levels that need to be achieved to be purchased as bread grain quality. Is a set-off for cereal products that instead focus on other qualities possible? Is it possible to somehow use beans or peas that have been affected by insect infestation? As part of an increased circular bioeconomy, more **efficient uses of side streams** for organic raw materials should be identified. ■

Short-term research needs

- Differences in content of antioxidants, bioactive components, and anti-nutritional substances in organic products.
- Goal conflicts around permitted and prohibited food additives.
- Food processing methods – especially plant-based – in larger and smaller scales that are compatible with the organic principles.
- Utilization of more organic side streams for an increased circular bioeconomy.

Long-term research needs

- The influence of inputs, soil type, and other factors on the content and taste of the crops.
- Further reduced risk of pesticide residue contamination in organic foods.
- Factors affecting the quality and taste of meat.
- More foods from protein of marine origin.
- The health effects of organic products based on studies that follow participants over a long period of time.

Relevant topics from the TP Organics strategic R&I agenda

- Dealing with contamination in organic products.
- Sustainable and healthy organic diets.
- Food safety in the organic supply chain .

PHOTO: SKASHKIN, ©ISTOCK.

Politics, consumption, and the market

PHOTO: ARTJAZZ, ©ISTOCK.

A close relationship between producer and consumer has traditionally been considered important in the organic farming movement. Although farm shops and direct sales through what are known as REKO-rings have grown in popularity, most trade in organic products in Sweden takes place in regular grocery stores. Labels – in Sweden KRAV and the 'EU leaf' – can be said to replace the direct contact between farmers and consumers and be a guarantor of the added value that the consumer expects. In Sweden, there are various forms of support for organic production as well as political goals. Despite support, however, the products are often sold at a significantly higher price for consumers, while the profitability for farmers is often insufficient. 'Locally produced' and 'vegan' are two strong trends in the current market that 'organic' needs to relate to.*

In January 2022, new **revised EU regulations** for organic production began to apply. A current area of research is how this will affect different production branches.

The consumer's willingness to pay extra for organic products presupposes knowledge of the added value of organic production. Important research questions regarding **consumer behavior** include how can such added values be better communicated and give in-depth knowledge to consumers? How does such an influence take place? Why are sustainable alternatives chosen to a greater extent in online shopping? How do different actors within the food chain influence the market and supply of organic products? Research into **different forms of communication and what support is needed for retail and producers** is also of interest.

Other **product qualities** besides "organic added value" could contribute to consumers being willing to pay a higher price for the products. Is there a market for tastier meat, for example using native breeds or via a more varied and tastier feed or pasture? Is there a market for products from old cereal varieties with a different taste and nutritional composition? What are the opportunities on the market for products that are both organic and locally produced, for example meat from small-scale local slaughterhouses?

To promote local organic production, changes in **eating habits** may need to occur. Is it culturally possible, for example, to replace rice with a local rye variety? Do vegans and flexitarians prefer products that are similar to meat products, or is there a market also for less processed locally produced products?

How the **added value of products from special production systems**, such as agroforestry, can be marketed is another question.

Improved **traceability** and more transparency for the consumer about the specific production methods of a certain product is desirable, but how can we bring that about without too high cost for the producer?

How can **contacts within the value chain** be facilitated? Sometimes there is a lack of organic raw materials in the food processing industry at the same time as the farmers claim that there is no market demand. What can models for better communication in the food chain look like?

How can we create a stable sale and income for organic producers? Where are the winnings taken out and where do the price mark-ups take place? What does the profitable farm look like? How can we create good conditions for local food processing? How can

PHOTO: DRAGANA991, ©ISTOCK.

the security for the farmer to get the products sold be increased? Contract farming for better or for worse? How do we build resilient companies with resistance to future changes? Is it possible to improve efficiency with cost-cutting measures and higher yields – is so-called ecological intensification possible?

For certain product categories, the organic products have a very small market share. This applies, for example, to organic **pig and chicken production**. Reasons for the low demand need to be investigated and bottlenecks identified. Measures for increased conversion and improvements in current production need to be developed.

PHOTO: ©ISTOCK.

At the same time as the EU's Farm to Fork strategy and the strategy for biodiversity point out clear development goals for organic production and consumption in Europe, the political dividing lines – at least in Sweden – regarding support for the development of organic production and consumption in recent years have tended to become clearer. Conflicting signals can create vulnerability and uncertainty about the future. More knowledge is needed about how **political goals**, for example defined area goals and consumption goals, and **policy instruments** affect the development. Here, comparisons can be made between different countries and support systems. Socio-economic costs for converting to organic on a large scale need to be set against the socio-economic values of organic production. The effects of various policy instruments need to be investigated. How much of the support is "eaten up" by administrative overheads for the farmer? Does this differ between different countries in the EU? What are farmers' attitudes towards different compensations and does this affect the effectiveness of the support? How can public procurement be directed more towards local organic producers? Is lower VAT on organic vegetables a possibility, for example?

Based on the crises of recent years with the pandemic and war in Europe, an important research question is to look at the **resilience** of organic farming and how organic farming can contribute to Sweden's food security.

Organic production of vegetables, fruit and berries is small, and often small-scale in Sweden. How does today's system disfavor **small-scale players**? Smaller farms can produce a lot per area, but then also require more labour. The agri-environmental payments are partly dependent on the farm area, there are difficulties for small players to get investment support and the taxes are often a heavy burden for small entrepreneurs. Studies that compare Swedish subsidies and tax systems with other countries are interesting for finding policy instruments that also benefit smaller agricultural companies. Research is also needed on **agri-environmental payments** and reversed charge for emissions allowances for carbon sequestration, biodiversity and more. Can the subsidies be targeted at entire complex farm systems and not just at individual measures? Compensation for results instead of actions? ■

Short-term research needs

- How the new EU regulations affect different branches of production.
- How political goals and policy instruments affect the development.
- Policy instruments that also benefit smaller organic producers and that focus on results and – not just special measures – to include complex farm systems.
- How the added value of organic production can be communicated to consumers and what support in this regard the retail trade and producers have access to.
- What measures are needed to create profitability and stable sales for organic producers.
- Models for better communication in the food chain so that raw materials are sold.
- Actions that increase demand and identify bottlenecks for products with a very small market share.
- How organic farming contributes to Sweden's food security.

Long-term research needs

- Other added values with more focus on cultural and product quality aspects for which consumers would be prepared to pay more.
- How the added value of special production systems, such as agroforestry, can be marketed.
- How the consumer can be given increased traceability and transparency about the production.

Relevant topics from the TP Organics strategic R&I agenda

- European market observatory for organic food & farming.
- The implementation of the new organic trade system.
- Better farming policies post 2020 for a more sustainable and diverse farming sector in the EU.
- Opportunities for young entrants in local sustainable food systems through green public procurement.
- Contribution of organics and agroecology to food security and sustainable management of natural resources on a global level.
- Consumer demand for minimal processing.
- Innovation for reducing food and packaging waste.
- Digital solutions for transparency across the value chains.

The visionary future of organic farming

During the development work called "Organic 3.0" carried out within the global organic farming movement some years ago, it was discussed whether organic farming is most useful to be at the cutting edge – an exclusive niche production that forces the rest of the producers to raise the standard, but where the gap between the two systems remains wide? Alternatively, does organics benefit the most if the largest proportion of food production becomes organic, which means that the requirements cannot be tightened to any greater extent? In any case, new innovative forms of organic production need to be tested to meet tomorrow's challenges.*

Today, the average age of farmers in Sweden is quite high, and a fundamental prerequisite for sustainable food production in the future is that a **new generation** wants to take over. Who are the organic producers of tomorrow? How do we create attraction for the green industries and the organic food chain? Are there new forms of ownership and ways in for those who were not 'born into' agricultural production?

'Regenerative' agriculture is something that has been talked about a lot lately. The methods of regenerative agriculture have their roots in organic farming but are sometimes used in terms of being a new way to achieve sustainability alongside organic and conventional production, with the term unclearly defined. More knowledge is currently needed about regenerative methods on different scales, about economics, sustainability, efficiency, carbon sequestration, optimal number of species in cultivation, effects on biodiversity, parasite pressure and more.

Agroforestry is well established within organic farming at more southern latitudes, but how can it be developed for Nordic climates? What are the effects on nutrient runoff/leaching, carbon sequestration, etc? How can nutrient supply to perennial crops be solved? How can financing models be designed considering the long establishment period? Which species are interesting and which products is there a market for? Cultivation of more 'exotic' perennials, mainly fruit, berries and nuts, may become possible with a milder climate and more cold-resistant varieties. A landscape perspective is needed to understand agroforestry's potential for biodiversity. Modelling with information about the importance of peren-

PHOTO: KJELL SJELIN.

nial plants for pollinators, for example, can be a viable route to increased understanding.

A form of agroforestry can be organic meat production on wooded pastures, where the trees can contribute to the production of fruit, berries or nuts, or be harvested as an energy forest and/or be nitrogen fixers and increase carbon sequestration. Such systems should be tested and developed, including aspects such as species composition, animal material, protection of young trees and economics in the short- and long term.

An organic farm may not need to choose an entire system such as agroforestry, regenerative agriculture, conservation agriculture or the like, but perhaps can do either on part of the farm and/or combine methods and systems? Partially cultivated forest edges can be a supplement that adds cultivated diversity and is also positive for the natural wild biodiversity on a farm. In general, it is important to find climate-adapted methods that fit in organic farming, strengthening the added values, are profitable, and bring products to market.

Animal husbandry of today is most often specialized, that is, with only one animal species per production unit. However, there may be advantages to keeping **several animal species** that need to be investigated more closely, for example for better pasture utilization and parasite control, as well as for the promotion of biodiversity.

Various new forms of **aquaculture** that are compatible with the organic principles need to be developed and tested. It is important to find new organisms and new cultivation techniques. Can wetland restoration be combined with production? The research should also review the development of different types of aquacultures with production **both for feed and human consumption**. For example, how can organic crayfish farming be developed in Sweden? Which organisms are most suitable as raw material for production of proteins for human consumption?

Research with a **landscape perspective** on organic farming, including water and forests, is interesting. Among other things, to look at the possibilities for continued development of **Eco-districts** ('Eco regions/bio districts') in Sweden (https://www.ecoregion.info/).

Urban farming and near-urban small-scale farming needs to be studied more closely. Production needs to be profitable to be sustainable. What factors contribute to success? How is it ensured that the production is climate-friendly? Does so-called 'food tech' also have a role in organic urban farming systems? How can urban small farms, allotment gardens or cooperative farms develop? What role can these play in learning about food production and social sustainability? Many large farms have small parcels that they don't use. How do we take advantage of these opportunities for small scale farming? The technological development can open up new opportunities for small-scale farming. ■

* https://www.slu.se/globalassets/ew/org/centrb/epok/dokument/eko3.0_broschyr_web.pdf
https://link.springer.com/article/10.1007/s13165-020-00312-4

Short-term research needs

- How to attract a new generation of organic farmers.
- How principles from regenerative agriculture can contribute to the development of organic farming.
- Agroforestry adapted to a Nordic climate.
- Methods and systems from principles of regenerative agriculture, conservation agriculture, agroforestry and more that can provide more added value, more products with increased profitability and environmental sustainability for organic farming.

Long-term research needs

- Sustainable agroforestry systems, in terms of both environment and profitability.
- Advantages of less specialized organic animal husbandry.
- New forms of aquaculture that can potentially provide both feed and food.
- Landscape perspective on organic farming.
- Opportunities for environmentally, economically, and socially sustainable small-scale production systems in rural as well as urban and peri-urban areas.

Relevant topics from the TP Organics strategic R&I agenda

- Achieving a circular economy in livestock production.
- Healthy crops and stable yields – crop management based onunctional diversity.
- Agroforestry for climate change mitigation and biodiversity.

How do we develop knowledge?

In organic agriculture, a holistic view is advocated, but research is often too disciplinary-oriented and has insufficient tools to deal with the complexity that the entire food system in interaction with the surrounding environment constitutes. The research also does not always correspond to the knowledge demanded in practice. In addition, there are results and knowledge from previously conducted research that never reached its intended recipients or came to be used. Further efforts are therefore needed to strengthen the relevance of research and the implementation of results.

To increase the public good resulting from research, there is a need to **increase cooperation** between researchers, practitioners, and other stakeholders. This will strengthen the usefulness of the research results and favor innovation and the development of more sustainable production systems and solutions throughout the food chain. It is important here to look at the conditions that apply within organic production and consumption. Here, participatory research and action research can be interesting methods to use. Test activities in demonstration facilities and testbeds should take place all over the country, since the conditions for 'green businesses' vary, and the work needs to take place close to the entrepreneurs.

Interdisciplinary research is a must to solve the great challenges of the future. The collaboration between natural science and social science research needs to be further developed to include different perspectives, especially if we want to see to the research needs of all actors in the food chain. The research also needs to ensure geographical coverage and increased cooperation between the Nordic countries.

An increased **long-term perspective** is also needed in research projects. To be able to study complex cultivation systems, for example where the effects of different crop rotations or perennial crops such as fruit and berries are studied, long-term trials and trials on a larger scale are needed. Effects of conversion to organic production in the longer term, ten years or more, are also interesting to study. Studies in already existing production systems may be relevant. The interactions of different methods with each other needs to be studied. It is important that research projects cover the entire innovation chain, from theory to implementation, so that the research can lead to practical use of the product or method. Financial profitability also needs to be included in the studies.

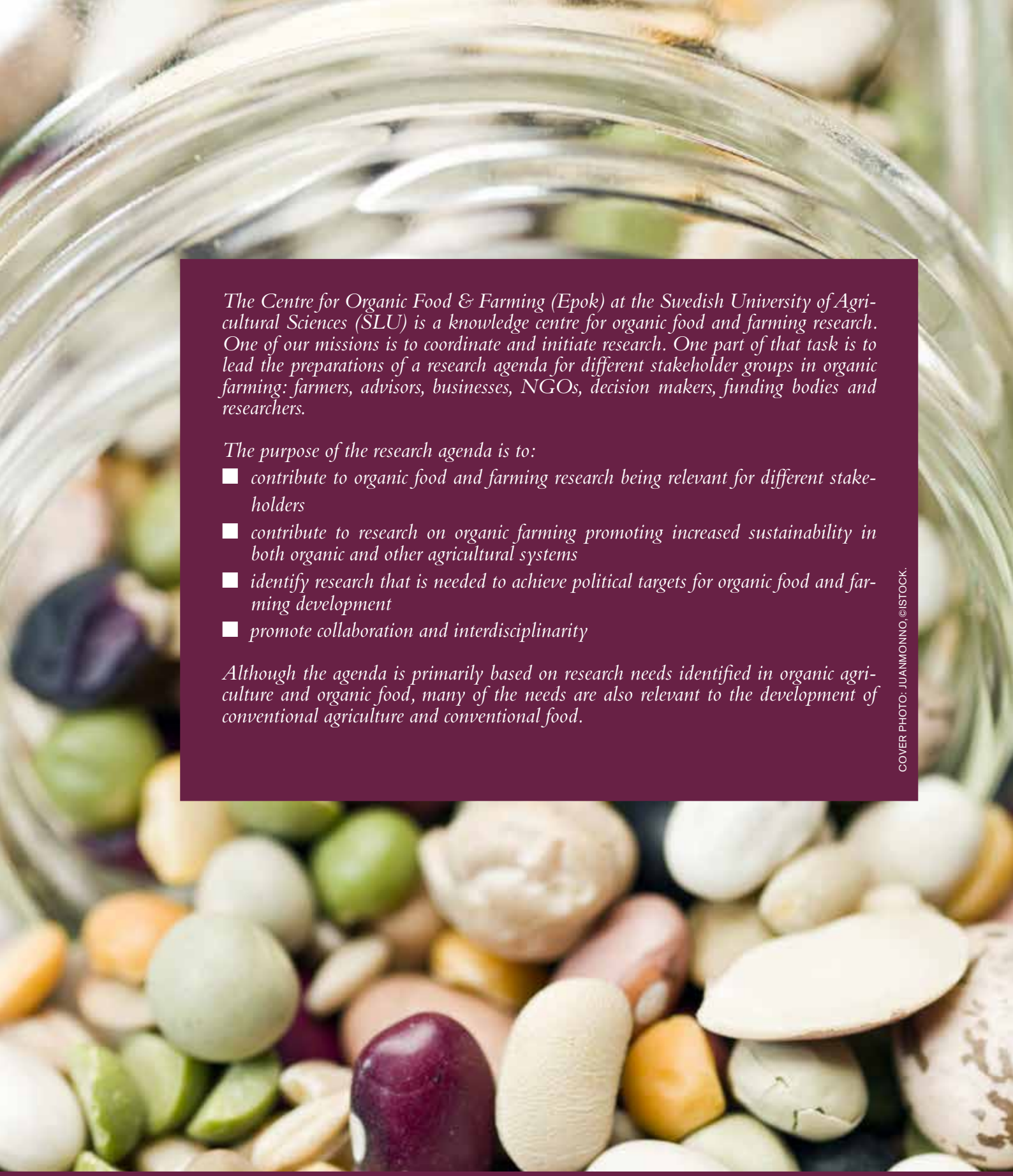
The research also needs to **reach out to relevant stakeholders**. Methods need to be developed to ensure that current research is compiled and disseminated in a systematic way, so that practitioners know how to find the forefront of the knowledge and how that knowledge can be applied. It should also be easy for advisers to be able to take part in the latest research so that the research reaches practice more quickly.

It is also important to systematically **identify knowledge gaps** in order to avoid duplicated research and to constantly move research forward.

Although a national and Nordic perspective is emphasized in this agenda, **international collaboration** and exchange are necessary for the research to be effective, innovative and of good quality. ■

Needs in both the short- and the long-term

- Increased collaboration between researchers, practitioners and other stakeholders.
- Increased interdisciplinary research.
- Increased long-termism, where effects over a longer perspective than one year are studied.
- Focus on entire systems, both in terms of production systems and entire food systems.
- Inclusion of profitability in research studies.
- Improved methods for knowledge exchange and for research to reach, and be implemented in, practice.
- Improved methods to continuously and systematically identify knowledge gaps.
- Increased international cooperation.



The Centre for Organic Food & Farming (Epok) at the Swedish University of Agricultural Sciences (SLU) is a knowledge centre for organic food and farming research. One of our missions is to coordinate and initiate research. One part of that task is to lead the preparations of a research agenda for different stakeholder groups in organic farming: farmers, advisors, businesses, NGOs, decision makers, funding bodies and researchers.

The purpose of the research agenda is to:

- *contribute to organic food and farming research being relevant for different stakeholders*
- *contribute to research on organic farming promoting increased sustainability in both organic and other agricultural systems*
- *identify research that is needed to achieve political targets for organic food and farming development*
- *promote collaboration and interdisciplinarity*

Although the agenda is primarily based on research needs identified in organic agriculture and organic food, many of the needs are also relevant to the development of conventional agriculture and conventional food.

SLU

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