PROCEEDINGS

Nordic Agri Research

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ICROFS International Centre for Research in Organic Food Systems

Luke NATURAL RESOURCES INSTITUTE FINLAND

FORI

LCSS Institute of Economics and Rural Development

NORSØK NORWEGIAN CENTRE FOR ORGANIC AGRICULTURE

NJF Nordic Association of Agricultural Science

AREI

Estonian University of Life Sciences
Research Centre of Organic Farming

Organics as a response to the urgent need for resilient food systems Proceedings

15-17th June 2026

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Publisher: Swedish University of Agricultural Sciences, Centre for Organic Food and Farming, Epok

Year of publication: 2026

Place of publication: Uppsala

ISBN (digital version):

DOI:

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Introduction

Resilience refers to a system's capacity to withstand or adjust to changes imposed by the surrounding environment.

In a world challenged by crises such as war, pandemics, climate change, biodiversity loss, finite nature resources, economic and political fluctuations, demographic shifts and rapidly changing market trends, building resilient food systems has never been more urgent. These external pressures affect the entire food system through all the stages of food production and consumption.

At this conference we explore how organics and its innovative methods can contribute to the need for increased resilience in the food system, from farm to fork and from local to global level. What challenges lie ahead? How can organic practices from farm to fork further strengthen its own robustness as well as having impact in a larger context? All dimensions of resilience within the food landscape – ecological, social and economic – will be addressed. Research relevant for organic food and farming should be in line with the principles of organic agriculture as defined by IFOAM.

The conference aims to share and discuss recent research outcomes, relevant for how organic food and farming can enhance food system resilience. With focus on the Nordic-Baltic region, which shares common conditions for food production and consumption, the conference also aims to strengthen networks among researchers - especially from the young upcoming generation - and provide a platform for translating research findings into policy action. We invite researchers, stakeholders and policymakers to join us in shaping a resilient future for organic food and farming.

Organisers

The conference is funded and organised by the following organisations

The Nordic Joint Committee for Agricultural and Food Research

Nordic Joint Committee for Agricultural and Food Research (NKJ) was established in 1965 as a coordinating body for the research councils within the agricultural sector in Denmark, Sweden, Norway, Finland and Iceland. NKJ ist the main funder of the conference.

SLU Centre for Organic Food and Farming (Epok)

SLU Centre for Organic Food and Farming at the Swedish University of Agricultural Sciences works with collaboration, coordination and information on organic agriculture research in a Swedish, Nordic and international perspective.

ICROFS, International Centre for Research in Organic Food Systems

ICROFS contributes to further development of a market-driven and competitive organic sector and thereby supports a continuous growth in the Danish organic sector. ICROFS is located at Aarhus University in Foulum, Viborg and has its own national board and own regulations. The centre supports organic research projects from many different institutions and industries.

Natural Resources Institute Finland (Luke)

The Natural Resources Institute Finland (Luke) is a research organisation operating under the Ministry of Agriculture and Forestry of Finland. Luke’s task is to promote competitive business based on the sustainable use of renewable natural resources, as well as wellbeing and the vitality of the countryside.

Finnish Organic Research Institute FORI

The Finnish Organic Research Institute FORI is a multidisciplinary research and expert network that operates under the auspices of the University of Helsinki and the Natural Resources Institute Finland.

LCSS Institute of Economics and Rural Development

The Institute of Economics and Rural Development (EKVI) is a division of the Lithuanian Centre for Social Sciences that conducts research in the fields of economics and management. Until 2021, EKVI was the Lithuanian Institute of Agrarian Economics, which has accumulated over 60 years of scientific research experience. EKVI is a nationally and internationally active research organization, whose scientists are involved in global networks of scientists and are open to cooperation.

NORSØK

The private, independent foundation NORSØK is a national centre for the development of organic agriculture through interdisciplinary research and outreach. Our work is based on the four principles of organic agriculture: health, ecology, fairness and care.

NORSØK contributes knowledge for increasing the sustainability of agriculture and society. Our staff covers a wide range of expertise, and provides a broad range of research, advising and outreach services. NORSØK’s main focus areas health and welfare in production systems, sustainable food systems and circular nutrient cycles and resource optimalization. Within these areas we are especially involved in the topics soil health, plant production, nutrient cycles and production animal welfare.

NJF – Nordic Association of Agricultural Science

NJF was founded in 1918 and is thus the oldest Nordic (today Nordic-Baltic) Agricultural sciences association for collaboration between the Nordic countries. Their objective is to promote agricultural research in the Nordic-Baltic countries.

Institute of Agricultural Resources and Economics (AREI)

Institute of Agricultural Resources and Economics (AREI) is leading research institution in Latvia, dedicated to development of sustainable agricultural production and crop breeding. With focus on integrated and organic farming systems, AREI conducts research on demands of these systems, development of sustainable crop cultivation technologies, evaluation of crop quality for effective use, production of feed, and economics of sustainable development of bioresource industries.

Research Centre of Organic Farming of Estonian University of Life Sciences

Research Centre of Organic Farming was established by the Estonian University of Life Sciences with the aim to bring together the knowledge and expertise that has been created at university through previous research in the fields of organic farming and food. The main activities include promoting scientific and applied research in organic farming, introducing environmentally sustainable lifestyles and organic food, training different target groups, and working with entrepreneurs to find solutions for developing the organic sector.

Organising committee

Sari Iivonen – FORI, Luke, Finland

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ORAL PRESENTATIONS

Session 1 – Producers and consumers perceptions on animal welfare

Citizen views on animal welfare in organic and low-input outdoor production and their trust in actors as information sources

Katja Lähtinen, Minna Väre, Charlotta Harju, Jarkko Niemi

Implications

Citizen views on food production affect their purchasing behaviour in the markets. As an outcome of this, potential of farmers to perform in their businesses and contribute, e.g., to resilience of food production systems varies depending on their production systems. Thus, delivery of information and communication of animal welfare issues are in a key role in enhancing the fit between supply and demand for responsible products in the European food markets.

For efficient and successful market communication, selection of communicators and communication channels is of a critical value. Especially important is to recognize the country-wise differences and their reasons. For instance, by choosing "wrong" actors as communicators, there may even be a risk for prejudices against animal welfare efforts in among citizens. Our research findings bring new insights on managing such risks.

Background and objectives

The contents of this abstract connect with PPILOW (Poultry and Pig Low-input and Organic production systems' Welfare) project funded by the European Union's Horizon 2020 research and innovation programme (grant agreement No 816172) ongoing in 2019–2024.

The purpose of this study was to examine 1) citizens' reactions to new approaches to pig and poultry production and animal welfare-related measures, and 2) citizen trust on different food system actors as communicators on animal welfare issues. The data of our work derived from a quantitative survey implemented in February 2021 in nine European countries as a part of i.e., Finland, UK, France, Denmark, the Netherlands, Belgium, Germany, Italy, Romania comprising altogether 3601 responses.

Key results and discussion

According to our results, for most of the countries, consumers had either neutral or negative perceptions on conventional indoor production of poultry and pigs. Contrastingly, in all countries, citizens had positive perceptions (organic production) or positive or neutral perceptions (non-organic outdoor, i.e., free-range production) compared to conventional indoor production. Thus, citizens were found to appreciate organic and free-range production of poultry and pigs over conventional production methods.

Regarding citizen trust on food system actors as communicators on animal welfare issues, our results showed considerable country-wise differences: in some countries (e.g., Finland and Denmark) citizens considered value-chain actors (i.e., farmers, food retailers, interest groups) more reliable sources on information than other actors (e.g., NGOs and academic organizations), while in some countries (e.g., Germany and Belgium) the results were opposite. In addition, indications were received also for very low country-wise trust on any actors on animal welfare issues.

In marketing of poultry and pork products, consumers with different preferences for product and production characteristics must be recognized. Furthermore, to enhance food production system resilience with communication towards citizens, both selection of communicators and communication channels and tailoring of messages meeting different types of value expectations (e.g., product properties, production responsibility aspects) is of a critical value.

The role of knowledge in evaluating animal welfare practices

Katriina Heinola, Janne Kaseva, Minna Väre, Jarkko K. Niemi

Implications

Understanding how citizens evaluate both housing- and environmental condition practices (e.g., additional space) and health, treatment and ethically oriented practices (e.g., methods to avoid killing male chicks) in organic and low-input outdoor poultry production is essential for designing welfare improvements that are feasible and publicly acceptable. Citizens' desirability for practices was associated with objective knowledge, socio-demographic factors (age, gender) and country context. Higher knowledge levels were associated with more favourable evaluations of practices with clear welfare rationales, whereas evaluations of ethically charged practices showed stronger associations with value orientations and national regulatory environments. These findings highlight the importance of transparent communication about welfare implications and the trade-offs involved in both housing- and treatment-related practices.

Background and objectives

Public's understanding of animal production is limited, and prior research often relies on subjective knowledge. This study set out to: (A) measure citizens' objective knowledge of organic egg production with an eight-item, fact-based quiz; and (B) analyse how this knowledge, together with socio-demographic factors and farm/animal experience, explains the desirability of poultry farming practices—across nine European countries.

Key results and discussion

Using survey data from 3 601 respondents in nine countries, we observed consistently high support for most housing- and environmental condition-related measures in organic and low-input outdoor poultry production. A clear majority of respondents rated practices such as improved indoor conditions, enhanced outdoor opportunities and increased space allowance or provision of behavioural opportunities as desirable, whereas practices involving year-round outdoor living received noticeably lower support and a higher share of "don't know" responses. In the health and ethical domains, slow-growing poultry breeds, nutrition adjustments for health and well-being, and avoiding the killing of male chicks were commonly viewed desirable. Opinions on beak trimming were quite evenly split between the practice being viewed either desirable or undesirable. An elevated uncertainty was associated with practices involving restricting or withholding medicines, thus reflecting mixed views on antibiotics and limited understanding of veterinary care. Across both domains, age, gender, country and objective knowledge were the most consistent predictors for the desirability of a measure in ordinal regression. Higher knowledge of organic farming was positively associated with the desirability of measures having a clear welfare benefits (e.g., condition improvements, slow-growing breeds), whereas ethically sensitive choices (e.g., beak trimming, male-chick issues, breeding for resistance) were more strongly shaped by values and national context. Professional experience with farm animals tended to reduce support for additional measures, suggesting a practitioner–public perception gap.

How work was carried out

Respondents in nine countries (FI, DE, NL, RO, DK, UK, BE, IT, FR) evaluated the desirability of 16 farming practices. These were analysed in three ordinal categories. Respondents' objective knowledge about organic poultry production was measured with an eight-item quiz. Associations with knowledge, demographics and experience were examined using ordinal regression.

The study is part of PPILOW (Poultry and Pig Low-input and Organic production systems' Welfare) project which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 816172.

Farmer Attributes Enhancing Resilience and Animal Welfare on Organic Farms

Minna Väre, Katja Lähtinen, Katriina Heinola, Jarkko Niemi

Implications

Based on this study, organic farmers consider themselves innovative and optimistic about future. Both attributes are related to farm resilience, which is a prerequisite for farming in constantly changing operating environment. In the study, organic farmers views on their professional attributes were quite similar to consumers views on attributes enhancing higher animal welfare. To be able to utilize this result in promoting organic products, consumer knowledge on organic production must be further improved.

Background and objectives

Increased consumption of organic products is a prerequisite for increasing organic production. Animal welfare being one of the major premises of organics, it is important to further strengthen consumers' trust on organic farming as an animal welfare enhancing production manner by improving consumer knowledge on organic production.

Farming organic requires many kinds of entrepreneurial skills and behind them, certain trait and attitudes. In earlier studies, both organic farmers' values and characteristics have been analysed, but not that much is known about their professional attributes. The aim of this study was 1) to examine the attributes of organic farmers with special interest on resilience and 2) to find out if these perceived organic farmer attributes correspond to consumer views on farmer attributes enhancing animal welfare.

Key results and discussion

According to the results, majority of organic farmers considered themselves dedicated, determined, innovative, knowledgeable, and collaborating with others. In addition, they found themselves optimistic about future, financially astute and having good knowledge of costumers but they did not find themselves traditional or risk averse. Similarly, most consumers associated high animal welfare with farmer being knowledgeable and dedicated, determined and having good knowledge of customers and suppliers, but also being both progressive and traditional. The associated attributes were also correlated with each other both in farmer and consumer survey.

The results suggest that organic farmers associate themselves with attributes related to farm resilience. Organic farmers views on their professional attributes as a farmer were also in line with consumers views on attributes enhancing higher animal welfare, the result of which should be utilized when promoting organic products.

How work was carried out

Two surveys were conducted in nine countries (Finland, Denmark, France, UK, Germany, Italy, The Netherlands, Romania and UK) in 2021. In the survey, organic pig and poultry farmers were asked to which extent different attributes characterize them as a farmer, and consumers to what extent are different professional attributes of a farmer associated with high animal welfare in pig and poultry farming. The datasets included responses from 64 organic farmers and 3600 consumers. The data were analysed quantitatively and by testing correlation between perceived association of attributes.

PPILOW project has received funding from the European Union's Horizon 2020 research and innovation programme (No 816172).

Identifying business and policy options to promote organic pig and poultry production

Jarkko K. Niemi[1], Minna Väre[1], Anne Collin[2] and Petra Thobe[3]

[1]Natural resources Institute Finland (Luke), Finland, [2]INRAE, France, [1]Thunen Institute of Farm Economics, Germany

Implications

Current challenging situation of organic markets calls for new business approaches and policy measures that enable valorising the high animal welfare of organic farming. Organic farming systems enable farmers to receive a price premium for their production. The common agricultural policy of the European Union could be an instrument that supports local and small-scale high animal welfare farms to enter the markets. Based on stakeholder consultation, it is important to ensure a level playing field across Europe, share trusted animal welfare information and initiate new business partnerships.

Background and objectives

It is essential that any planned improvements and modifications in organic farms are economically viable. Because the current market situation of organic farming in the Nordic countries is challenging, new business approaches and policy measures are needed to valorise high animal welfare of organic farming systems. This study aimed to identify approaches than can gain value for high animal welfare organic farming systems.

Key results and discussion

Several measures are pertinent to promote high-welfare organic farming systems. The study participants identified important to ensure a level playing field across Europe. As organic livestock farms are few in number and the businesses are often small in scale, promoting the transparency of markets, fair trading practices and fair price margins along the value chain, for example through regulation, were considered important. The participants called for awareness-raising and promotion measures among consumers. An example raised was communication with restaurants to promote organic products locally in the Nordic countries. The participants proposed animal welfare assessments, considering a harmonised animal welfare label and sharing animal welfare information to consumers as tools to valorise animal welfare improvements in market segments that are willing to pay a premium for products, thus making animal welfare improvements financially more attractive to farmers. Strengthening the funding of welfare improvements was identified as a need, and the common agricultural policy was foreseen as an instrument to support small-scale high-animal welfare farms to enter the market.

How work was carried out

A structured stakeholder workshop involving policy makers, stakeholder and other experts from Nordinc-Baltic countries and elsewhere in Europe was organized in March 2023. The aim was to examine the most critical features of value chains and the needs to strengthen organic pig and poultry production across Europe. The workshop focused on how animal welfare could be turned into business value and what policy and market actions are critical to enable welfare change. Rearing entire male pigs using dual-purpose poultry breeds were used as examples.

References

This abstract is part of the PPILOW project which has received funding from the European Union's Horizon 2020 Research and Innovation Programme (grant agreement N°816172).

Characteristics and challenges of outdoor pig systems

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Implications

Outdoor pig production (OPP) constitutes only a fraction of the total Swedish pig production and continues to decline. To facilitate practical advice for farmers, increased knowledge of the characteristics, management practices and challenges of OPP is needed. In the long term, improved knowledge can facilitate the development of OPP.

Background and objectives

OPP differs significantly from conventional production, with limited transferability of knowledge between systems. A diverse set of production systems is important for national food security and for addressing societal, economic and ecological sustainability. OPP may provide added value through ecosystem services, enhanced animal welfare and increased consumer choice. The aim of this study was to identify factors related to production purpose, scale, advisory support, perceived challenges and desired changes within Swedish OPP.

Key results and discussion

A survey conducted between April and August 2024 included responses from 70 pig owners in 16 Swedish counties rearing pigs outdoors on bare ground. Of these, 24% were certified according to KRAV's regulations and 2% according to EU regulations for organic production. A larger proportion (42%) were members of a pig association, commonly 'Föreningen Landtsvinet' or 'Jord På Trynet'. Most respondents (81.4%) kept pigs outdoors year-round. Farms were generally small-scale, with few stockpeople (1.7 ± 0.8), and large variations in herd size (166 ± 405 pigs) and paddock area (1.4 ± 2.59 ha). Most farmers reported feed spreading or mobile outdoor feeding/watering systems. Larger farms were more likely to use outdoor automatic watering systems (median: 84.5 vs 18.5 pigs, adjusted p=0.012), whereas smaller farms more commonly used mobile systems (median: 19 vs 76 pigs, adjusted p = 0.012). A majority (77%) reported multiple production purposes, most commonly private meat consumption, meat sale, live animal sale and soil cultivation. Most of the respondents (73%) kept only one breed, Linderöd pigs and modern hybrids being the most common. Reasons for keeping pigs outdoors graded as 'extremely important' by most respondents were providing good pig welfare, ensuring the five freedoms and the importance of food origin. Economic reasons were given less emphasis. Commonly reported challenges included for example providing pigs with water, profitability, pigs escaping, labour intensity and the impact of high and low ambient temperatures on pig welfare. Suggested changes to promote OPP were primarily increased consumer awareness, increased profitability, a cheaper and simplified slaughter process, better adapted legislations, and increased training and knowledge among advisors, inspectors and farmers. In need of pig health and welfare advice, respondents primarily consulted veterinarians or another OPP farmer. Farms using a veterinarian specialized in OPP had larger herd sizes than farms not using such veterinarians (median: 308 vs 20 pigs, adjusted p=0.006). The results reflect a diverse, small-scale, multipurposed and welfare-focused production struggling with policies, labour intensity, biosecurity and financial challenges. The latter may partly explain the small proportion of KRAV affiliated respondents. While broadly consistent with previous research, the representativeness of the findings for Swedish OPP remains uncertain. Further research is needed to facilitate supporting structures and tailored professional advice in response to the complex set of challenges.

References

Brajon, S. et al., 2024. Animal, 18(5), 101138.
Öhlund, E. et al., 2017. Int J Agric Sustain, 15(6), 693–707.

Laying the basis for an organic dairy cattle breeding program

M. Kargo, J. R. Thomasen, M. Hansen, T. Christensen, S. Denver, H.M. Nielsen, and R.M. Zaalberg

Implications

The first results of the Ø-KO-AVL project show that organic consumers prioritize animal welfare. Next, we will calculate economic values for an organic breeding goal, and test different types of organic breeding schemes through simulations. The results of this project will lay the foundation for future organic dairy breeding in Danmark.

Background and objectives

To promote sustainable agricultural production, the European Union set a target of 25% organic agricultural land by 2030. Strict regulations are implemented that should guarantee that organic animals are raised in accordance with the organic principles. Yet all "organic" animals are sourced from conventional breeding stocks. Selective breeding has the potential to improve the sustainability of organic dairy production, by adapting cows to the organic production systems, and in line with the demands of organic consumers. The Danish project "*Breeding dairy cows adapted for organic production (Ø-KO-AVL)*" aims to demonstrate methods to implement an independent organic dairy breeding scheme.

Key results and discussion

Consumer (organic and conventional) surveys have been carried out among German, Swedish and Danish consumers. The consumers were asked how much they were willing to pay for organic dairy products from animals that originated from an organic breeding program. The results showed that consumers were willing to pay most when welfare-traits were included in the breeding goal. Traits related to climate impact were considered less important, while there was nearly no willingness-to-pay for increased milk yield. Furthermore, the survey revealed that consumers knew little about "modern" reproduction techniques. Based on this limited understanding, consumers generally did not object to the use of these techniques in an organic breeding program.

The next step in the project is to define new breeding goals that considers both the consumer preferences and economic values derived from bio-economic models. Breeding goals will be defined for three organic production systems that were defined by a committee of Danish organic dairy farmers. For each of these organic production systems, an organic breeding goal will be defined by giving weights to traits based on the derived economic values and the consumer preferences.

The final activity of the project will be to design the optimal breeding scheme for organic production, which will incorporate the newly defined organic breeding goals. This will be done through simulations, followed by a cost-benefit analysis to assess the costs of the different breeding schemes. We will simulate different breeding schemes, for example a scheme where 1) all organic dairy cows come from an independent breeding program with an organic breeding goal, 2) conventional bulls for breeding organic cows are selected using an organic breeding goal, or 3) a breeding program where bulls are selected using an intermediate breeding goal that represents both the needs of the conventional and organic dairy farmers.

Conclusion

With this project we will deliver guidelines for dairy breeding schemes aimed at organic production systems, which will result in future dairy cows that are genetically adapted for organic production systems.

Session 2 – New safe nutrient sources

Marine-derived fertilizers for organic growing

Anne-Kristin Løes, Joshua Cabell, Sara Hansdotter (all NORSØK, Tingvoll, Norway).

Implications

Seaweed and marine-derived animal materials provide significant amount of nutrients and organic matter, applicable in organic growing to reduce reliance on inputs derived from conventional farming. Such materials may increase plant growth significantly[1], butchallenges related to salt and potentially toxic elements (PTEs) need to be solved[2]. Some materials may also have biostimulant effects, which are more difficult to study and demonstrate.

Background and objectives

Bio-based fertilizers are an important part of the circular economy. Finite mineral resources should be replaced by circular sources. In Norway, the fishery sector is large, and the seaweed industry is growing. Residual materials are available that may complement each other to produce complete, marine-derived fertilizer products. NORSØK has been testing such products over several years, and current testing is now at an international level in the Horizon EU project Bio2 (GA101181331)[3]. The aim of the presentation is to discuss the growth effects of seaweed and fish materials, the challenges posed by salt and PTEs, and some results from methods explored for testing biostimulant effects.

Key results and discussion

In pot and field experiments, bone-rich materials of lean fish (cod, saithe, etc.) had a very rapid growth effect on various crops. Best results were achieved in combination with residues from chemical extraction of rockweed (Ascophyllum nodosum), originating from the production of various growth promoters. The rockweed sludge has a substantial residual effect but is not permitted in organic growing (OG). Dried seaweed is applicable in OG, and may be applied e.g., to supply potassium supply in grasslands. Rates must be adapted to avoid risk of tetany disease in ruminants. Very high rates may increase the arsenic concentration in the crop. Composts may be made with only marine-derived materials[4], but the salt content may negatively affect crop yields. Seaweed may increase soil C, especially when the clay content is high[5]. The potential effect of chitin in crab shells was tested with barley seedlings infected by net blotch[6], a fungal disease transferred by the seeds. With milled crab shell as soil amendment, more plants showed less development of primary disease symptoms, but fewer plants showed the highest degree of infection. Finer milling could possibly facilitate the effect of crab shell chitin.

References

1 Løes et al. 2022. Fertilisation effects of marine-derived residual materials on agricultural crops. NORSØK Report 7 (13). https://orgprints.org/id/eprint/45330/

2 Løes et al., Elemental uptake in above-ground plant material of perennial ley after high application of seaweed materials. Accepted for review, J.Appl.Phycology, Jan. 2026.

3 Bio2, Natural solutions for organic farming. https://www.bio2project.eu/

4 Cabell et al. 2024. Suitability of residues from seaweed and fish processing for composting and as fertilizer. Sustainability www.mdpi.com/2071-1050/16/16/7190.

5 Kauer et al, Seaweed residues as soil amendments: effects on soil organic carbon dynamics across contrasting soils. Submitted to Appl. Env. Soil Sci., Nov. 2025.

6 Hansdotter et al. 2024. Sjøkonservert krabbeskall: Test av kalkvirkning og plantestyrkende effekt. NORSØK Report 9 (10). https://orgprints.org/id/eprint/53601.

Chicken manure and other by-products from egg and broiler production as fertilizers

Jukka Kivelä[1,2], Henrik Lindegren[3], Pirjo Niemelä[4], Mika Tuomola[5], Timo Lötjönen[6]

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Background and objectives

The consumption of chicken meat and eggs has grown rapidly in Finland in recent years. At the same time, production has become so concentrated that there are now fewer than 200 broiler farms and only 220 farms producing eggs. Most of the farms are in western Finland in a relatively narrow coastal zone. In addition to chicken meat and eggs, chicken and egg production generates a large amount of by-products, such as manure and slaughter by-products. The Canasta project (2021-2023 led by Fertilex Ltd) developed methods for processing by-products and studied the impact of different processing methods on the fertilizing effect of by-products.

The raw materials used in fertilizers suitable for organic farming are manure from production animals, mainly laying hens or broilers, animal by-products, and nutrient-rich industrial by-products such as vinasse or rejects. The fertilizing effect of various organic fertilizer products was developed and studied in collaboration with companies producing nutrient-rich raw materials and companies developing their processing, as well as two research institutes, the Department of Agricultural Sciences at the University of Helsinki and the Luke Ruukki research infrastructure.

Broiler production generates approximately 100 000 tons of by-products per year in Finland that are unsuitable for human consumption. The majority of these are processed into circular economy products by Honkajoki Ltd. The latest development is a feather meal production plant, which began operations in 2023 and was implemented by Honkajoki with the help of its subsidiary GMM Finland Ltd. The new production unit can process over 100 000 tons of feathers into high-protein hydrolysate annually.

Finland's more than 4 million laying hens produce nearly 500 000 tons of chicken manure per year. This is especially true today, when most eggs are produced in various types of floor housing systems. In 2025, 68% of all egg production was produced in floor-reared systems, 6% were organic eggs, and 4% were eggs from free-range hens. Broilers are produced in Finland in 12.4 million rearing facilities, which produce 140 million kilograms of meat. In total, more than 200,000 tons of broiler manure are produced annually.

Poultry production generates a large amount of nutrient-rich by-products each year, which should be used efficiently. During the product development phase, pre-dried chicken manure was processed using a microthermal (DTS Finland Ltd) method to make the nutrients in the manure more available to plants and improve the carbon-nitrogen ratio of the manure. Microthermal treatment of pre-dried chicken manure increased the nitrogen content of the manure to approximately 6.5% and reduced its carbon-nitrogen ratio. This resulted in a fertilizer raw material similar to meat and bone meal.

On the other hand, the conversion of poultry manure into granular fertilizers significantly improves the efficiency of nutrient utilization compared to untreated manure. Fertilex Ltd has developed a method for drying laying hen manure using ventilation air from chicken houses to pre-dry the manure so that it can be sanitized and pelletized into a finished product without separate drying. Only processed by-products are allowed to be used as fertilizers in organic farming.

Key results and discussion

Based on the results of the pot trial, both hydrolyzed feather meal and micro-thermally treated chicken manure corresponded well with commercial meat bone meal fertilizer (Biofer 10-3-1) in terms of their fertilizing effect (Kivelä et al 2024).

In the organic barley fertilization trial, chicken manure pellets (Fertilex 6-1-2), meat and bone meal fertilizer (Biofer 10-3-1), sugar beet pulp (SoilFood 2-0-3) and cattle slurry were used as fertilizers (Lötjönen 2024). Nitrogen was used at a rate of 60 kg/ha. The soil type was coarse sandy loam. In organic crop rotation, after clover grass, the unfertilized barley field that followed in the crop rotation yielded an average of 2.75 tons over two years. In the first trial year, fertilization produced an additional yield of 800-1000 kg/ha, and in the second, very dry year, 400-800 kg/ha. There were no significant differences between the fertilized plots, but there was a significant difference between the unfertilized and fertilized plots.

Based on these results, it can be said that the commercialization of poultry and eggs production by-products enables their use as raw materials for organic fertilizers, which have been proven to have a good fertilizing effect. As livestock production units grow and production becomes more concentrated in certain areas, it is important that all livestock production side streams are commercialized so that their nutrients can be used as organic fertilizers in a precise and controlled manner. Fresh manure often has a poorer fertilizing effect, and the amounts used per hectare vary, so it is not worthwhile to transport manure far from the production sites. Productization of manure and other side streams into fertilizer products offers an opportunity to improve the efficiency of nutrient recycling.

Based on the results of the Lex4Bio project, recycled fertilizers improve phosphorus uptake by plants by increasing soil microbial activity and, on the other hand, reduce phosphorus emissions to waterways compared to mineral phosphorus sources or untreated livestock manure (Ylivainio et al. 2026).

How work was carried out

These projects were funded by the Programme for nutrient recycling of the Ministries of Agriculture and Forestry and Environment in Finland as well as Honkajoki Ltd.

References

Kivelä, J. et al: Utilization of hydrolyzed feather meal and chicken manure treated with micro-thermal method as recycled organic fertilizer, EGU General Assembly 2024, Vienna, Austria, 14–19 April 2024, EGU24

Lötjönen, T. 2024: Kannattaako täydennyslannoitus. Luomu-lehti 2-2024.

Ylivainio_etal_2026_ResEnvSust_Phosphorus_mobilization.pdf

Recycled fertilizers and soil amendments in sustainable cropping systems – effects on soil carbon and microbial communities

Mari Unnbom, Jure Zrim, Juha Helenius, Priit Tammeorg Department of Agricultural Sciences, University of Helsinki

Implications

Recycled bio-based fertilizers and soil amendments increased SOC (soil organic carbon content) more than in the mineral fertilizer treatment. If applied repeatedly, they shifted soil microbial communities towards groups associated with carbon-rich conditions, further underlining their positive effect on SOC. The largest increases in soil C were seen with combinations of green manure and organic soil amendments. However, for continuously exceeding the four per mille target, the continuous input of plant-derived carbon is also required.

Background and objectives

Nordic and Baltic countries face shared and intensifying climate change impacts, such as faster warming of the region than the global average (Christensen et al., 2022), highlighting the urgency of maintaining fertile soils through carbon management to build resilience in food production under climate change pressures (Don et al., 2024; Norderhaug et al., 2023). Nutrient recycling from biomasses also enforces self-sufficiency of farming inputs in times of geopolitical uncertainties (Barbieri et al., 2022). Furthermore, soil microbial communities play a key role in nutrient recycling. Recycled organic fertilizers and soil amendments may alter soil microbial community composition by changing C and nutrient availability, potentially influencing SOC accrual and aggregation processes (Zong et al., 2025).

In this study we used bio-based fertilisers and soil amendments derived from recycled biomasses in a five-year crop rotation in southern Finland. Objectives of the experiment were to study the effects of these different recycled fertiliser concepts on SOC, soil physical properties, and microbial communities in comparison to mineral-fertilized control. The studied recycled fertiliser combinations were paper mill pulp with liquid biogas residue, paper mill pulp with food industry residues, meat and bone meal with pelleted chicken manure and a biowaste-hydrochar compost with ammonium sulphate. All but the last two product groups were approved for organic production. The amounts of added C in the five-year period were 13.7, 5.8, 0.87, and 1.5 Mg C ha-1, correspondingly.

Key results and discussion

Application of paper mill pulp at a rate of 8 and 5 Mg ha-1 increased the SOC content statistically significantly compared to the control plots the following year of application. The finding is consistent with a previous study with ligneous rich paper mill pulps at the application rates of 9–22 Mg C ha-1 (Peltokangas et al., 2023). The highest increase in soil C in all treatments between experimental years was after a year of green manure, underlining the importance of plant derived carbon.

Microbial community composition differed among treatments, with the clearest effects emerging in the last two years. This pattern is consistent with repeated applications of recycled fertilizers gradually reshaping the soil microbiome. Bacterial changes were most evident in the biowaste-hydrochar compost with ammonium sulphate treatment, which showed higher relative abundance of Firmicutes. Overall, the results show that recycling fertilizer inputs are acting as a selective pressure, favouring microbial groups which are suited for treatment specific nutrient forms and carbon substrates (Zong et al., 2025).

References

Barbieri, P., MacDonald, G. K., Bernard de Raymond, A., & Nesme, T. (2022). Food system resilience to phosphorus shortages on a telecoupled planet. Nature Sustainability, 5(2), 114-122.

Christensen, O. B., Kjellström, E., Dieterich, C., Gröger, M., & Meier, H. E. M. (2022). Atmospheric regional climate projections for the Baltic Sea region until 2100. Earth System Dynamics, 13(1), 133-157.

Don, A., Seidel, F., Leifeld, J., Kätterer, T., Martin, M., Pellerin, S., ... & Chenu, C. (2024). Carbon sequestration in soils and climate change mitigation—Definitions and pitfalls. Global Change Biology, 30(1), e16983.

Norderhaug, A., Clemmensen, K. E., Kardol, P., Thorhallsdottir, A. G., & Aslaksen, I. (2023). Carbon sequestration potential and the multiple functions of Nordic grasslands. Climatic Change, 176(5), 55.

Peltokangas, K., Kalu, S., Huusko, K., Havisalmi, J., Heinonsalo, J., Karhu, K., ... & Pihlatie,

M. (2023). Ligneous amendments increase soil organic carbon content in fine-textured boreal soils and modulate N2O emissions. PloS one, 18(8), e0284092.

Zong, D., Quan, Y., Penttinen, P., Qi, L., Wang, J., Tang, X., Xu, K. and Chen, Y., 2025. Organic Amendments Drive Soil Organic Carbon Sequestration and Crop Growth via Microorganisms and Aggregates. Agronomy, 15(12), p.2919.

Organic fertilization: advancing microbial indicators for sustainable food systems and agro-ecosystem resilience

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Implications

Organic fertilization offers a pathway towards resilient food systems by maintaining soil fertility through biological processes rather than chemical inputs. However, its success depends on how it shapes the stability and functionality of soil microbiomes that underpin agroecosystem resilience. Understanding microbial responses to organic inputs can guide next-generation of biomonitoring and soil restoration strategies, which is essential for sustainable food production.

Background and objectives

Healthy soils form the foundation of resilient agroecosystems, yet the microbial mechanisms underpinning their response to organic fertilization remain poorly characterized. This study advances knowledge on how different organic fertilization regimes (pig slurry (PS), cow manure (CM), and biogas digestate (BD)) influence the composition and function of core soil bacterial communities in grassland ecosystems. The objectives were to (i) determine community-level responses and functional shifts under varying fertilization regimes and (ii) identify potential microbial indicators of soil health.

Key results and discussion

Organic fertilization exerted distinct selective pressures on core soil microbiota, reshaping community structure and metabolic potential. PS application induced the strongest compositional changes, enriching copiotrophic genera such as Acidibacter, Pseudonocardia, Gaiella, and Nocardioides, while suppressing beneficial oligotrophs including Bacillus and Bradyrhizobium species. These compositional shifts corresponded with reduced prevalence of genes related to carbohydrate, nitrogen, sulfur, and methane metabolism, indicating a realignment of ecosystem functionality under nutrient-rich conditions. Laboratory experiments mirrored field trends, revealing that nutrient-driven selection and microbial interactions (both cooperative and competitive) governed community assembly under organic inputs. Identified biomarker genera demonstrated strong predictive potential for assessing soil health status and fertilization effects. This work highlights the ecological trade-offs of organic fertilization: while enhancing nutrient cycling, excessive nutrient loads can alter microbial networks and decrease functional diversity, challenging long-term soil health.

How work was carried out

The study integrated field and laboratory investigations. Field samples from organically managed grasslands were analyzed via 16S rRNA gene amplicon sequencing (V4 region) to characterize bacterial community composition. Complementary culture-based experiments were conducted to validate nutrient-driven shifts and microbial interactions.

References

Chamedjeu, R. R., Jani, K., Jetter, K., Wilhelm, K., Schäfer, P., Wilfert, L., ... & Riedel, C. U. (2025). Impact of Fertilisation on the Bacterial Core Microbiome of Grassland Soils: Abundance in the Field and Growth In Vitro. Environmental Microbiology Reports, 17(6), e70235.

Session 3 – Improving soil health

Arable soil microbial communities are affected by plant community and agricultural management

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Implications

The continuous cultivation of high-intensity crops that are non-hosts for arbuscular mycorrhizal fungi (AMF), such as cabbage, may impair beneficial soil functions related to nitrogen fixation and AMF symbiosis. In contrast, organic farming practices can enhance these functions. Microbial alpha diversity should not be used as the sole indicator of soil health, as many predicted soil ecosystem functions do not show a positive correlation with it.

Background and objectives

Microbial communities participate in soil nutrient and carbon cycling and are an important part of the overall soil health. Plants are known to shape soil microbial communities, but little is known for plant-microbiome-interaction in the cultivated farmlands.

In this study, we combined plant species richness and coverage data of the cultivated and associated plant species (i.e. plant community) (Toivonen et al., 2022) with soil microbial analysis. We assessed the impact of seven arable crop types (pasture, ley, oat, rye, faba bean, oilseed, and cabbage) and a long-term environmental fallow, together with production method (organic vs. conventional farming) and other management practices, on soil microbial community composition and diversity, the proportions of predicted bacterial genes related to C, N and P cycling, and fungal functional groups.

Key results and discussion

We found crop type, plant richness, plant coverage, and agricultural management to impact the soil microbiome on taxonomic and functional level. The most dissimilar microbial communities were under fallow and cabbage crop types, which represented the management and plant diversity extremes. Cabbage also differed from other crop types by having lowered proportion of the predicted N2 fixing genes and AMF. Plant richness influenced the community composition of bacteria and fungi, but plant community composition impacted only fungal community composition marginally. Organic production method impacted fungal but not bacterial community composition and increased the proportion of AMF and N2 fixing genes across crop types. Tillage intensity increased the proportion of bacterial carbon cycling genes. Fallow had lowered microbial diversity, but the proportion of nitrogen fixing and inorganic phosphorus solubilizing genes and AMF were increased. Although the effect of crop type effect dominates, we show the importance of including the whole plant community in the analysis of soil microbial communities in differently managed agricultural soils.

References

Toivonen, M., Huusela, E., Hyvönen, T., Marjamäki, P., Järvinen, A., & Kuussaari, M. (2022). Effects of crop type and production method on arable biodiversity in boreal farmland. Agriculture, Ecosystems & Environment, 337, 108061. https://doi.org/10.1016/j.agee.2022.108061

Belowground Traits in Relation to Yield Responses across Organic Cereal–Legume Cropping Systems: A Field Experiment

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Implications

In organic farming, particularly in low-input systems, yield responses in cereal–legume cropping systems often remain difficult to predict. This variability may reflect differences in mycorrhizal colonization and cereal root traits, which are rarely considered in mixture management (Homulle et al., 2022). Accordingly, accounting for plant–fungal and root characteristics may help to interpret yield responses and be relevant to the selection or design of crop mixtures.

Background and objectives

In organic farming, nitrogen supply is managed through organic fertilization or through legumes in cereal–legume intercropping, and the performance of both approaches depends on belowground processes. Complementary rooting patterns and mycorrhizal networks enhance nutrient and water uptake, promote root-derived carbon inputs to the soil, and are relevant to crop performance (Picone et al., 2025). The aim of this study was to examine relationships among mycorrhizal colonization intensity, cereal root morphological traits, and crop yield across treatments differing in legume inclusion and organic fertilization. The findings contribute additional insight into crop resilience and the sustainable management of low-input farming systems under Baltic conditions.

Key results and discussion

The experiment included spring barley and oat grown as sole crops, with or without organic granulated chicken manure, and in mixtures with red clover or field pea; field pea was also grown as a sole crop. Intercropping with field pea and red clover tended to improve root architecture and mycorrhizal colonization in spring barley and oat. The strongest root responses were observed in mixtures with red clover. Effects on mycorrhizal colonization (M%) and grain yield were crop-specific: field pea increased M% and was associated with higher yield in spring barley, whereas red clover improved both parameters in oat. Organic chicken manure fertilization tended to enhance yield, while its effects on root traits and mycorrhizal colonization were limited or inconsistent. During the growing season, weather conditions deviated from the long-term mean, with temperature 2.4 °C higher and precipitation 63.3 mm lower, potentially increasing response variability and making treatment effects less apparent (Brooker et al., 2024). Despite this, the results suggest species-specific positive interactions, with benefits likely depending on the particular crop combination rather than occurring universally (Landschoot et al., 2024).

References

1. Brooker, R.W. et al., 2024. Positive effects of intercrop yields in farms from across Europe depend on rainfall, crop composition, and management. Agronomy for Sustainable Development, 44, 68.

2. Homulle, Z. et al., 2022. Root traits with team benefits: understanding belowground interactions in intercropping systems. Plant and Soil, 471, 1–26.

3. Landschoot, S. et al., 2024. Cereal–legume intercropping: Which partners are preferred in northwestern Europe? Agronomy, 14, 1551.

4. Picone, R. et al., 2025. The contemporary plant–soil feedback in legume–cereal intercropping systems: a review of carbon, nutrient and microbial dynamics. Plant and Soil.

5. Veršulienė, A. et al., 2023. Mycorrhizal abundance and its interaction with cereal root traits and crop productivity in organically managed cereal/legume intercropping. Agronomy, 13, 2682.

Acknowledgment. This research is a part of NordForsk project AgroMixNorth (Climate-smart resilience through diversified cropping systems) and has received funding from the Research Council of Lithuania (LMT) under agreement no. Nr. S-NORDFORSK-23-7.

Hort2thefuture - Improving soil structure in horticultural production

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Introduction

Increasing Norwegian food production while reducing the environmental impacts of intensive agricultural systems represents a central political goal. Horticultural production is particularly vulnerable to soil degradation due to frequent tillage operations, repeated traffic with heavy machinery, and contract-based harvesting schedules that often disregard soil moisture conditions. These factors heighten the risk of soil compaction and long-term deterioration of soil structure, and the challenges are intensified by climate change, including wetter growing seasons, fewer workable field days, and increasing economic pressure. Innovative and scalable strategies to prevent and remediate soil compaction are therefore urgently required. Horti2Future is an EU-funded Horizon Europe project (2024–2028) that addresses major sustainability challenges in horticulture, with a particular focus on improving soil structure and reducing soil compaction. A central objective of the project is to develop and commercialise biological, chemical, and mechanical solutions that (i) enhance soil structure, (ii) mitigate compaction, and (iii) restore previously compacted soils.

Materials and Methods

Two field experiments were initiated at NIBIO's research station at Apelsvoll in 2024/2025 to evaluate approaches for improving soil physical conditions in horticultural systems.

Trial 1: Biomass management strategies and integration with high-value crops.

This trial aimed to identify effective biomass termination strategies enabling the integration of cover crops (CC), continuous soil cover, and high-value vegetable crops (onion and carrot). A multispecies CC mixture sown in autumn 2024 comprised hairy vetch (55%), oil radish cultivars 'Siletina' (10%), 'Siletta Nova' (8%), and 'TR Minor' (7%), honeywort (10%), and crimson clover (10%), with a seeding rate of 30–40 kg ha^{-1}, supplemented by 60 kg ha^{-1} winter rye. Termination methods included power harrow, roller crimper, and grass chopper, applied prior to spring planting of cash crops.

Trial 2: Short-term effects of bio-tillage species on soil compaction.

This experiment evaluated the capacity of selected CC species to alleviate soil compaction under conditions reflecting local agricultural practices. In July 2025, plots were compacted by four passes of machinery with a total weight of 9.5 Mg, followed by shallow harrowing (10 cm). Compaction effects were evident at 10 cm depth (soil density > 300 psi). Three CC species with contrasting rooting systems were sown on compacted and uncompacted plots: Italian ryegrass (40 kg ha^{-1}), oil radish (25 kg ha^{-1}), and lupin (18 kg ha^{-1}). Control plots without CC were included. Soil and biomass samples from 10 and 30 cm depth are being analysed at repeated intervals.

Results

Trial 1

Preliminary results from the 2025 season indicate that none of the termination methods sufficiently reduced CC biomass to levels compatible with successful establishment of onions and carrots. Hairy vetch, in particular, produced excessive biomass and

outcompeted the subsequent cash crops, substantially reducing their establishment and early growth.

Trial 2

Initial assessments in autumn 2025 show clear differences in CC establishment and growth between compacted and uncompacted plots. Compaction significantly reduced both root and shoot biomass across all tested CC species. Ongoing soil analyses will quantify differences in soil physical properties and rooting depth penetration between treatments.

Conclusion and Expected Impact

Findings from Hort2future will contribute to the development of soil-friendly horticultural practices aimed at reducing unsustainable soil management, improving soil health, and designing production systems that enhance soil physical conditions while decreasing the environmental footprint of Norwegian horticulture. The outcomes are expected to strengthen the resilience of both organic and conventional horticultural systems in Norway and support long-term sustainable intensification.

Impact of crop diversification on biological soil health in organic greenhouse systems

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Implications

This research enhances food system resilience by promoting soil health and biodiversity through diverse crop rotations in organic greenhouses. By testing approaches like intercropping legumes with cash crops such as cucumber, it demonstrates practical compliance strategies that build microbial soil functions. These practices reduce reliance on external inputs, buffer against pests and climate variability, and support long-term productivity in Nordic vegetable production. Preliminary results showing no significant differences between rotations after year one, suggest flexibility in implementation without compromising soil health.

Background and objectives

Soil health and biodiversity are fundamental to organic production systems and agroecological principles. According to EU regulation 2018/848 on organic production and labelling, it is now mandatory to consider the long-term fertility of soils in crop management and to increase plant biodiversity. In Nordic greenhouse vegetable production, which has traditionally relied on production in demarcated beds or pots, the regulation mandates shifting all cultivation directly into the soil, alongside implementing crop rotations that include at least one green manure crop. Producers are also required to grow legumes and maintain crop diversity within the greenhouse at all times. These green manure crops and legumes can be intercropped with cash crops, grown during the winter season, or used as ground cover crops. Depending on producers' chosen approaches to compliance with the regulation, the impacts of these practices on soil health in organic greenhouse systems remain largely underexplored. In a two-year project conducted in research polytunnels on organically managed land in southern Sweden, we tested two crop rotation approaches and analyzed biological soil health parameters. Both rotations complied with EU organic regulations but differed in the number of crops produced. The objective was to investigate whether different compliance strategies could affect biological soil health in distinct ways.

Key results and discussion

The last samples from this two-year project will be analysed in April 2026. Results from year one showed that no significant differences were found in terms of the soil health analyses between the two crop rotations. However, after the finalization of the second year, a more comprehensive analysis will be carried out. The results will be presented at the conference.

How work was carried out

The two crop rotation approaches were, i) sugar pea (Pisum sativum var. saccharatum), cucumber (Cucumis sativus), Daikon radish (Raphanus sativus var. longipinnatus), Mizuna (Brassica rapa var. nipposinica), and ii) cucumber (Cucumis sativus) under sown with crimson clover (Trifolium pretense), and Mizuna (Brassica rapa var. nipposinica). The biological soil health parameters analysed were primarily directed to microbial function. Soil samples were collected after the finalization of each crop in the respective rotations.

Covercrops – resilience in vegetable crop rotation

Mette G. Thomsen, Kari Bysveen, Emilie Sandell & Till Seehusen

Introduction

Vegetable production is intensive, in conventional as well as in organic production, both in terms of tillage, fertilization and plant protection. Which poses a significant risk of negative climate and environmental impacts such as nutrient leaching, greenhouse gas emissions, soil health, carbon loss, and soil compaction. Cover crops are a relevant measure that has the potential to reduce such challenges (Bøe et al 2019). Most previous studies under our conditions have included the use of cover crops in cereals, while we know less about effects in row crops. Cultivation of row crops often includes several resource-intensive operations and extensive tillage strategies. At the same time, large amounts of plant residues are left in the field after harvest, with a high content of nutrients and thus high risk of leaching through autumn and winter. All in all, the environmental impact of growing row crops can be great, and it is therefore important and desirable to try to minimize this.

Background and objectives

Background: investigate the possibilities of reducing the climate and environmental impact in Norwegian vegetable production by including and adapting cover crops in the crop rotation.

Objective: Keep cover crops in the vegetable crop rotation to reduce the negative effects of intensive tillage, improve soil structure, water retention and better utilization of nutrients, as well as reduce weed growth. In addition, better soil structure and aggregate stability can help increase the soil's resistance to drought and erosion during heavy rainfall. Better access to knowledge about the use of cover crops can therefore increase profitability and reduce the environmental impact of production.

Key results and discussion

Continuous use of covercrops, in a vegetable cropping rotation

- Reduced the coverage and biomass of weeds in spring when compared with no weed management.
- Chicory had the lowest competition against weed
- The optimum sowing time for cover crops depend on species and year as well as location.
- Rye, established best of the tested cover crops at late sowing time
- The amount of mineral nitrogen, Nmin, in spring is highest in the fields with rye and It. Ryegrass
- Aggregate stability improved with cover crops and It. Ryegrass and rye gave significantly better stability than the control treatment without cover crops
- Vegetable rotations organic or conventional would gain better soil conditions and reduce weed pressure by adding cover crops in the rotation.

References

Bøe, F., Bechmann, M., Øgaard, A.F., Sturite, I. & Brandsæter, L.O. 2019. Fangvekstenes økosystemtjenester – Kunnskapsstatus om effekter av fangvekster. NIBIO Rapport, 5(9) 2019.

Session 4 – Resilient organic arable production systems

Regulating soil microclimate and greenhouse gas emissions in open-field organic vegetables with a novel mulch farming approach

Bryan Dix, Michael Hauschild, Wiebke Niether & Andreas Gattinger

Implications

This research was the cornerstone of the EIP agri project "Mulch vegetables" and the outcome has the potential to revolutionize the cultivation practices of important field vegetables especially under rainfed conditions, with no or only little access to water. The mulch layer not just moderates the microclimate for the field crops and the soil biota but also suppresses weeds and thus spares tedious mechanical weeding.

Background and objectives

The production of vegetables is water and nitrogen intensive. Both resources play a crucial role in the context of climate change, with water becoming scarcer, and nitrogen contributing to global warming via nitrous oxide. Mulching especially in combination with a novel but scaleable technology with a MulchTec planter is a promising alternative to conventional vegetable farming with potential to improve water utilization and increase yields, while also influencing nitrous oxide emissions as has been shown in a previous study (Dix et al. 2024). Organic mulch with a high load of nitrogen could increase emissions while mulch with a high C:N ratio may even reduce them. To identify the potential benefits and trade-offs of organic mulching in cabbage cultivation, we investigated the effect of three mulch materials with increasing C:N ratios (alfalfa-grass: 16, vetch-rye-pea: 25, and rye: 46) on agronomic parameters, soil microclimate and soil greenhouse gas emission patterns.

Key results and discussion

We conducted weekly measurements on soil mineral nitrogen, water contents, temperatures, as well as N2O, CO2 and CH4 emissions. Additionally, the decomposition of the mulch materials was investigated, and cabbage yields and biomass production were recorded. All mulch materials increased marketable yields and altered the soil microclimate, with lower soil temperatures and higher water contents, while soil mineral nitrogen tended to be reduced under mulch. Mulch materials with a narrow C:N ratio (16 and 25) increased yields, but also area-scaled nitrous oxide emissions compared to both the non-mulched control and the material with a wide C:N ratio (46). However, all mulch materials tended to reduce yield-scaled N2O emissions. Regardless of the material, mulch can improve soil microclimate and water retention, which can be especially important in dry environments. Applying mulch with a wide C:N ratio under these conditions may even reduce N2O emissions and increase nitrogen use efficiency.

Overall, mulching is a promising technique for vegetable cultivation in regard to climate change induced challenges, due to the agronomic and environmental benefits.

References

Dix B, Hauschild M, Niether W, Wolf B, Gattinger A (2024) Regulating soil microclimate and greenhouse gas emissions with rye mulch in organic cabbage cultivation. Agriculture, Ecosystems and Environment 367: 108951, https://doi.org/10.1016/j.agee.2024.108951

Integrated pest and pollinator management in faba bean

Ola Lundin & Chloé Raderschall

Implications

Pollinators are critical for faba bean yield, but we did not find evidence of insufficient pollination contributing to yield instability in faba bean. Broad bean beetle is a main pest in faba bean production in Sweden affecting seed quality and limiting the production of faba bean for human consumption. No 'silver bullet' solution to manage broad bean beetle has been identified, but a combination of practices could contribute to pest regulation and making full use of faba bean for sustainable grain legume self-sufficiency in organic cropping systems.

Background and objectives

Organic and locally produced grain legumes such as faba bean can contribute to a more sustainable and resilient food system, with less need for external nitrogen fertilisers and imports of protein crops. Low yield stability of grain legumes, especially in organic production is, however, hampering the possibilities of grain legumes for reaching their full potential. We have evaluated to what extent both beneficial (pollinators, natural enemies) and harmful insects (pests) contribute to faba bean yield quantity and quality in Sweden and how such insect-crop interactions can be managed to maximise and stabilise faba bean productivity. Pollinators included managed honeybees and wild bumblebees, natural enemies included parasitoids, carabid beetles, rove beetles and spiders and pests included broad bean beetle (Bruchus rufimanus) and bean aphids (Aphis fabae).

Key results and discussion

At the plant scale, cultivars with earlier flowering are more attractive to the broad bean beetle but receive fewer floral visits from bumblebees. At the field scale, injury from broad bean beetles can be reduced in organically grown fields by combining trap crop borders of an early flowering faba bean cultivar and odor traps, while predators can be promoted with flower strips. At the landscape scale, complex landscapes with high crop diversity and a mix of cropped and semi-natural habitats promote visitation by bumblebees. Landscape-scale studies on the role of faba bean cropping history in the landscape on both bumblebees and broad bean beetles are ongoing. Pollinators, mainly bumblebees and honeybee contribute around one third of the faba bean yield, but fields do not show evidence of insufficient pollination. Broad bean beetles are omnipresent in Sweden, attacked by a parasitoid only in the southernmost part of the country and mainly affects yield quality.

How work was carried out

Field observations or field scale experiments were conducted in a total of 104 faba bean fields, of which circa two thirds were organically grown. Field-scale studies were complemented with cage experiments to add mechanistic understanding of how different pollinator and pest species affect faba bean yield component quantity and quality.

Growing annual legume companion crops alongside winter oilseed rape boosts both nitrogen levels and pest regulation

Ann-Charlotte Wallenhammar, Ola Lundin, Eva Edin, Per Ståhl, Kerstin Andersson and Lena Engström

Implications

New studies in organic crops of winter oilseed rape (OSR; Brassica napus subsp. napus L.) at high latitudes show the potential to increase nitrogen uptake in winter OSR with legumes that freeze away, while protecting the oilseed rape crop from damage by the cabbage stem flea beetle (CSFB). The findings will guide growers into more robust cropping systems with increased nitrogen provision and pest regulation, thereby bringing resilience into winter OSR production.

Background and objectives

Oilseed rape is a highly valued crop globally for food (high-value vegetable oil), feed and industrial use. Concurrently, several insect pests and diseases impact OSR production with a high use of pesticides consequently. In organic production new innovative robust cropping systems are crucial. Organic winter OSR is subject to a large pressure from the CSFB in early autumn. With an early growth start in spring, access of plant available soil mineral nitrogen (N) at early growth stages is essential. By intercropping (IC) winter OSR and annual legume crops that freeze during winter, soil mineral N will be available in early spring while gaining functional biodiversity. The objectives were to develop a concept to improve N management in organic crops of winter OSR by IC annual legume crops, to assess the impact of IC on the prevalence of the CSFB, and to provide the best technique for establishment of winter OSR and legumes in different regions of Sweden.

Key results and discussion

The time point for seeding in autumn is critical for the growth of winter OSR and the legume crops (LC) chosen. Nitrogen uptake varied between locations due to the site-specific mineralisation capacity. LCs with robust growth in autumn, as faba bean, caused severe winter injuries and a significant yield reduction in OSR, in contrast to a previous study conducted in a mild winter (Emery et al., 2021). The OSR yield increase for clover mix, where 100 kg per hectare corresponds to an additional income of 800-1000 SEK per hectare, suggests low-growing clovers as the best overall option. Plant assessments in early spring provided indications for a reduction of CSFB larvae. These studies provide an outline for further experiments at high latitudes in which seeding dates, choice of individual clover species and seed rate can be further evaluated. The multifunctional effect of legume crops on the injuries of the CSFB provides evidence for a wider use of legume intercrops in conventional production when effective insecticides become scarce.

How work was carried out

Altogether five field trials were seeded in August 2021 and 2022 in organic winter OSR crops in south and central Sweden. Row distances of 12.5 cm and 50 cm were used, and the LCs; faba bean, blue lupin, common vetch and a clover mix (Egyptian clover, Persian clover and squarrose clover) were seeded simultaneously with winter OSR. N-uptake was determined by crop samples in late autumn of LCs and winter OSR, in early spring and at BBCH 69 in winter OSR. Injuries of the CSFB were assessed in autumn and in early spring.

References

Emery S E., Anderson P., Carlsson, G., Friberg, H., Larsson, M., C., Wallenhammar A-C., Lundin, O. 2021.The Potential of Intercropping for Multifunctional Crop Protection in Oilseed Rape (Brassica napus L.).Frontiers in Agronomy 3:782686

How to optimize tillage to control creeping perennial weeds?

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Implications

In organic farming, utilization of different tillage methods outside the growing season may control Elymus repens and Cirsium arvense effectively, whereas Sonchus arvensis seems to be more tolerant. Optimized tillage practices reduce need for bare fallowing during summer and thus reduce costs and negative environmental effects of weed management.

Background and objectives

Perennial weeds are the most troublesome weeds in organic farming, because they are aggressive to spread vegetatively by utilizing their large root system. Well planned crop rotation with long-lived grass ley, half summer bare fallow and ploughing in heavy soils have often sufficient effect on perennial weeds (Brandsæter et al. 2011, Lötjönen & Salonen 2016). However, bare fallow and annual autumn ploughing should be avoided due to costs, erosion risk, nutrient loss, CO2 emissions, reduced soil biological activity and humus degradation.

For previous reasons, we arranged a two-year (2020-2021) experiment with spring oats on fine sand soil organic field, where it was high infestation of E. repens and rather dense growth of S. arvensis. The objectives were to find out, how to manage organic cereal production, when tillage measures are executed only outside of growing period and can ploughing be avoided? Our experiment was conducted in middle of Finland.

Key results and discussion

In our experiment, spring ploughing alone controlled weakly E. repens or S. arvensis. This could arise from light and soft soil, where the roots and sprouts grow fast through ploughing furrow slices. The same phenomenon was noticed also by Lötjönen & Salonen (2016). Repeated KvickFinn-harrowing once in autumn and once in spring was rather effective: after two years treatment there was 20-25 % of E. repens dry mass remaining compared to the untreated control. Implement "Root cutter" decreased dry mass of E. repens to 50-65 % compared to untreated. This machinery has been developed primarily to control weeds with deep roots, like C. arvense, and therefore it was not very effective against E. repens.

All studied mechanical methods, including ploughing, had poor effect on S. arvensis. It has been supposed that S. arvensis falls into winter dormancy quite early and thus tillage in late autumn or in early spring has limited effect on S. arvensis (Weigel et al. 2025). We had no C. arvense at all in our experiment, but according to Norwegian experiences the root cutter can have a rather good effect on C. arvense, at least on heavier soils.

References:

Brandsæter, L.O., Bakken, A.K., Mangerud, K., Riley, H., Eltun, R., Fykse, H., 2011. Effects of tractor weight, wheel placement and depth of ploughing on the infestation with perennial weeds in organic farmed cereals. Europ. J. Agron. 34, 239-246.

Lötjönen, T., & Salonen, J. 2016. Intensifying bare fallow strategies to control Elymus repens in organic soils. Agricultural and Food Science, 25(3), 153–163.

Weigel MM, Andert S, Alt M, Weiß K, Müller J, Gerowitt B. 2025. Root fragment weight and carbohydrate dynamics of two weedy thistles Cirsium arvense (L.) Scop. and Sonchus arvensis L. during sprouting. PeerJ 13:e19155. DOI 10.7717/peerj.19155

Trichoderma spp. as a potential biocontrol against black dot and silver scurf in potatoes

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Implications:

- Established a tuber disc pathosystem to assess the efficacy of biocontrol agents under laboratory conditions and developed a novel vermiculite-based soil inoculation approach to initiate pathogen infection under field conditions.
- Trichoderma-based biocontrol formulations significantly suppressed black dot and silver scurf in potatoes in laboratory experiments
- Field-scale validation under organic production conditions will provide critical knowledge on its efficiency under real potato production conditions.
- Combining Trichoderma spp. with other non-chemical management strategies could suppress black dot and silver scurf to a higher extend.

Background and objectives:

Silver scurf (H. solani) and black dot (C. coccodes) are economically significant tuber blemish diseases affecting organic potato quality and marketability (Errampalli et al., 2001). Various biocontrol strategies, including the use of living antagonistic microbes, bioprotectants and commercially approved biocontrol formulations, have demonstrated efficacy against C. coccodes and H. solani under laboratory, greenhouse, and small-scale storage trials (Gopan et al., 2025). Despite the strong research evidence for pathogen suppression and reduced lesion development, commercial adoption of biocontrol agents remains limited due to inconsistent field performance, formulation stability issues, regulatory barriers, higher costs, and limited farmer awareness. Bridging this gap will require biocontrol optimization and large-scale validation in field. The objectives of this study were to evaluate the efficacy of biocontrol against C. coccodes and H. solani using in vitro and tuber-based assays and to test the most promising biocontrol for further evaluation under field conditions.

Key results and discussion

Under laboratory conditions, the products Trianum (Trichoderma harzianum strain T-22) Asperello (Trichoderma asperellum strain T34) were the most effective products against C. coccodes, suppressing microsclerotia development by 72%; Serenade (Bacillus subtilis strain QST 713) showed moderate efficacy, while Charge (Chitosan hydrochloride) and Polyversum (Pythium oligandrum) were least effective.

Azatin (Azadirachtin) and Mycostop (Streptomyces griseoviridis strain K61) achieved the highest suppression of H. solani conidiophore development (52–53%), followed by moderate effects from Polyversum, Asperello, and Trianum, whereas Serenade and Charge increased silver scurf susceptibility under laboratory conditions.

Under field conditions, both Trianum and Asperello effectively suppressed black dot, whereas no significant differences were observed for suppression of silver scurf in potatoes.

References

Errampalli, D., Peters, R. D., & MacIsaac, K. A. (2001). Control of silver scurf (Helminthosporium solani) of potato with fungicides applied at harvest. Plant Disease, 85, 69–75.

Gopan AI, Ravnskov S, Hansen JG, Abuley IK. (2025) Perspectives on biological management of black dot and silver scurf in potatoes. Biological Control 212;105946. https://doi.org/10.1016/j.biocontrol.2025.105946

Session 5 – Feed and management of grasslands

Designing productive grassland mixtures to enhance soil carbon storage: the role of species traits and mixture composition

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Implications

Well-designed multi-species grassland mixtures can maintain high biomass yields and increase soil carbon (C) inputs under low nitrogen (N) inputs, enhancing soil fertility and C stabilization. Strategic species selection, rather than simply increasing species richness, offers a practical pathway for climate-smart grassland management and strengthens the resilience of grass-based agricultural systems in Nordic–Baltic farming.

Background and objectives

Perennial grasslands are widely recognized for their potential to increase soil C storage compared to annual cropping systems. However, the role of species composition and functional trait diversity in optimizing both productivity and soil C stabilization remains poorly understood. This knowledge gap is particularly relevant for organic and low-input grassland systems, where N availability can limit productivity and soil C sequestration. The objectives were to assess how grassland mixture composition and species traits regulate aboveground yield, root-derived C inputs, and the stabilization of newly formed soil C.

Key results and discussion

In a field experiment, we compared 2-species mixtures (grasses or forbs combined with red or white clover), multi-species mixtures with 6 and 18 species, and monoculture perennial ryegrass receiving from 0 to 450 kg N ha^{-1} yr^{-1}. All mixtures contained legumes and received 75 kg N ha^{-1} yr^{-1}. Red clover mixtures, including the multi-species mixtures, produced 14–21 t DM ha^{-1} across three years, matching high-fertilized ryegrass, while white clover 2-species mixtures yielded less (8–16 t DM ha^{-1}) matching ryegrass fertilized at 300 kg N ha-1 yr-1 (Mortensen et al., 2026). Increasing species richness beyond two species did not increase yield when red clover was present, but the 18-species mixture maintained a better balance between legume and non-legume proportions over time.

The 6-species mixture composed of productive, resource-acquisitive species produced the highest total C input, measured after the 1st production year (Mortensen et al., 2025a). This was driven by species complementary in rooting depth, root biomass, and rhizodeposition. In contrast, the 18-species mixture showed lower C input indicating that increased species richness alone does not guarantee enhanced soil C sequestration.

Species root traits regulated the fate of root-derived C, as legumes increased the proportion of rhizodeposited C stabilized as mineral-associated organic carbon (MAOC) via higher root N content, while grasses enhanced total rhizodeposited C and particulate organic carbon (POC) formation through high root length density (Mortensen et al., 2025b). Consequently, while higher species richness does not necessarily lead to higher soil C inputs in the short term, it may increase soil C storage and stabilization in the longer term via stable grass–legume proportions.

References

1.Mortensen E.Ø., Abalos D., De Deyn G.B., Rasmussen J. 2026. Red and white clover sustain high and stable yields in diversified perennial grasslands under low N input. Field Crops Research 341. DOI: 10.1016/j.fcr.2026.110426.

2.Mortensen E.Ø., Abalos D., Rasmussen J. 2025a. Well-designed multi-species grassland mixtures enhance both soil C inputs and aboveground productivity. Agriculture Ecosystems & Environment 385. DOI: 10.1016/j.agee.2025.109578.

3.Mortensen E.Ø., Abalos D., Engedal T., Lægsgaard A.K., Enggrob K., Mueller C.W., Rasmussen J. 2025b. Smart mixture design can steer the fate of root derived carbon into mineral-associated and particulate organic matter in intensively managed grasslands. Global Change Biology 31. DOI: 10.1111/gcb.70117.

Long-term organic grassland management and soil fertility under climate change in Norway

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Implications

Organic farming is promoted in Nordic agricultural policy as a key pathway toward resilient food systems, with grass–clover leys forming the backbone of organic livestock production. However, under northern conditions characterized by short growing seasons, high precipitation, and increasing climate variability, long-term soil fertility and yield stability cannot be assumed. Our results highlight the need for policy frameworks to place stronger emphasis on sustainable nutrient management, including phosphorus recycling, improved nutrient-use efficiency, and long-term monitoring to prevent gradual soil nutrient depletion and to ensure that organic farming effectively supports climate adaptation, food security, and environmental sustainability in the Nordic region.

Background and objectives

Nordic food systems face increasing pressure from climate change, nutrient constraints, and the need to reduce dependence on external inputs while maintaining productivity. Cold temperatures, short growing seasons, and high precipitation limit nutrient mineralisation and crop growth, posing particular challenges for organic farming systems in the region. Grass–clover leys are central to Nordic organic livestock systems and are often promoted in international policy frameworks as a solution to improve soil health, enhance nutrient cycling, and increase system resilience. However, there is limited long-term evidence on whether these systems can sustain soil fertility and yields under Nordic conditions without compromising productivity. The objective of this study was to evaluate long-term changes in soil organic matter, nutrient status, and grass–clover ley productivity following conversion to organic management in a Norwegian milk production system. By combining multi-decadal soil monitoring, yield records, and farm-gate nutrient budgets, this study provides relevant evidence for the design of resilient organic farming policies in northern regions.

Key results and discussion

Over the 30-year study period, mean annual air temperature increased by approximately 0.05 °C yr^{-1}. During the same period, expansion of the cattle herd led to a less diverse crop rotation, with a greater emphasis on grass–clover silage production and grazing. Yields declined in the first and second cuts by approximately 61 and 19 kg DM ha^{-1} yr^{-1}, respectively. Estimated biological nitrogen fixation varied widely, ranging from 7–82 kg N ha^{-1} yr^{-1} in the first cut and 3–71 kg N ha^{-1} yr^{-1} in the second cut, with a mean annual total of about 49 kg N ha^{-1}, well below reported European grassland values (100–380 kg N ha^{-1} yr^{-1}). Overall, topsoil (0–20 cm) soil organic matter declined from 10.3% to 7.8%, particularly in fields with high initial SOM, reflecting historic land-use change, drainage, regular ploughing (every ~5 years), and climate warming. Concurrently, long-term organic management led to declining soil phosphorus and potassium reserves, with topsoil P-AL values in 2021 ranging from 23 to 182 mg P kg^{-1} soil, and few fields falling below the critical threshold of 40 mg P kg^{-1}. Declining soil fertility was associated with reduced grass–clover dry matter yields, indicating that long-term productivity may be constrained without targeted nutrient management strategies. These findings challenge the assumption that grass–clover leys inherently maintain soil fertility over time in Nordic organic systems and underscore the importance of adapting management practices to local climatic and environmental conditions.

References

Zethof, J. H. et al. Evaluating trends in yield and soil quality over 30 years of organically managed grass-clover ley in Norway. Org. Agr. (2026) 16:8.
https://doi.org/10.1007/s13165-025-00538-0

Soil carbon storage, soil health and nitrate leaching in organic dairy crop rotations

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Implications

The results from the long-term organic dairy crop rotations experiment demonstrate that integrating a higher proportion of grass-clover ley into crop rotations enhances soil resilience, mitigates climate change via increased soil organic carbon (SOC) storage, and reduces nitrate leaching. Consequently, the management of dairy crop rotation systems can be tailored to better sustain productivity, adapt to extreme weather events, and to comply with environmental constraints.

Background and objectives

Organic dairy crop rotations, characterized by a high proportion of grass-clover in the rotation, have the potential to increase SOC storage and improve soil health (Jensen et al., 2022). These effects contribute with direct benefits for climate change mitigation and indirectly to climate adaptation via the development of a healthy soil, thereby enhancing resilience to extreme weather events. Rotations including grass-clover swards often have a large nitrogen (N) surplus (Thers et al., 2024), and management strategies to ensure continuous plant growth throughout the year is needed in the arable part of the rotation. The objectives were 1) to assess the effects of grassland proportion in the crop rotation on SOC storage and soil physical health and 2) to assess N leaching at crop level within two organic dairy crop rotations varying in grass-clover proportion during eight years. The long-term organic dairy crop rotations experiment, located at AU-Viborg, Denmark, established in 1987 on a loamy sand soil served as the research platform for this study.

Key results and discussion

The SOC stock increased by 5.3 Mg C ha-1 following the conversion of soil with a prehistory of cereal-dominated cropping to a crop rotation with 2 of 6 years in grass-clover, with a steady-state condition reached after a period of 20 years (Jensen et al., 2022). An increase in the grassland proportion from 2 to 4 years in grass-clover in the 6-year crop rotation, resulted in a further increase in the SOC stock of 3.8 Mg C ha-1 during a 17-year period and no sign of steady-state condition was observed. An increasing grassland proportion in the rotation also had positive effects on soil aggregate stability, which is an important indicator of soil health, reflecting carbon sequestration as a result of microbial activity and plant growth. Thus, crop rotations with high grass-clover proportion may serve as both a climate change mitigation measure and a way to improve and maintain soil health. An eight-year study (2017-2025) of annual N leaching in the two crop rotations revealed that N leaching can be minimised through the implementation of effective conversion and catch crop strategies. Notably, the average N leaching across the eight-year period in the crop rotation with 4 of 6 years in grass-clover was 12 kg N ha-1, which is comparable to set-aside. Consequently, crop rotations with a high soil N content can be cultivated in areas with strict limits on N losses when well-managed, and can function as a N mitigation measure.

References

Jensen J.L., Beucher, A. & Eriksen J. (2022). Soil organic C and N stock changes in grass-clover leys: Effects of grassland proportion and organic fertilizer. Geoderma 44, 116022.

Thers H., Jensen J.L., Rasmussen J. & Eriksen J. (2024). Increasing cattle slurry application to grass-clover leys of different ages, did not affect nitrate leaching but increased legacy effect in mixed organic crop rotations. Field Crops Research 306, 109233.

Enhancing resilience in organic pig production through feed diversification in free-range systems

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Implications

Organic pig production relies heavily on concentrate feeds, increasing land use, feed-food competition, and challenging system resilience. Strategic forage crops are expected to reduce the carbon footprint of organic pork while supporting natural behaviour. Early findings from free-range pig experiments show strong motivation for diverse forages, which may contribute to improved resilience in future organic pig systems.

Background and objectives

In major organic pork producing countries in EU, pig diets rely heavily on concentrate feeds based on cereals and oilseeds such as soybeans. In Denmark, concentrate feed accounts for more than 80% of organic sows' diets and more than 90% of fattening pigs' feed intake, contributing - together with lower feed efficiency and crop yields - to substantially higher land use than in conventional systems (Kongsted et al., 2024). This strong dependence on concentrates challenges farm resilience (Pfeifer et al., 2022), increases feed–food competition, and contrasts with pigs' natural foraging behaviour. At the same time, free range access is central to organic pig production, aligning with organic principles and supporting species-specific behaviour. While free ranging may increase land demand, it is crucial to ensure that the occupied farmland contributes substantially to on farm feed supply. A modelling study indicates that strategic use of forage crops can reduce land use and the carbon footprint in systems where direct foraging plays a major role (Jakobsen et al., 2015). The 4F and QUALIPORK projects aim to assess how diverse, seasonally adapted foraging crops affect pig behaviour, pig–crop performance, pork quality, soil nutrient load, and overall carbon footprint.

Key results and discussion

Preliminary results from the 4F project, comparing a traditional pasture mixture with a multi species mixture designed for pregnant sows, showed average daily herbage intakes of up to 8 kg per sow, with indications that pasture availability was the main factor limiting intake (Johannsen & Kongsted, 2026). In the QUALIPORK project, preliminary findings indicate a strong motivation among fattening pigs to graze newly established grass–clover–herb mixtures in summer and to forage beet and Jerusalem artichoke roots during winter. More results will be presented and discussed within a broader resilience framework, including how to strengthen the resilience capacity of future organic pig production in relation to multiple challenges, such as feed supply and emerging consumer trends. The projects are funded by GUDP (Organic RDD programme in DK, ICROFS).

References

Jakobsen et al. 2015. Increased foraging in outdoor organic pig production - Modeling Environmental Consequences. Foods, 4, 622-644.

Johannsen & Kongsted. 2026. Multi-species pasture for gestating sows. Abstract accepted for the IAHA conference, FiBL, 2026.

Kongsted et al. 2024. Green feed in organic pig farming. In J. Wiseman (red.), Advances in pig nutrition. Burleigh Dodds Science Publishing.

Pfeifer et al. 2022. The role of diversity and circularity to enhance the resilience of organic pig producers in Europe, Animal - Open Space, Volume 1.

On-farm trials with low protein concentrate feed rations for organic dairy cows

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Implications

Increasing protein supply from domestic crops is a high priority in organic production. Imports of organic soybeans challenge the credibility of organic farming, which strives for high self-sufficiency in feed as well as on the farm and the national level. Profitable strategies with forage dominated feed rations based on farm resources are urgent for the development of organic dairy production.

Background and objectives

Some research results have shown that it is possible to achieve profitable milk production without protein concentrate (Spörndly et al., 2017; Huhtanen, 2013). Most organic cows are still fed soy, and there is a challenge in translating research results into practical conditions. More knowledge is needed on how forage quality affects milk yield in rations without concentrate, and whether there are other alternatives where, for example, grain legumes and cereals are advantageous as complements to the forage. Furthermore, the following question needs closer investigation: Do high-yielding cows lose proportionally more in yield when protein concentrate is excluded from the ration compared to herds with more moderate yielding cows?

Key results and discussion

A field trial was conducted on eight farms with organic dairy production during the indoor season 2022–2023. Two feeding models were compared: one with protein concentrate (PC) and one without (NC). The trial was carried out during lactation months 1–4. Crude protein levels in the rations were 16.5% (PC) and 14.3% (NC). The average milk yield in the PC group was 38.4 kg/day. The NC group produced 14% less, 33.0 kg/day, a significant difference. Milk fat and protein contents were not significantly affected. Milk urea levels were 4.42 mmol/l for PC and 3.48 mmol/l for NC. Energy-corrected milk (ECM) followed the same pattern as milk volume. The effect of excluding protein concentrate varied between farms. The highest-yielding farms (over 40 kg ECM on average) had the largest reduction in milk yield, while farms with lower yields had little or no significant reduction. The economic outcome was influenced by milk price. At a high milk price, net income decreased slightly without concentrate, while at a lower price it remained unchanged. To reduce reliance on protein concentrate, sufficient forage with high protein content and high digestibility is required. One strategy may be to increase the proportion of legumes in the forage. Furthermore, the marginal effect of feeding protein concentrate is low, the dairy farmer should in many cases question whether he or she is sending money from the dairy company to the feed industry?

References

Huhtanen, P. 2013. Utfodring av mjölkkor utan proteinfoder - går det? NYTT, nr 1. Inst. för norrländsk jordbruksvetenskap.

Spörndly, R., Holtenius, K., Eriksson, T & Spörndly, E., 2017. Producera Mjölk på enbart vall och spannmål – en ekologisk modell som kan vara lönsam, men passar alla kor? Slutrapport till Stiftelsen lantbruksforskning.

https://login.lantbruksforskning.se/sbs/projectbank/downloadPb?appFormId=402880f6485f65ff01485f977b304d8c

Session 6 – Organic as a model for resilient food systems

Does Increasing the Land Area under Organic Farming Improve Sustainability and Resilience

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Implications

This study provides decision-makers with more information on the potential of organic farming to strengthen food system sustainability and resilience. It also contributes to broader discussions within both the organic sector and society regarding the role of organic farming in building more sustainable and resilient food system.

Background and objectives

The principles of organic farming are grounded in ecological processes, recycling, and diversity in local contexts. By definition, organic farming provides production designs that enhance agricultural sustainability. As organic farming aims to increase self-sufficiency in food production by reducing dependency on external inputs, it also offers a strategy for improving resilience at the food system level. Despite the growing focus on the importance of food systems in society (e.g. EC, 2025), the role of organic production in public discussions on strengthening food system resilience in an increasingly turbulent world has remained limited.

In Finland, there is a lack of comprehensive analysis concerning the sustainability performance of organic farming and its contribution to resilience. To address this knowledge gap, this study examines differences across organic crop and livestock production sectors from the perspectives of food production, economic impact, self-sufficiency, and environmental impact. We also assess how expanding organic production influences sustainability and resilience at the food system level. Finally, we identify key areas that should be prioritized in the future development of organic farming.

Key results and discussion

The impact of increasing organic production depended on the livestock sector in which growth was simulated. Our analyses indicated that the organic sector is closely interconnected with conventional agriculture through the use of intermediate inputs and products that enter the market as conventional. To guide future goal setting for organic farming and support the organic sector in enhancing food system sustainability and resilience, we highlight three themes requiring further attention: (1) developing more specific and clearly defined targets for organic growth beyond land area; (2) developing strategies to strengthen the role of Finnish markets in organic consumption; and (3) clarifying the potential of organic production as a driver of agroecological food system transformation.

References

EC, 2025. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Vision for Agriculture and Food Shaping together an attractive farming and agri-food sector for future generations. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52025DC0075

Organic farmers' interpretations and perceptions of regenerative farming practices

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Implications

This study contributes to the ongoing discussions about the role of certified organic production in the sustainability transition of agriculture, and what aspects of organic farming should be developed to better support the resilience of the food system.

Background and objectives

Regenerative agriculture has emerged as an opportunity to improve agricultural sustainability, yet there is no uniform definition of the term [1]. Regenerative agriculture shares some aims and principles – such as improving soil health and promotion biodiversity in the agricultural landscape – with organic production [2,3]. The production methods also largely overlap [4,5] except in the case of use of synthetic inputs, which are proscribed in Organic farming.

We interviewed nine Organic farmers in Finland to identify a priori classified 'regenerative' farming practices already in use and elucidate farmer perspectives on the benefits and challenges of the farming practices. We also examine how, from the farmers` perspective, Finnish organic production should be developed.

Key results and discussion

Results show that the regenerative farming practices were mostly familiar to organic farmers. Particularly, the farmers placed the goals of regenerative farming with as much year-round plant coverage as possible, minimising tillage, and increasing diversity were as part of the efforts of their organic farms. However, increasing wintertime vegetative soil cover and no-tillage were seen as challenging in open field vegetable production. Cattle farms showed interest and opportunities to develop grazing towards fast-rotating rotational grazing, which can increase soil carbon input.

How work was carried out

The data consists of nine semi-structured interviews with organic farmers from Southeastern Finland representing following production sectors; arable, dairy, livestock, mixed and open field vegetable farming. Interviews were conducted in 2020. We used purposive sampling to reach development-oriented farmers with views on a relatively new phenomenon, regenerative farming. We conducted qualitative thematic analysis on the transcribed interviews.

References

[1] Newton, P., et al. 2020. What Is Regenerative Agriculture? A Review of Scholar and Practitioner Definitions Based on Processes and Outcomes. Frontiers in Sustainable Food Systems, 4(10): 1–11

[2] Schreefel, L. et al. 2020. Regenerative agriculture – the soil is the base. Global Food Security, 26.

[3] IFOAM (n.d.). The four principles of organic agriculture. Accessed 16.1.2026

[4] Giller et al. 2021. Regenerative Agriculture: An agronomic perspective. Outlook on Agriculture 50(1): 13–25.

[5] Reganold, J. P. & Wachter, J. M. 2016. Organic agriculture in the twenty-first century. Nat. Plants 2: 15221.

From rural peripheries to food system hubs: a foodscape approach to investigate the potential of a bio-district in Eastern Finland.

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Implications

We develop a novel approach for regional foodscape analysis that unravels key resource flows and the networks of actors that govern them. This will allow us to identify critical input dependencies, opportunities to support rural development through local food production in a bio-district, and the key actors to engage with in building rural food hubs.

Background and objectives

Across countries of industrial food production, the consolidation of food industries has accelerated a concentration of value creation, e.g. though food processing, around urban centres and the development of a rural hinterland that primarily produces agricultural raw products. Such food system peripheries are characterised by low local value addition and critical dependencies on agricultural inputs and (inter-) national markets. These developments contribute to rural decline and can limit a region's sustainability and resilience capacities.

In search for food production models that support rural communities and re-embed food production in local socio-ecological systems, bio-districts have emerged. Bio-districts are based on cooperation between primary producers, food and tourism entrepreneurs, local authorities, and residents. Together, these actors commit to the sustainable use of local resources to create a regional hub of food system activities (Dias et al. 2021). These activities can include food production, processing and consumption, energy production, environmental protection, and tourism. In this study we investigate bio-districts as a potential starting point for building sustainability and resilience capacities in rural peripheries. Building these capacities in highly specialised and spatially segregated food systems requires tailored approaches that consider local food production systems integrated in the socio-ecological landscape they operate in, also described as foodscapes (Vonthron et al. 2020). The objective of this study is to map the current foodscape of a case study region in Eastern Finland, in order to identify opportunities and the key actors to engage with for building a local bio-district.

Key results and discussion

We integrate biophysical flows of biomasses, nutrients and energy with a social network analysis to create a multi-dimensional foodscape map for a case-study region in Eastern Finland. Preliminary results show that the region has characteristics of a rural food system periphery and faces challenges related to rural decline and its proximity to the Russian boarder. However, local actors identify as a hub for organic food and have shown interest in developing a bio-district. Developing such a bio-district will be investigated in a second step of the study. We will identify opportunities to increase value addition from local food production and evaluate how resource flows and related actors would have to change to arrive at this alternative scenario.

References

Dias et al. (2021): Building Bio-Districts or Eco-Regions: Participative Processes Supported by Focal Groups

Vonthron et al. (2020) Foodscape: A scoping review and a research agenda for food security-related studies

Connecting organics with territory and landscapes as the basis for governing agri-food systems for resilience: insights from the establishment of Bio-district Sörmland in Sweden

Courtney Adamson, PhD candidate at KTH Royal Institute of Technology and vegetable producer in Sörmland & Sofi Gerber, a founding member of Bio-district Sörmland and facilitator of Bio-district Sörmland Living Lab

Implications

The paper provides theoretical, methodological and practical insights into the way novel governance spaces framed by organic values and practices, such as bio-districts, enable governing local and territorial food systems for resilience.

Background and objectives

The development of organic agriculture has largely revolved around on-farm and value chain practices and dynamics, often lacking focus on the broader holistic values of organics concerning health, ecology, fairness and care (Arbenz et al. 2016). Further, the evolution of organic agriculture has been marred by simplified dichotomies between organic and conventional forms of farming in policy and practice (Adamson, 2023). The concept of a 'bio-district' (alternatively, 'eco-district' or 'bio-region') assists in overcoming these challenges. Passaro and Randelli (2022) liken the formation and existence of bio-districts to the opening up of new governance spaces for sustainable agri-food system transformations at the territorial scale. This paper explores how these territorial networks can play an important role in forming integrated local and territorial agri-food system governance built on multidimensional organic values and practices from a broader societal perspective. Concretely, it reports findings of transdisciplinary research (2024-onoging) concerning the establishment of Bio-district Sörmland, which is the first of its kind Sweden.

Key results and discussion

The key results illustrate the way public, private and civil actors are collectively creating alternative governance spaces, through entities such as Bio-district Sörmland, to govern local and territorial food systems for resilience. Additionally, the paper discusses preliminary findings from an ongoing transdisciplinary project regarding how these actors, together with academia, are progressing their work with the Bio-district and in other contexts. It will focus on the development of a novel methodology (including challenges faced) that draws on the values and practices of organics, as well as theory on agroecological territorial transitions. The methodology seeks to integrate the needs and interests of diverse food system actors and practitioners, as well as the agency of landscapes and ecosystems in Sörmland, into the way food is governed.

References

Adamson, C. (2023). Soil Health in principle and practice: a study of changing farmer perceptions and practices in the context of organic certification in Sweden. Retrieved from https://su.diva-portal.org/smash/get/diva2:1766143/ATTACHMENT01.pdf (accessed January 2026).

Arbenz M, Gould, D, Stopes, C. (2016). Organic 3.0-for truly sustainable farming and consumption, IFOAM Organics International, Bonn and SOAAN, Bonn. https://www.ifoam.bio/sites/default/files/2020-03/summary_organic3.0_web_1.pdf (accessed January 2026).

EU Commission. 2021. Action Plan for the Development of Organic Agriculture. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52021DC0141R(01) (accessed January 2026).

Passaro, A., and Randelli, F. (2022). Spaces of sustainable transformation at territorial level: an analysis of biodistricts and their role for agroecological transitions. Agroecology and Sustainable Food Systems, 46(8), 1198–1223.
https://doi.org/10.1080/21683565.2022.2104421

Session 7 – Biodiversity and importance of including landscape level

Beyond organic: targeted actions for farmland biodiversity

Trine Poulsen, Yoko L. Dupont (Department of Agroecology, Aarhus University, Denmark)

Implications

Both organic farming and biodiversity-friendly land use are key elements of Nordic and EU agricultural policy, yet their relative contributions to biodiversity outcomes remain uncertain. Using computer simulations, we show that targeted biodiversity-friendly management actions deliver stronger and more consistent biodiversity benefits than increasing the organic farm area alone. Landscape-scale simulation modelling can support better design of agri-environmental measures that complement organic farming and maximise biodiversity outcomes.

Background and objectives

Organic farming is widely promoted as a biodiversity-friendly alternative to conventional agriculture and is central to the EU Green Deal. At the same time, farmers are increasingly required to allocate land to non-productive, biodiversity-friendly areas. However, it remains unclear whether biodiversity gains are primarily driven by farming type (organic/conventional) or by targeted biodiversity-friendly management actions, and how these effects vary across landscapes and species. This study used long-term population modelling to assess how farm type and biodiversity-friendly management affect key biodiversity indicators at the landscape scale, and how responses differ among species and landscape contexts.

Key results and discussion

Using the ALMaSS agent-based modelling framework (Topping et al, 2003), we simulated 30-year population responses of farmland biodiversity indicator species across 25 Danish agricultural landscapes. Management scenarios increased the proportion of non-productive area (2–10%) using set-aside fields, flower strips, patches and hedgerows. Furthermore, some of these farm management actions were compared to scenarios where the organic farm area increased from current levels (11%) to the EU target of 25%. Increasing non-productive area generally enhanced biodiversity, but effects were highly dependent on management type, spatial configuration, indicator species and landscape context. Features integrated within fields, such as strips and patches, consistently resulted in higher population increases than whole-field set-aside. In contrast, increasing the organic farm area alone resulted in smaller and more variable population responses. Species responses differed noticeably and landscape context strongly influenced the magnitude of responses, highlighting the importance of tailored, landscape-specific solutions.

How work was carried out

Long-term population dynamics were simulated using detailed, dynamic landscape models combined with agent-based species models. Management scenarios were co-developed with organic farmers and advisors to ensure practical relevance and feasibility.

References

Topping, C. J., T. S. Hansen, T. S. Jensen, J. U. Jepsen, F. Nikolajsen, and P. Odderskær. 2003. ALMaSS, an agent-based model for animals in temperate European landscapes. Ecological Modelling 167:65-82.

EcoMetric –a farmland biodiversity index

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Bent Rasmussen, Julie Søby, Innovation Centre for Organic Farming, Denmark

Implications

EcoMetric is a proof-of-concept biodiversity metric for farmland that integrates land use, landscape structure, and long-term population responses of indicator species representing key ecological functions. By focusing on functional and habitat diversity, EcoMetric provides a framework for a farmland biodiversity index that quantifies biodiversity in a consistent, transparent, and scalable way.

Background and objectives

In Northern Europe, agriculture occupies a large proportion of the terrestrial area, making agricultural biodiversity relevant in conservation. Biodiversity is increasingly included in sustainability reporting requirements, yet is one of the most difficult to understand and document. The aim of the EcoMetric project is to develop a science-based framework for measuring biodiversity in agricultural landscapes managed for organic production.

Key results and discussion

EcoMetric combines landscape-scale habitat mapping with computer simulations to predict long-term population responses of key organisms. Landscapes vary in structural heterogeneity, described by (1) Composition, defined as the proportion of semi-natural areas (2) Configuration, defined as edge density (Martin et al, 2019). We used three land use categories: crop fields (CF), permanent grassland (PG), and permanent landscape elements (PLE) to characterize composition (PG + PLE) and configuration (total edge length relative to area of CF). Biodiversity responses in landscapes varying in composition and configuration were predicted using ALMaSS, a landscape-scale modelling framework for assessing the effects of land-use change and management on animal populations (Topping et al, 2003). Simulation outputs of multiple species were used to construct a farmland biodiversity metric, that can be used for long-term biodiversity enhancement at farm and landscape levels.

How work was carried out

We constructed 96 artificial landscapes in which composition and configuration were systematically varied within empirically realistic ranges derived from landscape analyses of Danish landscapes and reports. Population dynamics were simulated for seven biodiversity indicator species representing different functional groups: beetle, spider, solitary bee, ladybird, skylark, vole, and hare. These simulation results form the basis for a farmland biodiversity index reflecting landscape-level support for functional biodiversity.

References

Martin, E. A., et al. 2019. The interplay of landscape composition and configuration: new pathways to manage functional biodiversity and agroecosystem services across Europe. Ecology Letters 22:1083-1094.

Topping, C. J., T. S. Hansen, T. S. Jensen, J. U. Jepsen, F. Nikolajsen, and P. Odderskær. 2003. ALMaSS, an agent-based model for animals in temperate European landscapes. Ecological Modelling 167:65-82.

Biodiversity benefits of grazing are highest at extensive levels, also under organic management

Irina Herzon, Torgny Backman, Laura Bosco, Sanna Mäkeläinen, Andrea Santangeli, Aleksi Lehikoinen, Venla Saaristo, Johan Ekroos, Helena Wirta

Implications

Our findings suggest that the biodiversity benefits of grazing are most effectively realized through extensive grazing, including on organic farms. Intensifying pasture management is likely to be one of the practices increasing yields in organic systems but undermining their biodiversity benefits (Röös et al., 2028). Cattle farmers can increase resilience of their production by maintaining a pasture reserve area at low grazing intensity or setting it aside as a patchwork refuge in grasslands, as well as grazing at least some cattle groups in semi-natural areas (Herzon et al., 2024). If society adopts a lower overall consumption of animal food, it may be able to accommodate lower production levels using more environmentally benign practices.

Background and objectives

Ruminant production places considerable strain on ecosystems due to land-use change for pasture and fodder cultivation. The grazing obligation is considered one of the benefits that organic farms provide for biodiversity. However, also organic cattle farms have been increasing their herd sizes and intensifying pasture management. In Finland, for instance, organic farms rely on high-input rotational grasslands, or leys. The biodiversity value of such grasslands remains particularly poorly understood. We tested benefits of grazing on arthropods and farmland birds on 43 dairy and suckler cow farms in southern Finland that practice different grazing regimes, including zero grazing. Sixteen of the farms were certified organic.

Key results and discussion

Cattle grazing enhanced the taxonomic richness and abundance of ground-dwelling arthropods and the species number of birds, but did not affect the biomass of ground-dwelling arthropods or the abundance of aerial arthropods over fields. These benefits were particularly pronounced under extensive grazing at the farm scale. Ground-dwelling arthropod richness was higher on organic farms than on conventional farms, but only at low grazing intensities, and the same pattern was indicative for birds. Low to intermediate grazing intensity was also associated with higher abundance and diversity of bird guilds. Having a larger area of pasture relative to the size of the cattle herd may allow for the maintenance of heterogeneous resource patterns on pastures and across a farm. Tolerating and maintaining such heterogeneity in varied vegetation structures is important for biodiversity and acts as a buffer against weather extremes.

References

Röös et al., 2018. Risks and opportunities of increasing yields in organic farming. A review. Agronomy for sustainable development, 38(2), p.14.

Herzon et al. 2024. Improving biodiversity in agricultural grassland systems. In: Advances in temperate grassland science and management (Burleigh Dodds Science Publishing, Cambridge, UK) Available OA.

Long-term bumblebee monitoring reveals stable trends in Estonian agricultural landscape

Liiskmann, Egle; Tiitsaar, Anu; Karise, Reet; Mänd, Marika

Implications

We suggest increasing the growth area for organic and environmentally friendly fields to support bumblebee communities in agricultural and surrounding landscape, especially to support long-tongued bumblebees. Another suggestion would be to reintroduce red clover to crop rotation and simultaneously using rotational mowing on the same field to secure feed crop for cattle, food for pollinators, and seed production. We would also encourage cooperation between farmers in the same region to use the fields in crop rotation bring together farmers who have the fields similar in size and region, to grow subsequently grains, legumes, cattle, and other produce/crops.

Background and objectives

Europe is moving towards a more sustainable agriculture with the goal of reducing the risks from using chemical pesticides, with initiatives like Farm to Fork Strategy. Farmers are tackling the situation by transitioning from conventional to environmentally friendly and organic farming. Growing leguminous plants is one way to build more resilience for future agricultural production. Red clover, for example, provides different ecosystem services, including nitrogen fixation and improved soil health. It also offers food for pollinators, such as bumblebees1,2, and cattle. Bumblebees could be considered as a keystone species3 in agricultural and natural landscapes.

Key results and discussion

We present an overview of long-term monitoring of bumblebees on crop fields and entomophilous field edges in Estonia, comparing the abundance and species richness of bumblebees in conventional, organic, and environmentally friendly farming practices. Our results show that species richness has remained stable throughout the monitoring period, with almost all true bumblebee species consistently present. The overall abundance of bumblebees has also been stable, even slightly rising in organic and conventional fields. Sites transitioning from organic to environmentally friendly schemes in 2023 showed significantly less individuals compared to control sites that remained constantly organic in 2024, indicating the negative effect of reintroduced agrochemicals. Long-tongued bumblebees were less abundant than expected, while several short-tongued species showed increasing trends in organic sites, indicating species-specific responses to farming practices.

How work was carried out

Monitoring took place between years 2010-2025, bumblebee species and their abundance was recorded during standardised transect counts during vegetation period.

References

1. Rundlöf, M., Persson, A. S., Smith, H. G. & Bommarco, R. Late-season mass-flowering red clover increases bumble bee queen and male densities. Biol. Conserv. 172, 138–145 (2014).

2. Dupont, Y. L., Damgaard, C. & Simonsen, V. Quantitative Historical Change in Bumblebee (Bombus spp.) Assemblages of Red Clover Fields. PLoS ONE 6, e25172 (2011).

3. Sepp, K., Mikk, M., Mänd, M. & Truu, J. Bumblebee communities as an indicator for landscape monitoring in the agri-environmental programme. Landsc. Urban Plan. 67, 173–183 (2004).

Impacts of carbon farming practices on biodiversity at the farm scale: abundance as an early, context-dependent indicator in boreal Finland

Hanna Susi; Paula Thitz; Marleena Hagner; Krista Raveala; Johan Ekroos; Anna-Liisa Laine

Implications

Improving resilience in organic and low-input food systems requires management that strengthens ecosystem functions (e.g., soil food webs, pest regulation, pollination) while remaining feasible for farmers. Using a national on-farm network in Finland, we show that biodiversity can respond within a few years to carbon-farming practices i.e., diversified plant cover, reduced disturbance, adaptive grazing. However, responses are strongly context dependent, varying by practice and taxon. Across above- and belowground groups, abundance was the most sensitive metric, often detecting ecological change when community composition metrics did not. This supports using abundance-based monitoring as an "early warning" approach for resilient farming transitions in Nordic–Baltic boreal conditions, alongside complementary diversity metrics.

Background and objectives

Biodiversity loss from intensive agriculture threatens the long-term sustainability and resilience of food production systems. Carbon farming practices are promoted for climate change mitigation and may also support biodiversity, but evidence from boreal agroecosystems is scarce and indicator choice can strongly affect conclusions. We asked:

(1) Do different carbon farming practices differ in their biodiversity impacts at the farm scale under realistic production conditions? (2) Which biodiversity metrics are most sensitive across taxa? (3) How can these findings inform resilience-oriented management relevant to organic farming in the Nordic–Baltic region?

Key results and discussion

Biodiversity responses were strongly context dependent, varying by practice, taxonomic group, and metric (Susi et al., 2026). Abundance emerged as the most sensitive alpha metric across taxa, often detecting changes not reflected in community composition metrics. In general, alpha diversity was more sensitive than beta diversity, implying that management effects often manifested as changes in the number of individuals and local diversity rather than turnover in community composition. Arthropods were particularly responsive: adaptive grazing increased herbivorous arthropod abundance relative to its control, while some annual practices showed reduced arthropod abundance compared to controls. Nematode abundance was higher in perennial systems (ley mixtures and adaptive grazing) than in annual systems, with practice-specific contrasts relative to controls. Bird community metrics showed no clear treatment effects at this plot scale, suggesting that detectable responses may require larger treated areas or longer timeframes. Overall, the results indicate that carbon-farming-type practices can support biodiversity, but benefits are not universal; tailoring practice choice to target taxa and local context is key for building resilient agroecosystems. For resilience-oriented organic and low-input systems, monitoring should prioritize abundance as a sensitive early indicator, complemented by diversity and composition metrics to avoid missing longer-term community change.

How work was carried out

We surveyed 19 farms in Southern and Central Finland selected from the Carbon Action network (105 farms) (Mattila et al., 2022). Farms implemented one of four practices in 1.5-ha field plots since 2019: undersown cover crops, diverse ley mixtures, adaptive grazing, and "all-in" combinations (e.g., subsoiling, no-till/direct sowing, amendments

with manure, plus ley/cover crops). Each treatment plot was paired with an adjacent control with the same crop/pasture under conventional management, enabling within-farm comparisons under realistic conditions. In 2023 we collected data on plants, arthropods, nematodes, and birds, and analysed multiple alpha (abundance, richness, Shannon, evenness) and beta diversity metrics.

References

Mattila, T. J., Hagelberg, E., Söderlund, S. & Joona, J. 2022. How farmers approach soil carbon sequestration? Lessons learned from 105 carbon-farming plans. Soil and Tillage Research 215: 105204.

Susi, H., Thitz, P., Hagner, M., Raveala, K., Ekroos, J. & Laine, A.-L. 2026. Impacts of carbon farming practices on biodiversity at the farm scale. Agriculture, Ecosystems & Environment 400: 110230.

Session 8 – Measuring sustainability of organic production systems

Developing indicators for farm preparedness and resilience: Is there space for economists in the interdisciplinary room?

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The world has changed. Previously unexpected crises have now become reality. For instance, Swedish farmers have experienced severe extreme weather events and economic crises that have disrupted agricultural production and farm preparedness1. Examples revealing a lack of farm preparedness were the 2018 and 2023 droughts affecting Swedish agriculture, which resulted in major yield losses, negative financial impacts, and farm bankruptcies2,3.

It is not too late to act. By building resilience to these climatic extremes and economic crises4, adversity can be mitigated, and preparedness can be enhanced5. One solution lies in the hands of farmers themselves through adopting innovations6, which can enhance preparedness and resilience. Understanding how the economic preparedness and resilience of Swedish farms can be enhanced requires a set of context-specific indicators. However, such indicators are currently lacking7.

The aim of this paper is to investigate how innovations are related to the preparedness and resilience of Swedish farms by developing novel indicators to measure the economic preparedness and resilience. Building on existing literature on farm resilience4,8,9 and preparedness5,10, we develop quantitative indicators to measure farm preparedness and resilience. These indicators feed into a conceptual framework that integrates preparedness and resilience. During a stakeholder workshop, the proposed indicators will be discussed and verified to ensure their applicability to Swedish agriculture.

We subsequently examine the potential of various innovations applicable to both

conventional and organic farming systems. Our analysis encompasses technological innovations (e.g., precision farming and drones), non-technological innovations (e.g., new on-farm marketing channels), and collaborative innovations involving other farmers (e.g., knowledge exchange and machinery sharing).

Finally, we reflect critically on the role of economists in interdisciplinary resilience assessments. We contend that economists can make a distinctive contribution by

evaluating trade-offs among resilience indicators and by supporting policymakers in navigating these trade-offs when designing resilience-oriented policies.

References

1. SOU. Livsmedelsberedskap För En Ny Tid. (2024).

2. Tamminen, L.-M., Båge, R., Åkerlind, M. & Olmos Antillón, G. Farmers´ sense of the biological impact of extreme heat and seasonality on Swedish high-yielding dairy cows – A mixed methods approach. Preventive Veterinary Medicine 224, 106131 (2024).

3. Schmitt, J., Offermann, F., Söder, M., Frühauf, C. & Finger, R. Extreme weather events cause significant crop yield losses at the farm level in German agriculture. Food Policy 112, 102359 (2022).

4. Meuwissen, M. P. M. et al. A framework to assess the resilience of farming systems. Agricultural Systems

176, 102656 (2019).

5. Duchek, S. Organizational resilience: a capability-based conceptualization. Bus Res 13, 215–246 (2020).

6. Tambo, J. A. & Wünscher, T. Enhancing resilience to climate shocks through farmer innovation: evidence from northern Ghana. Regional Environmental Change 17, 1505–1514 (2017).

7. Tóth, K. et al. EU food system monitoring framework. From concepts to indicators. JRC Publications Repository https://publications.jrc.ec.europa.eu/repository/handle/JRC137971 (2024) doi:10.2760/94456.

8. Slijper, T., de Mey, Y., Poortvliet, P. M. & Meuwissen, M. P. M. Quantifying the resilience of European farms using FADN. European Review of Agricultural Economics 49, 121–150 (2022).

9. Alloush, M. & Carter, M. On the Definition and Estimation of Economic Resilience using Counterfactuals. Working Paper at https://doi.org/10.3386/w33290 (2024).

10. Mathijs, E. & Wauters, E. Making Farming Systems Truly Resilient. EuroChoices 19, 70–73 (2020).

Challenging carbon footprint calculation premisses for organic practice – *Attribution of emissions between livestock and field products*

Julie Henriksen, Frank Oudshoorn, Malene Myllerup

Implications

Allocating greenhouse gas (GHG) emissions from manure deposited in the field when grazing livestock, to the crops grown in the field, would reduce the carbon footprint (CF) of milk and meat for organic systems.

Background and objectives

Although farm animals typically are part of a whole farm system, LCA calculations with functional unit kg of milk or meat, often do not subtract the emissions from animal manure deposed in the field, which has influence on the field product carbon footprint. In addition, yield level has substantial effect on the emissions of nitrous oxide and should be addressed. In this study, the GHG emissions of dairy cows from different dairy systems are compared, when attributing GHG emissions from manure to the products they belong to. Barn and storage emissions to animal products, field emissions to crops (not shown in table).

Key results and discussion

KG CO2-e per cow per year	**Conventional Av. yield*, 100% barn**	**Organic Av. yield**, 100% barn**	**Org. yield**, 84% barn**	**Org. yield**, 79% barn**	**Org. yield**, 64% barn**
Methane, barn and storage	1753	1652	1474	1379	1142
Nitrous oxide, barn and storage	496	468	435	416	374
Total CO_2-e cow.y^{-1}	**2249**	**2120**	**1909**	**1796**	**1516**
Cow emissions (CO_2-e kg ECM.y^{-1})	0,20	0,20	0,18	0,17	0,15
% difference from Conventional yield, 100% barn	0%	4%	6%	11%	26%
** yield = 11477 kg ECM cow.y^{-1}*					
*** yield = 10398 kg ECM cow.y^{-1}*					

Milk yield level influences the amount of nitrogen uptake as feed, and therefore, also the amount nitrogen ex-animal, causing both direct and indirect (NH3 and nitrous oxide emissions). Furthermore, the amount of nitrogen ex-animal in the barn and storage decreases with the time the animals are outside. Methane emissions from manure and slurry in the barn and in the storage are also decreased considerably. Organic certification requires alignment with natural behaviour of livestock, where grazing is imperative. The attribution of GHG emissions to the climate impact of milk and meat is important to show, how system adaption could reduce climate impact. Emissions from barn and storage are only part of the total CF of milk and meat. The reduction percentages mentioned in the table above, will not be the same for the total CF.

Methods

Danish Average yield and field data for organic and conventional dairy production and IPCC emission factors were used

References

IPCC 2025.

Henriksen, 2024 Report Innovationcenter for organic farming; climate impact of grazing and lower milk yield.

Organic dairy farming as means for GHG mitigation

Frank Willem Oudshoorn, Malene Myllerup, Julie Cherono Schmidt Henriksen

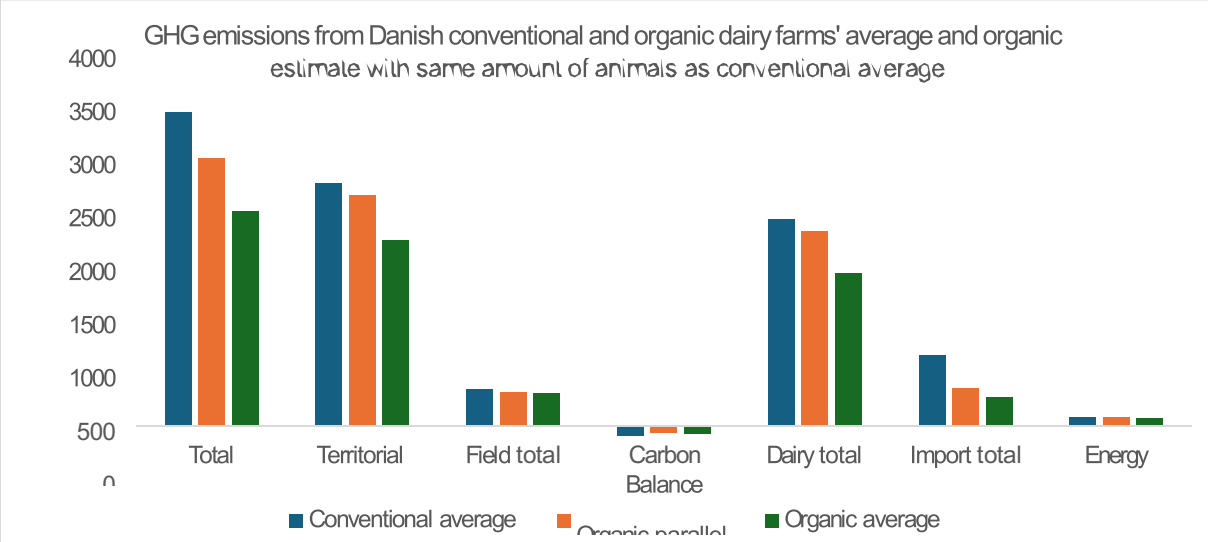
Implications

National reductions in greenhouse gas (GHG) emissions from livestock production can be achieved by transitioning to systems with lower livestock densities per hectare. In addition, keeping livestock outdoors reduces GHG emissions—particularly methane—from housing and manure storage. In Denmark, organic dairy farming already incorporates these practices, while also delivering co-benefits for resilience, such as increased feed self-sufficiency, improved animal welfare, and enhanced agrobiodiversity. Consequently, organic dairy farming can be recognised as a viable GHG mitigation measure contributing to national emission reduction targets under the UN framework.

Background and objectives

A governmental expert panel in Denmark concluded that mitigation of GHG emissions at the national scale could not be achieved in agriculture without the introduction of CO_2 taxation as an incentive. It was proposed that such taxes should be calculated based on emissions exceeding a real-time baseline emission rate per animal and per hectare. As organic livestock and dairy systems were expected to emit less than this baseline, the present study aimed to test this hypothesis using empirical farm-level data from national databases.

Key results and discussion



Conventional average; 268 dairy cows; 242 ha, 11,559 kg ECM cow-1y-1 Organic parallel; 268 dairy cows; 319 ha; 10,159 kg ECM cow-1y-1 Organic average; 213 dairy cows; 319 ha; 10,159 kg ECM cow-1y-1

Conversion of an average conventional dairy farm to organic management would reduce territorial GHG emissions by 23%. If the same number of animals were managed organically, the reduction would be 5%. When global impacts are included (e.g. feed imports and fertiliser production), the corresponding reductions increase to 31% and 15%, respectively. Organic practice would use more land, especially grassland, additionally giving rise to animal welfare and biodiversity. Less import of feed would be required, increasing the resilience of the system. GHG emissions calculated per kg CO2 e of ECM milk would be within uncertainty levels (conventional 1.11; organic parallel; 1.06; organic practice; 1.08).

Methodology

Farm-level data from Danish agricultural databases were compiled, and GHG emissions were calculated using national inventory emission factors, primarily based on the IPCC 2019 guidelines using the farm level climate calculator ESGreenTool Climate.

References

Henriksen, 2025; Organic livestock farming as means for climate mitigation (link to come). Anonymous, 205; ESGreenTool manual and background.

Organic crop production can reduce nitrogen leaching and its eutrophication impact in the Baltic Sea

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Implications

Our results indicate that organic crop production can reduce pressure on aquatic ecosystems of the Baltic Sea, thereby supporting more sustainable and resilient food production. However, since organic crops typically have higher eutrophication impacts per unit of product than conventional ones, improving organic yield levels is essential. Further research including empirical studies is also needed to understand the differences in phosphorus (P) leaching in organic versus conventional systems.

Background and objectives

Nutrient management differs substantially between conventional and organic production systems. In the latter, fertilisation is based on nutrient cycling and biological nitrogen (N) fixation, which reduces the need for external inputs and adds resilience toward disruptions. Differing nutrient management may also affect nutrient losses from the system and resulting eutrophication impacts. In Finnish inland waters, P is the main cause of eutrophication, while the Baltic Sea is impacted by both N and P. Eutrophication impacts of agricultural products can be assessed using Life cycle assessment (LCA); however, thus far LCA methods have been unable to adequately distinguish the impacts of organic and conventional crop production. We developed new N and P leaching and transport models for Finnish food LCAs (Kostensalo et al. 2024, Kostensalo et al. unpublished, Virkajärvi et al. unpublished) and are applying them in a national-level case study on the aquatic eutrophication impacts of organic and conventional crops in Finland.

Key results and discussion

Preliminary results for cereals, peas, broad bean, oilseed crops, and potato show that N leaching per ha is on average 15% lower in organic than in conventional production. The eutrophication impact of N in the Baltic Sea in PO_4 eq/ha is 35% lower for organic crops due to the reduced N leaching and greater N retention in inland waters. Impacts per product unit are on average 47% higher in organic systems, except for peas, broad bean, potato and winter turnip rape, which show lower impacts due to higher N retention in inland waters. For P, the picture is less clear. In winter cereals, P leaching and its eutrophication impact per ha (combined for inland waters and the Baltic Sea) appear similar in organic and conventional systems, while impacts per product unit are lower in conventional production. However, uncertainty in P leaching estimates is higher than for N due to limited data and model uncertainties. Overall, the results indicate that organic cultivation can reduce pressure on aquatic ecosystems, particularly in the Baltic Sea.

References

Kostensalo, J., Lemola, R., Salo, T., Ukonmaanaho, L., Turtola, E., Saarinen, M. 2024. A site-specific prediction model for nitrogen leaching in conventional and organic farming. J. Environ. Manag. 349, 119388.

Kostensalo, J., Hardenbol, A., Salo, T., Lemola, R., Räty, M., Lötjönen, T., Liimatainen, M., Saarinen M. Nitrogen-leaching model for Finnish agricultural soils. Unpublished.

Virkajärvi, P., Uusitalo, R., Räsänen, T., Karimaa, AE., Saarinen, M. Toward conditions-, site- and management-specific P emission model for LCA of agricultural products – the Finnish case. Unpublished.

Quality of life of organic and conventional fruit growers in Poland - a pilot study

Dobrowolski, H., Szumigaj, B., Włodarek, D., Kazimierczak, R., Obidzińska, J., & Rembiałkowska, E.

Implications

The development of organic farming depends on many factors, including the situation of organic producers. Their high quality of life provides a solid basis for the further development of the sector and for further analysis of social relationships in organic and conventional farming communities.

Background and objectives

Resilient food systems encompass environmental, social, and economic aspects. Among the social elements, the well-being of those involved in the agri-food production chain should be mentioned. According to the World Health Organisation, health is a state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity. Well-being is therefore part of the modern concept of health adopted by the WHO (World Health Organisation, 1997). Well-being is a key element of quality of life, reflecting both a subjective sense of satisfaction and the objective conditions in which a person functions. Quality of life is a multidimensional concept that influences a person's overall perception of life in relation to their personal expectations. It primarily depends on subjective perceptions of one's physical condition, mental health, and social relationships. In their review, David et al. (2021) found that organic farmers generally had better mental and physical health than conventional farmers, based on 29 studies from different countries. The effect size ranged from small to large, depending on various factors. However, to date, no studies have compared the quality of life of Polish organic and conventional producers. This study aimed to analyse the quality of life of a group of Polish fruit growers using organic and conventional methods.

Key results and discussion: Fifty-three people participated in the study. The WHOQOL-BREF questionnaire was used to assess quality of life. Participants were also asked additional questions about their health, financial knowledge, and farming experience. Participants' weight and height were recorded. Most participants rated their economic situation and health as good, but organic fruit growers rated their health as better than that of conventional fruit growers. Overall, participants scored 300 points (range 231–388), with organic fruit growers scoring significantly higher than conventional fruit growers ($p = 0.041$). Participants generally rated various aspects of quality of life highly. Organic fruit growers rated social relationships substantially higher than conventional fruit growers ($p = 0.047$). Assessing one's own health was associated with both physical and mental health ($p < 0.05$). At the same time, the number of chronic diseases was associated with physical health and social relationships ($p < 0.05$). In summary, the quality of life among fruit growers was quite good, but organic fruit growers showed better results in self-rated health, overall quality of life, and social relationships.

References

David, L, Dambrun, M, Harrington, R, Streith, M, and Michaud, A. Psychological and physical health of organic and conventional farmers: a review. Sustainability. (2021) 13:11384. doi: 10.3390/su132011384

The WHOQOL Group. Development of the World Health Organization WHOQOL-BREF quality of life assessment. Psychol Med. (1998) 28:551–8. doi: 10.1017/S0033291798006667

https://www.who.int/about/governance/constitution

Session 9 – Breeding for a more robust production system

The potential of heritage cereals in organic farming

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Implications

Heritage cereals can contribute to more resilient and diversified food systems by facilitating viable cereal production in low-input conditions. Their appreciation by consumers, relatively stable yields under abiotic stresses, potential nutritional advantages, crop diversity and cultural values make them a promising complement to modern varieties, particularly in organic farming systems. Increasing production would benefit from development of available infrastructure for processing grains and improved linkages between actors involved in heritage cereals along the food supply chains.

Background and objectives

Increasing crop diversity through a wider use of species and varieties is a key strategy for strengthening food security and sustainability in Sweden and the EU strategy Farm to Fork. We define heritage cereals as older species, landraces, and evolutionary populations developed prior to the mid-20th century. They have gained renewed interest among organic farmers, artisan bakers, and consumers. These cereals are often perceived as better adapted to low-input conditions and as offering unique processing and sensory qualities resulting in high consumer acceptance (Ortman et al. 2023). This presentation aims to synthesize current knowledge on heritage cereals in the Swedish context, in relation to agronomic performance, resilience, nutritional and sensory properties, and value chain characteristics, compared with modern cereal varieties.

Key results and discussion

Heritage cereals generally perform well under low-medium soil fertility and reduced nitrogen inputs (Ortman et al. 2023), with yield differences compared to modern varieties being small under such conditions (Ortman, 2024). Heritage cereals typically produce longer straw and greater biomass, enhancing weed competitiveness, soil organic matter inputs, and straw availability for livestock systems, although this also increases the risk of lodging, which can be mitigated through adapted nitrogen management.

Yield stability under drought and other abiotic stresses is often higher in heritage cereals, despite lower average yields, resulting in reduced yield gaps under stressful conditions (Ortman, 2024). Their greater within-variety genetic diversity contributes to resilience against pests and diseases and constitutes an important genetic resource for future breeding and production (Newton et al 2009). Nutritional studies indicate higher protein and mineral concentrations, particularly iron and zinc, as well as increased antioxidant capacity in some heritage cereals (Zamaratskaia et al, 2021). Sensory evaluations demonstrate that products made from heritage cereals differ in flavor, aroma, and texture, with consumer acceptance varying by species, variety, and product type (Zamaratskaia et al. 2021; Kristofers et al 2024). Despite increasing consumer demand, heritage cereals remain a niche crop due to limited seed availability, processing infrastructure, and market saturation risks, highlighting the importance of value chain coordination prior to farm-level adoption (Ortman, 2024).

References

Kristofers H, et al (2024). "Liking and willingness to eat of landrace porridges: a comparison between consumer groups" Int J of Gastronomy & Food Science 35, 100864.

Newton, Adrian C., et al. (2011). "Cereal landraces for sustainable agriculture." Sustainable Agriculture Volume 2: 147-186.

Ortman, T. (2024). "New potential in old varieties". Acta Universitatis Agriculturae Sueciae (2024:7)

Ortman, Tove, et al (2023). "Farmers' motivations for landrace cereal cultivation in Sweden." Biological Agriculture & Horticulture 39.4 (2023): 247-268.

Zamaratskaia, G., Gerhardt, K., & Wendin, K. (2021). "Biochemical characteristics and potential applications of ancient cereals -An underexploited opportunity for sustainable production and consumption". Trends in Food Science & Technology, 107, 114-123.

Mass selection is a potential tool for farmers to improve specialty crops that are important for local food production

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Implications

Buckwheat is an example of well-suited special crop to organic and agroecological production. The cultivation area in Finland has increased, reaching 2,700 hectares in 2025. Buckwheat achenes do not contain gluten, making it an important food crop also for people with celiac disease1. In addition, buckwheat flowers produce nectar and pollen for many insects, and beneficial phenolic compounds from the pollen are transferred to honey. In terms of nutrient requirements, it is undemanding. Locally produced raw materials have also been assigned an important role in enhancing the profitability of primary production and strengthening food culture in the Finnish food strategy published at the end of 20252. A key challenge in buckwheat, as in other locally important specialty crops, is the lack of breeding programs and cultivars adapted to Nordic-Baltic conditions.

Background and objectives

Buckwheat is a cross-pollinated species, and pollination is primarily carried out by insects. The aim was to investigate whether mass selection could be used to improve buckwheat seed material in a way that would also enhance its cultivation potential. Another objective was to generate information on whether the method could be suitable for implementation by farmers themselves and possibly serve as an example for other specialty crops as well. The study was part of the Diversilience -project3.

Key results and discussion

The starting material consisted of a locally cultivated buckwheat population, whose seed yield in the trial year (2024), after two years of mass selection (2022 and 2023), was observed to be approximately ten percent higher than that of the original seed material. All experiments were carried out on Luke's organic field. Also, the harvest window for buckwheat may be longer than previously assumed, since the seed yield at the end of August was almost equal to that obtained from harvest conducted three weeks later. It may therefore be possible to improve farm own buckwheat seed by advancing the harvest time. This allows the earliest maturing seeds to be harvested, and when the practice is repeated over several years, the cross-pollinated buckwheat population may gradually adapt to local farm conditions. In the next phase, mass selection should be continued over several years to monitor how yields develop and how the quality traits of the achenes are established. An appropriate way to move forward would be to work collaboratively and participatorily with farmers and other value chain actors in an agroecological manner, bridging research infrastructure and a living lab environment4. Improvement of seed material is needed for many less commonly cultivated crop species that are not included in commercial breeding programs. For this reason, methods should be developed in a way that allows farmers to participate in producing better seed in collaboration with research. In addition, deeper cooperation across the Nordic-Baltic region is needed.

References

1. Zamaratskaia et al. 2023. Buckwheat: an underutilized crop with attractive sensory qualities and health benefits. Critical Reviews in Food Science and Nutrition 2024, VOL. 64, NO. 33, 12303–12318. https://doi.org/10.1080/10408398.2023.2249112
2. Ministry of Agriculture and Forestry 2025. National Food Strategy 2040. A land of happy food https://urn.fi/URN:ISBN:978-952-383-034-9
3. Diversilience – Diversifying organic crop production to increase resilience - https://projects.au.dk/coreorganiccofund/2021-call-projects/diversilience.
4. Agroecology Partnership https://www.agroecologypartnership.eu/en/

Dual-purpose genotypes can deliver meat from a more holistic production system

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Implications

Dual-purpose genotypes can be a solution to the ethical dilemma in the modern egg-production, where millions of day-old male chickens are killed each year in EU. Dual-purpose genotypes can produce both eggs and meat in a more holistic production system exploring all resources. However, the product quality might change and this call for an important task of communication towards the consumer.

Background and objectives

Every year, millions of day-old male chickens from efficient layer breeds are killed in European egg production. The male chickens from the highly specialized egg-laying breeds do not have sufficient growth potential which makes them unsuitable for meat production. The spent hens are likewise often not used for human consumption due to lack of economic incentive. This applies to both conventional and organic production. It raises questions about ethics, animal welfare and resource utilisation and reflects a production system lacking robustness. In the organic system it challenges the principle of a holistic production where all animals are included in the value chain. Dual-purpose genotypes, where females are used for both egg and meat production and males for meat production, could solve the issue of culling and will reflect a more holistic production system based on organic principles. By integrating egg and meat production within the same genotype, the system becomes less dependent on highly specialized lines and external inputs, supporting a more robust and self sustaining production model. However, if the dual-purpose production system is to expand, it needs to fulfil consumer expectations to the products like meat from both broilers and spent hens. The objective of the present study, which is part of the project "Holistic organic poultry production to improve sustainability, welfare and product diversity – HOPeS"[1] is to evaluate the meat quality from dual-purpose genotypes when slaughtered as broilers and spent hens.

Key results and discussion

The carcasses from the dual-purpose broilers have a different distribution between breast filet and leg compared to the conventional broiler, with the breast filet constituting 20% versus 30%, respectively of the whole carcass. Likewise, the conventional broiler was less tough and had more intra-muscular fat, both characteristics which commonly is positive meat characteristics, compared with the dual-purpose genotypes. This highlights the importance of communication towards the consumer about the production systems and the products, as the story behind the production will be an important value of the product. The results on the meat quality of the spent hens will be presented and discussed in a broader perspective of development of a robust and ethical production system of egg and meat from dual-purpose genotypes.

How work was carried out

Male and female chickens of the genotypes Isa-Dual and Lohmann-Dual were raised in a free-range system with an outdoor area of 4 m2/animal covered with willows, grass and clover. For comparison an organic broiler (JACY87) and an organic egg-layer (Dekalb) were also included and raised in the same free-range system. At the age of 88-97 days the male broilers were slaughtered, whereas the egg-layers were slaughtered after 47 weeks of egg production, 65 weeks old. The meat quality of the breast fillet from both males and females were compared between the genotypes.

1. Funded by the Green Development and Demonstration Programme (GUDP), Ministry of Food, Agriculture and Fisheries, Denmark

Economic values of growth, fillet yield, disease resistance and survival in organic rainbow trout (Oncorhynchus mykiss)

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In aquaculture, breeding goal traits are often weighted based on desired gains rather than economic values (EVs) [1]. Including EVs into breeding goals enables optimization of the economic benefit of genetic improvement, as EVs quantify the change in profit resulting from a genetic improvement of one unit in a certain trait [2]. EVs can be derived by using profit equations or bio-economic models [3]. Especially for more complex systems, such as fish farms, bio-economic models are a useful tool for derivation of EVs as the production system can be modelled in detail [1]. In rainbow trout (Oncorhynchus mykiss), few studies have used bio-economic modelling [4, 5]. However, to our knowledge, no EVs have been published for organic aquaculture of rainbow trout. Organic aquaculture systems differ from conventional systems in several aspects, including lower stocking densities, restricted use of veterinary treatments, prohibition of hormone use, and mandatory use of organic feed [6]. The aim of this study was to derive EVs for growth, fillet yield, disease resistance and survival traits in an organic production system of rainbow trout in Denmark. This organic aquaculture system is constrained by a maximum allowable feed input based on phosphorus and nitrate limits. To assess the implications of this constraint, two scenarios were simulated: (1) an organic farm operating without feed limitation, and (2) an organic farm with a feed limitation. A deterministic bio-economic model was developed in R version 4.4.2 to simulate an organic rainbow trout farm [7]. The model included four traits: thermal growth coefficient (TGC; g1/3/(℃·d) × 10³), fillet yield (%), rainbow trout fry syndrome (RTFS) survival (%) and overall survival (%). Phenotypic means and genetic standard deviations for all traits can be found in Table 1. EVs were based on an average one-year production period and were calculated as the change in gross margin following an improvement of one genetic standard deviation in each trait, while keeping the other traits constant. Derived EVs (€·kg production-1 ·trait unit-1) for the scenario without and with feed limitation can be found in Table 1. Results demonstrate that all evaluated traits are of economic importance in organic rainbow trout breeding, with fillet yield being the most economically important trait for improvement given the current trait units. Incorporating a feed limitation changed economic values by decreasing the EV of TGC to near zero and increasing the EV of both overall survival and RTFS survival.

Table 1. Derived economic values (€/kg production/trait unit) for a scenario without and with feed limit.

Trait	Phenotypic mean	Genetic standard deviation	Economic value (€/kg production/trait unit)	
			Without feed limit	With feed limit
TGC ($g^{1/3}$/(℃·d) × 10³)	1.486	0.199	4.87	-0.03
Fillet yield (%)	0.489	1.10	8.60	8.60
Overall survival (%)	80.0	9.4	1.71	3.79
RTFS survival (%)	51.0	22.1	0.69	0.77

References

1. https://doi.org/10.1186/s12711-016-0278-x
2. https://doi.org/10.1093/genetics/28.6.476
3. https://doi.org/10.1080/09064702.2013.827237
4. https://doi.org/10.1016/j.prevetmed.2023.106055
5. https://doi.org/10.1016/j.jclepro.2024.142296
6. https://doi.org/10.1007/978-3-030-05603-2
7. R Core Team, R: A Language and Environment for Statistical Computing. 2024, R Foundation for Statistical Computing: Vienna, Austria.

POSTERS

Relative importance of landscape heterogeneity, flowering herbs, and insect abundance for farmland birds

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Implications

This study highlights the dominant role of landscape composition for bird occurrence in agricultural landscapes. Herb richness showed positive associations in five out of eight cases, suggesting that vegetation-based indicators may capture aspects of habitat quality. In contrast, insect abundance was positively related to bird metrics in only two out of eight cases, indicating limited explanatory power. These findings suggest that biodiversity monitoring should prioritize landscape context and vegetation diversity rather than relying solely on temporally variable measures like insect abundance.

Background and objectives

Farmland birds have undergone severe population declines across Europe, largely driven by agricultural intensification. They are particularly relevant for monitoring, as they serve as biodiversity indicators under the EU Biodiversity Strategy. This study assesses how the abundance of four species, abundance and species richness of farmland birds and 'all birds' (i.e. species outside the farmland-bird category), relate to landscape composition and local biological indicators, including herb richness and insect abundance.

Key results and discussion

Landscape composition was the most important factor explaining bird occurrence, showing consistent associations across all bird groups and species. Herb richness was moderately but repeatedly, positively linked to bird metrics (five of eight cases), likely reflecting cumulative effects of long-term reduction in farming intensity rather than short-term conditions. Insect abundance showed positive relationships in only two out of eight cases and displayed species- and season-specific patterns. The lack of consistent associations between birds and insect abundance suggests that insect sampling may represent a snapshot of food availability rather than overall habitat quality. Overall, the results indicate that landscape context and herb richness provide more robust indicators of farmland bird habitat quality than temporally variable measures of insect abundance.

How work was carried out

The study was conducted in five agricultural landscapes in Jutland, Denmark, each centered on an organic farm representing different production systems and regions. In total, 78 observation points (15–16 per farm) were established to survey farmland birds in 2022, 2023, and 2025. At the same points, flowering herbs were surveyed and flying arthropods were sampled. Landscape variables were derived from a 9-ha buffer around each observation point using QGIS. Model selection was applied to identify the best-performing models among nine candidate models combining landscape, herb, and arthropod variables.

References

DANMARKS STATISTIK. 2021. Arealopgørelser [Online]. Available: https://www.dst.dk/da/Statistik/emner/miljoe-og-energi/areal/arealopgoerelser

[Accessed 19-12 2025].

PRINCÉ, K., ROBUCHON, M., LIQUETE, C. AND GUERRERO, I., 2024. Identification of appropriate indicators for the targets of the EU Biodiversity Strategy in relation to agro-ecosystems. Luxembourg: European Commission, Joint Research Centre.

Readiness of Finnish organic and conventional vegetable farmers to use actions supporting biodiversity

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Implications

Results indicate that the key factors supporting growers' decisions to apply biodiversity measures are 1) availability of sufficient economic support, 2) availability of practical help in planning and performing farm-specific measures, 3) encouragement by commercial buyers of agricultural products and 4) capacity building in grower's biodiversity knowledge and skills. Further, according to the growers' opinions the measures supporting biodiversity in agricultural environment should be aligned with the requirements of food production.

Background and objectives

Biodiversity in agricultural environments is continuously declining, due to farm specialization, use of chemical plant protection products and decline of grazing by animals. In Finland, some research data is available of the effectiveness of active measures to enhance biodiversity on farms, but less data has been collected from vegetable farms. The objectives of this research were to evaluate 1. what is the capacity and willingness of vegetable growers to adopt measures to enhance biodiversity in their farms and 2. what kind of decision-making process is behind these measures. Research focused on organic and conventional vegetable growers who had already performed some measures to enhance biodiversity.

Key results and discussion

The farmers participating the interviews had already used several different measures to enhance biodiversity. On average, the organic growers had considered biodiversity aspects more widely than conventional growers in the production planning on their farms. This reflects the need for systemic and predictive thinking in organic horticulture, as the direct measures for managing plant pests or diseases are limited.

Three most important motives for biodiversity actions among all growers were economic subsidies, education and guidance, information and research. Among organic growers, also the legislation, organic ideology and biodiversity per se were regarded as important motives. The most important factor limiting the use of biodiversity measures was lack of time. The organic growers also mentioned frequently costs, bureaucracy and "resistance to change". However, when asking about the costs, growers did not consider them high.

When discussing the desired visual appearance of the farming environment, some variation between organic and conventional growers were found. Most of the organic growers described the visual farm appearance as small-scale, mosaic-like, diverse and versatile. Conventional growers highlighted the cleanliness of the fields and field margins, successful sowing, straight plant rows and low number of weeds.

How work was carried out

The data was obtained via semi-structured interviews of 11 vegetable growers and was analysed in a qualitative method. The work is a bachelor's thesis to Häme University of Applied Sciences, Degree Programme in Horticulture.

References

Pyhälä, S. 2026. A Study of the Vegetable Farmers Readiness to Take Action to Support Biodiversity at the Open Field Horticultural Farms in Finland. Bachelor's thesis. Häme University of Applied Sciences.

Resilient cultivars for Finnish organic production

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Implication

Conventional plant breeding can provide well-performing cultivars for organic production when traits relevant to organic cultivation are included in testing process.

Background and objectives

Oat (Avena sativa L.) is the most important cereal crop in Finnish organic farming. However, Finland currently lacks own organic oat breeding, resulting and forcing growers to rely on conventionally bred cultivars in organic seed production. Official variety trials are also conducted exclusively under conventional management, making it difficult to assess cultivars' suitability for organic conditions. Both organic and conventional oat production are frequently challenged by Fusarium head blight (FHB) and the associated mycotoxin deoxynivalenol (DON), which often leads to rejection of oat batches in trade. Disease resistance would be particularly valuable in organic production. However, the expression of quantitative oat FHB resistance in organic production remains unknown because all resistance testing is performed under conventionally managed field trials. In addition, soil and phyllosphere microbes may influence cultivar performance more strongly in organic systems, where nutrient availability is lower and fungicides are not used. The objectives of this study were: 1. to identify traits important for organic oat production by comparing organic and conventional field trials, 2. to evaluate available cultivars for FHB resistance, and 3. to compare microbial communities in organically and conventionally managed oats.

Key results and discussion

Results from field trials indicate that cultivars developed under conventionally managed fields by Nordic and German breeders perform well also under high-input organic conditions. No significant genotype × management interactions were detected for key traits such as yield or earliness within trial locations, suggesting that conventional variety trials can reliably predict cultivar performance in organic systems. Significant differences among cultivars were observed in yield, plant height, establishment speed, disease severity, maturation time, and grain quality traits. Substantial variation in DON accumulation was also detected. Overall, the findings highlight the importance of cultivar choice as a practical tool for improving the resilience of the Finnish organic oat production chain. The project was funded by the Foundation of Organic Production Research in Finland (Luonnonmukaisen tutkimuksen säätiö).

How the work was carried out

Twelve cultivars were tested in parallel organic and conventional replicated yield trials located in three geographically distinct regions of Finland in 2025. Traits relevant to organic production such as emergence speed, disease resistance, weed competitiveness, and nitrogen use efficiency were assessed. The material included both early- and late-maturing high-yielding cultivars recommended by local mills, as well as one landrace. FHB resistance was evaluated in organically and conventionally managed inoculated disease nurseries in both southern and northern Finland. Root samples were collected for mycorrhizal analyses, and panicle microbiomes were sampled from disease nurseries under different management regimes.

Characteristics of the oat (Avena sativa L.) variety 'Stendes Lote'

Lauma Kārkliņa, Sanita Zute

The oat (Avena sativa L.) variety ‘Stendes Lote’ was developed in Latvia at the Stende Research Centre of the Institute of Agricultural Resources and Economics during the period 2007–2023. The breeding programme focuses specifically on the development of varieties suited to organic farming systems. Breeding material was evaluated from the F5 to F10 generations under certified organic management conditions. This approach ensures that ‘Stendes Lote’ is well adapted and recommended for organic production.

The variety expands the range of oat cultivars available in Latvia by offering comparable yield levels while distinguishing itself by a higher thousand-kernel weight and higher test weight — important quality traits for grain processing. ‘Stendes Lote’ demonstrates improved yield stability under organic growing conditions. The variety is characterised by yellow husks, light-coloured kernels, and good lodging resistance. The growing period ranges from 90 to 105 days, plant height from 68 to 98 cm, and the yield potential reaches up to 4.5 t ha^{-1}.

In Latvia, expanding the range of varieties for organic cultivation is needed to ensure high yield and grain quality; this study aimed to evaluate the new variety ‘Stendes Lote’ compared with the standard variety ‘Laima’, focusing on yield, grain quality, and yield stability under organic growing conditions. To determine the yield potential of a genotype, field trials should be conducted in multiple locations with different meteorological conditions and soil properties, as well as over more than one year (Erbas Kose, 2022). The variety was evaluated for agronomic traits under an organic growing system at three locations across Latvia over a two-year period and has been tested in breeding plots at the Stende Research Centre since 2020. The new variety ‘Stendes Lote’ showed comparable yield to the standard variety ‘Laima’ (table), while displaying significant higher 1000-kernel weight and volume weight, and a lower hulled kernel percentage, highlighting its improved grain quality and suitability for organic cultivation.

Indicator	Laima	Stendes Lote	Absolute difference	Percentage difference	Significant
Yield, t ha^{-1}	2.53	2.53	0.00	0.08	ns
TKW, g	31.74	34.32	2.58	8.13	*
Volume weight, g L^{-1}	473.90	492.00	18.10	3.82	*
Hulled kernel, %	28.16	22.73	-5.43	-19.30	*
Protein, %	10.25	9.74	-0.50	-4.92	ns

Six-year results from breeding trial fields demonstrated that ‘Stendes Lote’ achieved a higher average grain yield compared to ‘Laima’ (4.02 and 3.87 t ha^{-1}, respectively), with similar yield stability (approximately CV = 19%). Evaluation of thousand kernel weight and test weight showed that ‘Stendes Lote’ produced higher values, with a thousand kernel weight of 35.5 g (31.9 g for ‘Laima’) and an average test weight reaching 517 g L^{-1} (CV=4.5%), where ‘Laima’ averaged 486 g L^{-1}. Yield is a complex trait controlled by numerous genes and influenced by multiple factors, including genotype, environment, and their interaction (Desheva, Valchinova, 2024), therefore, in 2023–2024, a decline in the average yield level was observed, which was mainly affected by meteorological conditions. Overall, ‘Stendes Lote’ exhibited higher productivity and better suitability for ensuring stable yield quality under organic growing conditions.

References

Desheva G., Valchinova E. (2024). Evaluation of yield stability and adaptability of oat genotypes (Avena sativa L.). Poljoprivreda, Vol. 30 (1), p. 3–12.

Erbas Kose O.D. (2022). Multi-Environment Analysis of Grain Yield and Quality Traits in Oat (Avena sativa L.). Journal of Agricultural Sciences, Vol. 28 (2), p. 278–286.

A perennial cereal for the Nordic-Baltic region

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Implications

Perenniality and crop diversity are major factors for building resilient food systems [1] but the availability of perennial food grain crops is extremely limited. To our knowledge there is no commercial cultivation of perennial cereals or even perennial grain crops in general in the Nordic-Baltic region. The introduction of a commercially viable perennial cereal would be a transformative innovation with the potential to greatly improve resilience and sustainability of organic food systems.

Background and objectives

The concept of perennial cereals is gaining traction with ongoing breeding efforts in several species, each with its own profile in terms of environmental adaptation, use and stage of development. Perennial rye (PR) is derived from crosses between annual cereal rye, Secale cereale, and perennial Secale strictum [2, 3]. Preliminary experiments at Aarhus University (AU), Denmark, found first year grain yields of PR rye, averaging nearly 4 dry ton/ha. This is comparable to spelt wheat, which is currently grown commercially for novelty flour. The agronomic performance combined with the regional traditions of the use of rye makes PR a strong candidate for a Nordic-Baltic perennial cereal providing grain for human consumption.

The ClimateRye project aims to facilitate the adoption and further development of PR using a three tracked approach: 1) the commercial partner Aurion will test grow and evaluate the end use quality of current PR. The aim is to achieve a small-scale organic production where farmer driven innovation can take place and the most relevant research questions for academia can be identified. 2) At AU, we will develop new management strategies, mainly focusing on improving second year yields and weed control. 3) Also at AU, we will develop novel genetic resources for further improvements of PR. Our first priority is to obtain reduced height mutants. Secondary target traits include grain size and reduced pre-harvest sprouting.

Key results and discussion

ClimateRye started in January 2026 with the majority of experiments to be established with the autumn sowing. At present we have produced an M1 mutant population. From this, we will sow out 10.000 M2 seeds in August. We will collect samples for DNA extraction in September/October in order to screen the population using Oxford nanopore sequencing and digital PCR methods during the winter months. This will allow us to identify valuable mutants before pollination and carry out controlled crosses in the field.

References

1. Sanford, G.R., et al., Perenniality and diversity drive output stability and resilience in a 26-year cropping systems experiment. Field Crops Research, 2021. 263: p. 108071.

2. Acharya, S.N., Perennial Cereal Rye: A profile of traditional research in developing a new crop. Biodiversity, 2001. 2(4): p. 13-19.

3. Gruner, P. and T. Miedaner Perennial Rye: Genetics of Perenniality and Limited Fertility. 2021. 10, DOI: 10.3390/plants10061210.

WelBredPOrg: Towards breeding for behaviour indicative of positive welfare in organic grower pigs

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Implications

The WelBredPOrg project presents an innovative approach to selectively breed for improved pig welfare by finding new ways to assess indicators of positive welfare for breeding purposes. We will develop a method based on RFID-data to define a new indicator trait for natural foraging behaviour in pigs and analyse the selection potential for this new indicator trait. In addition, we will study if roughage provision and the expression of rooting behaviour results in positive welfare.

Background and objectives

The ability to express natural behaviour contributes greatly to the welfare of pigs 1. By nature, pigs are strongly motivated to forage and root for their feed. For this reason, organic pig farmers must provide roughages in the form for e.g. silage or vegetables to meet the natural need of pigs. Yet, no large-scale studies have proven a clear link between rooting and increased positive welfare in grower pigs 2. With the rise of precision livestock farming (PLF), it is now possible to study foraging and rooting behaviour of pigs using technology (sensors, video, GPS). Behaviour of many individuals can be recorded automatically and continuously, which allows to evaluate the feasibility of selective breeding for positive welfare in pigs. The WelBredPOrg project aims to 1) develop an automatically recorded trait for positive welfare in organic grower pigs that reflects time spent on natural foraging behavior, 2) validate this trait with (positive) welfare indicators, and 3) assess the trait's potential to be used for selective breeding purposes.

Key results and discussion

Preliminary analyses of RFID-data from a commercial farm show that many pigs use the roughage area after roughages are provided (feeding event). Moreover, there is great variation in how often pigs visit the roughage area after a feeding event: some pigs visit <10% of the time, whereas others visit >80% (median 35%). The RFID data show that pigs are most active during the evening, and least during the morning. Finally, no link was observed between the growth rate and how frequently pigs visited the roughage area. Next, we will estimate the heritability and genetic correlations between the visiting frequency to the roughage area (RFID data) and production traits (growth rate).

Materials and methods

The WelBredPOrg project collects data in a commercial setting and an experimental setting. The first data collection takes place at a commercial organic pig farm. Each unit housed ~400 pigs and included an in- and outdoor area with straw, a concentrate feeder with a scale, and an outdoor area with an area where roughage was provided five times a day. RFID-sensors were placed in the roughage area, and the presence of pigs within 2m of the scanners was recorded 24/7 until they were slaughtered. Data collection started in Sept '24 and will end in Oct '26. The second part of the study takes place at a research farm. Groups of eight pigs were assigned to different treatments, where they had access to the outdoors (yes/no), and access to roughages and rooting materials (yes/no). Pigs were tracked using GPS ear tags, their behaviour (behaviour type, tail position) was determined at regular intervals during the growth-finisher period through visual observation (live and video), and their weight was measured using 3D video cameras. Data collection has started in Dec '25.

References

1 https://doi.org/10.1007/s10806-005-4493-7

2 https://doi.org/10.1016/j.applanim.2020.105070

Beyond Biodiversity: Unveiling the Potential of Organic Farming in Mitigating Beef Losses in Sweden

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Implications

By revealing the positive effect of organic cattle farming on food losses, another argument, besides the already established argument of increased biodiversity, for promoting organic production in the dairy and beef sector is gained.

Background and objectives

In previous research we quantified losses of cattle, and thereby beef, at farm level in Sweden (Strid et al., 2023). The purpose of the present project was to quantify the losses of beef for different animal groups at organic and conventional farms.

Key results and discussion

The results are published in Strid et al, 2025, and the main results are reproduced in Figure 1. All organic animal groups had significantly lower losses than their non-organic peers, except for beef females. The hot spot group dairy cows had e.g., 15 % lower losses, expressed as lost carcass weight per yearly produced carcass weight.

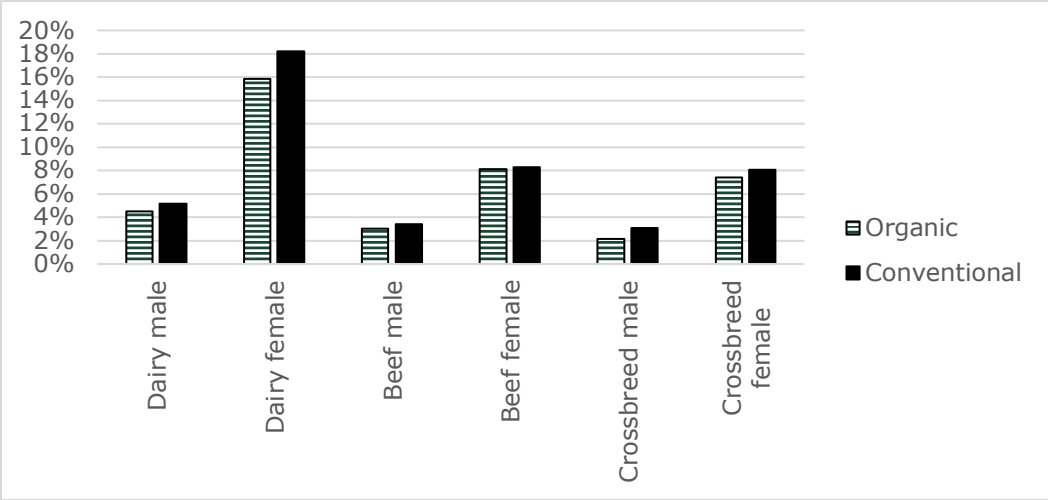

Figure 1. Average loss rates for 2017-2021 for organic and conventional dairy, beef, and crossbreeds in Sweden, divided on males and females.

How work was carried out

The work was based on data from the Swedish cattle movement registry, slaughter statistics and the farm registry, where farms can be classified as organic or not'.

References

Strid I, Jacobsen M, Alvåsen K and Rydén J (2023). Loss of beef during primary production at Swedish farms 2002-2021. Front. Sustain. Food Syst. doi: 10.3389/fsufs.2023.1171865

Strid I, Jacobsen M, Rydén J and Alvåsen K (2025). Unveiling the potential of organic farming in mitigating beef losses in Sweden. Agricultural Systems doi.org/10.1016/j.agsy.2025.104262

Selective breeding of an organic line of rainbow trout (Oncorhynchus mykiss) in Denmark

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Implications

A rainbow trout selected specifically for organic production will reduce environmental impact of the production. In addition, more fish will survive due to higher resistance to disease, which will increase fish welfare. The methods developed in this project can also be applied to conventional rainbow trout breeding.

Background and objectives

Organic aquaculture production is driven by interest in sustainable utilization of resources. It combines fair environmental practices, biodiversity, preservation of natural resources, and high animal welfare standards. A significant issue in aquaculture is the transmission of infectious diseases, stemming from the high density of individuals in farms and the struggle to prevent pathogen contamination. In organic aquaculture, this is an even bigger challenge because the use of antibiotics and chemo-therapeutic treatments is restricted and the concentration of medicine in organic products should be minimized. The procurement and certification of organic juveniles constitute an additional challenge for organic aquaculture operations (EUMOFA, 2022). Denmark is a key player in Europe's organic aquaculture, particularly for rainbow trout. Ådal Ørred in Denmark, has done innovative work in developing a specialized line of rainbow trout for the organic market. They manage the entire production process, starting from organic eggs and fry to the final sale of whole trout both in Denmark and abroad. Yet they still lack tools to further enhance fry resilience, lower mortality rates, and decrease the climate footprint of organic trout farming, while also boosting fish welfare.

Therefore, the objective of this project is to use selective breeding to further adapt the Ådal line of rainbow trout to the organic production system. We will do this by defining a breeding goal with traits important for organic production. We will also select the fish for increased resistance to the disease rainbow trout fry syndrome (RTFS).

Key results and discussion

We have recorded time of death of around 3,000 fish from a farm outbreak of the disease RTFS. The fish came from mating of ~200 females and 60 males. Tissue samples were also collected for genotyping. This data will be used to study if specific families are resistant towards RTFS and to verify if the QTL for RTFS found in other populations (Palti et al., 2025) also exists in the organic line at Ådal Ørred. The next step will be to develop a breeding plan that controls the inbreeding rate to ensure genetic diversity in the breeding population.

References

EUMOFA. 2022. The EU fish market. 2022 edition. Eur. Mark. Obs. Fish. Aquac. Prod.

Palti, Y., R.L. Vallejo, G. Gao, S. Liu, A.G. Hernandez, C.E. Rexroad III, and G.D. Wiens. 2015. Detection and Validation of QTL Affecting Bacterial Cold Water Disease Resistance in Rainbow Trout Using Restriction-Site Associated DNA Sequencing. PLoS One 10:1–14.

Farmers' Strategies for Organic Control of Docks (Rumex spp.) in Grasslands: A Qualitative Case Study from Norway

Sara Hansdotter (NORSØK), Kari Løe (NORSØK), Maud Grøtta (NLR)

Implications

Understanding how farmers manage dock (Rumex spp.) in grasslands contributes to knowledge relevant for organic farming systems, where weed control must be based on agronomic practices rather than synthetic herbicides. By documenting farmers' experiences and management strategies at farm level, the study provides insight into practical approaches to weed management in Nordic grassland systems. This knowledge is relevant for discussions on how organic production systems can maintain productivity and adapt to agronomic challenges, thereby contributing to a resilient food system.

Background and objectives

Dock (Rumex spp.) represents a persistent weed problem in grassland systems, affecting forage quality and productivity. In organic farming systems, where synthetic herbicides are not permitted, dock control relies on preventive and mechanical measures integrated into overall farm management. For some farmers, effective dock control is perceived as a bottleneck when considering conversion from conventional to organic agriculture due to uncertainty about how to manage infestations without chemical inputs.

The objective of this study is to explore farmers' strategies for managing dock in grasslands and to examine what influences their choice of management practices. The study forms part of a broader project combining a literature review and field trials. This abstract presents results from a work package focusing on qualitative case studies conducted in Norway.

Key results and discussion

The study documents how farmers perceive dock-related challenges and which management practices and strategies they apply or have applied over time. Through qualitative interviews, farmers describe their experiences with weed management, their assessment of the severity of dock infestations and the measures implemented on their farms.

The study identifies factors that farmers consider important for controlling dock populations. The findings illustrate variation in management approaches between farms and highlight how dock control is embedded in broader grassland management practices. The results contribute to ongoing discussions on organic grassland management in the Nordic–Baltic region, where grass-based livestock systems are central to food production, and add context-specific insight relevant to the development of resilient organic farming systems.

How work was carried out

Case studies were conducted on five to six farms located in different areas in Norway. Farms were selected based on their different management practices that influenced dock populations. Qualitative interviews were carried out. Farmers were interviewed about weed management practices, perceived level of dock-related problems and strategies currently or previously implemented on the farm. Interviews were recorded, processed and systematically organized to enable identification of factors influencing dock control.

In addition to interviews, some field registrations were conducted, and soil sample data and climatic data were collected to contextualize management practices at farm level.

Enhancing Agroecological Performance by Integrating Food Crops into Grass–Livestock Farms

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Implications

Increasing crop diversification on organic grass–livestock farms may strengthen agroecological performance and contribute to more resilient food systems in Norway. By integrating food crops into forage-dominated systems, farms can potentially enhance local food production, reduce dependency on external inputs, and strengthen regional food security. The project addresses structural and practical barriers to diversification and explores pathways for supporting resilient, locally embedded organic production systems.

Background and objectives

In Norway, vast areas are dedicated to grassland for livestock feed, while local food crop production remains limited. At the same time, concerns related to food security, climate resilience, and sustainable diets highlight the need for more diverse farming systems.

Forage-dominated farms with limited crop rotation face agronomic challenges such as high pressure of perennial weeds. Integrating food crops into these systems may enhance agroecological performance at farm and territorial level. However, farmers and advisors report significant barriers to diversification, including infrastructure needs, labour demands, and weak market structures for local food crops.

The project aims to:

1. Identify key opportunities and challenges for enhancing agroecological performance on organic farms in Mid-Norway.

2. Explore the potential for increasing food crop production on selected organic farms supplying local markets.

3. Develop policy recommendations and support schemes to promote crop diversification and local market access.

Key results and discussion

The poster presents an ongoing project establishing a network of 5–7 organic farms in Mid-Norway, ranging from specialized forage-livestock producers to diversified production systems. Through participatory processes and multi-criteria assessments, the project explores how increased crop diversity may influence farm performance, resource use, and local value chains.

By addressing both farm-level management and policy frameworks, the project contributes to discussions on how organic farms in the Nordic region can strengthen their adaptive capacity and support resilient food systems.

The project is conducted in collaboration with NORSØK (Norwegian Center for Organic Agriculture), NLR (Norwegian Agricultural Advisory Service), and the County Governor of Trøndelag.

Innovative local based organic food systems - the case of Samsø

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Poster presented by Marco Calabro mcalabro@ruc.dk

This PhD project takes an innovative and transdisciplinary approach to fostering organic and local food systems transition. Departure is taken applying a co-creative and co-innovation perspective in cooperation with the green land trust Organic Samsø, researching and finding ways of improving the social conditions and value chains of their small-scale organic farms on the Danish island Samsø – to thus further developing the organic food community on Samsø. The process seeks to establish the basis for new business models for the organic farms to strengthen relationships across the local food value chain. To do this the PhD project will apply different mapping methods to understand the current food system on Samsø and to discover barriers and opportunities for change. Further the PhD will apply theory of change to facilitate and evaluate the innovation process of Organic Samsø – what are key learnings in fostering local and organic food systems transition and food communities?

The PhD project will result in learnings on several themes and aspects of local and organic food systems:

- Food flow and competence analysis: Identifying the opportunities and barriers for change in the current food system related to actors and value chains.
- Power and narratives: Addressing assumptions, interests and worldviews across the local food system. Can local and rural community development serve as common ground?
- Key learnings from Organic Samsø's process on local organic community building and business models.
- Understanding and exploring the role of the green land trusts as potential facilitators of change in the Danish agricultural landscape

The PhD project is associated with the InnOFoodLabs project under the call: HORIZON-CL6-2024-FARM2FORK-02 which aim is to develop project aims to transform organic value chains into pillars of local economies.

Optimizing Biowaste Recycling by promoting organic food and adoption of bio fertilizer in Finland for improving the sustainability and resilience of Food System

Ehsan Gale Gafi, Bodo Steiner

Implications

The adoption of organic agriculture supports biowaste recycling by increasing the ratio of organic food waste, by-products, and side streams that can be returned to the system as organic biofertilizers. In addition, the consumption of organic products may encourage more environmentally conscious consumer behavior regarding waste handling, including greater participation in biowaste separation and recycling. This can further improve the quantity and quality of recovered biomass and enhance the effectiveness of biofertilizer outputs. It is possible to improve biowaste recycling by enhancing source separation quality, nutrient recovery, and soil fertility while reducing dependency on synthetic fertilizers. This research demonstrates how organic food production and consumption can act as leverage points for more resilient and environmentally sustainable food systems in Finland.

Background and objectives

Organic agriculture is built on the principles of health, ecology, fairness, and care, emphasizing closed nutrient cycles, reduced external inputs, and long-term ecosystem resilience. In Finland, large volumes of food waste are still disposed of in mixed waste streams, limiting their recovery potential and increasing environmental impacts. At the same time, organic farming faces challenges related to nutrient availability, particularly phosphorus and nitrogen sourced from recycled materials. This study aims to explore how organic food consumption patterns, improved source separation, and organic-compatible recycling pathways (e.g., compost and digestate use) contribute to lower greenhouse gas emissions, higher nutrient recovery, and enhanced system resilience.

Key results and discussion

Studies indicate that higher shares of organic food consumption can lead to cleaner biowaste streams, reduced contamination, and improved recycling efficiency. These improvements increase the suitability of recycled outputs—such as compost and anaerobic digestion digestate—for use in organic agriculture, thereby closing nutrient loops more effectively. The results suggest that policies promoting organic food can indirectly strengthen biowaste recycling systems by aligning consumer behavior, waste management practices, and agricultural nutrient needs. This creates reinforcing feedback loops between organic farming, waste valorization, and climate mitigation. The findings support the view that organic food systems are not only production alternatives but also systemic enablers of circular and resilient food systems, consistent with Nordic sustainability goals and the principles of organic agriculture.

How work was carried out (not mandatory)

References

IFOAM (2020) – Organics International. Principles of Organic Agriculture. Bonn, Germany: https://www.ifoam.bio/principles-organic-agriculture-brochure

Adam J, Wellacher M, Azizi F, et al. (2024). Determination and improvement of the quality of separately collected bio-waste from households. Waste Management & Research: The Journal for a Sustainable Circular Economy. 42(9):842-854.

Sterman, J. (2000). System Dynamics: Systems Thinking and Modeling for a Complex World. Massachusetts Institute of Technology. Engineering Systems Division

Series/Report no. ESD Working Papers;ESD-WP-2003-01.13-ESD Internal Symposium.

Organic products in the school catering system in Latvia

Lasma Aleksejeva

Implications

In May 2020, the European Commission adopted two strategies to enhance food system sustainability: the EU Biodiversity Strategy for 2030, focusing on ecosystem restoration, and the Farm to Fork Strategy, promoting a fair, healthy, and environmentally sustainable food system. At both EU and national (Latvia) levels, key priorities include stimulating demand for organic products and building consumer trust. Green public procurement (GPP) is a main instrument to achieve this, leading in Latvia to increased policy attention and debate on improving the quality and sustainability of school meals.

Background and objectives

The school catering programme in Latvia is centralized and applies to all municipalities, including 7 state cities and 36 regional municipalities. It covers all children enrolled in preschool and general education institutions within municipal schools.

Since 1 July 2017, the application of GPP criteria in food supply and catering service procurement has been mandatory in Latvia. Technical specifications related to food quality require that at least 50% of milk and fermented dairy products and 20% of cereals procured are organically produced. These criteria have contributed to an increase in the share of organic food in GPP; however, the participation of local organic producers in these procurement processes remains low.The aim of this study is to assess the opportunities for increasing the share of organic food in the school catering programme in Latvia.

Key results and discussion

The study identifies several key barriers limiting the inclusion and expansion of organic products in school catering:

1. Higher costs – Locally produced organic food is more expensive than conventionally produced alternatives, limiting affordability for some municipalities.

2. Insufficient supply and data gaps – There is a lack of information on the availability and volume of products that meet GPP requirements. Current production levels—especially for vegetables and meat—are insufficient to meet public procurement demand. Additionally, real-time digital data systems for planning and monitoring are lacking, as is statistical data on the share of local food in procurement.

3. Inequality in meal provision – Equal access to equivalent meals is not ensured across all municipalities. Menu development varies depending on factors such as kitchen infrastructure, available funding, product accessibility, procurement practices.

4. Weak cooperation among suppliers – There is insufficient collaboration in organizing supply (e.g., through cooperatives or other forms of aggregation).

5. Lack of unified information sources – Contracting authorities lack centralized information on locally available products and suppliers.

6. Limited knowledge of local products – Stakeholders have insufficient knowledge about local food production and availability.

How work was carried out

The study is based on the analysis of national policy planning and regulatory documents, as well as insights from 25 stakeholder discussions on improving the school catering system. These discussions involved more than 30 representatives from public institutions and non-governmental organizations engaged in school food systems.

References

1. Cabinet of Ministers (2025). Order No. 571 "Action Plan for the Improvement of the School Catering System in Latvia 2025–2027". Available: https://likumi.lv/ta/id/363073

2. Aleksejeva, L. (2024). Green Public Procurement as an Element of the Organic Food System in Latvia. Doctoral dissertation, Latvia University of Life Sciences and Technologies. Available: https://lbtufb.lbtu.lv/dissertation summary/food_economics/Lasma_Aleksejeva-promocijas-darba-kopsavilkums_LBTU-2024.pdf

3. Aleksejeva, L. (2025). School Meals Case Study: Latvia. Research Consortium for School Health and Nutrition, School Meals Coalition. Available: https://researchonline.lshtm.ac.uk/id/eprint/4672332/1/Aleksejeva_2025_School_Meals_Case_Study_Latvia.pdf

Fresh energy and positivity for the organic sector in the three regions of the Finnish Lake-District

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[1] Finnish Organic Association, [2]ProAgria East-Finland, [3]ProAgria South-Savo

The Uutta Virtaa Järvi-Suomen luomuun project aims to revitalize organic production in its target regions, enhance regional cooperation, and stimulate the marketing and demand for organic products. The project supports the operations and competence of organic farmers and encourages new producers to enter the sector. Special attention is directed to organic livestock farms as well as identifying suitable marketing channels. The work also includes consumer-oriented communication on the benefits of organic production and the availability of organic products.

Organic production plays an important role in safeguarding the security of food supply. Organic farmers possess extensive experience in food production, in which a significant share of external inputs—such as chemical fertilizers and pesticides—is replaced with renewable and circular practices.

Organic production contributes positively to the environment through reduced chemical pressure, increased biodiversity, and favourable impacts on climate change mitigation and water quality. Water protection is especially important in these regions: inland waters account for 18% of total land area in North Savo and North Karelia, and 26% in South Savo—higher than in any other region of Finland.

The benefits of organic production are recognized in EU's agricultural, environmental, and regional policies, as well as in Finnish and regional development strategies. These frameworks set both quantitative and qualitative targets for organic production and call for a comprehensive range of organic products for consumers. In recent years, however, the extent of organic farming in the project area has significantly decreased, highlighting the need to invest in reversing the negative trend.

To strengthen professional skills and knowledge, the project organizes training sessions and workshops both in person and online. Marketing efforts are enhanced through meetings and study visits that connect producers with companies involved in processing and marketing organic products, supporting both domestic sales and export opportunities. Thematic webinars are organized to share the latest research results and good practices.

Consumer communication is carried out at public events. Project staff works together with other regional initiatives to organize several gatherings and assists organic farms in arranging and promoting open door activities. A group of voluntary consumers joined an experiment, which aims to find out if additional information about food production has impact on the awareness and choices they make.

The project contributes to strengthening the knowledge base, visibility, and market potential of organic production, thereby supporting long-term sectoral resilience and growth.

Implementers: ProAgria East-Finland, ProAgria South Savo and Finnish Organic Association.
Project period: 1 April 2025 – 31 December 2027.
Funders: European Union; Economic Development Centre, Eastern Finland.
Private co-funding is provided by organizations such as the Organic Production Promotion Foundation and the regional organic associations Savo–Karjala Organic Association and Saimaan Luomu ry.
Keywords: know how, marketing channels, consumer awareness, growth target

The robust organic farm in a changing world

B. Johansson, A. Backlin and G. Johansson. Swedish Board of Agriculture.

Implications

Organic livestock farms can play a key role in building a resilient food system. By reducing dependence on external inputs and focusing on closed nutrient cycles, biodiversity, and local energy sources, these farms strengthen robustness against crises. Spreading such strategies can make Swedish agriculture more resilient and less vulnerable to global disruptions.

Background and objectives

Recent global uncertainties have highlighted weaknesses in the current food system, which relies heavily on imported inputs such as mineral fertilizers, pesticides, and feed. Resilience, the ability to withstand, adapt, and transform during crises, is essential and is commonly framed as robustness, adaptability, and transformability (Stockholm Resilience Centre, 2016). In a publication (in Swedish), the Swedish Board of Agriculture aimed to illustrate how organic livestock farms contribute to resilience and inspire both organic and conventional producers (Johansson et al., 2024).

Key results and discussion

Organic farms strengthen resilience through several interconnected strategies. High self-sufficiency in feed and energy reduces vulnerability to price fluctuations and supply disruptions. Crop rotations that include perennial grassland improve soil fertility, promote biodiversity and reduce disease risks. Diversity in production, such as keeping multiple animal species and adding complementary activities like processing or farm shops, spreads economic and operational risks. Preventive measures, including hygiene routines, backup power systems, and resource storage, further enhance preparedness.

Farmers emphasized that resilience is not only about production methods but also about planning, stress tolerance, and access to knowledge. Well-developed routines, continuous competence development, and collaboration with other farmers are critical factors. A sound energy strategy, often supported by biogas plants that provide both energy and valuable nutrients, contributes to sustainability. Using home-grown seed reduces the risk of shortages, and well-functioning drainage is essential for almost all arable land.

Adapting farming practices to local conditions, such as using manure from own animals, incorporating nitrogen-fixing legumes in crop rotations and producing biogas, reduces dependence on imported fertilizers. However, complete local adaptation can also limit resilience in severe local crises, making external support and good networks important.

How work was carried out

Four organic livestock farms with different production focuses were studied through interviews and written contributions. Strategies were analysed using resilience principles from Stockholm Resilience Centre (2016) and summarized according to their relevance for agriculture.

References

Johansson B., Johansson G., Löfquist I., Holstmark K., Schneider L. and Backlin A. 2024. Den robusta ekogården i en föränderlig omvärld. Inspireras av fyra djurgårdars strategier. Jordbruksverket. Jordbruksinformation 3 (JO24:3).

Stockholm Resilience Centre. 2016. Resiliens i praktiken – Sju principer som bygger resiliens i social-ekologiska system. Based on Biggs et al. (2015) Principles for building resilience: sustaining ecosystem services in social-ecological systems.

Enhancing forest resilience through organic non-timber forest products

Hanna Muttilainen

Implications

The findings suggest that certification of organic collection areas of forests could play an important role in promoting multiple use of forest and in that way strengthening resilience in forest management. Lowering the economic and administrative barriers for forest owners appears crucial for increasing participation in organic NTFP production. Certification of organic collection areas can further enhance the value of NTFPs, particularly in export markets where organic products are well recognized and trusted. Policy instruments, advisory services, and value chain development that support certification and market access could significantly enhance the utilization of underused NTFPs. More broadly, increased utilization of NTFPs and their integration into forest management strategies can contribute to food security and crisis preparedness, thereby strengthening the resilience of both forest management and food systems and supporting the bioeconomy. Given Finland's abundant but underutilized NTFP resources, NTFP production represents a significant opportunity to enhance sustainable forest use and rural livelihoods.

Background and objectives

Diversifying forest use is widely recognized as a key strategy for enhancing sustainability, and NTFPs are a key component of multifunctional forest management with potential links to resilient food systems. Finland has extensive natural product resources that remain largely underutilized. Organic forest certification provides an opportunity to increase the attractiveness of NTFP production by enabling products to be marketed as organic, potentially improving market access and price premiums, especially in export markets. Non-industrial private forest (NIPF) owners are the main owner group in Finland ja therefor their decision and values shape how forests are managed, and which benefits are prioritized. That is why it is crucial to understand their perspectives to promote multiple use of forestry and support the development of NTFP-related businesses. The objective of this paper is to examine forest owners' views on NTFP production and certification of organic collection areas of forests, and to assess whether certification could encourage more diversified, sustainable, and resilient forest management.

Key results and discussion

The results show that forest owners perceive NTFPs as a valuable opportunity to diversify both forest use and income generation. Their motivations are driven by a combination of economic values, such as additional and more stable income sources, and self-actualisation-related values, including personal interest and meaningful use of forest resources. While organic forest certification was largely unfamiliar to most forest owners, more than one third (35%) expressed willingness to certify their forests either fully or partially. Interest was even higher for the certification of organic collection areas, particularly if it would provide direct economic benefits (40%) or involve no additional costs or effort for the forest owner (45%). Organic collection areas were perceived as supporting multiple-use forestry, the bioeconomy, and sustainable forest management. Organic certification may increase the perceived value of NTFPs by strengthening associations with health, environmental sustainability, and ethical production, thereby enabling new market opportunities and premium pricing. Overall, the findings highlight the potential of organic collection areas to generate both ecological and economic value and to strengthen the role of NTFPs in diversified and resilient forest management.

References

Muttilainen H. (2025). Towards multiple use of forests with non-timber forest products – forest owners' perspectives. Dissertationes Forestales 2025, 381. https://doi.org/10.14214/df.381.

A more comprehensive assessment is needed to assess sustainability of organic diets to secure resilient food systems

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Implications

Today there is a growing focus on reducing climate impact related to our food intake. Changes in production systems in direction of more intensive production is one potential climate mitigation strategy. Another way to reduce climate impact from food intake is to change the diet composition in direction of more plant-based foods and to reduce food waste.

Background and objectives

Focusing only on climate mitigation create a risk for trade-off where other impacts can be harmed at the same time. Therefore, there is a need for a more comprehensive assessment of the sustainability of the diet to avoid pollution swapping and to secure a more resilient food system. The present study compares the sustainability of organic versus conventional diets including the effect on climate, land use, biodiversity, eco toxicity, pesticide residues and animal welfare.

Key results and discussion

The analysed diets had same composition to get the effect of switching from conventional to organic produced food in the diet.

The organic diet had similar carbon footprint as a conventional diet and a higher land use. The organic diet was in favour regarding animal welfare, ecotoxicity and a lower risk of pesticide residues in food and a higher plant biodiversity on the land for food production.

Some of these differences between organic and conventional production could easily be incorporated in LCA whereas other differences still are rather difficult to integrate in LCA as for example effects on biodiversity, animal welfare or multifunctionality of agriculture.

How work was carried out

There are still a lot of missing data regarding climate impact, land use and ecotoxicity for especially organic food items. Amount of pesticide residues in food items was analysed in a relative high number of both organic and conventional food items. Effect on animal welfare was based on the Danish method applying a number of hearts depending on the production system and its conditions.

Methane emission from grazing dairy cattle (MetGraz)

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Implications

The organic RDD9 project MetGraz shows that grazing dairy cows have a lower methane emission compared to feeding a silage-based ration in the barn. Properly accounting for grazing in climate models and national inventories, leads to a correct carbon footprint of organic milk and thereby shows a climate benefit of grazing. In addition, organic farmers may get a financial deduction in the planned carbon tax when methane emission is lower during grazing than feeding a ration indoors. Overall, the project has the potential to enhance the credibility of organic milk production from a consumer and a society perspective and drive dairy production towards more grazing.

Background and objectives

In Denmark, organic milk production is associated with grazing as 100% of the organic dairy cows graze from spring to autumn, as opposed to only 15% of the conventional cows. In 2021, the total number of organic dairy cows in Denmark was 82.000. By organic legislation, grazing is mandatory from 15th of April to 1st of November as long as the weather and field conditions and the health of the animal allows (Landbrugsstyrelsen, 2023). Regardless of the production system, cows emit the greenhouse gas methane as a natural result of feed fermentation in the digestive tract (enteric methane). Studies from abroad suggest that enteric methane emission is lower when cows are grazing on pasture compared to feeding a mixed ration (O'Neill et al., 2011; Dall-Orsoletta et al., 2016) or silage in the barn (Klootwijk et al., 2021; Koning et al., 2022; Lardy et al., 2025), but without a clear understanding of the mechanisms behind. As no data is available on methane emission of grazing dairy cows in Danish organic systems, no distinction is made between cows in organic and conventional production systems when we account for methane emission in climate models or national inventories. Considering the substantial number of cows grazing, this may lead to an overestimation of the carbon footprint of organic milk production and subsequently an overestimation of the carbon tax for organic farmers if implemented by the Danish government. In order to accomplish a correct accounting for grazing in existing climate models and inventories, the project aim of MetGraz is to quantify enteric methane production at cow level (g/d, g/kg dry matter intake, and g/kg milk yield), while at the same time exploring the underlying mechanisms for the potential methane reduction during grazing as opposed to feeding a silage-based ration indoors, and to estimate the revised carbon footprint of organic milk production.

Key results and discussion

The scientific work on quantifying enteric methane emission of grazing dairy cows and examining the underlying mechanisms (i.e., grass composition, rumen fermentation and microbial synthesis, passage rate, digestibility, and feeding behavior) for lowered methane emission has been conducted in a standardized grazing trial at AU Viborg. The trial was conducted over 9 experimental weeks from May 6th to July 7th, 2024. The results indicate that during this period, methane emission (g/d and g/kg ECM) was lower for cows grazing during the day and night, compared to the feeding of spring growth grass/clover silage indoors. Cows that grazed during the day and were fed with spring growth grass/clover silage indoors during the night, had methane emission (g/d and g/kg ECM) intermediate to the silage and day and night grazing treatments. Data is currently

undergoing analysis to clarify the underlying mechanisms for these findings. On four commercial organic farms, SEGES quantified methane emissions from grazing dairy cows in 2024 and 2025. Here, grazing dairy cows had a lower methane emission from late April into June compared to the feeding of an organic mixed ration in March and early April before the grazing season started. This effect on methane coincided with a higher grass intake and different grass quality compared to later in the grazing season. Therefore, studies are needed to separate effects of grass quality and grass intake.

The generated data on methane emission will be used by Innovationscenter for Økologisk Landbrug as input in climate models of ARLA and Danish Crown to estimate the yearly methane reduction on farms that practice grazing and the carbon footprint of organic milk and meat production.

References

Dall-Orsoletta, A.C., J.G.R. Almeida, P.C.F. Carvalho, J.V. Savian, and H.M.N. Ribeiro-Filho. 2016. Ryegrass pasture combined with partial total mixed ration reduces enteric methane emissions and maintains the performance of dairy cows during mid to late lactation. J. Dairy Sci. 99:4374–4383. http://dx.doi.org/10.3168/jds.2015-10396

Klootwijk, C.W., L. Koning, G. Holshof, A. Klop, and R.L.G. Zom. 2021. Enterische methaanemissie van melkvee in relatie tot (vers) graskwaliteit Jaarrapport 1: 2020, Wageningen Livestock Research, Openbaar Rapport 1342. https://doi.org/10.18174/556029

Koning, L., G. Holshof, A. Klop, and C. Klootwijk. 2022. Enterische methaanemissie van melkvee in relatie tot (vers) graskwaliteit Jaarrapport 2: 2021; Resultaten van een meerjarige beweidingsproef naar methaanemissie bij weidegang, zomerstalvoedering en graskuil. Wageningen Livestock Research, Openbaar Rapport 1402. https://doi.org/10.18174/583403

Landbrugsstyrelsen. 2023. Bekendtgørelse nr. 63 af 23. januar 2023 om økologisk jordbrugsproduktion mv.

Lardy, Q., H. Kismul, S. Nyamuryekung'e, J. Sandvik, M. Hetta, M. Ramin, and V. Lind. 2025. Milk production and methane emissions in dairy cows on production or exercise pastures with an automatic milking system. J. Dairy Sci. 108:9802–9812. https://doi.org/10.3168/jds.2024-26059

O'Neill, B.F., M.H. Deighton, B.M. O'Loughlin, F.J. Mulligan, T.M. Boland, M. O'Donovan, and E. Lewis. 2011. Effects of a perennial ryegrass diet or total mixed ration diet offered to spring-calving Holstein-Friesian dairy cows on methane emissions, dry matter intake, and milk production. J. Dairy Sci. 94:1941–1951. https://doi.org/10.3168/jds.2010-3361

Assessment of farm-level sustainability using the SMART tool: lessons for resilient food systems from farms in Poland

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Implications:

Farm-level sustainability data help move beyond single indicators toward a systemic understanding of agricultural performance. The SMART assessment generates structured information across environmental, economic and social dimensions. These data support farm-level improvement and provide an analytical basis for understanding how different farming systems contribute to sustainable and resilient food systems in Central and Northern Europe.

Background and objectives:

Farm-level studies of organic and conventional agriculture are predominantly focused on production, economic efficiency, or selected environmental indicators. This research uses the SMART sustainability assessment to analyse farm-level sustainability in central Poland. The conference presentation focuses on four farms assessed in the early phase of a PhD project that includes a total of twenty-four farms of different types and scales. The assessment identifies strengths and weaknesses across environmental, economic and social dimensions and lays the groundwork for later comparative analysis of farming systems and food-system resilience.

Key results and discussion:

The presentation reports sustainability assessment results from four farms in central Poland using the SMART tool. The results show apparent differences in environmental, economic and social performance across farm types. Organic farms show stronger sustainability performance compared to conventional and on-conversion farms.

The assessment identifies key strengths, weaknesses and trade-offs at the farm level and provides a basis for discussing farm resilience and sustainability transitions within food systems.

How work was carried out:

Data were collected through structured farmer interviews, on-farm observations and document analysis. Indicator scores were calculated in the SMART software and compared across farm types to identify performance patterns and areas for improvement.

References:

1. Schader, C., et al. "Using the Sustainability Monitoring and Assessment Routine (SMART) for the systematic analysis of trade-offs and synergies between sustainability dimensions and themes at farm level." Sustainability 8.3 (2016): 274.

2. Feledyn-Szewczyk B., Kopiński J. "Productive, environmental and economic effects of organic and Conventional Farms—Case Study from Poland." Agronomy 14.4 (2024): 793.

3. Berbeć, A. K., et al. "Assessing the sustainability performance of organic and low-input conventional farms from eastern Poland with the RISE indicator system." Sustainability 10.6 (2018): 1792.

Hub-based peer learning and farm-level data generation for climate-positive organic farming under Nordic conditions

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Implications

Hub-based peer learning supports organic farmers in applying climate-related knowledge on their farms while also enabling the collection of data from real farming environments. The Finnish hub experience shows how learning processes and research can be practically linked under Nordic conditions.

Background and objectives

Climate change mitigation and adaptation in organic farming require not only appropriate farming practices but also effective structures for knowledge exchange and learning. European agricultural policy increasingly emphasises advisory services, peer learning and Agricultural Knowledge and Innovation Systems (AKIS) in supporting farmers' climate-related decision-making. Under northern farming conditions, short growing seasons, high interannual weather variability and diverse soil conditions limit the applicability of generic solutions and highlight the need for locally embedded learning models. Hub-based approaches integrated into AKIS provide a structured way to connect farmers, advisors and research-based knowledge through facilitated peer-to-peer learning. The objective of this poster is to describe the Finnish implementation of the OrganicClimateNET project, focusing on two national hub groups coordinated by Luomuliitto. It examines how hub-based peer learning supports the uptake and contextualisation of climate-positive organic farming practices under Nordic conditions.

Key results and discussion

The two-hub model has supported peer learning among organic farmers and facilitated the integration of advisory services and research-based knowledge into practical farming questions. Within the hubs, climate-positive practices have been discussed in relation to challenges specific to northern conditions, including soil structure and carbon management, grassland systems, and adaptation to extreme weather events. Peer learning has enabled the exchange of experiences and the interpretation of climate-related practices from the perspective of different farm types and local conditions. The presence of two hubs has also created opportunities for dialogue between hubs and for national-level knowledge exchange, strengthening the learning potential of the model without aiming to generalise findings through indicators or impact assessments. From a discussion perspective, the hub model can be understood as a practical interface within the AKIS framework, where climate- and carbon-related knowledge is translated into farm-relevant understanding through farmer-to-farmer interaction. This highlights the role of the model in supporting knowledge applications rather than evaluating individual practices.

How work was carried out

Two national hubs were established in Finland as part of the OrganicClimateNET project, each involving organic farmers, a hub coach and a lighthouse farm. The hubs organised facilitated peer-learning activities, including on-farm visits and thematic discussions. In parallel, farm-level data were collected through structured surveys and documentation of farming practices.

References

OrganicClimateNET project (Horizon Europe)

Towards a parsimony in organic food systems: farmer- consumer pathways in building resilient organic food systems in Finland and Sweden

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Implications

In today's world, recurrent crises driven by political tensions, economic downturns, disease outbreaks, natural disasters and climate change create challenging conditions for the success of entrepreneurial initiatives (Bian et al., 2026; Newman, et al., 2022; Sharma et al. 2024), including organic farming. In particular, organic farming is considered more risky than conventional farming (Väre et al., 2021) as the organic food market operates in an environment of rapidly changing consumer preferences, volatile global markets, fluctuating prices of raw materials and legislative changes (Barman et al., 2026). Understanding preparation, response, and learning processes across different levels of the organic food chain might contribute to the sustainable growth of the sector (DiBella et al., 2023). In line with this view, we suggest that adopting a parsimonious approach that prioritizes simple and efficient interactions between farmers and consumers represents one possible solution for strengthening resilience in organic food supply chain models. We base our analysis on two Nordic countries, Finland and Sweden but the implications have a global validity.

Background and objectives

Recent industry reflections express concern that achieving resilience requires diversification strategies and more robust local markets that go beyond certification (see Rundgren, 2023, for an example). We argue that the organic food chain should be revisited in terms of determining who decides what resilient organic food chain should entail. We also contend that, achieving food system resilience largely requires maintaining parsimonious relationships between primary producers and consumers, which should be characterized by efficient, low cost, and minimally complex direct interactions (Herzig and Zander, 2025; Sciortino et al., 2025).

Key results and discussion

Our study focuses on Finland and Sweden, two Nordic countries with structural differences as far as organic farming is concerned. In Finland organic farming struggles with economic viability, fluctuating subsidy conditions, and market access, which affect farmers' confidence in organic as a resilient livelihood strategy (Lippo, 2025). In Sweden, organic food indicates different trends. In Sweden, organic food sales exhibit diverse trends: despite ongoing challenges in market demand and pricing, and the government's target for 30% of agricultural land to be organic by 2030 (Organic Sweden, 2024), organic food sales have experienced some decline in recent years (Jimmanson, 2023). In response to these fluctuations, alternative models such as REKO may help build resilience in the organic supply chain by facilitating more direct and reliable interactions between farmers and consumers. Although both countries leverage organic agriculture to enhance resilience, Sweden's larger organic sector and stronger consumer base make its food system potentially more resilient in terms of local supply, while Finland relies more on a combination of conventional and organic farming. What Finland and Sweden share as a commonality is the emergence of platforms such as REKO Rings, which enable consumers to purchase locally produced food directly from farmers

through organised local groups. REKO represents an informal and loosely structured arrangement that supports resilience by enabling direct interaction between organic food farmers and consumers. The absence of rigid organisational or formal rules allows these actors to coordinate through shared local practices and physical meeting points and to rely on grassroots communication, adaptability and trust. Taken together, these dynamics indicate that decentralised trade models such as REKO Rings represent a promising pathway toward enhanced food system resilience and green growth.

References

Barman, P., Hazarika, U., & Choudhury, M. (2026). Ethical sourcing and food systems: environmental benefits and impact. In Health, Nutrition and Sustainability (pp. 3-22). Academic Press.

Biam, K. P., Singh, N. U., Roy, A., Paul, P., Yumnam, A., Gowda, C. H. R., ... & Singh, B. (2026). Entrepreneurship Development and Support Systems in the Organic Sector. In Organic Agribusiness and Management (pp. 391-415). Apple Academic Press

DiBella, J., Forrest, N., Burch, S., Rao-Williams, J., Ninomiya, S. M., Hermelingmeier, V., & Chisholm, K. (2023). Exploring the potential of SMEs to build individual, organizational, and community resilience through sustainability-oriented business practices. Business Strategy and the Environment, 32(1), 721-735.

Herzig, J., & Zander, K. (2025). Determinants of consumer behaviour in short food supply chains: a systematic literature review. Agricultural and Food Economics, 13(1), 21.

Jimmanson, A. (2023, March 23). Demanding year: Organic sales slow in Sweden but overall share at 8.2% remains impressive. Natural News

Desk. https://naturalnewsdesk.co.uk/2023/03/23/demanding-year-organic-sales-slow-in-sweden-but-overall-share-at-8-2-remains-impressive/

Hushållningssällskapet. (2021, November 4). REKO-ringar I sverige.

Hushållningssällskapet. Retrieved February , 26 from https://hushallningssallskapet.se/forskning-utveckling/reko

Lippo, F. (2025). Policy Priorities and Sustainability Tensions in Finnish Food and Agricultural Governance.

Newman, A., Obschonka, M., & Block, J. (2022). Small businesses and entrepreneurship in times of crises: the renaissance of entrepreneur-focused micro perspectives. International Small Business Journal, 40(2), 119-129.

Organic Sweden. (2024). Industry Facts. Retrieved from https://en.organicsweden.se/branschfakta (accessed on 29 of January, 2026) Rundgren, G. (2023) 40 years of organic agriculture. Resilience.org, 6 September. Available at: https://www.resilience.org/stories/2023-09-06/40-years-of-organic-agriculture/(Accessed: 27 January 2026)

Sciortino, C., Giamporcaro, G., Sgroi, F., & Modica, F. (2025). Exploring the role of short food supply chains in agricultural sustainability and resilience: a literature review. Agricultural and Food Economics, 13(1), 1-21.

Sharma, G. D., Kraus, S., Liguori, E., Bamel, U. K., & Chopra, R. (2024). Entrepreneurial challenges of COVID-19: Re-thinking entrepreneurship after the crisis. Journal of Small Business Management, 62(2), 824-846.

Väre, M., Mattila, T. E., Rikkonen, P., Hirvonen, M., & Rautiainen, R. H. (2021). Farmers' perceptions of farm management practices and development plans on organic farms in Finland. Organic Agriculture, 11(3), 457-467.

Organic-Oriented Public Catering as a Policy Tool for Resilient Food Systems: Food Waste Reduction in Educational Institutions in Warsaw, Adapted from Copenhagen Good Practices

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Implications

This study shows that organic-oriented public catering, embedded in public policy and supported by systematic food waste monitoring, stakeholder co-responsibility, and sustainable procurement, can strengthen resilience across the food chain from procurement to consumption. By stabilising demand for organic and plant-based food, improving resource efficiency, and enhancing institutional learning, public food services can better withstand external shocks such as supply disruptions, price volatility, and demographic fluctuations. The main output is a Code of Good Practices based on Copenhagen solutions adapted to the institutional and procurement conditions of Warsaw, with relevance for the Nordic–Baltic region. The Warsaw research was conducted within a competitively awarded doctoral scholarship of the City of Warsaw, supporting policy-relevant research in cooperation with municipal stakeholders, and coincided with ongoing work on the city food policy.

Background and objectives

A sustainable food system ensures food and nutrition security while safeguarding environmental, social, and economic foundations for future generations. However, current food systems are characterised by high levels of food loss and waste, which account for approximately 8–10% of global greenhouse gas emissions and a blue water footprint of about 250 km^3 annually. These inefficiencies significantly weaken the resilience of food systems. Organic food systems, grounded in the principles of health, ecology, fairness, and care, are increasingly recognised as key contributors to resilience from farm to fork. Public catering in schools and kindergartens represents a stable, policy-governed segment of the food system that shapes dietary patterns, food literacy, and demand for sustainable and organic food. The study aimed to (1) identify key drivers and stages of food waste in educational public catering and (2) translate organic-oriented good practices into resilience-enhancing solutions. Empirical research was conducted in Warsaw, while Copenhagen served as a reference case of an advanced organic public catering model.

Key results and discussion

Results from Warsaw educational institutions indicate that food waste is widely recognised by stakeholders (84.4% staff/management; 70.2% kitchen/catering) but rarely monitored. The most wasted items are vegetables, fruit, and sandwiches, reflecting issues with menu acceptance, portion sizing, and dining conditions. Key drivers include low food literacy, preference for highly processed foods, and organisational constraints such as short lunch breaks and rigid meal planning. Proposed solutions focus on systematic waste monitoring, organic and plant-forward menus, strengthened green public procurement (GPP), and stakeholder education to enhance the resilience of public catering systems.

References

FAO (2021). The State of Food and Agriculture 2021: Making Agrifood Systems More Resilient. Rome.

UNEP (2021). Food Waste Index Report 2021. Nairobi.

IFOAM – Organics International (2017). The Principles of Organic Agriculture. Bonn.

Improving resilience with efficient refined digestate

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Implications

Development of an efficient nitrogen fertilizer from biogas digestate will offer a better possibility for organic and conventional farmers to utilize nutrient resources from organic matter in a resource efficient and environmentally healthy way, in accordance with the organic principles of Health and Ecology.

Background and objectives

Organic plant production relies on nutrient recycling, where organic fertilizers play an important role. The traditional handling of slurry and other organic fertilizers often impose big nitrogen losses to the environment especially when the losses are substituted with mineral fertilizers. Although no mineral fertilizers are used in organic farming nitrogen losses should still be addressed.

The global change to quit fossil fuels means a rising need for other carbon sources to produce plastic and other synthetic substances. Agriculture can supply society with a useful carbon source as methane from biogas production besides powering with energy and provide agriculture with recycled nutrients. With most animal manure going to biogas production in the future organic farming will be more dependent on digestate, and therefore it is important to treat the digestate to ensure lower losses of nitrogen and smaller emissions of direct and indirect nitrous oxide. It is though imperative to investigate if the new digestate fertilizers can be used in accordance with the organic principles.

Key results and discussion

In the project "Efficient degassed nitrogen fertilizer" (Opti-BioN) (2026-2029) the liquid fraction of separated digestate is aerated with oxygen in tanks to facilitate a biological nitrification. Lime is used to balance the pH in the process. The result is a liquid fertilizer rich in nitrate that can be applied very accurate to the crops, in small doses, to ensure high nitrogen utilization and less losses. Application with spraying equipment in the field will also be gentler to soil compaction than with heavy slurry transporters.

Nitrogen balance and GHG emissions from the manufacturing process are measured and the nitrogen efficiency, and NH3 and N2O emissions are measured in lab scale, field scale, and greenhouse cropping trials. The environmental and economic implications of a widespread use of the new fertilizer are estimated and the alignment of the new fertilizer with the regulation of organic farming is investigated.

Converting raw digestate containing organic carbon into a liquid nitrate fertilizer looks like a violation of the organic tradition not to use readily available nutrients in accordance with the organic principles. However, to ensure that organic farming is a relevant answer to the environmental and climate challenges in agriculture, other considerations must be handled too. Lack of nitrogen is often the cause of low yields in organic farming and nitrogen losses and greenhouse gas emissions to the environment are directly in contradiction to the organic principles.

The organic principle of Care prescribes that new technologies must be scientifically tested before the introduction into organic farming practices. The Opti-BioN project will deliver such an investigation.

References

Description of the project: Opti-BioN

BIO² - Natural bio-mass and microbial bio-control agent solutions for the replacement of contentious inputs in organic farming.

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Implications

BIO² develops natural, circular alternatives to copper and sulfur fungicides, nutrient inputs that may contain pesticide residues, and pharmaceutical livestock treatments. These products support the EU Farm to Fork Strategy, the European Green Deal, and the transition toward low-input, environmentally responsible food systems by reducing ecotoxicity, protecting soil and plant health, and reinforcing resilience in both Nordic-Baltic and wider European organic systems.

Background and objectives

Organic farming continues to rely on several contentious inputs1. Copper and sulfur fungicides accumulate in soils, affect non-target organisms, and represent a major environmental burden2,3. Nutrient inputs from conventional farming origins can introduce pesticide residues, while veterinary pharmaceuticals used in organic livestock systems affect off-target species and may contribute to drug resistance. These issues limit system resilience and challenge the long-term sustainability of organic production.

Expected key results

BIO² develops encapsulated biocontrol agents combining beneficial yeasts, bacteria, and algal-derived antifungal molecules. Calcium phosphate and algal polymer matrices improve the stability and release of these active compounds under field conditions. The project also creates bio-based fertilizers from fish protein hydrolysates, phosphorus-solubilising microorganisms, sanitized human urine, and marine biomass, designed to enhance nutrient availability and tailored for different plants and soil conditions. For livestock, BIO² advances spruce bark-based antiparasitic preparations4 and microbial immunostimulants developed from inactivated Mycobacteria and Corynebacteria, which strengthen innate immunity5 and reduce reliance on pharmaceuticals.

How work will be carried out: BIO² combines laboratory screening, biochemical characterization, and pilot-scale production of microbial, algal, and biomass-derived materials. Biocontrol agents and fertilizers are tested on grapevine, wheat, potato, and strawberry under controlled conditions and in field trials. Livestock health products are evaluated in mice, lambs, and goats. Sustainability, toxicology, and economic assessments accompany development, and farmer involvement ensures practical relevance and compatibility with organic regulations. BIO² (2025–2029) receives funding from the European Union’s Horizon Europe Innovation Action programme under grant agreement No. 101181331.

References

1. Reimer, M. et al. Nutr Cycl Agroecosyst 129, 299–315 (2024).

2. Tamm, L. et al. Agronomy 12, 673 (2022).

3. Alvarez, F. et al. EFSA Journal 21 (2023).

4. Blomstrand, B. M. et al. Acta Vet Scand 64 (2022).

5. Ferreras-Colino, E. et al. Res Vet Sci 162, 104963 (2023)

Soil microbiome structure in response to short-term crop type changes and long-term sustainable farming practices

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Implications

Sustainable farming practices build resilience in agricultural production through improving crop diversity, soil functions such as pest- and disease suppressiveness and reducing the need for external inputs1. Soil health is an important axis of resilience as improved soil function through sustainable farming methods can lead to better water retention, nutrient cycling and disease suppression2. Simultaneously, some crops can significantly impact soil health at the short-term by facilitating the development of specific soil function groups such as rhizobacteria and mycorrhizal fungi3.

Background and objectives

Two fields were selected that have been managed under sustainable farming practices as part of a long-term field experiment in Southern Finland. Spring wheat (Triticum aestivum) was either grown as monoculture, grown in a 2-year crop rotation with barley (Hordeum vulgare) or rapeseed (Brassica napus napus) or grown in a 4-year crop rotation with barley, rapeseed and pea (Pisum sativum). Oats (Avena sativa) and barley were both grown under similar practices (monoculture vs. 4-year rotation) and both fields were managed by either conventional yearly plowing, or a no-tillage management. In a separate field, several legumes including faba bean (Vicia faba) and lentil (Lens culinaris) were grown either as monoculture or intercropped with buckwheat (Fagopyrum esculentum) or oats. Finally, ten fields under short-term sustainable farming management with perennial crops such as caraway (Carum carvi) or nettle (Urtica dioica) were included. We investigated the soil microbiome using 16S/ITS amplicon sequencing from each of these sites to determine the extent to which short-term changes in crop type, or long-term changes in management practice can change the community structure and function.

Key results and discussion

Preliminary results show that short-term changes in crop type and management practice did not have a significant impact on microbial soil diversity. However, some crop-types such as caraway showed a distinct community signature from the majority of the other fields. Community composition was also significantly impacted by tillage practices and crop diversity, though the variation displayed did not exceed the variation within the conventionally managed sites. As of yet, the data have not been analyzed by specific taxonomic group or functional profile. Though these do not include settings that qualify as organic farming, we show important shifts in soil community composition and potentially function as a result of sustainable farming practices.

References

1. *Yu et al. Front. Microbiol. 2021 – 2. Jayaraman et al. J Soil Sci Plant Nutr. 2021 – 3. Hu et al. Appl Soil Ecology 2025*

Winter wheat performance following green manure mixtures in organic farms in Latvia: agronomic and economic evaluation

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Background and objectives

In organic farming systems, winter wheat yields are often limited and variable due to insufficient field nutrients and challenges in maintaining soil fertility, particularly under fluctuating rainfall and drought. Green manure crops provide a valuable rotational break, improving soil structure, nutrient availability, and microbial activity, thereby supporting more sustainable crop production. The objective of this study was to evaluate the agronomic and economic effects of selected green manure mixtures on winter wheat across organic farms in different regions of Latvia. Field trials were conducted on larger plots from 2022 to 2024 at four organic farms ('Gaikeni', 'Geidas', 'Mazbungas', and 'IRGK Serviss') located in Vidzeme, Kurzeme, Zemgale, and Latgale. Three green manure mixtures were compared against a control (black fallow): oats–mustard–oilseed rape–buckwheat (non-legume), oats–buckwheat–peas (legumes <50%), and oats–lupin–vetch (legumes >50%). Data were collected on green biomass production, nutrient content (N, P, K), winter wheat yields, and economic performance, taking into account site-specific soil and meteorological conditions.

Key results and discussion

The three-year comparison showed that the mixture legume below 50% was the most suitable for Ltd. 'Mazbungas', producing higher dry matter yields, whereas other mixtures exhibited greater variability across locations and years. These findings highlight the importance of species composition in optimising crop performance and enhancing adaptation to local environmental conditions. Short-term positive effects were primarly observed after mixture legume above 50%. Despite lower dry matter yields in some years, mixture legume above 50% increased winter wheat yields by 96.05% at 'Mazbungas' and by 93.59% at 'Gaikeni' compared with the control. These results confirm the importance of site- and year-specific mixture selection to optimise wheat productivity, as positive effects were observed only under specific site conditions. Other mixtures produced inconsistent responses, and nutrient composition differed among mixtures, with the highest phosphorus content in non-legume mixtures, potassium in mixture legume below 50%, and nitrogen in mixture legume above 50%; however, the long-term effects of these differences within crop rotations remain unclear. Similar findings by De Notaris et al. (2019) suggest that legume-based green manure can contribute to yield stabilisation, while Zhao et al. (2024) reported variable nutrient responses and cumulative effects in long-term crop rotations, highlighting the complexity of green manure impacts. Economic analysis showed a significant increase in gross margin associated with green manure cultivation, demonstrating its financial viability. Overall, the results indicate that green manure practices can enhance the sustainability, productivity, and profitability of organic farming systems, while emphasising the need for region-specific mixture selection under climatically variable conditions.

References

De Notaris, C., Rasmussen, J., Sorensen, P., Melander, B. & Olesen, J.E. 2019. Manipulating cover crop growth by adjusting sowing time and cereal inter-row spacing to enhance residual nitrogen effects. Field Crops Research 234, 15–25.

Zhao, N., Zhang, J., Li, X., Ma, J., Cao, J., Liu, H., Wang, X., Bai, L. & Wang, Z. 2024. Limited advantages of green manure planting on soil nutrients and productivity in intensive agriculture: a case study of wheat–maize–sunflower rotation in hetao irrigation district. Agronomy 14, 100.

PUSH-PULL strategy to reduce damages in vegetables caused by the Tarnished Plant Bug – (Lygus rugulipennis)

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Implications

A new strategy in the protection of strawberry against a sever plant bug are being tested in vegetable production

Background and objectives

The tarnished plant bug is a polyphagous insect capable of causing severe damage to a wide range of berry and vegetable crops. In the UK, a push–pull strategy to mitigate damage caused by this pest was tested in both organic and conventional strawberry tunnel production systems (Fountain 2021). In organic crops, the proportion of damaged berries was reduced from 90% to 41–51%. Similarly, in conventional crops, the damage rate was halved.

The push component of this strategy consists of wax tablets containing the bug's alarm pheromone, while the pull component comprises a pipette releasing the bug's sex pheromone together with a plant volatile compound. We aimed to evaluate the same strategy in vegetable production, where severe damage has been observed in several crops in Trøndelag, central Norway.

How work was carried out

In 2025, in conventional head cabbage and turnip fields, each comprising four plots (15 m × 15 m), 81 sticks (0.5 m high) containing the push element were installed in each plot immediately after transplanting the seedlings. Twelve insect funnel traps equipped with the pull elements were installed around the plots. In an organic carrot field, two plots with the same push–pull elements were established shortly after the plants had emerged. In each field, untreated control plots were also included. Throughout the growing season, plant damage and insect trap catches were recorded regularly.

Key results and discussion

The highest number of tarnished plant bugs per trap was recorded in the carrot field, with an average of 27.6 bugs per trap. In the head cabbage and turnip fields, the corresponding averages were 22.0 and 5.4 bugs per trap, respectively. However, the greatest number of damaged plants was found in the head cabbage field. In total, we recorded 30 damaged plants in the untreated plots and 8 in the treated plots. In the other fields, we found no more than three damaged plants in the turnip field and two in the carrot field. It was surprising that we did not observe more damaged plants in the carrot field, where we captured the highest number of bugs. In June 2025, the weather in the experimental area was very wet and cold, which delayed the sowing of carrot seeds compared to normal conditions. When the plants sprouted, the bugs were likely not at the appropriate developmental stage to damage the seedlings. The unusual weather conditions likely also affected the head cabbage and turnip fields, reducing overall bug damage. Nevertheless, the results from the head cabbage field are promising, and new experiments in 2026 will hopefully provide clearer insights into the impact of the push–pull strategy.

References

Fountain MT, Deakin G, Farman D, Hall D, Jay C, Shaw B, et al. (2021) An effective 'push–pull' control strategy for European tarnished plant bug, Lygus rugulipennis (Heteroptera: Miridae), in strawberry using synthetic semiochemicals. Pest Management Science; 77(6):2747-55.

The use of cover crops to enhance climate-resilient in potato farming systems

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Implications

Cover crops are recognized for their ability to improve soil structure. Northern regions are expected to see more heavy rainfall under climate change, worsening soil erosion and compaction. Under these conditions, cover crops may serve as an effective tool to protect soils and enhancing soil infiltration. However, the short growing season in Nordic countries may limit the full development of cover crops before winter, potentially reducing their benefits.

Background and objectives

Cover crops are a promising strategy to improve soil health and resilience, but their establishment under Norway's short growing season is poorly quantified. In potato systems, they can be sown during the preceding crop's growth or after early harvested potatoes. Knowledge is limited to which species are best suited to Nordic conditions and their effects on soil structure. This study evaluated the aboveground biomass of three cover crop species, oilseed radish, Italian ryegrass, and oats, under real farm conditions in two major potato-growing regions and assessed their impact on soil structure.

Key results and discussion

Cover crop aboveground biomass production varied substantially among species, years, and production systems. Italian ryegrass consistently produced the greatest autumn biomass, averaging 739 kg DM ha^{-1} in 2024 and 1,167 kg DM ha^{-1} in 2025 in late potato systems, and 832 kg DM ha^{-1} in 2024 but only 24 kg DM ha^{-1} in 2025 in early potato systems. Delayed sowing time was the primary factor explaining the low Italian ryegrass biomass observed in 2025. Oilseed radish and oats produced lower aboveground biomass than Italian ryegrass, with mean values of 180 kg DM ha^{-1} in 2024 and 640 kg DM ha^{-1} in 2025 for oilseed radish, and 290 kg DM ha^{-1} in 2024 for oats. The establishment of oilseed radish and oat was more variable than for Italian ryegrass.

Soil structure was assessed using the Visual Evaluation of Soil Structure (VESS) method in Italian ryegrass fields during spring and autumn. Spring assessments, conducted after winter and prior to cover crop termination, indicated minimal differences in soil structure between plots with and without Italian ryegrass in both potato systems. In autumn, when Italian ryegrass reached its highest growth potential, soils in the ryegrass plots were classified as having good structure, characterized by soil lumps easily broken by hand and consisting of small, rounded aggregates. In contrast, control plots without cover crops exhibited moderate soil structure, with aggregates hard to break by hand and with a mixture of rounded aggregates of varying sizes and the presence of some angular, less porous clods that may restrict root growth. Well-developed soil structure supports climate resilience, as it enhances water infiltration, root penetration, and resistance to compaction under increasingly frequency of heavy rainfall events.

References

Rittl, T.F; Grønmyr, F.; Bakken, I., Løes, A.-K. (2023) Effects of organic amendments and cover crops on soil characteristics and potato yields, Acta Agriculturae Scandinavica, Section B — Soil & Plant Science.

The Role of Organic Greenhouses in Nordic Food System

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Implications

The food system has become disconnected from—and now exceeds—planetary boundaries (Soussana, 2025) with e.g. more extreme weather events. Greenhouse cultivation may help to secure vegetable production under such conditions. However, organic greenhouse production must adapt to the new organic regulations. These regulations require cultivation in soil and crop rotation with legumes (EU, 2018). Nordic organic greenhouse systems are challenged by these requirements, as previous infrastructure are designed according to a somewhat different production approach.

Background and objective

Organic greenhouse cultivation in the Nordic countries was estimated at 50 hectares in 2016 (Hickmann, 2016). Historically, cultivation in demarcated beds has been common in the Nordic region. Transitioning to direct soil cultivation are for many growers unfamiliar. Additional production costs may also be a barrier to transition (Friis Pedersen, 2025). Across the Nordic countries, the share of organic greenhouse production varies from 2% to 23% of cultivated area and from 0.5% to 20.8% of market share (Friis Pedersen, 2025).

Greenhouse production offers several advantages as extended growing seasons, higher yields, and improved product quality. Nordic food strategies should acknowledge these advantages and involve local stakeholders in planning processes (Soussana, 2025).

An emerging trend is market gardening with direct sale (Milford et al., 2021). Projections based on calculations for healthy diets (PHDI) suggest that global production of vegetables, fruits, and nuts may need to increase by 63% by 2050. The PHDI diet also recommends daily servings of legumes (Rockström, 2025).

Within planetary boundaries, agricultural land use may need to be reduced while productivity is increased, and greenhouse production could contribute to this objective.

Key results and discussion

The transition requires new expertise to ensure economic viability and sustainability under the revised legal framework. Key areas include: (1) compost-based growing media, (2) appropriate irrigation practices, (3) implementation of green manure, and (4) diversification through crop rotation and companion planting.

Both growing media and irrigation practices must be carefully adapted to the specific crop cultivated in the greenhouse. When implementing green manure, it is essential to ensure that it is well established before transplanting the main crop. Winter leafy crops are well suited to crop rotations in systems where e.g. tomato is the primary crop. Greenhouse cultivation enhances yield and quality. However, long-term greenhouse production may deplete soil quality and weaken the connection to surrounding ecosystems. Organic greenhouse production should play a prominent role in Nordic food system.

References

EU, 2018. Europaparlamentets og rådets forskrift (EU) 2018/848 om økologisk produksjon og merking av økologiske produkter, EUR-Lex - 02018R0848-20250325 - EN - EUR-Lex

Friis Pedersen, S. 2025. Dyrking I (u)avgrenset bed I Nordisk, økologisk veksthus – en utredning for RVU Organic Eprints - Dyrking i (u)avgrenset bed i Nordisk, økologisk veksthus – utredning for RVU

Hickman, G.B. 2016. International Greenhouse Vegetable Production; Statistics, 2016 edn, pp138, http://cuestaroble.com/statistics.htm

Milford, A.B., Prestvik, A.S. & Kårstad S. 2021. Markedshager i Norge – Utfordringer og muligheter med småskala grønnsaksproduksjon for direktesalg. NIBIO Rapport, 7(153).

Rockström et al 2025 EAT Lancet, 2025. The EAT–Lancet Commission on healthy, sustainable, and just food systems. The Lancet, 406 (10512)

Soussana J-F.,2025. Transforming food systems to return to earths limits. Scientific advisory committee (SAC) UN Food systems coordination hub. 9p.

Production of Dairy Analogues from Fermented Oats

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Implications

Utilisation of oats as a local crop to produce fermented dairy analogues.

Background and objectives

Oats (Avena sativa) are easy to cultivate in the Nordic countries and are inherently nutrient dense which make it a popular grain. As soy is used in East Asian countries to make fermented dairy alternatives, oats have the potential to be fermented by Lactobacillus acidophilus (LA) to produce dairy free yoghurt alternatives. Fermentation with LA offers multiple health benefits such as modulating stomach pH and strengthening gut barrier [1], and production of prebiotic exopolysaccharide that has bioactive properties of its own like anti-cancer, anti-gastritis and cholesterol reduction [2]. Oats, besides being rich in fibre and saturated and unsaturated fatty acids, are also a local crop. Hence, its use as an agro-based substrate for fermentation has a lower climate impact than imported soy. The principles of organic production apply to the entire process chain and not just the expected final product, as the oats are locally sourced and organically farmed in the Nordics, and LA is not a genetically modified strain, rather isolated from existing European fermented milks, tying it to the principle of emulating and sustaining an already existing system of producing fermented food. The objective of this work was to study the growth of LA on hydrolysed oats and to enhance the nutritional profile of the oats via fermentation for producing a future dairy-free yoghurt analogue that could potentially improve gut health.

Key results and discussion

The Lactobacillus acidophilus was grown on hydrolysed oats to its highest viable count of approximately 1×108 cells/mL, and the post fermented oat showed the presence of exopolysaccharide (EPS) confirmed by FTIR absorption bands at 3400 cm^{-1}, 2925 cm^{-1}, and 1640 cm^{-1} representing functional groups oh O-H, C-H and C=O. EPS is a known prebiotic and is expected to lend a slimy texture to the fermented product, reminiscent of fermented milks. The total lipid content of the fermented oats also improved by two folds compared to the already lipid rich oats with modest increase in both saturated and unsaturated fatty acids.

How work was carried out

The fermentations were carried out in triplicates in 250 mL Erlenmeyer flasks until viable counts (Neubauer Chamber) were achieved. The exopolysaccharides were extracted by the method of Khalil, Sonbol [3] analysed on FTIR. The lipid and fatty acid analysis were analysed on gas chromatography using the methodology by Cavonius, Carlsson and Undeland [4].

References

1. Gao, H., et al., The Functional Roles of Lactobacillus acidophilus in Different Physiological and Pathological Processes. J Microbiol Biotechnol, 2022. 32(10): p. 1226-1233.
2. Kaur, N. and P. Dey, Bacterial exopolysaccharides as emerging bioactive macromolecules: from fundamentals to applications. Research in microbiology, 2023. 174(4): p. 104024.
3. Khalil, M.A., et al., Exploring the therapeutic potentials of exopolysaccharides derived from lactic acid bacteria and bifidobacteria: antioxidant, antitumor, and periodontal regeneration. Frontiers in Microbiology, 2022. 13: p. 803688.
4. Cavonius, L.R., N.-G. Carlsson, and I. Undeland, Quantification of total fatty acids in microalgae: comparison of extraction and transesterification methods. Analytical and bioanalytical chemistry, 2014. 406: p. 7313-7322.


Nordic-Baltic scientific conference:
'Organics as a response to urgent need for resilient food systems'
Uppsala, Sweden, 15–17 June 2026